MINISTRY OF FOREIGN TRADE AND ECONOMIC RELATIONS,
BOSNIA AND HERZEGOVINA
FEDERAL MINISTRY OF ENVIRONMENT AND TOURISM,
FEDERATION OF BOSNIA AND HERZEGOVINA

THE PROJECT FOR MASTER PLAN FOR REMEDIATION OF HOTSPOTS IN BOSNIA AND HERZEGOVINA

FINAL REPORT

MAY 2014

JAPAN INTERNATIONAL COOPERATION AGENCY
JICA EXPERT TEAM (NIPPON KOEI CO., LTD.)

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Locations of the Project Area (Target Sites of Site Survey)

BOSNIA AND HERZEGOVINA

The Project for Master Plan for Remediation of Hotspots
in Bosnia and Herzegovina

Final Report

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List of Abbreviations

AMD	Acid Mining Drainage
BD	Brcko District
BiH	Bosnia and Herzegovina
C/P	Counterpart
CDFs	Confined Disposal Facilities
CIC	Community Involvement Coordinator
DARTS	Decision Aid for Remediation Technology Selection
DFR	Draft Final Report
DMP	Draft Master Plan
DOQ	Data Quality Objectives
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
ELD	Environmental Liability Directive
EU	European Union
FBiH	Federation of Bosnia and Herzegovina
FEPF	Environmental Protection Fund of FBiH
FMoAFW	Federal Ministry of Agriculture, Forestry and Water Management
FMoEMI	Federal Ministry of Energy, Mining and Industry
FMoET	Federal Ministry of Environment and Tourism
F/R	Final Report
GCLs	Geosynthetic Clay liners
HCAS	Historical Cost Analysis System
HEIS	Hydro - Engineering Institute Sarajevo
HTRW	Hazardous, Toxic and Radioactive Wastes
HRS	Hazard Ranking System
IC/R	Inception Report
ICs	Institutional Controls
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
MACs	Maximum Allowable Concentration
MoAWF	Ministry of Agriculture, Water Management and Forestry
MoEMI	Ministry of Energy and Mining and Industry
MoFTER	Ministry of Foreign Trade and Economic Relations
MSPEP	Ministry of Spatial Planning and Environmental Protection
NAPL	Non-aqueous Phase Liquid
NPL	National Priorities List
PCBs	Polychlorinated Biphenyls
PEL	Probable Effect Levels
REReP	Regional Environmental Reconstruction Programme
PPE	Personal Protective Equipment
RACER	Remedial Action Cost Engineering and Requirements
REC	Regional Environmental Center
RMWC	Regional Waste Management Center
RS	Republic of Srpska
SEA	Strategic Environmental Assessment
SGVs	Soil Guideline Values
SHM	Stakeholder Meeting
SHPP	Small Hydropower Plant
ST/C	Steering Committee
SVE	Soil Vapor Extraction
S/W	Scope of the Work
SPM	Suspended Particle Material
TPP	Thermal Power Plant
T/C	Technical Committee
UNDP	United Nation Development Programme
UNIDO	United Nations Industrial Development Organization
VOCs	Nonhalogenated Volatile Organic Compounds
X-VOCs	Halogenated Volatile Organic Compounds
X-SVOCs	Halogenated Semi- Volatile Compounds
WMS	Waste Management Strategy

CHAPTER 1 INTRODUCTION

1.1 Background

Bosnia and Herzegovina (hereinafter referred to as BiH) has various environmental issues that need urgent attention. In particular, problems of legacy pollution from the era of the Socialist Federal Republic of Yugoslavia and the subsequent period of internal strife need to be controlled immediately considering their potential adverse impacts on people and ecosystems in BiH. Because finding polluters liable for cleanup of legacy pollution sites is difficult, remediation of such site generally requires government-led planning and implementation of remediation measures. However, authorities in BiH have not yet developed official mechanisms to identify and register environmental hotspots[1], prioritize the need for remediation, develop remediation plans, implement them, and de-register the site.

Under these circumstances, the Council of Ministers of Bosnia and Herzegovina requested the Government of Japan to provide technical cooperation. In response, the Japan International Cooperation Agency (hereinafter referred to as JICA) sent a mission in November 2011 to design the project. Based on discussions between the Council of Ministers of BiH and JICA, both sides officially agreed to implement the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina (hereinafter referred to as "the Project"), and signed the Scope of Work documents (hereinafter referred to as S/W) (Annex 1) in December 2012.

It was noted that the Constitution of Bosnia and Herzegovina organizes the state into administratively divided entities, the Federation of Bosnia and Herzegovina (FBiH) and Republic of Srpska (RS). In addition to the entities, there exists also the Brčko District of Bosnia and Herzegovina (BD), as a local self-government unit. According to the Constitution of Bosnia and Herzegovina, state level authorities are not directly responsible in matters of environmental protection. However, the Law on Ministries and other Administrative Bodies of Bosnia and Herzegovina (Official Gazette of BiH, No. 5/03, 26/04, 42/04, 45/06, 88/07, 35/09, 59/09 i 103/09), designates the Ministry of Foreign Trade and Economic Relations of BiH (MoFTER BiH, hereinafter MoFTER) as the responsible state level authority to conduct activities and tasks related to the definition of policy, basic principles, coordination of actions and harmonization of plans of entity authorities and representation at the international level.

According to the RS Constitution, RS institution organizes and provides for environment protection. When it comes to the Federation of BiH, the Constitution of FBiH envisages that the Federation Government and cantons share responsibilities in environmental protection. Concerning Brcko District, it has responsibility over all fields which are not responsibility of the state. Accordingly, the Government of Brčko District has responsibilities that are entrusted to entities, municipalities (and cantons in FBiH) when it comes to environmental protection.

The Ministry of Physical Planning, Civil Engineering and Ecology of Republic of Srpska was involved in all the activities to prepare the project proposal and made the decision to not participate in the Project in accordance with the Act No.15.04-96-193/11 from 07.11.2011. Thus, the S/W was signed by the representatives from MoFTER and Ministry of Foreign Affairs at the central level, Federal Ministry of Environment and Tourism (FMoET) and JICA.

1.2 Overall Framework of the Project

1.2.1 Objectives

The objectives of the Project, as agreed in the S/W, are:

- To formulate a Draft Master Plan for sustainable management and proper treatment of environmental hotspots located in the Federation of Bosnia and Herzegovina (hereinafter referred to as FBiH), which is one of the entities of the BiH, and

[1] In this report, an environmental hotspot generally means a site contaminated with hazardous substance, and the terms "environmental hotspot" and "contaminated site" are used interchangeably without rigorous definition as in BiH these terms are often used synonymously.

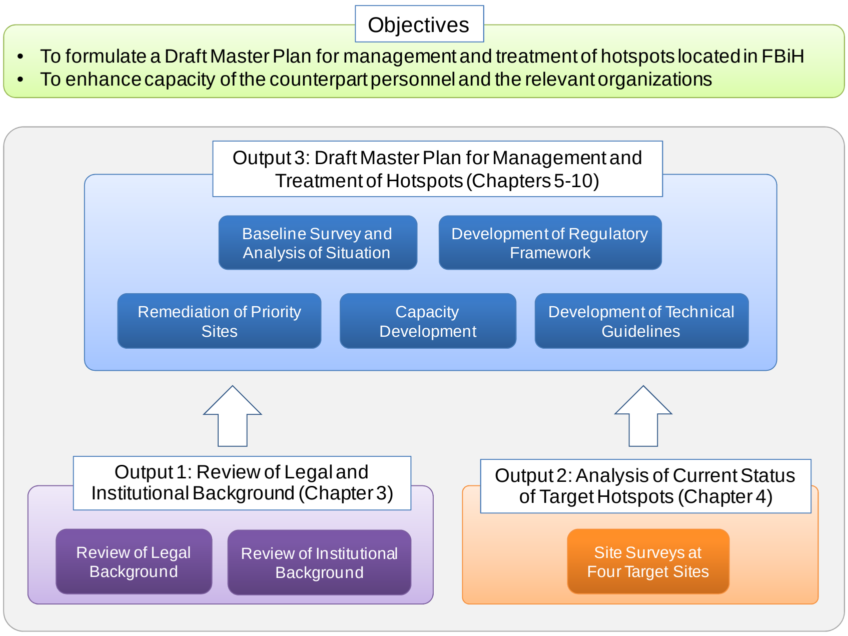
- To enhance the capacity of the counterpart personnel and relevant organizations for the policy planning on environmental management in FBiH.

1.2.2 Framework of the Project

Figure 1.2-1 summarizes the overall framework of the Project. In order to achieve these objectives, the Project is expected to produce three main outputs:

- Output 1: Legal and institutional background of hazardous waste management in BiH is reviewed.
- Output 2: Current status of hazardous waste management in the environmental hotspots of FBiH is analyzed.
- Output 3: The draft master plan for the management and the treatments of environmental hotspots is drafted.

First, legal and institutional background related to management of environmental hotspots contaminated with hazardous waste is reviewed. In parallel, a site survey of four typical environmental hotspots in FBiH is carried out. Based on the results of the review work and the experiences gained through the site survey, the draft master plan for the management and treatment of environmental hotspots is formulated.



Source: JET

Figure 1.2-1 Overall Framework of the Project

1.2.3 Project Area

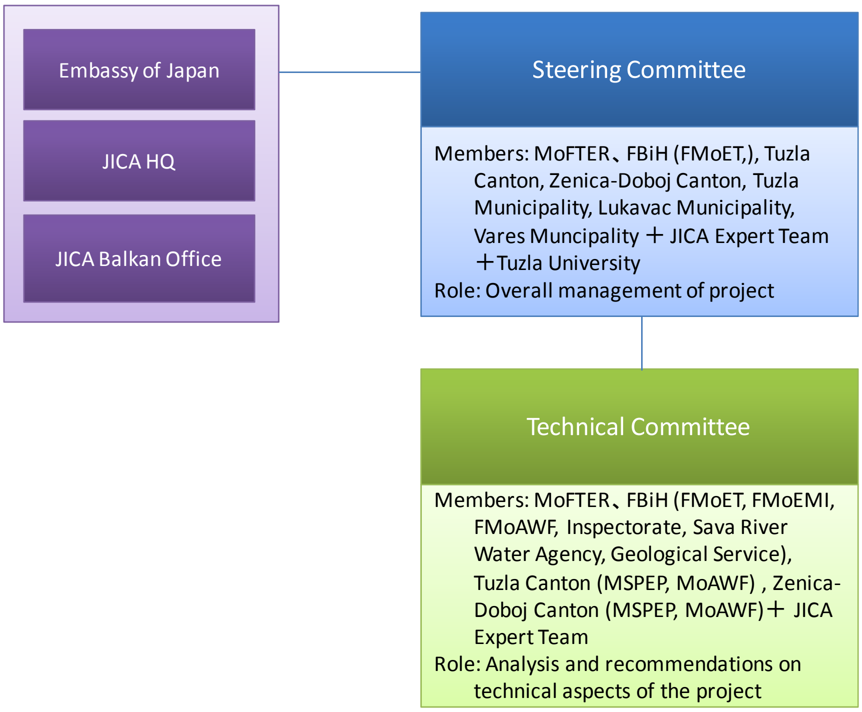
The Project areas are hotspots in FBiH. The following four sites in Tuzla and Zenica-Doboj cantons were selected as the target sites:

- Former chemical factory in Tuzla, Tuzla Canton
- Former soda factory in Lukavac, Tuzla Canton
- Lake Modrac in Tuzla Canton
- Abandoned open-pit pond, former processing plant, and a tailings pond and dam in Vares, Zenica-Doboj Canton

1.3 Organization of the Project

1.3.1 Overall Organizational Structure of the Project

In order to carry out the Project activities, a steering committee (ST/C) was organized with the chairmanship of a representative from the Ministry of Foreign Trade and Economic Relations (MoFTER) in accordance with the S/W signed in December 2012. Under the ST/C, a technical committee (T/C) was also organized in order to discuss the technical aspects of the Project. Figure 1.3-1 summarizes the overall organizational structure of the Project.



Source: JET

Figure 1.3-1 Organizational Structure of the Project

1.3.2 Steering Committee

The members of the ST/C are listed in Table 1.3-1.

Table 1.3-1 List of Steering Committee Members

No.	Name	Title	Name of Organization	Note
Members of Bosnia and Herzegovina Side				
1	Ms. Nermina Skejovic Huric	Senior Advisor for Programs and Projects	Ministry of Foreign Trade and Economic Relations (MoFTER)	-
2	Mr. Admir Softic	Advisor – Head of Deputy Minister Cabinet	Ministry of Foreign Trade and Economic Relations (MoFTER)	-
3	Mr. Mladen Rudez	Assistant Minister	Federal Ministry of Environment and Tourism (FMoET)	-
4	Mr. Mehmed Cero	Assistant Minister	Federal Ministry of Environment and Tourism (FMoET)	-
5	Ms. Fadila Muftic	Official	Federal Ministry of Environment and Tourism (FMoET)	-
6	Mr. Armin Djuliman	Advisor	Federal Ministry of Energy, Mining and Industry (FMoEMI)	-
7	Ms. Mirela Uljic	Head of Department of Water Management	Ministry of Agriculture, Forestry and Water management, Tuzla Canton	-
8	Mr. Goran Misic	Assistant Minister	Ministry for Spatial Planning and Protection of Environment of Tuzla Canton	-

No.	Name	Title	Name of Organization	Note
9	Mr.. Nedzad Alic	Chief of Lab for Geology and Civil Engineering	Faculty of Mining, Geology and Civil Engineering, University of Tuzla	-
10	Mr. Edin Terzic	Minister	Ministry of Spatial Planning, Transport and Communication and Environment of Zenica-Doboj Canton	Until February 2014
11	Mr. Sead Cizmic	Assistant Minister	Ministry of Spatial Planning, Transport and Communication and Environment of Zenica-Doboj Canton	-
12	Mr. Brano Surkic	Expert Associate for Economic Development	Vares Municipality	-
13	Ms. Kemal Kurevic	Chief Advisor for Communal Works	Tuzla Municipality	-
14	Mr. Jozo Tunjic	Chief Advisor	Lukavac Municipality	-
15	Mr. Nedim Mujkic	Coordinator for Infrastructure Works	Lukavac Municipality	-
Members of Japanese Side				
16	Mr. Toshiya Abe	Resident Representative	JICA Balkan Office	-
17	Mr. Itaru Okuda	Team Leader /Environmental Management	JICA Expert Team	-
18	Mr. Hisamitsu Ohki	Hazardous Waste Management	JICA Expert Team	-
19	Ms. Masako Teramoto	Soil Pollution Control /Pollution Risk Analysis	JICA Expert Team	-
20	Ms. Tomoe Takeda	Environmental Pollution Survey /SEA/Coordinator	JICA Expert Team	-

Source: JET

There were two ST/C meetings during the course of the Project as summarized in Table 1.3-2. The minutes of the ST/C meetings are given in Annex 8.

Table 1.3-2 Steering Committee Meetings

No.	Date and Venue	Main Agenda	Number of Participants
Steering Committee Meeting No. 1	20 September 2013, MoFTER, Sarajevo	The JICA Expert Team explained the plans for the project activities and site survey. Then, the members agreed on the following items: - Contents of the inception report (Ic/R) and activity plan in this project. - Members of ST/C. - Members of T/C. More members will be added afterwards. - Four target sites to be investigated in this project. - Survey plans at all target sites. - How to organize and what topics will be discussed at the T/C meetings	19
Steering Committee Meeting No. 2 / Final Seminar	23 April 2014, Hotel Bristol, Sarajevo	The following four presentations were made: - "Outcomes of the Project" by JICA Expert Team - "Implementation of Stockholm Convention in BiH" by MoFTER - "Directions to Remediation of Environmental Hotspots" by FMoET - "Activities of Federal Environmental Protection Fund" by Federal Environmental Fund The S/C members confirmed the following: - The project activities in BiH were successfully executed in accordance with the Scope of Work signed in December, 2012. - The S/C members thanked the efforts made by all the participants, and also promised to make further efforts to resolve the issues of environmental hotspots in BiH. The Bosnian side hoped for further opportunities for bilateral cooperation with Japan, and the representative of JICA promised to convey the message to JICA Headquarters in Japan.	47

Source: JET

1.3.3 Technical Committee

The members of the T/C are listed in Table 1.3-3.

Table 1.3-3 List of Technical Committee Members

No.	Name	Title	Name of Organization	Note
1	Ms. Nermina Skejovic Huric	Senior Advisor for Programs and Projects	Ministry of Foreign Trade and Economic Relations (MoFTER)	-
2	Mr. Admir Softic	Advisor – Head of Deputy Minister Cabinet	Ministry of Foreign Trade and Economic Relations (MoFTER)	-
3	Mr. Mehmed Cero	Assistant Minister, Environment Sector	Federal Ministry of Environment and Tourism (FMoET)	-
4	Mr. Dragan Sulovic	Advisor to the Minister for the Environment	Federal Ministry of Environment and Tourism (FMoET)	-
5	Mr. Mladen Rudez	Assistant Minister, Sector of Environmental Licenses	Federal Ministry of Environment and Tourism (FMoET)	-
6	Ms. Fadila Muftic	Official, Environment Sector	Federal Ministry of Environment and Tourism (FMoET)	-
7	Ms. Suada Numic	Expert Advisor	Federal Ministry of Environment and Tourism (FMoET)	-
8	Mr. Josip Dolusic	Advisor to the Minister for the Environment	Federal Ministry of Environment and Tourism (FMoET)	-
9	Mr. Armin Djuliman	Expert Advisor on Energy Facilities	Federal Ministry of Energy, Mining and Industry	-
10	Mr. Sedin Alispahic	Geologist	Federal Ministry of Energy, Mining and Industry	-
11	Mr. Stjepan Mijac	Head of Mining Department	Federal Ministry of Energy, Mining and Industry	-
12	Ms. Azra Slijepcevic	Advisor in Mining Department	Federal Ministry of Energy, Mining and Industry	-
13	Ms. Redzic Zijada	Expert Advisor for Water Protection	Federal Ministry of Agriculture, Forestry and Water management	-
14	Mr. Salih Krnjic	Advisor to Director for Technical Issues	Agency for Sava River Watershed	-
15	Mr. Enes Alagic	Advisor to Director for Technical Issues	Agency for Sava River Watershed	-
16	Ms. Mirela Uljic	Head of Water Management Department	Ministry of Agriculture, Forestry and Water management, Tuzla Canton	-
17	Mr. Anto Bosankic	Advisor	Ministry of Spatial Planning and Environmental Protection, Tuzla Canton	-
18	Mr. Goran Misic	Assistant to the Minister for the Environment	Ministry of Spatial Planning and Environmental Protection, Tuzla Canton	-
19	Mr. Bojan Bosnjak	Minister	Ministry of Agriculture, Forestry and Water management, Zenica-Doboj Canton	Until February 2014
20	Ms. Branka Pavlic	Expert Advisor for Agriculture	Ministry of Agriculture, Forestry and Water management, Zenica-Doboj Canton	-
21	Ms. Senada Malicbegovic	Expert Advisor for Water-Management Affairs	Ministry of Agriculture, Forestry and Water management, Zenica-Doboj Canton	-
22	Mr. Edin Terzic	Minister	Ministry of Spatial Planning and Environmental Protection, Zenica-Doboj Canton	Until February 2014
23	Mr. Cizmic Sead	Assistant Minister	Ministry of Spatial Planning and Environmental Protection, Zenica-Doboj Canton	-
24	Ms. Amra Pojskic	Expert Advisor	Ministry of Spatial Planning and Environmental Protection, Zenica-Doboj Canton	-
25	Mr. Brano Surkic	Expert Associate for Economic Development	Vares Municipality	-
26	Mr. Kemal Gutic	Faculty Dean	Faculty of Mining, Geology and Civil Engineering, University of Tuzla	-

No.	Name	Title	Name of Organization	Note
27	Mr. Nedzad Alic	Chief of Lab for Geology and Civil Engineering	Faculty of Mining, Geology and Civil Engineering, University of Tuzla	-
28	Mr. Zoran Ilickovic	Vice Dean for Science	Faculty of Technology, University of Tuzla	-
29	Mr. Franc Andrejas	Associate Professor	Faculty of Technology, University of Tuzla	-
30	Mr. Ibro Kulin	Environmental sector	Federal Inspectorate	-
31	Mr. Omer Causevic	From Environmental sector	Federal Inspectorate	-
32	Mr. Ferid Osmanovic	From Mining sector	Federal Inspectorate	-
33	Mr. Muamer Hajdarevic	Environmental Inspector, Tuzla Canton	Cantonal Inspectorate for Tuzla Canton	-
34	Ms. Elvedina Delic	Environmental Inspector, Zenica-Doboj Canton	Cantonal Inspectorate for Zenica-Doboj Canton	-
35	Mr. Toni Nikolić	Expert Advisor for Engineering geology	Federal Institute for Geology	-
36	Ms. Sanja Pandur Bosiljcic	Head of Department for the preparation and monitoring of the project implementation	Environmental Protection Fund of FBiH	-

Source: JET

In total, two T/C meetings were held during the course of the Project as summarized in Table 1.3-4.

Table 1.3-4 Technical Committee Meetings

No.	Date and Venue	Agenda	Participants
Technical Committee Meeting No. 1	4 November 2013, Hotel Hollywood, Sarajevo	Three presentations were made by the JICA Expert Team, namely: (i) introduction to hazardous waste management, (ii) site investigation of soil and groundwater, and contamination, and (iii) risk management. The participants requested the JICA Expert Team to clarify the priorities among the target sites, and hoped for further support by the Japanese government.	42
Technical Committee Meeting No. 2	25 February 2014, Hotel Hollywood, Sarajevo	Five technical presentations, on result of site investigation, risk assessment and remediation plan for environmental hotspots, were made by HEIS on (i) former soda factory site, (ii) former chemical factory site, (iii) Lake Modrac, (iv) abandoned mining sites. The participants discussed issues to be considered for implementation of remediation plans.	35

Source: JET

1.3.4 JICA Expert Team

The JICA Expert Team (hereinafter referred to as JET) consists of four members, as summarized in Table 1.3-5.

Table 1.3-5 JICA Expert Team

Name	Position
Itaru OKUDA	Team Leader/Environmental Management
Hisamitsu OHKI	Hazardous Waste Management
Masako TERAMOTO	Soil Pollution Control/Pollution Risk Analysis
Tomoe TAKEDA	Environmental Pollution Survey/SEA/Coordinator

Source: JET

1.4 Project Activities

1.4.1 Introduction

In line with the Scope of Work agreed between the BiH side and the Japanese side in December 2012, the project implemented activities related to the three outputs of the project.

1.4.2 Output 1 – Review of Legal and Institutional Background

(1) Review of Policies and Regulations (Chapter 3)

The current policies and regulations related to the management of environmental hotspots were reviewed. A special emphasis was placed on the status of environmental standards in FBiH because they are important in defining the unacceptable levels of pollution. Also, the laws and regulations related to waste management, industrial pollution control, mining, environmental liability, information disclosure, and other aspects were reviewed. Similarly, the current organizational set up for the management of hotspots at the central, entity, and cantonal levels were reviewed.

(2) Identification of the Gaps with EU Directives (Chapter 3)

Many EU directives are related to the management of pollution, of which the most pertinent to the management of hotspots contaminated with hazardous substances is the Environmental Liability Directive (2004/35/EC). While the basic concept of environmental liability has been stipulated in the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09), FBiH is yet to implement the tasks of transposing the Directive. Some of the major legal gaps include the lack of definition of contaminated site, lack of definition of environmental damages, and clarification of liabilities of innocent/incompetent operators. These legal gaps are addressed in the Draft Master Plan developed in this Project.

Other directives, such as the Waste Framework Directive (2006/12/EC), Directive on Hazardous Waste (91/689/EEC amended in 1994), Water Framework Directive (2000/60/EC), Directive on Integrated Pollution Prevention and Control (96/61/EC), and Environmental Impact Assessment Directive (85/337/EEC amended in 1997 and 2003), are also important in controlling hotspots, and the statuses of the transposition of these directives are being reviewed under an EU-funded project.

(3) Recommendations for Management of Environmental Hotspots (Chapter 7)

A detailed legal review report on environmental liability was developed by local lawyers, which included the principles of environmental liability in FBiH and civil liability for the damage caused to the environment in the legislation governing environmental protection, obligations, the concessions and privatization. Based on this report, recommendations on existing legal and institutional recommendations were provided in the draft master plan.

1.4.3 Output 2 – Analysis of Current Status of Target Hotspots

(1) Selection of Target Hotpots (Chapter 4, Annex 3)

Previous studies on hotspots in BiH were reviewed. Also, a cadastral map of FBiH was checked for the industrial locations in Tuzla and Zenica-Doboj cantons. Then, a number of meetings were held to select the target sites. Based on the discussions, the following four sites were selected as the target sites:

- Former chemical factory
- Former soda factory
- Lake Modrac
- Abondoned open-pit pond, former processing plant, and a tailings pond and dam

(2) Site Survey (Chapter 4, Annex 3)

In October and November 2013, a series of surveys were conducted by the sub-contractor at the four sites mentioned above based on the sampling plans designed by JET. Table 1.4-1 summarizes the number of the samples at each site. Details are explained in Chapter 4 and Annex 3 of this report. Prior to sampling, concentrations of heavy metals and soil gases were measured using portable equipment in order to optimize sampling design and also to demonstrate how to implement a rapid on-site survey.

Table 1.4-1 Results of Site Survey and Suggested Remediation Measures

Site		Number of Samples	Results	Suggested Remediation Measures
Former chemical factory site in Tuzla		56 soil samples, 2 surface water samples, 3 bore holes, 5 groundwater sample, including background samples	- Soil polluted by Hg (max 105mg/kg), Pb, Cd, Zn and PCBs - Waste material heavily polluted by Hg and heavy metals - Groundwater contained 4.7μg/L PCB at monitoring well	- Additional investigation (polluted area and depth, pollution plume of PCB in groundwater etc.) - Realization of the final site remediation plan - Proper disposal of hazardous material currently stored at site - Proper dismantling of existing facilities with sorting and proper disposal of waste - Heavy metals polluted soil remediation by soil washing technique - PCB polluted soil remediation by chemical oxidation - Groundwater remediation (if necessary. Technology to be defined.) - Monitoring of soil and groundwater
Former soda factory site in Tuzla		4 waste samples and 3 surface water samples	- As (56mg/kg) in the waste at the former disposal site - High concentration of inorganic dissolved components including chloride	- Additional investigation related with the alternatives for the Re-Use of the waste - Site closure has been proposed as the primary option against which (in terms of technical /economical and environmental benefits) all the alternatives which may become available (after all necessary studies) have to be compared
Lake Modrac		4 sediment and 7 lake water	- Pb, Cu and CN were almost equal to or little higher than the prescribed standard - Hg (1.8 – 1.9 mg/kg) and Cr (190 – 265 mg/kg) in the sediment were higher than the Probable Effect Levels (PEL) of in freshwater sediment	- Additional investigations on sediment quality and biota - Basin management plan in order to decrease the quantity of pollutants and sediments (including erosion prevention measures) reaching the lake - Dredging of the lake sediments in three phases in parallel with continuous monitoring of extracted sediment s quality. - Monitoring of water quality and bio-accumulation in biota (fishes etc.)
Abandoned mining sites in Vares	Abandoned open-pit pond	1 sediment sample and 4 surface water samples	- No serious amounts of the heavy metals - The concentration of heavy metals in the water was not high, due to the relatively high pH (not acid)	- Remediation of the abandoned mined slopes - Adequate monitoring system for the planned use (recreation)
	Processing plant facility/ Tailing pond and dam	12 soil/tailing/sediment samples, 8 water samples, background samples	- Elevated levels of heavy metals in soil around the processing plant facility (max. 3005 mg/kg of Pb) - Tailing contained much elevated concentration of Pb (around 2,000 mg/kg) and other heavy metals - In the water, the significant problem was not confirmed	- Additional investigations to asses tailing dam stability and detail project for the restoration of dam including downward slope - Realization of the final site remediation plan for the flotation plant and tailing pond. - Proper disposal of hazardous material currently stored at site - Proper dismantling of existing facilities with sorting and proper disposal of waste. - Unprocessed or partially processed mineral can be disposed in places with similar metal composition (tailing disposal site or original mine) eventually can be re-processed to obtain valuable concentrate if the flotation plant will be reconstructed

Source: JET

(3) Sample Analysis and Development of Hazardous Waste Maps (Chapter 4, Annex 3)

Following the sampling, the samples were analyzed at the laboratory of the subcontractor. Then, a set of hazardous waste maps was prepared for different contaminants for the selected sites where relatively dense sampling was done.

(4) Evaluation of Results and Assessment of Environmental Risks (Chapter 4, Annex 3)

The results of the analysis were compared against local and international environmental standards for soil, sediment, surface water and groundwater. Key findings are summarized in Table 1.4-1 above. Also, environmental risks at each site were evaluated for different pathways using the Hazard Ranking System (HRS) developed by United States Environmental Protection Agency (USEPA). It was found that the former polyurethane factory in Tuzla and the site of former flotation plant and tailings dam in Vares are heavily contaminated.

(5) Discussions with Stakeholders (Chapter 4, Annex 3)

Two stakeholder meetings and a T/C meeting were organized on 7 and 11 November 2013 and 25 February 2014, respectively, to discuss the results of the site surveys and proposed remediation measures with the stakeholders.

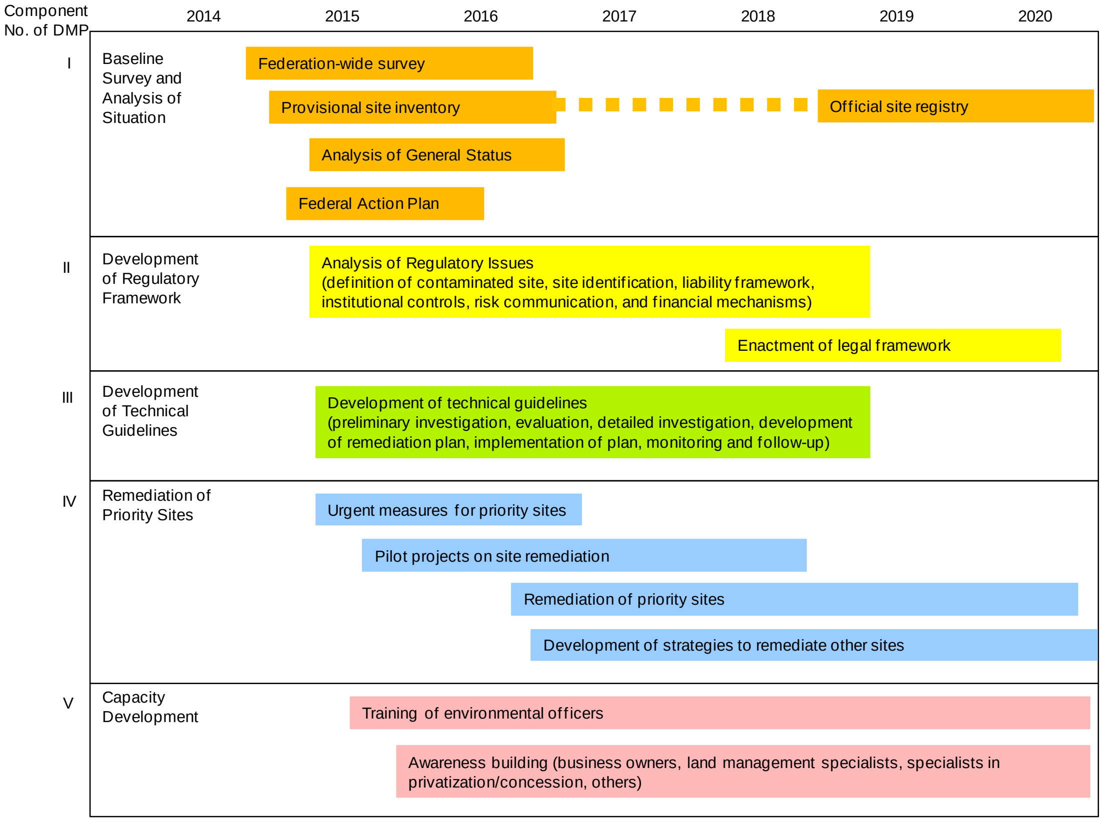
(6) Development of Possible Remediation Measures (Chapter 4, Annex 3)

Remediation measures were suggested for each site. It should be pointed out that these measures were developed merely to demonstrate how such measures can be developed considering the specific conditions of each site. In accordance with the laws in FBiH, it is the responsibility of the polluter or operator to develop and implement a remediation measure.

1.4.4 Output 3 – Drafting of Master Plan for Management and Treatment of Hotspots

(1) Formulation of Draft Master Plan (Chapters 5-10)

A draft master plan for 2014-2020 was prepared which elaborated various actions that FBiH has to take in order to develop the regulatory framework for the management of hotspots, to remediate priority sites, to train environmental officers and raise awareness of stakeholders. Figure 1.4-1 shows the framework of the proposed draft master plan. The draft master plan is presented in Chapters 5 to 10 of this report. To minimize environmental and social impacts of the draft master plan, plausible impacts were analyzed and mitigating measures were incorporated into the draft master plan as presented in Chapter 11.



Source: JET

Figure 1.4-1 Framework of the Proposed Draft Master Plan

(2) Development of Checklists (Annex 4)

A checklist of the site-level activities was developed and annexed to the draft master plan.

(3) Reference on Treatment Methodologies (Annex 5)

A guideline summarizing the treatment methods for various hazardous substances was developed. It is annexed to the draft master plan.

(4) Nation-wide Seminar

A seminar was organized in April 2014 in conjunction with 2nd Steering Committee Meeting.

CHAPTER 2 ENVIRONMENTAL HOTSPOTS IN BOSNIA AND HERZEGOVINA

2.1 Introduction

This chapter reviews the information on known environmental hotspots in BiH. Endowed with rich mineral resources (e.g., lignite, lead, zinc, bauxite, limestone, and rock salt), BiH has flourished as a mining and industrial center in the Balkans. Many of these areas have long histories of intensive chemical, mining, and other industrial activities, and it is possible that some of these sites may be heavily contaminated with hazardous substances because production technologies in the earlier days were often crude and measures for environmental protection were limited.

As described below, many of these sites have been identified and investigated in the past. However, there have been no systematic surveys on such hotspots. Consequently, there is no inventory of hotspots that is officially accepted and maintained.

2.2 Historical Studies

Overall, information on environmental hotspots in BiH is still scarce. Also, the definition of environmental hotspot is broad. Depending on the objective of the study, some investigated situations of pollution are associated with a particular class of chemicals (e.g., PCBs), while others included a broad range of chemical, medical, and mining wastes. Some covered issues of domestic wastewater, municipal solid waste, and vulnerable natural environment.

In 2003, the Regional Environmental Center for Central and Eastern Europe (REC) produced a report on environmental hotspots in Albania, BiH, Croatia, the Former Yugoslav Republic of Macedonia, Serbia and Montenegro, within the framework of the Regional Environmental Reconstruction Programme for South Eastern Europe (REReP). This study identified 35 areas in BiH with significant environmental issues, including polluted industrial sites, areas with sewage problems, solid waste problems, contaminated air, and areas with vulnerable nature, biodiversity, and protected areas. Figure 2.2-1 shows the environmental hotspots in BiH including polluted areas as well as areas with high environmental values identified in this study while Table 2.2-1 lists the details.

Source: REC, Developing a Priority Environmental Investment Programme for South Eastern Europe, 2003

Figure 2.2-1 Environmental Hotspots including Areas with High Environmental Values in BiH

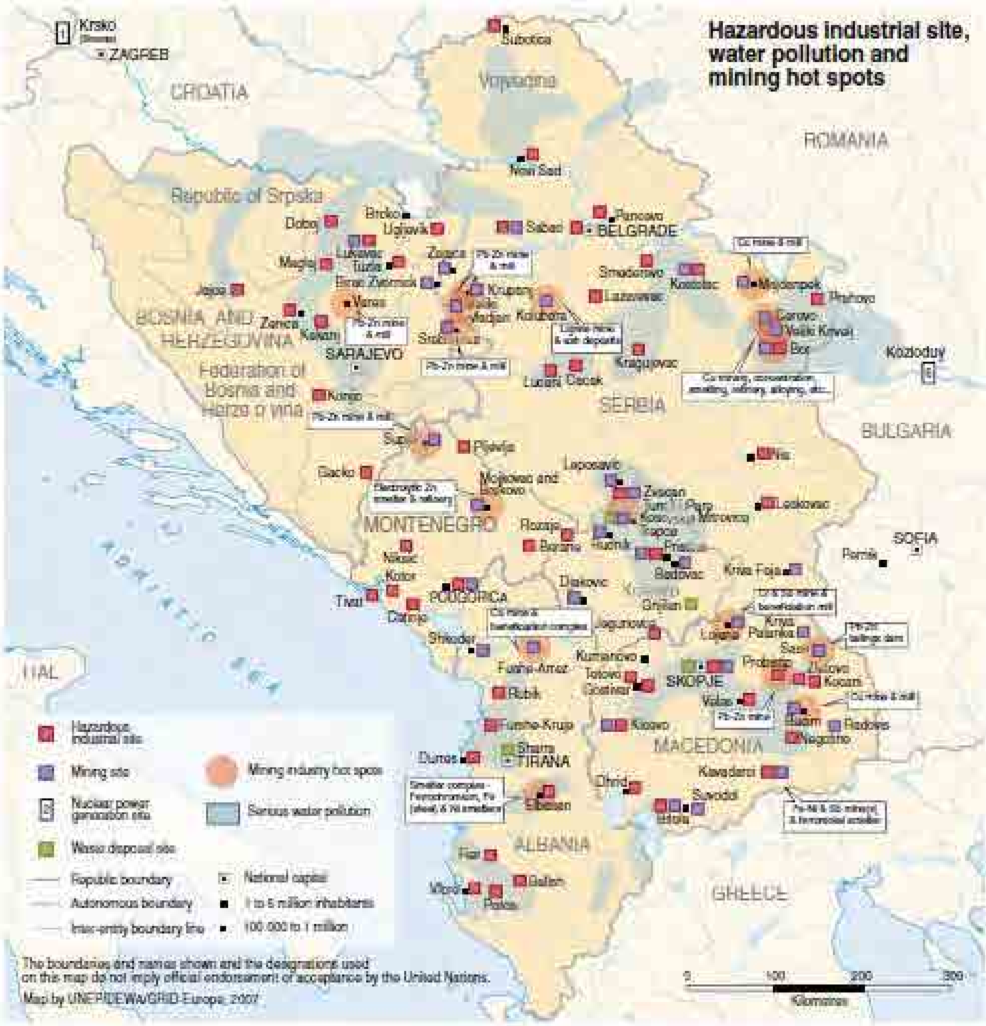
Table 2.2-1 List of Environmental Hotspots including Areas with High Environmental Values in BiH

No.*	Area	Environmental Issue	No.	Area	Environmental Issue
10	Mostar	Aluminum factory	25	Zenica	Waste from mining-metallurgic plant
11	Bileca	Sewerage system and wastewater treatment plant			Air
		Reconstruction of wastewater treatment plant of carpet factory	26	Boracko Lake	Infrastructure facilities
12	Konic Municipality	Sewerage system and wastewater treatment plant	27	Ugjevik	Power plant
		Constructing sanitary landfill	28	Kakanj-Catici	Power plant
13	Sarajevo	Ambient air quality	29	Gacko	Power plant
		Wastewater treatment plant	30	Jajce	Ferrou-Silicy factory

No.*	Area	Environmental Issue	No.	Area	Environmental Issue
14	Tuzla	Tuzla power plant	31	Prenj-Cvrsnica-Cabulja National Park	Natural values
		Sewerage system and wastewater treatment plant	32	Treskavica-Igman-Bjelasnica National Park	Natural values
		Waste from chlor-alkaline complex	33	Una River National Park	Natural values
15	Banja Luka	Sewerage system and wastewater treatment plant	34	Bijambare	Protected landscape
		Ambient air quality	35	Skakavac	Natural values
		Waste from cellulose and viscose factory	36	Hutovo Blato Nature Park	Natural values
16	Bijeljina	Sewerage system and wastewater treatment plant	37	Blidinje Nature Park	Natural values
17	Brcko	Sewerage system and wastewater treatment plant	38	Bardaca	Nature park
18	Prizici (Vares)	Disposal site of waste from lead and zinc production	39	Sutjeska National Park	Nature values
19	Srebrenica	Waste from lead and zinc production	40	Kozara National Park	Nature values
20	Zvonik	Disposal of red mud from the TG Birac	41	Jahorina Nature Park	Natural values
21	Bosansko Petrovo Selo	Waste from asbestos production	42	Vranica Nature Park	Natural values
22	Lukavac	Waste from coke-chemical industry	43	Miljacka River Canyon Nature Park	Valuable species
23	Maglaj	Waste from cellulose and viscose factory	44	Trebevic Nature Park	Natural values
24	Prijedor	Waste from cellulose and viscose factory			

Note: * corresponds to the numbers in the Figure 2.2-1.
Source: REC, Developing a Priority Environmental Investment Programme for South Eastern Europe, 2003

In 2006, the United Nations Environment Programme (UNEP) updated its desktop study on polluted environmental hotspots in Southeast Europe, with focuses on mining and transboundary pollution. In this study, about 40 sites in BiH were reviewed, and among the priority sites are the lead-zinc mining and beneficiation in Srebrenica, lead-zinc mining and beneficiation in Vares, smeltering in Jajce, and aluminum smeltering in Moster. Based on this review and other information, UNEP produced a map that shows the hazardous industrial sites, areas with water pollution, and mining sites in BiH and neighboring countries (Figure 2.2-2).



Source: UNEP, Balkan Vital Graphics, Environment without Borders, 2007.

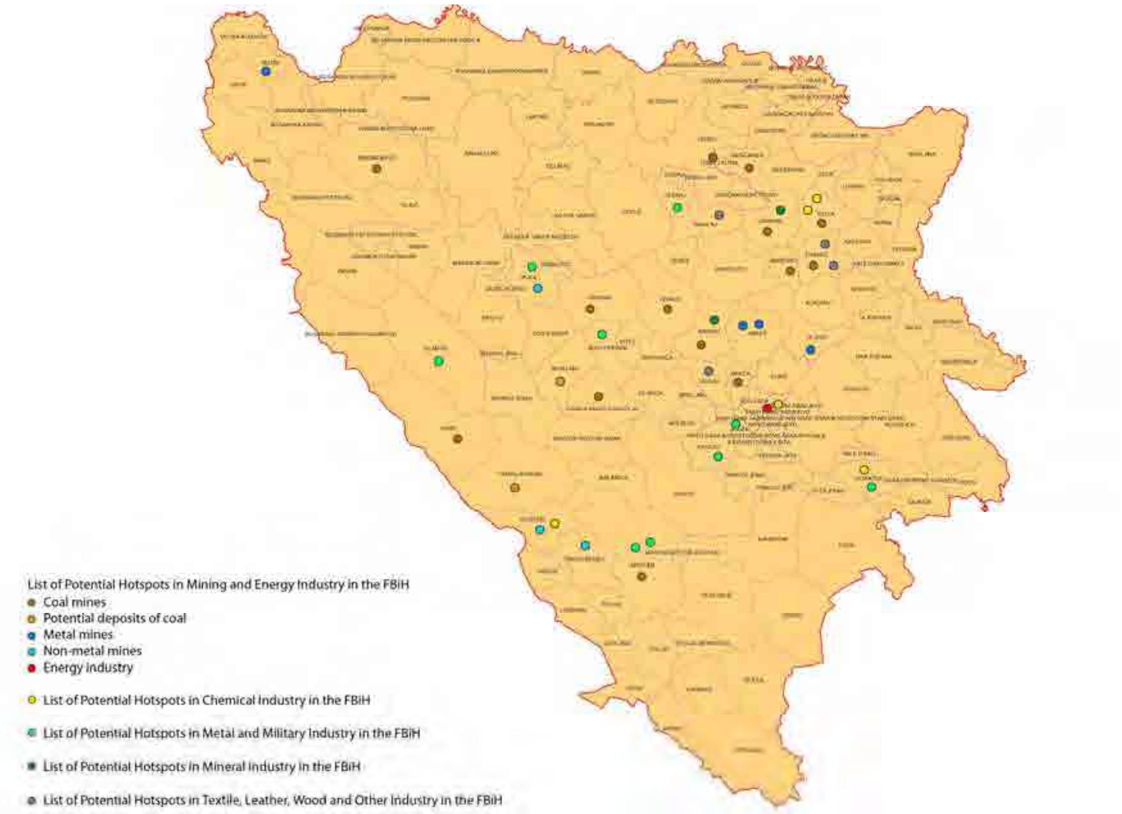
Figure 2.2-2 Hazardous Industrial Site, Water Pollution Areas, and Mining Sites

More recently, the Netherlands-funded project entitled “Strengthening Capacities in BiH to Address Environmental Problems through Remediation of High Priority Hotspots[1]” reviewed seriously polluted sites in BiH and proposed the following nine remediation projects:

- Reconstruction of wastewater treatment plant: line for neutralization – former military industry of Bratstvo, BNT Novi Travnik;
- Adaptation of SASE-Srebrenica industrial dump for protection of the Drina River;
- Clean-up of old leather waste disposal site – KTK Visoko leather industry;
- Rehabilitation of the Jajce industrial and municipal waste disposal site;
- Sanitation of ashes disposal site - Kakanj TE;
- Decontamination of soil contaminated by PCB oils from transformer stations in the vicinity of Incel Banja Luka Factory;
- Clean-up of sites disposed with bottoms and reaction residues – locations of DITA-Tuzla Factory (2/3 of dumpsite surface) and Polihem Factory (1/3 of surface of the waste disposal site);
- Remediation/clean-up of waste oil lagoons - Municipality of Modrica; and
- Reconstruction of wastewater treatment plant – former military industry Pobjeda Gorazde.

[1] Strengthening Capacities in BiH to Address Environmental Problems through Remediation of High Priority Hotspots, funded through Netherlands Regional Environmental Program West Balkan, 2010.

Many of the industrial and mining sites identified through these historical studies have been compiled as shown in Figure 2.2-3, which includes the result of survey of industrial, mining and other hazardous wastes in BiH conducted in the early 2000s.



(Source: Enova d.o.o. Sarajevo based on data from Source: Governments of FBiH and RS, Environmental Protection Assessment Report for Industrial, Medical and Other Hazardous Wastes in BiH, 2002; UNEP Vienna, South – Eastern European Mining – Related Risks: Identification and Verification of Environmental Hot Spots, 2006; UNDP, Strengthening Capacities in BiH to Address Environmental Problems Through Remediation of High Priority Hot Spots, 2010; Ministry of Foreign Trade and Economic Relations, State of Environment Report of BiH, 2012)

Figure 2.2-3 Locations of Industrial and Mining Environmental Hotspots in BiH

Aside from industrial and mining sites, solid waste disposal sites are a major environmental concern in BiH because many waste disposal sites have received all kinds of both hazardous and non-hazardous wastes in the past. According to the Federal Waste Management Plan 2012-2017 of FBiH, there are only 81 legal waste disposal sites in FBiH registered by local municipalities. Many waste disposal sites are open dumpsites and do not meet the conditions of a proper sanitary waste disposal site, which should be lined and equipped with leachate and gas collection systems. With respect to illegal waste disposal sites, there are 340 registered illegal waste disposal sites in FBiH, and there is a speculation that there are as many as 2,000 such illegal waste disposal sites in FBiH. Environmental risks associated with such sites have not been fully investigated in the past.

Table 2.2-2 Registered Legal and Illegal Waste Disposal Sites in FBiH

Canton	Registered Legal Waste Disposal Sites	Registered Illegal Waste Disposal Sites
Herzegovina-Neretva	12	75
West Herzegovina	8	68
Canton 10	8	20
Bosnian-Podrinje	3	8
Central Bosinia	14	18
Zenica-Doboj	11	40
Tuzla	14	2
Posavina	3	32
Una-Sana	7	29
Sarajevo	1	48
Total	81	340

Source: Federal Waste Management Plan 2012-2017

2.3 Contaminated Sites in Europe and Other Countries

As shown in the previous section, dozens of environmental hotspots have been identified in BiH, and local governments are aware of more hotspots that are not covered in the previous section. However, there has been no systematic survey of hotspots in BiH, and it is likely that more hotspots exist. At this point, it is not possible to estimate the number of unidentified sites in BiH, but it is of interest to know the situation in other countries.

In 2011-12, the European Commission, through the European Environmental Information and Observation Network for soil (EIONET-soil) surveyed information on contaminated sites and potentially contaminated sites, covering 38 countries in the region, including the 27 EU member states, Iceland, Lichtenstein, Norway, Switzerland, Turkey, and the West Balkan countries, namely: Albania, BiH, Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Serbia, and Kosovo under the UN Security Council Resolution 1244/99. In this survey, representative offices in these countries were asked to submit information on contaminated sites, where contamination has been confirmed, and potentially-contaminated sites, where contamination is suspected but has not been verified. Out of these 38 counties, 33 countries provided some data (BiH replied but data were not provided). Table 2.3-1 summarizes the numbers of potentially contaminated and contaminated sites in 20 countries. The estimates for Japan and the US are also added to the table from different sources.

Table 2.3-1 Numbers of Potentially Contaminated Sites and Contaminated Sites in Selected Countries

Country	Potentially Contaminated Sites (PCS)			Contaminated Sites (CS)			
	Estimate of Unidentified PCS	Identified PCS	Total PCS*	Estimate of CS based on Unidentified PCS	Estimate of CS based on Identified PCS	Identified CS	Total CS**
Germany	-	-	-	-	-	14,209	14,209
France	43,000	257,200	300,200	-	-	969	969
UK	119,898	178,398	298,296	-	-	645	645
Spain	-	-	-	-	-	61	61
Netherlands	-	180,000	180,000	-	-	78,500	78,500
Switzerland	-	10,000	10,000	-	2,400	1,020	3,420
Norway	-	724	724	-	-	-	-
Austria	7,000	2,114	9,114	1,250	500	68	1,818
Finland	2,000	17,100	19,100	1,000	8,500	2,200	11,700
Ireland	-	2,371	2,371	-	-	-	-
Hungary	830	200	1,030	330	160	742	1,232
Slovakia	110	909	1,019	90	680	255	1,025
Croatia	-	2,264	2,264	-	-	4	4
Lithuania	3,864	5,000	8,864	1,500	2,300	660	4,460
Serbia	-	296	296	-	74	29	103
Cyprus	30	84	114	-	-	4	4
Estonia	-	78	78	-	63	28	91

Country	Potentially Contaminated Sites (PCS)			Contaminated Sites (CS)			
	Estimate of Unidentified PCS	**Identified PCS**	**Total PCS***	**Estimate of CS based on Unidentified PCS**	**Estimate of CS based on Identified PCS**	**Identified CS**	**Total CS****
Macedonia	-	54	54	-	54	13	67
Malta	430	117	547	-	39	5	44
Montenegro	-	-	-	-	-	5	5
Japan***			330,000-928,000	-	-	993	993
USA****	-	-	130,000-425,000	-	-	6,792	6,792

Note:
*: Sum of estimated and identified potentially contaminated sites based on new part of the questionnaire in 2011.
**: Sum of estimated and already identified contaminated sites based on new part of the questionnaire in 2011.
-: Data not available.
***: Number of PCS in Japan is based on Geo-Environmental Protection Center, Estimation of Cost for Remediation of Contaminated Sites in Japan, 2000, and other estimates; the number of CS in Japan is the number of officially registered contaminated sites. Source: Ministry of Environment Japan, Oct. 2013.
****: Number of PCS in USA is based on GAO, “Superfund: Extent of Nation's Potential Hazardous Waste Problem Still Unknown”, 1987; the number of CS in USA is based on USEPA, Site Assessment Accomplishments, September, 2013.
Source: EIONET, 2012 version of the CSI015 indicator “Progress in the Management of Contaminated Sites”, 2012.

It is not straightforward to compile such data, because available information on contaminated sites is highly limited in many countries, and the reported numbers may not accurately represent the actual situation of the country. While a number of countries already have reasonable databases of contaminated sites based on a well-established methodology, other countries have to report the data based on experiences and knowledge of limited number of experts. Also, the way site identification is made varies significantly from country to country. In many countries, sites are identified by government-led investigations, while in some countries (e.g., Belgium), private industries and landowners play an important role play an important role because of legal requirement of soil certificate for transaction of immobile asset. Furthermore, many countries reported only the number of “identified” sites, and did not estimate the number of “unidentified” sites. For these reasons, it is not possible to compare the numbers of sites across countries.

Nonetheless, it is worth noting that hundreds of contaminated sites exist in many countries. Based on population-based extrapolation, the survey estimated that there are 2,521,000 potentially contaminated sites and 342,000 contaminated sites in these 38 countries. About 37% of the estimated number of contaminated sites, or 127,000 sites, have already been identified; and 17% of the estimated number of contaminated sites, or 58,000 sites, have already been remediated.

The situations in Japan and USA are also similar. In Japan, only about 1,000 sites are officially registered, but many site owners had remediated sites in the past to avoid environmental liability and negative environmental image.

Judging from these data, it is not surprising if there are hundreds, if not thousands, of contaminated sites in BiH. Some of the potential sites include former waste dumping sites, chemical factories that use hazardous substances, metal and other mining sites, dry cleaning shops, and gas stations with leaking underground tanks, and many of such sites have not been fully investigated in BiH.

CHAPTER 3 REVIEW OF THE LEGAL AND INSTITUTIONAL BACKGROUND

3.1 Introduction

This chapter reviews the existing legal and institutional framework for the management of environmental hotspots, in particular, contaminated sites. The most pertinent questions are on the following:

- Definition of contaminated site, and acceptable/unacceptable environmental conditions;
- Existing protocols and procedures for identification, investigation, remediation, and other technical aspects of contaminated site management;
- Existing mechanisms for information disclosure and public participation in the management of contaminated sites;
- Roles and responsibilities of the polluter and other parties who have/had control over the operation that caused the pollution, those of different levels of governmental organizations, and those of citizens and NGOs; and
- Gaps between the current legal and institutional framework and the requirements of the EU.

In FBiH, various laws and regulations are related to these questions. However, none of them are specific to the management of contaminated sites. Consequently, management of contaminated site is generally dealt with through a complex array of related laws and regulations for environmental management, waste management, environmental licensing, water management, mining, protection of agricultural soil, and public health, which are nested at various levels of government and jurisdiction. Also, there are various legal and institutional gaps. Some of the key problems include, but are not limited to, lack of legal definition of a contaminated site, lack of procedures for investigation and prioritization of problems, ambiguity related to environmental liability, e.g., environmental responsibility of current landowner of historical pollution, lack of disposal site for hazardous waste, and lack of funding.

3.2 Legal Background

3.2.1 General Framework of Laws and Regulations for Environmental Management

Table 1.3-5 summarizes the major environmental laws and regulations in FBiH, Tuzla Canton, and Zenica-Doboj Canton, as well as some of the relevant international treaties. Please note that the list is not exhaustive as there are about 100 relevant laws and regulations. For a more complete list of laws, rulebooks, decrees, and decisions, please see Annex 2.

Table 3.2-1 List of Environmental Laws and Regulations Related to the Management of Environmental Hotspots

Name of Laws
FBiH Laws
- Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09)
- Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09)
- Law on Waters (Official Gazette of FBiH, No.70/06)
- Law on Air Protection (Official Gazette of FBiH, Nos. 33/03 and 4/10)
- Law on Mining (Official Gazette of FBiH, No. 26/10)
- Law on Agriculture (Official Gazette of FBiH, Nos. 88/07, 4/10, 27/12 and 7/13)
- FBiH Law on Inspections (Official Gazette of FBiH, No.69/05)
- FBiH Law on Spatial Planning and Land Use (Official Gazette of FBiH, Nos.2/06, 72/07, 32/08, 04/10,13/10 and 45/10)
- FBiH Law on the Environmental Protection Fund (Official Gazette of FBiH, No.33/03)
- FBiH Law on Obligations (Official Gazette of FBiH, Nos. 29/03 and 42/11,)
- FBiH Law on Criminal Procedure in FBiH (Official Gazette of FBiH, Nos. 35/03, 37/03, 56/03, 78/04, 28/05, 55/06, 27/07, 53/07, 09/09, 12/10 and 08/13)
- FBiH Law on Privatization (Official Gazette of FBiH, Nos. 27/97, 8/99, 32/00, 45/00, 54/00, 61/01, 27/02, 33/02, 28/04, 44/04, 42/06 and 4/09)
- FBiH Law on Health Protection (Official Gazette of FBiH, Nos. 46/10 and 75/13)

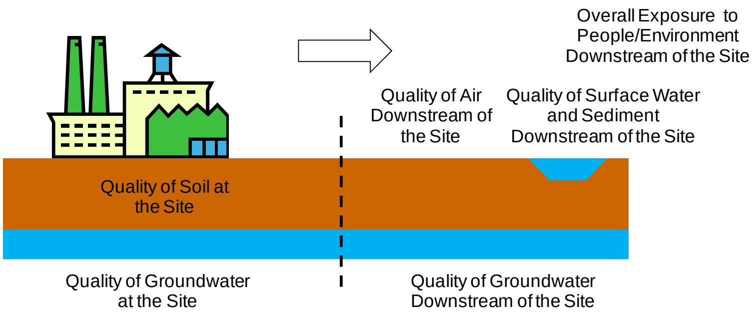
Name of Laws
- FBiH Law on Concessions (Official Gazette of FBiH, Nos. 40/02 and 61/06)
Laws of Tuzla Canton
- Law on Environmental Protection (Official Gazette of TK, Nos. 06/98 and 15/00, subsequently abolished by Law on Abolishing the Law on Environmental Protection, Official Gazette of TK, No. 14/11)
- Law on Concessions (Official Gazette of TK, Nos. 5/04, 7/05, 6/11 and 1/13)
- Law on Mining (Official Gazette of TK, No.14/11)
- Law on Waste (Official Gazette of TK, No.17/00)
- Law on Waters (Official Gazette of TK, No.11/08)
- Law on Spatial Planning and Construction (Official Gazette of TK, Nos.06/11, 04/13 and 15/13)
Laws of Zenica-Doboj Canton
- Law on Environmental Protection (Official Gazette of ZDK, No.01/00)
- Law on Geological Survey (Official Gazette of ZDK, No.08/12)
- Law on Mining (Official Gazette of ZDK, No. 10/12)
- Law on Spatial Planning and Construction (Official Gazette of ZDK, No. 1/14)
- Law on Concessions (Official Gazette of ZDK, No. 5/03 – consolidated text)
- Law on Waters (Official Gazette of ZDK, No. 17/07)
International Conventions
- Convention on Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989; accession by BiH, 2001)
- Protocol on Pollutant Release and Transfer Registers (Kiev, in 2003; signature by BiH in 2003)
- Convention on Persistent Organic Pollutants (Stockholm, 2001; ratification by BiH in 2010)
- Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam in 1998; accession by BiH in 2007)
- Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (adoption in Aarhus 1998; accession by BiH in 2008)
- Protocol on Strategic Environmental Assessment (Kiev, 2003; signature by BiH in 2003)
- Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes (Helsikini in 1992, amended Madrid in 2003; accession by BiH in 2009)
- Convention of Environmental Impact Assessment in Trans-boundary Context (Espoo, 1991; accession by BiH in 2009)
- Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Trans-boundary Waters (Kiev, 2003; signature by BiH in 2003)
- Framework Agreement on the Sava River Basin (Kranjska Gora,2002; ratification by BiH in 2003)

Source: JET based on UNECE, the Second Environmental Performance Review of Bosnia and Herzegovina, 2011.

3.2.2 Environmental Standards and Guideline Values

(1) General

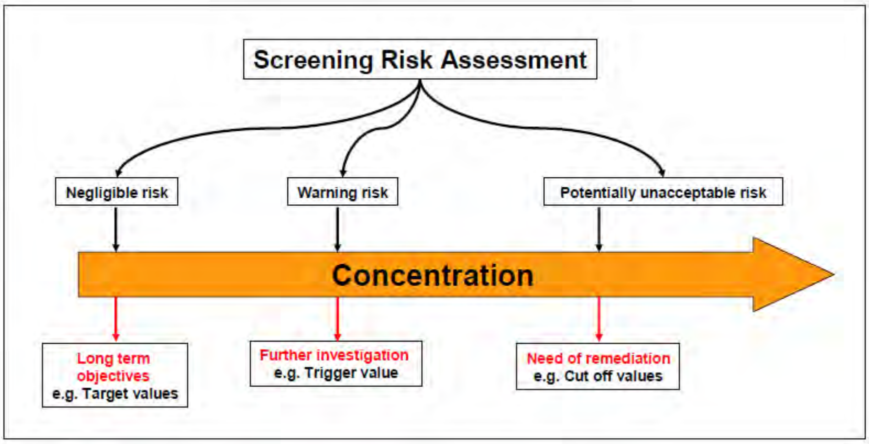
This section examines the environmental standards and guideline values that are used to define and control contaminated sites as environmental hotspots. In principle, two types of environmental standards are of interest, namely, (i) those used to characterize and evaluate a source of pollution (e.g., quality of soil and/or groundwater) in order to designate if the site is acceptable or not, and (ii) those related to the acceptable levels of exposure to receptors downstream of the source (see Figure 3.2-1).



Source: JET

Figure 3.2-1 Environmental Standards Relevant to the Management of Contaminated Site

For each environmental medium, there could be at least three levels of environmental standards corresponding to negligible, warning, and potentially unacceptable risks (see Figure 3.2-2).



Source: JET based on JRC, Carlon (edit.), Derivation method of soil screening values in Europe. A review and evaluation of national procedures towards harmonisation, 2007.

Figure 3.2-2 Screening Values for the Management of Contaminated Site

These values are used as (i) benchmark for long-term administrative target under which environmental risk is negligible considering long-term exposure, (ii) benchmark to screen environmental condition that requires more detailed investigation because of non-negligible environmental risk, and (iii) benchmark for environmental condition that requires remediation and other types of environmental intervention because environmental risk is unacceptable.

Table 3.2-2 summarizes the availability of relevant environmental standards in FBiH. Because human health and environmental risk aspects of many environmental standards are not clear, the classification of the standards in the table is only indicative. In addition to the environmental standards, emission standards are also listed for reference. Emission standards may not be relevant to the management of legacy pollution because they apply to pollution sources under operation.

Table 3.2-2 Classification of Environmental Standards/Guidelines in BiH

Media	Environmental Standard			Emission Standard
	Target Value for Ambient Environment	Trigger Value	Intervention Value	
Soil	No	No	For agricultural soil, Rulebook on Determining Permissible Amounts of Harmful and Hazardous Substances in Soil and their Method of Testing (Official Gazette of FBiH, No.72/09)	For agricultural application of sewerage sludge, Rulebook on Determining Permissible Amounts of Harmful and Hazardous Substances in Soil and their Method of Testing (Official Gazette of FBiH, No.72/09; for agricultural soil)
Sediment	No	No	No	No
Surface Water	Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH (Official Gazette of SR BiH, No. 18/80) Rulebook on Determining Areas Subject to Eutrophication and Sensitive to Nitrates (Official Gazette of FBiH, No.71/09) Rulebook on Sanitary Quality of Drinking Water (Official Gazette of BiH, Nos.40/10, 43/10, 30/12; drinking water)	Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH (Official Gazette of SR BiH, No. 18/80)	Decree on Hazardous and Noxious Substances in Water (Official Gazette of FBiH, No.43/07) Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH (Official Gazette of SR BiH, No. 18/80)	Decree on Conditions for Discharging Wastewater Into Natural Recipients and Public Sewer Systems (Official Gazette of FBiH, No. 4/12)
Ground Water	Rulebook on Determining Areas Subject to Eutrophication and Sensitive to Nitrates (Official Gazette of FBiH, No.71/09) Rulebook on Sanitary Quality of Drinking Water (Official Gazette of BiH, Nos.40/10, 43/10, 30/12; drinking water)	No	No	No
Air	Rulebook on the Method of Monitoring Air Quality and Defining the Types of Polluting Types of Pollutants, Limit Values and Other Air Quality Standards (Official Gazette of FBiH, No.01/12)	Rulebook on the Method of Monitoring Air Quality and Defining the Types of Polluting Types of Pollutants, Limit Values and Other Air Quality Standards (Official Gazette of FBiH, No.01/12)	Rulebook on the Method of Monitoring Air Quality and Defining the Types of Polluting Types of Pollutants, Limit Values and Other Air Quality Standards (Official Gazette of FBiH, No.01/12)	Rulebook on Limit Values of Emissions into the Air from Combustion Plants (Official Gazette of FBiH, No.03/13)
Waste	No	No	No	Rulebook on Waste Categories with Lists (Official Gazette of FBiH, No.9/05)

Note: The new decision on classification of surface water and groundwater, "Decision on categorization of surface water and groundwater, reference condition and parameters for evaluation of water conditions and water monitoring" (Official Gazette of FBiH, No.1/14) was not reviewed here, but it is expected to replace relvant standards on qualities of surface water and groundwater.
Source: JET

As discussed below, FBiH still lacks many environmental standards and guideline values, and consequently, it is difficult to legally designate a contaminated site or to evaluate exposure pathways within the legal framework. When a relevant standard or guideline value is not available within FBiH, European or American standards and guideline values are often cited. In many cases, this is practical and acceptable, although use of such values could lead to ambiguity on how administrative and legal decisions are made.

1) Soil

Soil quality standard is widely used to evaluate and designate contaminated sites, and also to assess possible risk of dermal exposure. In Japan, for example, the soil quality standard is the main tool for screening contaminated sites to be registered in the inventory of contaminated sites.

In FBiH, there is an intervention standard for agricultural soil, which defines the unacceptable levels of pollutants in agricultural soil. However, there is no standard for other types of soils, such as soils in residential and industrial areas, in important habitats, or soils in general. This makes it difficult to legally define "contaminated soil" in FBiH (unless the soil is agricultural). Similarly, there are no benchmarks for uncontaminated soil or soil that requires further environmental investigation. In order to evaluate the level of soil contamination, soil quality standards in European countries, such as the Netherlands and Germany, are therefore often referred to.

2) Sediment

There is no standard for sediment in FBiH.

3) Surface Water

Surface water can be an important exposure pathway for those living downstream of the site, especially those who use the water for drinking. Exposure through contaminated fish or contaminated irrigation water is also a concern.

According to Article 32 of the Law on Waters (Official Gazette of FBiH, No. 07/06), the status of a surface water body shall be determined by its ecological status (high, good, moderate, poor, or bad) and chemical status (good or bad). However, this classification system has not been fully implemented, and the Class I–Class IV system based on the "Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH (Official Gazette of SR BiH, 19/80)" from the time of Socialist Federal Republic of Yugoslavia is still in use. This decree from the former Yugoslavian republic lists the allowable concentrations of basic water parameters. For allowable concentrations of hazardous substances, there is the "Decree on Hazardous and Noxious Substances in Water (Official Gazette of FBiH, No. 43/07)". In addition, in December 2013, the Government of the FBiH adopted the Decision on Characterization of Surface Waters and Groundwaters, Reference Conditions and Parameters for Assessing Water Status and on Water Monitoring (Official Gazette of FBiH, No. 1/14).On the other hand, there is a central-level standard for drinking water, namely, the Rulebook on Sanitary Quality of Drinking Water" (Official Gazette of BiH, Nos.40/10, 43/10 and 30/12), which is considered for evaluating water quality of drinking water.

On the other hand, there is a central-level standard for drinking water, namely, "Rulebook on sanitary quality of drinking water" (Official Gazette of BiH, No.40/10), which is considered for evaluating water quality of drinking water.

It should be noted that there is a new decision entitled "Decision on categorization of surface water and groundwater, reference condition and parameters for evaluation of water conditions and water monitoring" (Official Gazette of FBiH, No.1/14). This decision is expected to replace relevant environmental standards as well as the methods of classification and monitoring of surface water and groundwater.

4) Groundwater

Groundwater is also a possible exposure pathway, especially for those using groundwater for drinking. Once contaminated, groundwater aquifer is very difficult to remediate, and it is of interest to evaluate groundwater quality.

Unfortunately, there is no environmental standard for groundwater quality in FBiH. However, drinking water standard is available. Also, as it is the case for surface water, the new decision on categorization of surface water and ground water (Official Gazette of FBiH, No.1/14) is expected to be introduce much needed environmental standard for groundwater.

5) Air

Exposure through air, including dust from site, can be a dominant route of exposure in the immediate vicinity of the site.

There is a "Rulebook on the Method of Monitoring Air Quality and Defining the Types of Polluting Types of Pollutants, Limit Values and Other Air Quality Standards (Official Gazette of FBiH, No. 01/12)". According to the Rulebook, air quality is regularly monitored at fixed macro- and micro-locations, and data are supplemented by monitoring at other locations. Macro-locations are used to monitor representative ambient air quality of several square kilometers, while micro-locations are for monitoring air quality affected by local pollution sources.

The rulebook sets the following: (i) limit value, which indicates the level determined on the basis of scientific knowledge with the aim of avoiding, preventing, or reducing harmful effects on human health and/or the environment as a whole; this level must be attained within a certain period and should not be exceeded later; (ii) tolerant value, which means the limit value plus the margin of tolerance; (iii) tolerant margin, which means the percentage of the approved overdraft limit value under prescribed conditions; (iv) target value, which indicates a certain level in order to avoid more long-lasting harmful effects on human health and/or the environment as a whole; this level must be attained within a certain period where possible; and (v) critical-level, which is the level determined on the basis of scientific knowledge, which when exceeded can result in direct adverse impacts on certain receptors, such as vegetation and natural ecosystems but not on humans. Among different media, environmental standards for air appear to be the most complete. It is important to note that this rulebook is intended mainly for ambient air quality monitoring at fixed locations that are representative of a large area, while exposure around a contaminated site may be highly localized. In such case, occupational health and safety standards are also relevant.

(2) Risk-based Criteria for Contaminated Site

Media-specific environmental standards and guideline values are easy to understand, straightforward to measure on site, do not require subjective and ambiguous judgment that becomes the source of dispute, and are considered good administrative tools for environmental management. However, such standard can only tell that the soil, air, or water is contaminated, and does not say if the site is dangerous to the people living around or to the ecosystem downstream of the site.

For this reason, many developed countries use risk-based approaches to evaluate contaminated site. In such approach, health risks or environmental risks associated with a contaminated site are evaluated based on exposure to human or target biota through different pathways. In order to evaluate exposure, one has to be able to estimate, in addition to the concentrations of pollutants in the environmental media (e.g., water), how much contaminated water a receptor is likely to consume in the long term, how much pollutant will be adsorbed by the body of the receptor after drinking water, and so forth. The results are evaluated based on risks, such as whether the increase in the estimated probability of developing cancer due to the exposure exceeds the threshold for acceptable risk, typically 10^{-5} or 10^{-6}. Such approach may be used to prioritize contaminated sites for remediation, and also to optimize remediation measures of each site based on risks associated with each pathway. In FBiH, a risk-based approach has not been introduced for the management of contaminated sites.

3.2.3 Waste Management

Although there is no law in FBiH that has been specifically formulated for the management of contaminated sites, the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09), by-laws adopted on the basis of the Law, and the Federal Waste Management Plan 2012-2017 represent the environmental regulations and policies most pertinent to the management of contaminated sites. These regulations cover all kinds of waste management activities, operations, and installations, including waste from mining activities. They address the following issues:

- Persons responsible for waste management,
- Management of waste with unknown composition and without owner,
- Handling and transporting of hazardous wastes,
- Activities for developing a list of hotspots and remediating priority sites and illegal waste disposal sites, and
- Financial mechanisms in dealing with waste management issues, including remediation of legacy pollution sites.

(1) Responsibility of Waste Management

According to the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09), the producer or holder of waste shall bear the costs of its prevention, treatment, and disposal. This is the general basis of liability under the Law on Waste Management. Also, according to the Federal Waste Management Plan 2012-2017, the Federation provides environmental remediation for locations highly loaded with hazardous wastes if the legal successor of the location is not known. While unexcavated contaminated soil is excluded from the Waste Framework Directive (2008/98/EC) of EU, it is apparently covered under the Law on Waste Management in FBiH.

(2) Management of Waste of Unknown Composition Without Owner

With respect to legacy pollution, the Rulebook on the Treatment of Hazardous Waste Not on the Waste List or Whose Content is Unknown (Official Gazette of FBiH, No. 33/03) stipulates that if waste with unknown composition is found, the cantonal inspector has the duty to inspect the waste, have it analyzed, and order 1) the owner of the waste to dispose the waste at an authorized operator, or 2) the authorized operator to dispose the waste in an environmentally friendly way. It also stipulates that the cost will be borne by the owner of the waste, and if the owner is not known, the necessary funds for waste disposal are provided from the municipal or cantonal budget.

(3) Management of Hazardous Waste

In order to remediate a polluted site, one of the most important issues to consider is whether the site is contaminated with a hazardous substance or not. Article 4 of the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09) defines hazardous waste as “any waste which is covered by separate regulations, has one or more of the properties hazardous to human health and to the environment due to its origin, composition, or concentration; and is in the list of wastes adopted by a separate regulation as hazardous”. It is also explained in detail in the Rulebook on Waste Categories with Lists (Official Gazette of FBiH, No. 09/05).

While the concept of hazardous waste is now well recognized, there is no waste disposal site for hazardous waste in FBiH as explained by the Federal Waste Management Plan 2012-2017. While shipping of hazardous waste to other countries is technically possible as BiH is a member country of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, it is very costly. The lack of hazardous waste disposal site is one of the most serious problems of remediation of contaminated sites in FBiH.

(4) Financial Mechanism for Remediation of Contaminated Sites

In principle, municipalities are responsible for the management of landfills. Based on the Federal Waste Management Plan 2012-2017, until regional waste management centers become available, action plans for the management and closure of municipal landfills should be developed, and municipalities have to come up with the financial plans in accordance with the action plans. With respect to remediation of environmental hotspots, the Federal Waste Management Plan 2012-2017 mentions that remediation requires substantial investment and funding can be provided through Environmental Protection Fund of FBiH and foreign donor funding.

(5) Activities Proposed in the Federal Waste Management Plan

Table 3.2-3 summarizes the activities related to the management of contaminated sites, or environmental hotspots, proposed in the Federal Waste Management Plan 2012-2017. Various activities have been proposed, which include the development of a list of hotspots; development of projects for rehabilitation of priority hotspots; making of a short-term program for removal of illegal landfills in all municipalities with assessment funds; and development of action plans for remediation of municipal landfills. These plans are all highly relevant to the remediation of hotspots, but many of the proposed activities are already behind the schedule.

Table 3.2-3 List of Selected Activities Related to the Management of Contaminated Sites Proposed in the Federal Plan for Waste Management 2012-2017

Activity	Year	Organization	Budget (BAM)	Source of Budget	Others
Make a short-term program for removal of illegal landfills in all municipalities with assessment funds	2012	Municipalities	200,000	Cantonal budget	-
Develop action plans for remediation of municipal landfills	2012	Municipalities	50,000 per plan	Cantonal budget	WB
Create and implement public campaign to raise awareness on consequences of inadequate disposal of waste on the environment and human health	2012-2014	Cantonal Ministries, FMoET, Ministry of Health of FBiH	200,000	Cantonal and federal budget; Environmental Protection Fund of FBiH	-
Define and develop a list of hot spots	2012-2013	FMoET	200,000	Federal budget	-
Develop projects for rehabilitation of priority hotspots	2015	FMoET	1,000,000	Federal budget	Donor funds
Remediate and close municipal landfills	2017	Municipalities	250,000,000	Municipal, cantonal and federal budget; Environmental Protection Fund of FBiH	EU, WB
Develop a Federal Management Plan of Hazardous Waste	2012	FMoET and cantonal ministries for environment	200,000	FMoET and cantonal ministries for environment	-
Establish the capacity to accept hazardous waste at RWMC	In accordance with dynamics of establishment of RWMC	FMoET and cantonal ministries for environment	1,000,000 (60,000-80,000 per RWMC)	FMoET and cantonal ministries for environment	WB

Note: RWMC: Regional Waste Management Center
Source: Federal Waste Management Plan 2012-2017

3.2.4 Control of Industrial Activities

This section examines the general legal framework related to the control of industrial activities. The following aspects of environmental legislation are pertinent to the management of contaminated sites:

- Control of industrial activities in FBiH,
- Remediation of contaminated sites in the framework of environmental permitting, and
- Control and treatment of environmental accidents and treatment of such once occurred.

Current legislative systems for the control of industrial activities in FBiH focus largely on the prevention of environmental pollution, while the provisions on remediation of contaminated sites are limited.

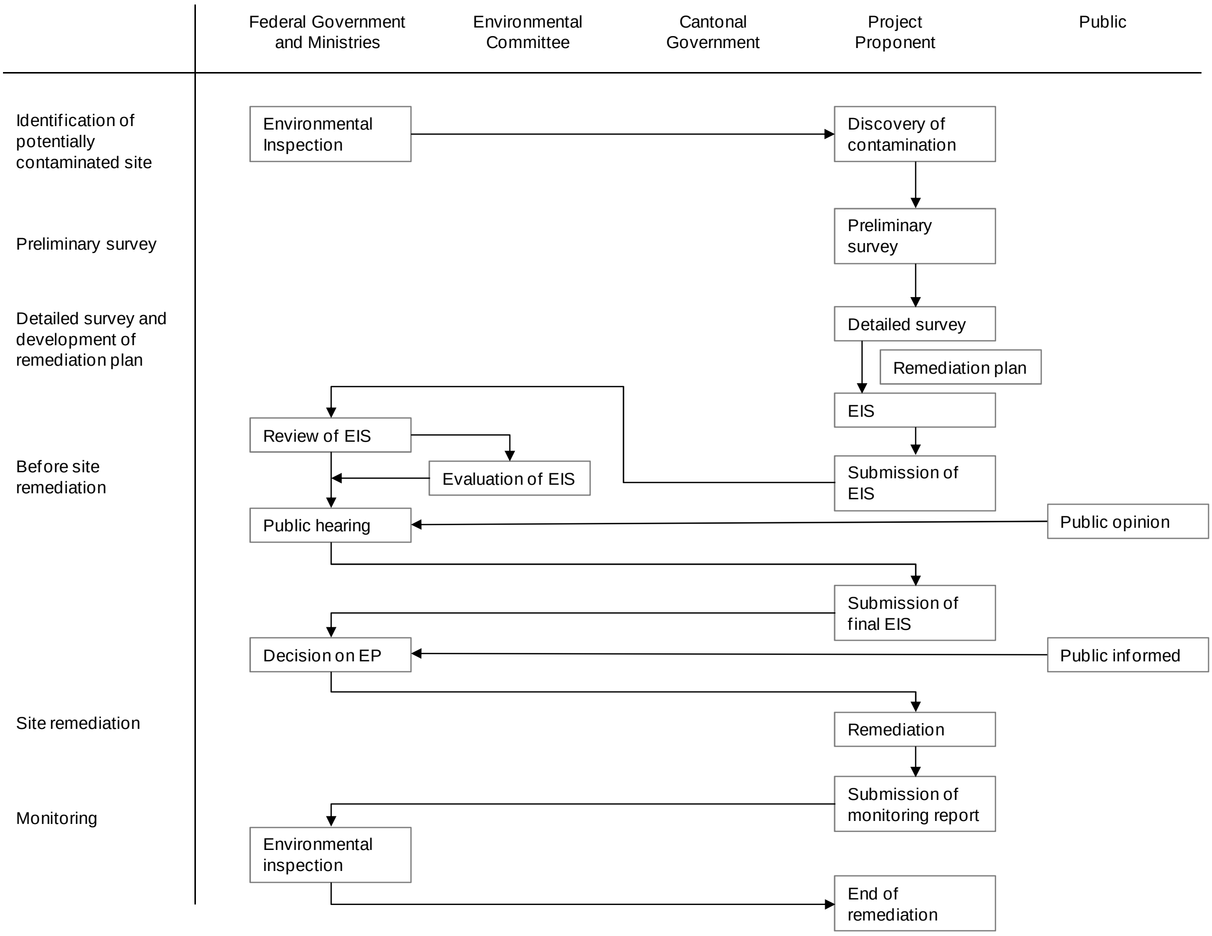
(1) Control of Industrial Activities

Article 67 of the Law on Environmental Protection (Official Gazette of FBiH, Nos.33/03 and 38/09) articulates the basic obligations of an operator, which include the following: not endanger or impair the health of people in the impact zone and the environment; take preventive measures against pollution; minimize waste generation and use of natural recourses; prevent accidents; and upon cessation of activities, return the site to a satisfactory state where all environmental quality standards relevant to the site of the installation, especially those concerning protection of soil and water, are met.

Industrial activities are controlled through the issuance of environmental permit. For large- and medium-scale activities that require an environmental impact assessment (EIA), an EIA based on the Rulebook on Plants and Facilities Subject to Obligatory Environmental Impact Assessment, and on Plants and Facilities that can be Constructed and Commissioned Only if Granted an Environmental Permit (Official Gazette of FBiH, No.19/04), is a prerequisite for an environmental permit. For selected industrial sectors, such as paper, metal finishing, surface and underground mining, and power plant, best available techniques (BAT) are required based on the IPPC Directive (2008/1/EC) of EU. It was noted that under the recast IPPC Directive (2010/75/EU), a baseline report is required for all sites where the activity involves the use, production, or release of hazardous substances and has the possibility of soil and groundwater contamination.

(2) Remediation of Contaminated Sites and Environmental Permitting

As is the case for general pollution control in on-going industrial activities, environmental permitting is the main administrative tool to manage remediation of industrial sites in FBiH. In particular, Article 67 of the Law on Environmental Protection (Official Gazette of FBiH, Nos.33/03 and 38/09) requires that “necessary measures are taken upon cessation of activities to avoid any pollution risk and to return the site of operation to a satisfactory state” when terminating a project that requires an EIA. Similarly, Article 56 of the same Law stipulates that “termination of the operation of the projects and demolishing the sites in connection with such decommissioning are subject to EIA”. Also if the site of the project is contaminated when the project is started, remediation of the site is included in the condition for the environmental permit for operation. Figure 3.2-3 summarizes the typical processes of remediation of contaminated industrial sites. In this process, the proponent of the project carries out the remediation project, and FMoET and the Federal Inspectorate are the main organizations overseeing the project.



Note: EIS: Environmental Impact Study; EP: Environmental Permit
Source: JET based on Enova d.o.o. SarajevoSarajevo, Final Report of "Survey for Strategic Environmental Assessment (SEA) for the Project for Master Plan for Hotspots in Bosnia and Herzegovina", 2014.

Figure 3.2-3 Flow Chart of Remediation of a Contaminated Site based on Environmental Permit

(3) Environmental Accident

With respect to prevention of environmental accidents, industries with hazardous substances have to submit a report on the state of their security, which shall contain at least: i) the plan for the prevention of major accidents; ii) location of plants and facilities; iii) facilities and plants; iv) identification and analysis of potential risks and prevention measures; and v) measures of protection and intervention plan to prevent the spread of the consequences of the accident, in accordance with the Rulebook on the Contents of the Report on the State of Safety, Contents of Information on Safety Measures, and Contents of Internal and External Intervention Plans" (Official Gazette of FBiH, No. 48/05).

In the event of an accident, the operator has to report to the competent ministry in accordance with Article 76 of the Law on Environmental Protection (Official Gazette of FBiH, Nos.33/03 and 38/09). The operator is strictly liable for the damage caused by the activity irrespective of fault. This issue is stipulated separately in Articles 103-111 of the aforementioned Law on Environmental Protection, and discussed later in this chapter.

3.2.5 Control of Mining Activities

FBiH has a long history of mining, which is one of the primary industries of FBiH. Mining operation is usually large in scale, and once an environmental problem occurs in the mining sector, it tends to be significant in magnitude. Failure of tailings dams is a good example of environmental disaster related to mining operation. Many mines in FBiH are metal mines extracting lead, zinc, iron, aluminum, etc., which means large quantities of concentrated metals, many of them are toxic, exist at the site. Many of the mining sites are considered environmental hotspots (see Chapter 2). In controlling contaminated sites in the mining sector, the following two questions are most pertinent:

- How environmental issues are addressed in the mining sector, which is governed by regulatory systems different from those for manufacturing sectors?
- How abandoned mines are controlled?

(1) Regulation of Environmental Issues in the Mining Sector

In many countries, environmental issues in the mining sector are regulated through mining regulations. Hence, it is of interest to examine how environmental issues are treated in the Law on Mining (Official Gazette of FBiH, No. 26/10).

Mining activities in FBiH are controlled through a series of licenses and permits. Among these are license for extraction, permit for works according to the mining project, permit for use of mining facilities, plant, equipment and installations, and permit for execution of the work, in accordance with Article 37 of the Law. All of such permits are based on the mining project plan. Environmental permit is a prerequisite for the license for extraction.

As stipulated in Article 17 as well as Article 109 of the Law, the mining contractor must comply with regulations on environmental protection. In accordance with Article 39, the extraction license would be revoked if the operation threatens the environment and the reclamation of areas damaged by the mining works is not performed according to the approved project plan.

Before closing the mining operation, the mining company has to obtain the permission for suspension of operation in accordance with Article 42 of the Law. Then, the contractor has to carry out the final remediation of the land and environment and eliminate the consequences arising during the execution of the mining activities based on the project of remediation and reclamation, in accordance with Article 59. Article 61 stipulates that the contractor shall defray the costs for eliminating the damage caused by mining activities. Also, in accordance with Article 109, the company cannot obtain a license for a new mining field if it fails to make a technical reclamation to its previously approved mining field.

As it is clear from the above, the Law on Mining does provide a number of clauses related to environmental protection, although the environmental aspects of mining in FBiH are largely controlled through environmental permits and environmental regulations, such as the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09) and Law on Waste Management (Official Gazette of FBiH, Nos.33/03 and 72/09).

(2) Remediation of Abandoned Mines

With respect to abandoned mines, the Law on Mining (Official Gazette of FBiH, No.26/10) defines "reclamation of abandoned and extraction spaces includes all actions necessary to be performed in a mining area for the purpose of final remediation and revitalization of areas degraded by mining operations according to the mining project". However, there is no special clause on remediation of abandoned mines, and there is no mechanism to pool money for the remediation of abandoned mines.

3.2.6 Environmental Liability

This section examines the issue of environmental liability associated with a contaminated site – who is responsible for remediation of the site and in what way. These are highly complex and sensitive issues because remediation often costs millions of euros and the liable party has to bear the cost. The concept of environmental liability has been introduced in Articles 103 to 111 of the Law on Environmental Protection (Official Gazette of FBiH, Nos.33/03 and 38/09). Article 104, which refers to the liability for activities dangerous to the environment, stipulates that "the operator of an activity dangerous to the environment is liable for the damage caused through this activity to persons, property, or the environment, irrespective of fault". This seems straightforward for a pollution problem caused by present operators of the installation. However, in order to deal with issues of a site contaminated in the past and transferred to another party due to bankruptcy or land transaction, liability issues become very complex. Some of the key questions include:

- How far back in time does the polluter become legally liable for the pollution he/she had caused?
- Is a landowner liable for pollution in his/her property even if he/she did not pollute the site?
- Is the liability transferred in business transaction?
- Who will bear the cost to demonstrate the contamination caused the damage?
- Who has the stand to file a legal case against a polluter?
- If pollution is caused by gross negligence or willful misconduct of the polluter, is this considered a criminal activity?
- What is the responsibility of the environmental authority in controlling pollution?

In order to answer such questions, one has to be familiar with the Law on Obligations (Official Gazette of FBiH, Nos. 29/03 and 42/11) which is widely used in FBiH to settle issues related to personal damages to health and properties. Also, knowledge on other civil/criminal/contractual laws, such as the Criminal Code (Official Gazette of FBiH, Nos. 36/03, 37/03, 21/04, 69/04, 18/05, 42/10 and 42/11), the Law on Criminal Procedure (Official Gazette of FBiH, Nos. 35/03, 37/03, 56/03, 78/04, 28/05, 55/06, 27/07, 53/07, 09/09, 12/10 and 08/13), the Law on Administrative Disputes (Official Gazette of FBiH, No. 09/05), and the Law on Administrative Procedure (Official Gazette of FBiH, Nos. 2/98 and 48/99) becomes important.

Because of the complexity of the issues, a detailed review of the liability issues is beyond the scope of this Project. But considering its importance, the Project requested local lawyers to prepare a report on the current status of environmental liability in FBiH. It is not simple to summarize the current status, but the salient features of the current liability frameworks related to sites contaminated in the past may be summarized as stated below.

Under the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09) and the Law on Obligations (Official Gazette of FBiH, Nos.29/03 and 42/11), the current site owner is generally considered to be the operator liable for remediation of the contaminated site as he has the control over the site. This means any landowner in FBiH could potentially become liable whether or not he had actually polluted his land, and there is no provision to exempt innocent landowners from the liability. The issue is further compounded by the fact that there is no legal definition of a contaminated site in FBiH.

If the current site owner does not agree with such injunction, the site owner can file a law suit against a wide range of parties who had control over the site, including former operators who operated/controlled the installation, environmental authority, and others. There is no provision for exemption of retrospective liability, and any party who had some involvement with the site from the past could potentially be dragged into the problem.

3.2.7 Information Disclosure

BiH is a member country of the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (usually known as the Aarhus Convention), and (i) access to environmental information, (ii) public participation in environmental decision-making, and (iii) access to justice (right to appeal) are covered in the Law on Environmental Protection (Official Gazette of FBiH, Nos.33/03, 38/09).

Public participation and information disclosure are stipulated first in Article 10 as “each individual and organization shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes”. Then, Chapter V of the law is dedicated to environmental information and education. Article 28 requires the ministry responsible for environmental affairs to keep registers of installations and of pollution. Access to environmental information is covered in Articles 33-37 of the Law. According to Article 33, “the Federal Ministry, upon the request of the concerned person, shall make available environmental information to the public". Also, Article 36 discusses the procedures of public participation in decisions on specific activities, especially the public consultation in EIAs and environmental permitting.

3.2.8 Administrative Dispute

Individuals and non-governmental organizations can exercise the right of access to justice through an administrative dispute to challenge acts and omissions by private persons and public authorities. Article 39 of the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09) stipulates that "the members of the public concerned have the right to appeal and to initiate a review procedure before the court to challenge the substantive and/or procedural legality of any decision, act or omission". Similarly, Article 15 of the Law on Administrative Disputes (Official Gazette of FBiH, No. 09/05) opens the possibility of legal proceedings to administrative decisions. Within the prescribed time limit, the defendant (administrative body) is obliged to submit to the court all the documents related to the case. If the defendant fails to submit the case files or states that he cannot send them, the court may resolve the matter without the files, if the action contests the challenged administrative act due to misapplication of substantive law (Council of Ministers of BiH, Answers to the List of EU Questions on Chapter 27, Environment, 2012).

3.2.9 Legal Issues

(1) Gaps between the Regulatory Systems in FBiH and European Directives for Management of Environmental Hotspots

1) Relevant European Directives

Table 3.2-4 lists the selected European directives and thematic strategies related to the management of environmental hotspots. There are some 70 directives in the area of environment, and if the regulations and decisions are included, the number rises to more than 120. Thus, only those that are highly relevant are listed in the table.

Table 3.2-4 Selected European Directives and Thematic Strategies Related to the Management of Environmental Hotspots

Area	Directive	Relevance		Aspects Related to the Management of Environmental Hotspots
		Directly	Indirectly	
Horizontal	Environmental Impact Assessment Directive (85/337/EEC)	-	√	Provide a working mechanism for prevention of contamination.
	Directive on Access to Environmental Information (2003/4/EC)	-	√	Provide a mechanism for information disclosure.
	Environmental Liability Directive (2004/35/EC)	√	-	Clarify liability for environmental damages, and responsibilities of operator and public authority in managing environmental hotspots.
Waste	Waste Framework Directive (2008/98/EC)	-	√	Define requirements for minimization, recycle, reuse, and final disposal of all kinds of wastes, including hazardous wastes. Unexcavated contaminated soil is excluded from the directive.
	Landfill Directive (1999/31/EC)	-	√	Define measures, procedures, and guidance to prevent or reduce negative environmental impact of landfill including landfills for hazardous waste and closure of landfills.
	Directive on the Disposal of PCBs and PCTs (96/59/EC)			Compile and regularly update inventories of equipment containing PCBs.
	Directive on Management of Waste from Extractive Industries (2006/60/EC)	-	√	Require inventory of closed mining waste facilities and also closure and after-closure procedures for mining waste facilities.

Area	Directive	Relevance		Aspects Related to the Management of Environmental Hotspots
		Directly	Indirectly	
Water	Water Framework Directive (2000/60/EC)	-	√	Serve as a framework directive for sustainable management of water and achieving "good status" for all waters.
	Drinking Water Directive (98/83/EC)	-	√	Ensure drinking water is free from substances that constitute danger to human health.
	Directive on Protection of Groundwater (2006/118/EC)	-	√	Require members to establish national standards (threshold values) for groundwater, and prohibit discharge into groundwater of prohibited substances.
Air	Air Quality Framework Directive (96/62/EC) and its daughter directives	-	√	Serve as a framework directive to establish objectives for ambient air quality in the EU, assesses ambient air quality and dissemination information using common methods and criteria, and maintain and improve ambient air quality.
Soil	Thematic Strategy for Soil Protection (COM(2006)231) and proposal for Soil Framework Directive.	√	-	Under discussion in EU. Within the framework of wider soil protection, take measures to limit the introduction of dangerous substances into the soil. Set up an inventory of contaminated sites, a mechanism for funding the remediation of orphan sites, preparing a soil status report, and establishing a national strategy for the remediation of identified contaminated sites.
Industrial	Directive on Integrated Pollution Prevention and Control (96/61/EC) and its recast (2010/75/EU)	-	√	Require industries to adopt integrated measures (best available techniques) for prevention and control of pollution. The recast of IPPC now requires reporting of status of soil and groundwater contamination.
	Major Accidents and Emergencies Directive (96/82/EC)	-	√	Require operators that handle hazardous substances to take preventive measures, and also require the environmental authority to impose procedural requirements.
Environmental Crime	Environmental Crime Directive (2008/99/EC)	-	√	Set minimum requirements to be implemented in national criminal laws

Source: Edited by JET based on World Bank, International Experience in Policy and Regulatory Frameworks for Brownfield Site Management, 2010; Regional Environment Center, Handbook on the Implementation of EC Directives, 2007.

2) Environmental Liability Directive

Under the current legislative framework in EU, the directive most pertinent to the management of environmental hotspots is the Environmental Liability Directive (2004/35/EC)[1], which sets out, based on polluter-pays-principle, a framework to prevent and remediate damages to protected species and natural habitats, water damages, and land damages. It requires the operator to take necessary preventive and restorative measures for environmental damage. If the operator is not in a position to take preventive or restorative measures, these should be undertaken by the competent authority and the costs recovered at a later date. See Chapter 6 on "Clarification of Liability Framework" for more explanation about the Environmental Liability Directive. Some of the critical tasks for the transposition of this directive include:

- Identify the competent authority (or authorities) that shall have responsibility for implementing the directive and ensure that adequate financial, human, and technical resources are provided.

[1] Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (OJ L 143, 30.4.2004), as amended by Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC (OJ L 102, 11.4.2006).

- Consider whether to integrate the directive into existing environmental liability procedures, whether to combine procedures or to have separate procedures.
- Design the assessment procedure by which the competent authority can evaluate whether environmental damage has taken place and an operator is liable.
- Develop a procedure for determining when the competent authority should take remedial action.
- Provide clear legal rules and guidance on the scope of the directive with respect to environmental and biodiversity damage as well as the permissible exceptions.
- Create a procedure and guidelines for dealing with prevention and mitigation activities while ensuring that the restoration/remediation of the environment takes place in an effective manner ensuring that the relevant restoration objectives are achieved.
- Create a procedure for ensuring that the liable operator restores the damaged environment.
- Create a procedure for the competent authority to restore the damaged environment, in cases where a liable operator cannot be found and the polluter-pays-principle cannot be applied.
- In cases where there are several instances of environmental damage that cannot all be remediated at the same time, create procedures by which the competent authority can prioritize remediation and clean-up.

A more complete list of tasks for transposing this directive at the stages of planning, regulation, guidance and training, consultation, and reporting is detailed in the Handbook on the Implementation of EC Environmental Legislations 2008. Chapter XIV of the Civil Liability for Environmental Damage of the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09) stipulates the basic provisions in line with the directive. Nevertheless, the tasks for transposing the directive to FBiH have not been started.

In order to transpose this directive, harmonization with existing civil liability legislations, especially the Law on Obligations (Official Gazette of FBiH, Nos. 29/03 and 42/11), has to be taken into consideration. Also, while highly pertinent to the management of environmental hotspots, this directive does not apply to historical pollution, and FBiH has to decide whether to extend the environmental liability framework to historical pollution or not. There are other issues to be clarified such as the liability of innocent landowners, support for incompetent operators, liability of multiple operators including different members of a joint stock company, and criteria for governmental intervention, among others. The draft master plan developed in this Project covers some of these issues.

3) Thematic Strategy for Soil Protection

In 2006, the European Commission released a document entitled the “Thematic Strategy for Soil Protection (Com(2006)231)” together with a proposal for Soil Framework Directive (COM/2006/0232) that amends the Environmental Liability Directive (2004/35/EC) in order to promote the protection of soil and preservation of its capacity to perform its functions. In addition to the issues of erosion, organic matter decline, compaction, salinization, and landslides, the proposed directive addresses the issues of contaminated soils. According to the proposal, the members states are supposed to draw up a list of sites contaminated by dangerous substances at the levels that pose a significant risk to human health and the environment, and of sites where certain polluting activities have been carried out. The proposed directive further suggested that when these sites are sold and the transaction is made, the owner or potential buyer must submit a report prepared by a licensed body to the competent authority. For these reasons, the strategy and the proposed directive are highly pertinent to the management of contaminated sites in FBiH.

However, further progress of the directive was blocked by some states in 2010, and the directive has not been approved yet. In 2012, the European Commission published a policy report on the implementation of the strategy and ongoing activities, and invited the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions to submit their views on it.

4) Other Directives

In addition to the Environmental Liability Directive (2004/35/EC) and the Thematic Strategy for Soil Protection (COM(2006)231), many directives are important for the remediation of environmental hotspots, as explained in Table 3.2-4. Examples of such directives include those related to environmental permitting (e.g., IPPC Directive 96/61/EC and 2010/75/EU and Environmental Impact Assessment Directive (85/337/EEC)), directives related to hazardous waste and mining waste (e.g., Waste Framework Directive (2008/98/EC) and Directive on Management of Waste from Extractive Industries (2006/60/EC), and directives related to landfills (e.g., Waste Framework Directive (2008/98/EC) and Landfill Directive (1999/31/EC)), among others. The statuses of approximation of these directives in BiH have been regularly reported by BiH to EU and reviewed (e.g., refer to Councils of Ministers of BiH, Answers to the List of EU Questions on Chapter 27, Environment, 2012; European Commission, Bosnia and Herzegovina 2013 Progress Report; UNECE, Second Environmental Performance Review, 2011). Most recently, the EU-funded project entitled “Strengthening of Bosnia and Herzegovina’s Environmental Institutions and Preparation for Pre-Accession Funds” carried out a series of legal gap analysis on environmental acquis and drafting of the environmental approximation strategies. For the details of the current statuses of approximation, please refer to these documents.

Let it suffice to point out that the approximation of environmental acquis in BiH is still slow, and as pointed out by the European Commission, “the establishment of a harmonized legal framework for environmental protection, adequate administrative capacity, and a functioning environmental monitoring system remain the priorities” (European Commission, Bosnia and Herzegovina 2013 Progress Report).

(2) Shortage of Bylaws and Standards

The management of contaminated sites in FBiH is covered in the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09), and there are many laws that govern related issues, such as discharge and transport of hazardous waste, discharge of wastewaters, control of industrial activities, and control of environmental accidents. Nevertheless, most of these laws and regulations have been developed to prevent and control pollution from existing installations. When it comes to controlling and remediating contaminated sites polluted in the past, the current legal frameworks still lack many details. Among the important problems are:

- Contaminated site is not defined in the laws.
- There are no technical guidelines regarding how a site should be investigated, how remediation goals should be set, and how a site should be remediated.
- The current legal frameworks for environmental liability have various problems (e.g., innocent site owners, retrospective liability, and support for incompetent site owner) on effectively resolving issues of contaminated sites.

These problems are compounded by other practical problems, such as the lack of disposal site for hazardous waste in FBiH.

(3) Lack of Detailed Strategy

Another problem is the lack of a detailed strategy for the management of environmental hotspots. Currently, the Federal Waste Management Plan (2012-2017) is the only strategy, and FBiH needs more detailed strategies that clarify goals for governmental actions and interventions, priorities among different sites, mobilization of resources for remediation, and capacity development to achieve the goals. The main problem is that right now, nobody has enough information on the environmental hotspots, which makes it difficult to develop a detailed strategy.

3.3 Institutional Background

This section reviews the institutional aspects of the remediation of contaminated sites. There are four layers of public administration in BiH, namely: central, entity, canton and municipality, and all of them play important roles. Information given in this section was largely taken from "Answers to the List of Questions on Chapter 27 Environment, Council of Ministers, Bosnia and Herzegovina, 2012".

As explained in Chapter 1, the Constitution of Bosnia and Herzegovina organizes the state into administratively divided entities, the Federation of Bosnia and Herzegovina (FBiH) and Republika Srpska (RS). In addition to the entities, there exists also the Brčko District of Bosnia and Herzegovina (BD), as a local self-government unit. According to the Constitution of Bosnia and Herzegovina, state level authorities are not directly responsible in matters of environmental protection. However, the Law on Ministries and other Administrative Bodies of Bosnia and Herzegovina (Official Gazette of BiH, Nos. 5/03, 26/04, 42/04, 45/06, 88/07, 35/09, 59/09 i 103/09), designates the Ministry of Foreign Trade and Economic Relations of BiH (MoFTER BiH) as the responsible state level authority to conduct activities and tasks related to the definition of policy, basic principles, coordination of actions and harmonization of plans of entity authorities and representation at the international level.

According to the RS Constitution, RS institution organize and provide for Environment protection. When it comes to the Federation of BiH, the Constitution of FBiH envisages that the Federation Government and cantons share responsibilities in environmental protection. Concerning Brčko District, it has responsibility over all fields which are not responsibility of the state. Accordingly, the Government of Brčko District has responsibilities that are entrusted to entities, municipalities (and cantons in FBiH) when it comes to environmental protection.

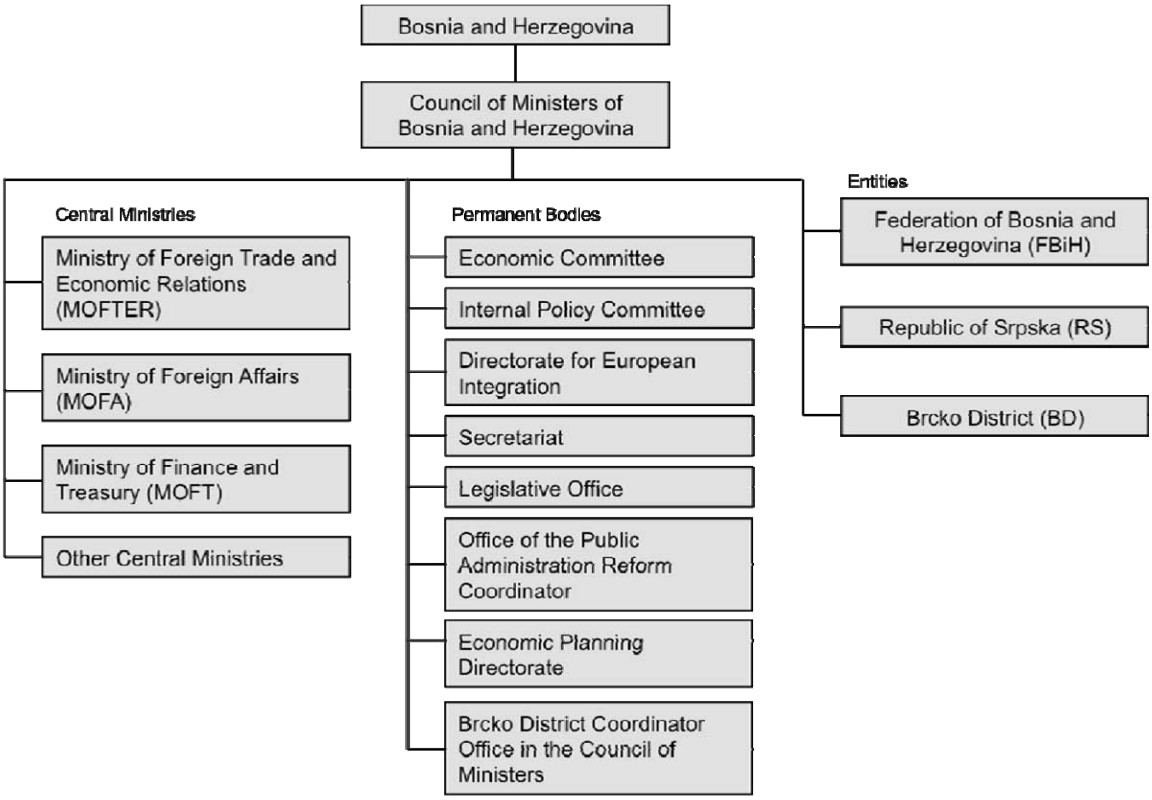
3.3.1 Organizational Structures

(1) Central Level

Figure 3.3-1 summarizes the organizations at the central level at the central level. MoFTER is the most pertinent organization for environmental management. One of the eight divisions in MoFTER is the Division for Natural Resources, Energy and Environment Protection, with about 30 staff members. There are six departments in the division, namely: (i) environment, (ii) primary energy and policies, (iii) secondary energy and projects, (iv) tourism, (v) water resources, and (vi) implementation of projects.

Although the legal authority to formulate policy and legislation is largely delegated to the entity-level organizations, MoFTER is an important institution because it is the focal point of international environmental initiatives, which are important driving forces for local environmental management in BiH, including remediation of environmental hotspots. Examples of such international initiatives include environmental treaties, such as the Stockholm Convention on Persistent Organic Pollutants (POPs). Currently MoFTER is supporting physical removal of PCBs through the Stockholm Convention. MoFTER also coordinates various international environmental projects, including this Project and a UNDP project with Czech Republic on remediation of sites contaminated with hydrocarbons.

Also, MoFTER plays a key role in activities related to the accession to EU, such as various dialogues with EU representatives, development of strategies for accession, coordination with various organizations at entity and lower levels toward transposition of environmental acquis, and securing of pre-accession funds.



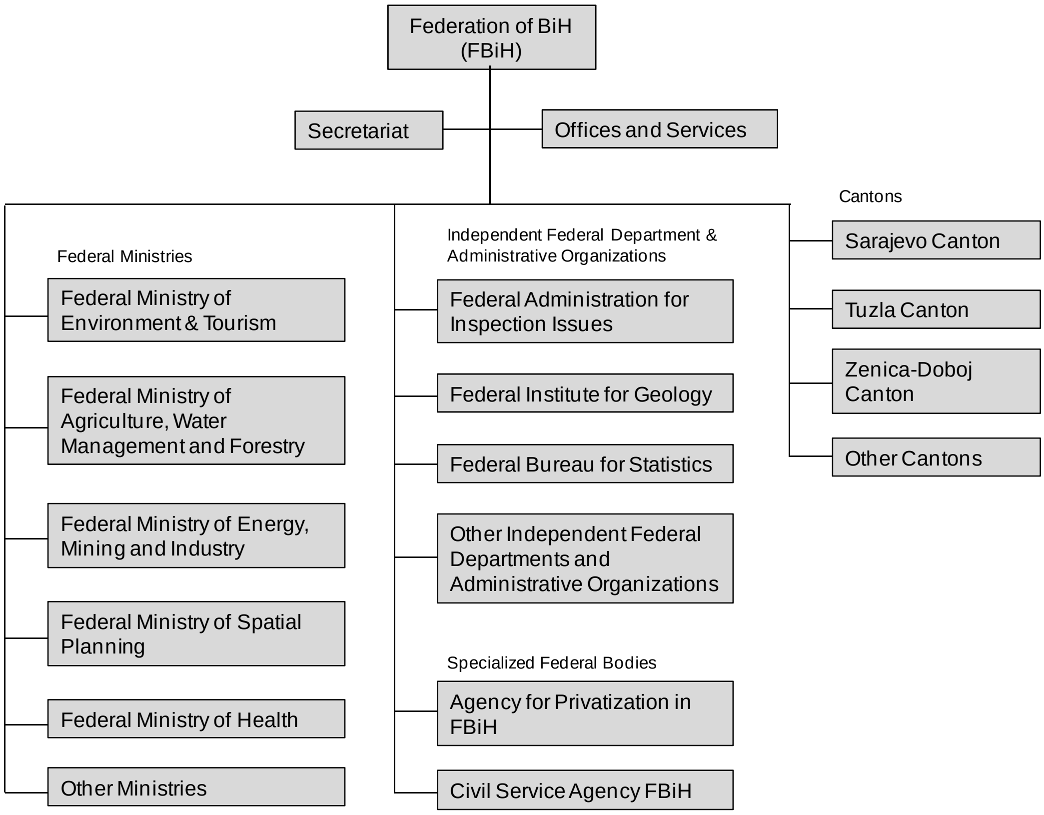
Source: JET

Figure 3.3-1 Organizational Diagram of Bosnia and Herzegovina

(2) Entity Level

Figure 3.3-2 summarizes the organizational chart of FBiH.

In FBiH, the Ministry of Environment and Tourism (FMoET) has the responsibilities for general environmental protection. Two divisions in FMoET are pertinent to environmental management, namely, the Division for Environmental and the Division for Environmental Permitting. These two divisions have a total of 48 work posts, but only 16 of them have been filled. FMoET is particularly pertinent to the remediation of environmental hotspots because it (i) evaluates the environmental impact study (EIS) and issues the environmental permit for site remediation projects; (ii) deals with waste management issues, including hazardous waste generated during site remediation; (iii) carries out administrative supervision of the Fund; and (iv) is in charge of developing related environmental laws, regulations, and policies. According to the Federal Plan for Waste Management 2012-2017, the Federation is responsible for environmental remediation at locations which are highly contaminated with hazardous waste and where the legal owner is not known.



Source: JET

Figure 3.3-2 Organizational Diagram of the Federation of Bosnia and Herzegovina

The Ministry of Agriculture, Forestry and Water Management(MoAWF) is in charge of policies for surface water and groundwater. Twelve out of about 100 staff members in the ministry work in water management. MoAWF prepares the Federal Water Management Strategy (WMS), designates water bodies, and issues authorizations for water testing laboratories. Meanwhile, rivers and lakes in FBiH are classified into Class I and Class II waters in accordance with Article 5 of the Law on Waters (Official Gazette of FBiH, No. 07/06). Class I waters are managed by the Water Agency for Sava River Basin District (63 employees) and the Water Agency for Adriatic Sea River Basin District (30 employees). The responsibility for issuing water permit for Class I, maintaining water management structures, and conducting water and water quality monitoring are delegated to these water agencies. Hence, prevention of pollution of Class I water bodies is very important to the water agencies.

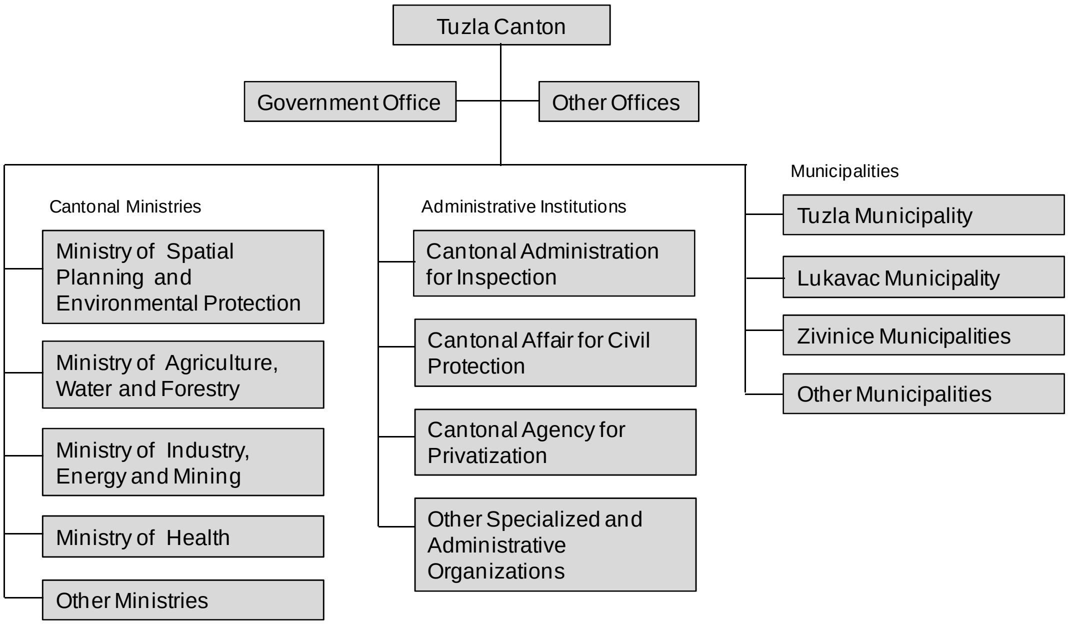
The Ministry of Energy, Mining and Industry (FMoEMI) is in charge of developing mining policies and issuing mining permits including the permit for permanent closure of mining operation at the entity level.

Another important organization is the Federal Administration for Inspection Issues (Inspectorate). The Inspectorate is an independent federal organization organized under the Law on Inspections (Official Gazette, No. 69/05), and there are a total of 15 inspectors for urban water management and environmental inspections. About six of them specialize in environmental affairs. The main task of environmental inspectors is enforcement of Federal laws and regulations on the environment. Federal inspectors are the frontline officers of the Federal government who are well aware of the environmental issues on the sites. Together with the cantonal inspectors, Federal inspectors play very important roles in identifying environmental hotspots, initiating administrative procedures, following up remediation processes, and communicating with polluters as well as local residents and other stakeholders.

The Environmental Protection Fund of FBiH is a non-profit public institution created based on the Law on Environmental Protection Fund of FBiH (Official Gazette of FBiH, No. 33/03). It manages the Environmental Protection Fund collected from special tariff paid for registering motor vehicles, tariff paid by polluters for the amount of air emissions, a part of the water tariffs, budget of FBiH, and other sources. For environmental projects in FBiH, the Environmental Protection Fund of FBiH has so far invested around BAM 40 million (or about EUR 20 million) from accumulated funds and funds that have been raised during its period of operation (2010-2012) (MoFTER, State of the Environment Report of Bosnia and Herzegovina 2012). The Fund has been used to implement environmental improvement projects, including site remediation projects. Details are discussed in See Chapter 6.

(3) Canton Level

Figure 3.3-3 shows the organizational structure of Tuzla Canton. There are ten cantons in FBiH, and they generally have similar structures.



Source: JET

Figure 3.3-3 Organizational Diagram of Tuzla Canton

The Ministry of Spatial Planning and Environmental Protection of Tuzla Canton is in charge of a number of functions related to the management of environmental hotspots. Among these are development and implementation of the spatial plan of the canton, issuance of urban-technical documentation (urban planning consent, building permits, and use permits), issuance of environmental licensing at the canton level, collection and distribution of funds to finance environmental protection, and establishment and maintenance of a registry of plants and pollution. There are nine employees in the ministry, two of whom are engaged mainly in environmental issues. Other cantons also have a similar ministry, although most cantons have only two or three environmental officers at the most. For example, Zenica-Doboj Canton used to have only one environmental officer, now two.

The Ministry of Agriculture, Water and Forestry of Tuzla Canton has four departments, among which the Department of Water Resources, Forestry and Timber Industry is pertinent to the remediation of environmental hotspots. Some of the duties of the department include the management, planning, utilization, and protection of water and watercourses, as well as the establishment of an information system of integrated water management including databases on water and cadastre of polluters.

Aside from these ministries, the Cantonal Administration for Inspection is highly relevant to the remediation of environmental hotspots. There is only one environmental protection inspector in Tuzla Canton, and the situation is similar in other cantons (from 2014, an apprentice is working under the environmental protection inspector in Tuzla). Activities of inspectors are important because they are responsible for on-site enforcement of environmental regulations, and often they are the ones who spot unacceptable environmental situation. Also, they are the ones who respond to environmental complaints from local residents.

3.3.2 Institutional Issues

(1) Shortage of Human Resources

One of the biggest problems is the shortage of human resources for environmental management. Even in Tuzla with a territorial area of 2,649 km^2 and population of about 500,000, those in charge of pollution issues only include a few officers from the Ministry of Spatial Planning and Environment and one environmental inspector. According to the State of the Environment Report of FBiH (FMoET, 2010), environmental officers in many EU countries are about 20 officers per 100,000 population. It is not simple to compare such numbers internationally, because the way each country tallies statistics is different. For example, in some countries, those engaged in the management of natural parks and forests are considered environmental officers, while in other countries, they are not. Nevertheless, there is no doubt that local environmental authorities in FBiH are significantly inadequate. In Japan, the number of local government officers involved in resolving pollution-related complaints is 11,292 officers per 128 million population, which is about 8 officers per 100,000 people (Ministry of Internal Affairs and Communications, Report on Committees for Resolution of Environmental Disputes, 2012).

The number of environmental officers at the state or central level in BiH is 0.08 officer per 100,000, as compared to that in other EU countries, ranging from 2.4 in Germany to 20 in Finland, according to the State of the Environment Report of FBiH (FMoET, 2010). In Japan, the Ministry of Environment at the central level has 1,235 staff in 2011, or 1.0 officer per 100,000 population, which are engaged in tasks of different areas of national policy making. Again, the comparison is not straightforward. In BiH, environmental authorities at the entity level (e.g., Division of Environment of FMoET) are engaged in policy-making tasks similar to those done by the state-level authorities in other countries. Even considering such aspects, environmental policy makers are significantly lacking in BiH, especially if the daunting tasks of approximation of European acquis are considered.

(2) Limited Expertise

Another main problem is the shortage of experts specializing in different aspects of remediation of environmental hotspots, which include, but not limited to:

- Site investigation,
- Risk assessment,
- Remediation technologies,
- Resolving liability and other legal issues,
- Environmental communication, and
- Support for victims.

It was noted that environmental authorities have no in-house laboratories for environmental analysis. Private sectors, such as environmental consultants and waste management companies, can provide some technical expertise, especially site investigation, risk assessment, and remediation technologies. However, it should be noted that the remediation of environmental hotspots is new, and available technologies in BiH are still limited. Also, environmental officers should have basic knowledge on the fate and transport of pollutants in the environment, risk evaluation, standard procedures for site investigation, and typical remediation technologies for different sectors and polluters. Liability and other legal matters are other areas that require significant strengthening. Most environmental officers are aware of different provisions of environmental regulations, but they have not been trained to address broader legal issues, and in most organizations, there is no legal expert they can regularly consult with. Similarly, specialized expertise in environmental communication and support for victims are desired. All of these issues of expertise are related to the issues of shortage of human resources, which hamper the specialization of officers in different tasks of environmental management.

(3) Limited Communications and Coordination among Different Organizations

The issues of shortages of human resources and expertise are made worse by limited communications and coordination among different organizations. The population of FBiH is only about 2.5 million, but there are four layers of governance, namely national, entity, canton, and municipality, and environmental management is spread over numerous organizations through these layers. Even within the same level, tasks are highly fragmented. At the entity level, for example, environmental permit is issued by the Division of Environmental Permitting of FMoET, while on-site inspection is done by the Inspectorate. Management of water and soil is generally under the jurisdiction of MoAFW, but for the issues of pollution, the role of FMoET is also important.

In addition to the issue of horizontal coordination, the lateral coordination across the different levels of local governance is also a major problem. For example, environmental permit issued by FMoET is the primary mechanism to control remediation projects in FBiH, and cantonal government is not directly involved in this process. Some documents available at the entity level are not readily available at the cantonal level. Also, municipality offices are not well informed about the financial and technical supports from the federal government.

These difficulties of obtaining information from other organizations and coordination with other organizations are preventing environmental officers to take initiatives in cleaning up environmental hotspots at all levels. This is one of the major reasons why there are so many historical environmental hotspots in FBiH.

CHAPTER 4 SITE SURVEY

4.1 Introduction

The site survey was carried out at selected target sites in order to investigate the current status of typical environmental hotspots in FBiH and to identify current practices and issues on each step of investigation and development of a remediation plan. The site survey included the following works:

- Desktop survey,
- Sampling survey[1],
- Chemical and physical analysis,
- Drawing of hazardous maps[2],
- Risk assessment of environmental destruction and human health damage, and
- Development of a preliminary remediation plan for each target site.

During the course of the site survey, the meetings with stakeholders were held in order to discuss the directions of development of the preliminary remediation plans and their opinions were reflected in the plans. The summary of the meetings is shown in Annex8.

The major issues identified through these surveys were used for the preparation of the draft master plan presented in the next chapter of this report. The data and information shown in this chapter are based on the results of the subcontract work done by Hydro-engineering Institute Sarajevo (HEIS). The details are shown in Annex 3. While some preliminary remediation plans for each site were proposed in the site survey, it is noted that they were developed merely as examples of possible remediation measures as case studies. In accordance with the laws and regulations in FBiH, remediation measures should be developed and implemented under the responsibility of the site owner or other party responsible for remediation.

4.2 Site Selection

4.2.1 Selected Target Sites

In selecting the sites, historical studies of environmental hotspots, land use maps, and other information were reviewed. Then, counterparts and JET had a series of discussions, and agreed on the sites listed in Table 4.2-1 after the conditions of these sites have been confirmed on site. The reason of selection of targets sites is mentioned in Annex 3.

Table 4.2-1 Selected Target Sites

No.	Name of Site	Location	Suspected Pollutants	Suspected Pollution Sources
1	Former Chemical Factory Site	Tuzla, Tuzla Canton	Mercury and PCBs (polychlorinated biphenyls)	Chemical factory producing polyurethane and its raw material
2	Former Soda Factory Site	Lukavac, Tuzla Canton	Soda related chemical materials	Soda factory
3	Lake Modrac	Tuzla Canton	Coal related chemical materials	Mining industries and other pollution sources in the upstream of Lake Modrac
4	Abandoned Mining Sites	Vares, Zenica – Doboj Canton	Iron forge related chemical materials	Former open-pit mining land, processing plant facility and mine tailings

Source: JET

[1] One-time sampling for each site was implemented from the end of October to the early November 2013 in order to finish the site work before the snow season. In advance of the sampling, simplified measurement of heavy metal and soil gas was conducted as a preliminary survey as needed.

[2] Hazardous maps were prepared for the former chemical factory site in Tuzla Canton and the processing plant facility site in Vares, Zenica-Doboj Canton since the localized pollution was suspected for these two sites, while distributions of pollutants in other sites are considered to be relatively uniform.

4.3 Objectives of the Site Survey

The objectives of the site survey are to investigate the current status of typical environmental hotspots in FBiH, and to identify the major issues of current institutional framework and technical aspects through the site survey activities in order to develop a realistic draft master plan.

4.4 Summary of the Site Survey

4.4.1 Reference Values Used in the Site Survey

One of the key steps in site investigation is the comparison of site data, such as concentrations of pollutants in soil and water, against the reference values, such as environmental standards and intervention standards. For surface water in lakes and rivers, the standard criteria in FBiH were used for the comparison. However, for other media, there are no criteria established in FBiH. In such case, the data are compared with the criteria in the European Union (EU) and evaluated case by case. In this site survey, the “reference values” for soil as shown in Table 4.4-1 were used for the comparison. For sediment, surface water, and groundwater, the results were compared with the reference values shown in Table 4.4-2.

Table 4.4-1 Reference Values for Soil Used in this Site Survey

Parameter	Units (referred to D.W.)	Reference Values for Soil
Cd	mg/kg	10
Pb	mg/kg	500
T-Cr	mg/kg	250
T-Hg	mg/kg	10
Cu	mg/kg	600
Ni	mg/kg	140
Zn	mg/kg	1,000
Mn	mg/kg	2,000
As	mg/kg	50
Se	mg/kg	100
Co	mg/kg	240
Sn	mg/kg	500
F	mg/kg	1,000
Cyanide	mg/kg	50
PCBs	mg/kg	5

Note: EU does not have uniform standard values for screening of contaminated soil and EU member nations have their own criteria for each. The proposed values in the above table are based mainly on the standard for soil applied in Austria because it is the middle range of the other standards in EU. The details are explained in Annex 3.

Source: Prepared by JET based on “HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014”

Table 4.4-2 Reference Values for Other Media Used in this Site Survey

Type of Sample	Criteria Used
Sediment	- Canadian Sediment Quality Guidelines for Protection of Aquatic Life, Canadian Council of Ministers of the Environment (CCME) - In the case that the sample was taken from a discharged channel and the purpose of the sampling is not for the protection of aquatic life, the reference values for soil in this survey were used as tentative reference.
Surface water	- Decree on Hazardous and Noxious Substances in Water (Official Gazette of FBiH, No. 43/07) - Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of SR BiH (Official Gazette of SR BiH, No. 18/80)

Type of Sample	Criteria Used
Groundwater	Same as surface water or cited from other criteria in EU member nations, etc. Note: In FBiH, the criteria for drinking water are the only standard values for groundwater. On the other hand, in this survey, there were no groundwater samples for drinking purpose. Furthermore, water use for drinking around the target site has not been confirmed. The purpose of sampling in this survey was to confirm the contamination status of groundwater caused by the contaminated soil or hazardous material from upstream or in the environmental situation. Therefore the environmental standard for surface water and others were used as tentative reference.

Source: JET

4.4.2 Former Chemical Factory Site in Tuzla Canton

(1) General Site Information

The site of the former chemical factory is located within a large, former industrial complex, which is now largely derelict. It is located beside the river flowing through the center of Tuzla City. Table 4.4-3 provides basic descriptions of the site based on the desk review and site visit.

Table 4.4-3 Baseline Data on the Former Chemical Factory Site

Item	Description
Current Site Conditions	- The site has an abandoned former polyurethane factory. In the main area, there are abandoned buildings and facilities, which are no longer being used and are heavily damaged. Next to the site are a metal recycling firm, other factories in operation, and a large chemical factory bankrupted recently. - During the site visit, drops of liquid mercury on the ground and storage of waste material contaminated by mercury were confirmed. - A transformer tank containing PCBs has been reportedly removed from the site. - The existing report indicates that disposed waste materials called “cruks” have been buried in some parts of the former chemical factory site. - The nearby Jala River is the main water course in Tuzla Municipality. The water quality is not within the prescribed class because of wastewaters discharged from Tuzla City. The average flow of the river is rather low (1.76 m^3/s).
Geology	- The site is located on a river alluvium terrace overlying Kreka coal basin, and filled with topsoil.
Water Use	- Local residents use the public water supply system. - There is no indication that groundwater in the area is being used as drinking water. - Some residents living downstream of the site use individual wells for gardening, among other activities. The nearest well is in the northeast direction within a 1 km radius.
Hydrology	- The site is located in the immediate catchment and the left bank of the river. - Groundwater under the site seems to drain into the river and flow down in the same direction of the river flow.
Public Health Issues	- In Tuzla, some regional public environmental issues (air quality, waste water, solid waste, etc.) are recognized and their impacts on human health are studied. - Complaints from local residents who directly related to this target site are not confirmed currently.

Source: Prepared by JET based on “HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014”

It was evident that one of the most serious environmental problems in the site is mercury pollution inside and outside the electrolysis plant building. The possibility of contamination of other pollutants, such as PCBs and heavy metals, was not so clear at the beginning of the site survey. The site pictures are shown in Figure 4.4-1.

 Mercury on the ground of the electrolysis plant	 Drums of mercury waste left in the electrolysis plant
 Water channel in the electrolysis plant	 Sedimentation tank for discharged water which comes from the electrolysis plant

Source: Taken by JET in September 2013

Figure 4.4-1 Site Photos of the Former Chemical Factory in Tuzla

(2) History of the Site

The site used to be a former polyurethane factory whose assets have been transferred and divided to some firms after its bankruptcy. Therefore, the history of the site is very complicated. Currently, the main part is owned by a chemical company and they plan to renovate the site. They already acquired an environmental permit to demolish a part of the site in 2013 on the basis of the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09). A part of the remaining site is owned by a metal recycling firm and it is being used for storage, sorting, and recycling of metal waste. The western part of the target site is managed by a bankruptcy trustee and is now idle. The remaining part is owned by some industrial companies. The sampling survey for this Project covered the area owned by the chemical company and the area managed by the bankruptcy trustee.

The end product of the former factory consists of several types of polyurethane. There were some production processes and sub-processes that were functionally dependent. The chlor-alkali electrolysis and sodium hypochlorite production unit represented the core of the inorganic section of the former chemical factory, in which electrolytic cells composed of about 50 tonnes of mercury (Hg) was used as a cathode.

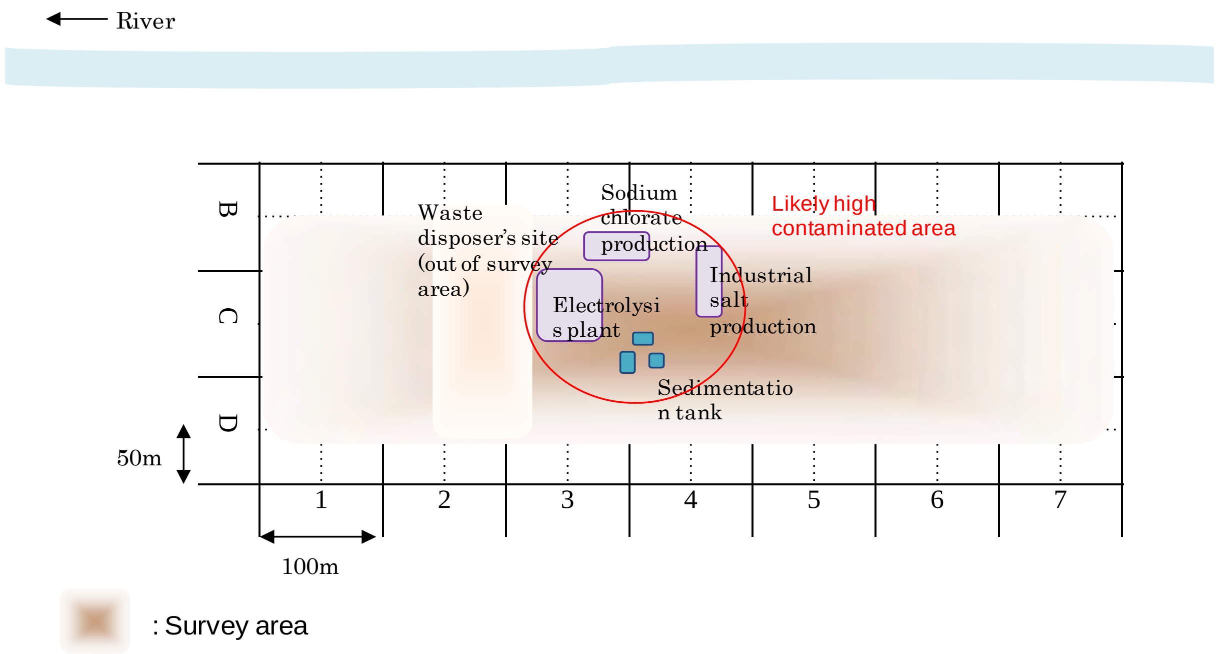
(3) Site Investigation Plan

The site investigation plan was prepared based on suspected distributions of hazardous pollutants and pathways of contamination, as described in Table 4.4-4. Mercury pollution in and around the electrolysis plant building was evident, but distributions of other pollutants were not clear. Thus, a portable X-ray fluorescence (XRF) analyzer was used to quickly investigate the site and optimize the sampling design. This revealed elevated concentrations of some heavy metals around the salt plant. Therefore the sampling was focused on the electrolysis plant, salt plant, and sodium chlorate production plant areas. The layout of the said areas is shown in Figure 4.4-2.

Table 4.4-4 Site Investigation Plan for the Former Chemical Factory Site

Item	Description
Suspected contamination	- Soil and groundwater are contaminated by mercury, PCBs, other heavy metals, organochlorine solvent, oil, and waste from the process of toluene diisocyanate (TDI) or other production process. - It is suspected that the main sources of contamination are the buildings for industrial salt production, sodium chlorate production, and chlor-alkali electrolysis production. - For the electrolysis plant, it was suspected that the main exposure pathway was a water channel from the electrolysis plant to other surface/discharged water courses and groundwater.
Sampling points	- For the area where high contamination is suspected, soil samples were taken from each grid (50 m x 50 m). - For other areas, composite samples were taken from some sampling points in a large grid (100 m x 100 m) in order to cover larger area with limited number of samples. - One monitoring well (to the top of the confining layer) was constructed to check groundwater. Two drillings (up to 5 m) were carried out to get boring samples in the area where high contamination is suspected. - River water was collected at the upstream and downstream areas to see the influence of the target site on surface water quality. - The sampling location map is shown in Annex 3.
Sampling quantities	- Around 53 samples of soil/sediment/waste including boring core samples from three boreholes at different depths and three background soils - Three samples of water from sedimentation tanks, two samples of surface water from the nearby river and five samples of groundwater including background samples - In this site, the serious soil contamination of heavy metal was suspected obviously, but the exact contaminated area was not estimated. Therefore, a large number of sampling was designed.
Measurement parameters	- Main parameters including T-Hg, PCBs, Cd, Pb, Cr, Zn, As, Se, CN, and other major parameters - 16 soil parameters, 17 water parameters, and 5 field parameters in total

Source: JET



Note: The sampling grid was defined to determine the sampling location at specified distance.
Source: JET

Figure 4.4-2 Image of Survey Area and Location of Facilities in the Chemical Factory in Tuzla

(4) Site Investigation Results

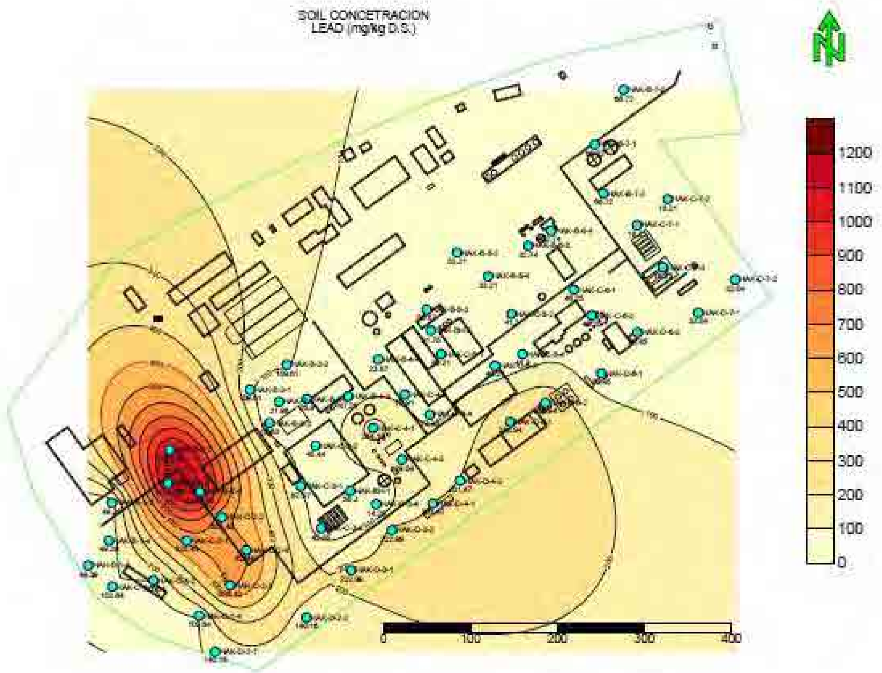
The results of the chemical analysis are summarized in Table 4.4-5. Elevated concentrations of Hg, Cd, Pb, Zn, and PCBs were detected from the surface soils especially around the buildings for industrial salt production and electrolysis production. This has been expected. The pollution of Hg was distributed along the suspected pollution pathway from the waste drums, and drainage channel of the electrolysis plant to the sedimentation tank. As for groundwater, the detection of PCBs at 4.7 μg/L in the monitoring well should be noted. The water quality of the river did not indicate a significant negative impact by the target site.

Table 4.4-5 Summary of the Analysis Results

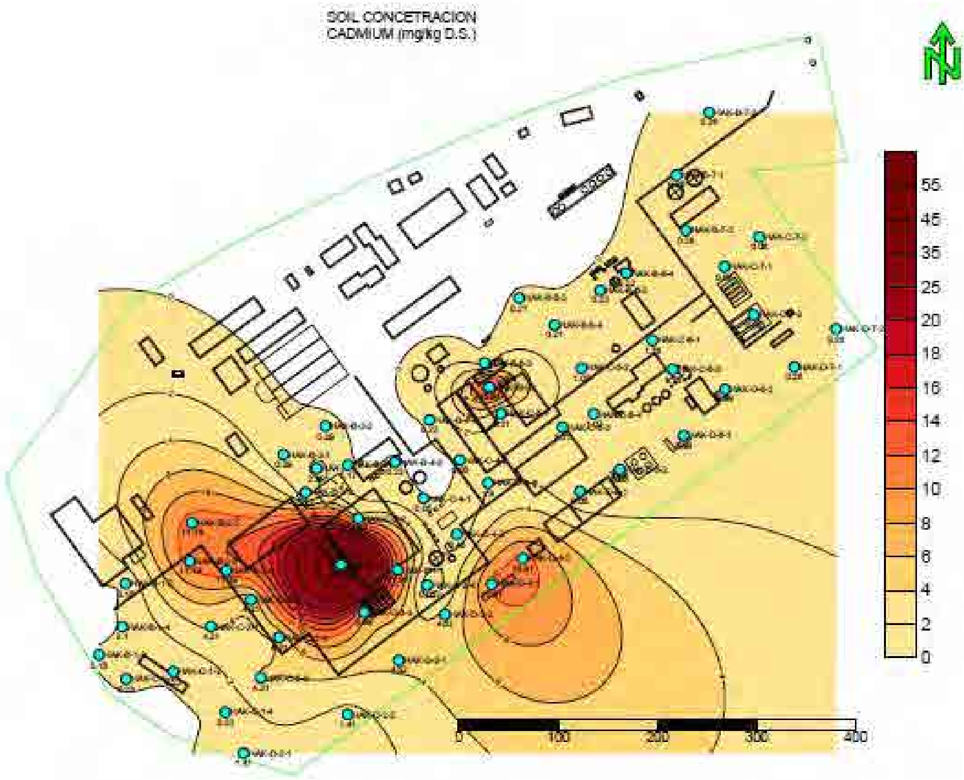
Sample Type/ Parameter	Main Result	Reference Value	Suspected Pollution Source
Surface soil			
Hg	- Max. of 105 mg/kg on the south side of the electrolysis plant - Total of three samples indicated more than 10 mg/kg (reference value for soil in this survey)	10 mg/kg (reference value for soil in this survey)	Hg used for electrolysis plant and its waste
Cd	- Max. of 53 mg/kg on the west side of the electrolysis plant - Total of five samples were higher than 10 mg/kg (reference value for soil in this survey)	10 mg/kg (reference value for soil in this survey)	Metal waste or past production activities
Pb	- Max. of 1,124 mg/kg of composite soil	500 mg/kg (reference value for soil in this survey)	Metal waste or past production activities
Zn	- Max. 1,400-1,800 mg/kg	1,000 mg/kg (reference value for soil in this survey)	Metal waste or past production activities
PCBs	- 40 mg/kg of composite soil at C-5 grid	5 mg/kg (reference value for soil in this survey)	Leaked transformer oil because the point is located near old substations
Boring soil			
Heavy metal and PCBs	- Though the surface soil of two boring core samples were contaminated by high Cd and Hg, soil deeper than 1 m did not exceed the reference value for soil in this survey.	-	-
Sediment in the sedimentation tank			
Heavy metal	- High concentration of Cd, Pb, Hg, and Zn - pH level is high (more than 9.0)	-	Discharged sludge from electrolysis plant and other facilities
Waste			
Hg	- Waste drums have more than 22% of mercury	-	Electrolysis cells with mercury cathode
Groundwater			
PCBs	- 4.7 μg/L groundwater at the monitoring well	- 0.1 μg/L (intervention: Austria)	Transformer oil or PCB-contaminated sludge / waste /soil
Heavy metal	- Cd : 0.011 mg/L - Pb : 0.052 mg/L - As : 0.067 mg/L	- 0.05 mg/L of Cd - 0.01 mg/L of Pb - 0.01 mg/L of As (intervention: Austria)	Multiple contamination of chemical or/and metal waste
River water			
Heavy metal	- Cd: 0.0058-0.0067 mg/L - Pb: 0.066-0.060 mg/L - CN: 0.009 mg/L. The upstream river water already contains some pollutants. Significant difference of water quality between the upstream and downstream was not confirmed.	- Cd: 0.0005-0.005 mg/L - Pb: 0.002-0.08 mg/L - CN: 0.001-0.1 mg/L (Class I-II - Class III-IV, hazardous and harmful substances in the water, FBiH)	-

Note) Sampling date: 21, 22 and 31 October and 1, 5 and 6 November 2013
Source: JET

The distributions of hazardous substances are shown in Figure 4.4-3 (hazardous waste maps). Because pollution is highly localized around a specific location or facility and the density of the sampling is not high enough, it is not possible to accurately draw equi-concentration lines. This contour line is drawn by interpolation based on the measured concentration of pollutant in soil.

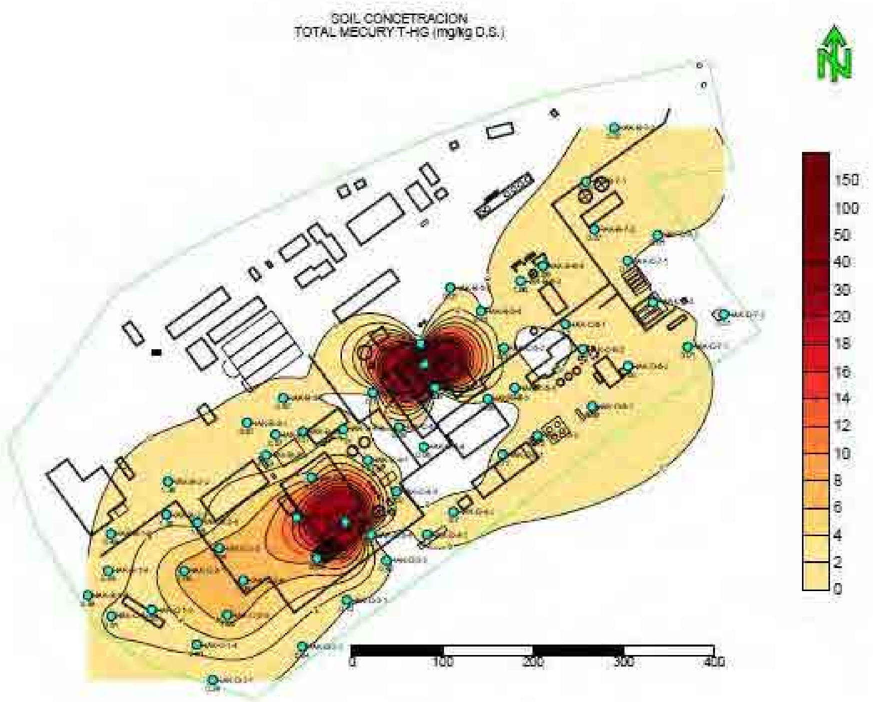


Pb (mg/kg D.W., soil concentration)

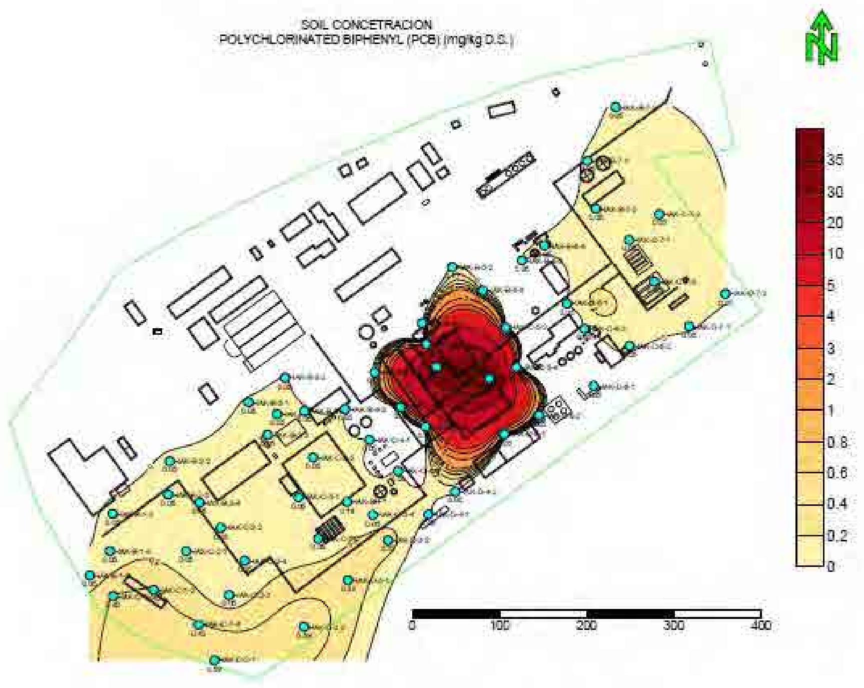


Cd (mg/kg D.W., soil concentration)

Figure 4.4-3 (1) Hazardous Maps of Former Chemical Factory in Tuzla



Hg (mg/kg D.W., soil concentration)



PCBs (mg/kg D.W., soil concentration)

Note) In this hazardous map, the concentration of un-sampled area is estimated by interpolation. Generally, when the sampling number is limited, the accuracy of equal-concentration line is low. Extension of the polluted areas, especially when far from sampling points, should be considered only as indicative and it will require being checked during future investigation.

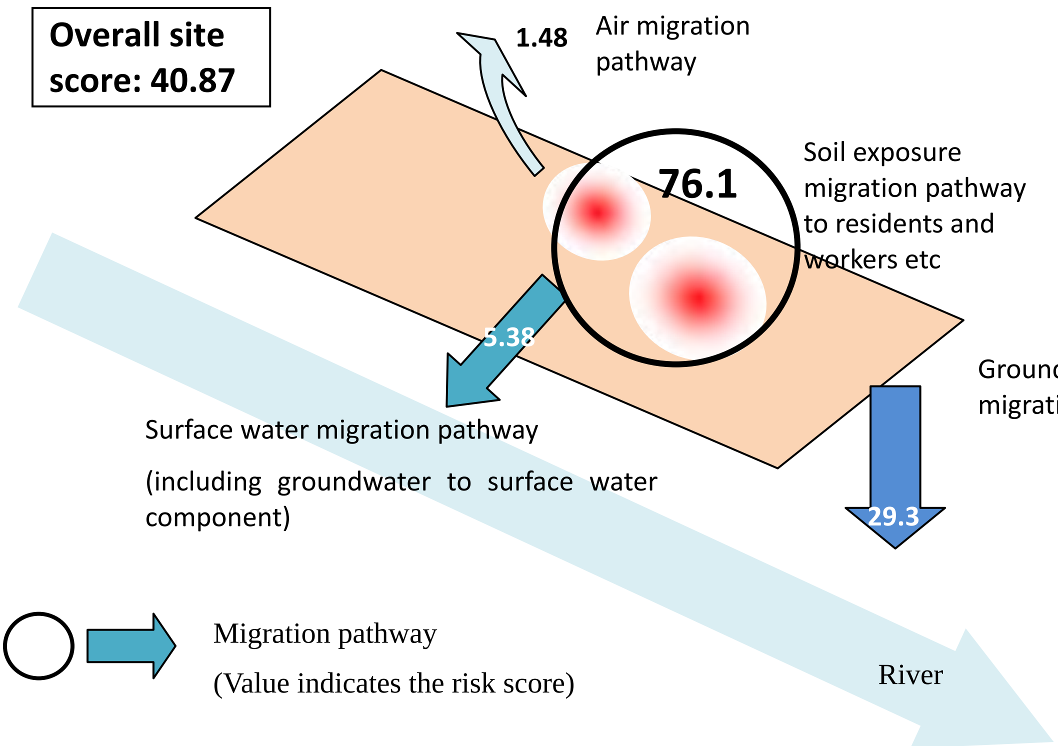
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure 4.4 3 (2) Hazardous Maps of Former Chemical Factory in Tuzla

(5) Risk Analysis

Cd, Pb, Hg, Zn, and PCBs were detected at concentrations higher than the reference values. These pollutants are known as hazardous and/or toxic substances that have potential negative impacts to human beings and ecological systems. Although many heavy metals have high affinity to soil particles, relatively low water solubility, and strongly absorbed by soil, under certain conditions, e.g., low pH, they could spread though groundwater and result in exposure to humans through drinking water and food crops. In order to screen out risky sites and take appropriate measures, risk assessment, based on the framework of pollution source – pathway – receptor, is an effective tool. In this survey, the overall risk of harmful effects to human health and ecological systems at each target site was evaluated semi-quantitatively using the Hazard Ranking System (hereinafter referred to as HRS) (USEPA, 1992; USEPA, 2006), a methodology regularly used by the United States Environmental Protection Agency (USEPA) to select uncontrolled waste sites to be registered in the National Priorities List (NPL) as mentioned in Section 8.3.

The results of HRS analysis for the former chemical factory site are shown in Figure 4.4-4. The figure indicates that the soil exposure migration pathway contributes to a large part of the overall site score which is higher than the NPL threshold of 28.5. HRS is a well-established tool for preliminary risk assessment, but it requires dozens of parameter inputs for source and pathway characterizations, and it is designed for regulatory requirements in the US. This was probably one of the first time HRS was tested in FBiH, and a number of parameters were not readily available for the target sites. Hence, the results should be interpreted accordingly.



Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

Figure 4.4-4 Results of Risk Assessment of the Former Chemical Factory Site by HRS Method

(6) Preliminary Remediation Plan

The proposed remediation measures include removal and treatment of highly contaminated soil and waste, as described in Table 4.4-6. One significant problem is that there is no controlled disposal site for hazardous waste in FBiH so that the contaminated waste has to be transferred to another country for disposal. It has to be reiterated that the remediation measures presented below were developed to demonstrate how such measures can be developed. The remediation of the site has to be designed and executed with the responsibility of the current business owner in accordance with the conditions of the environmental permit.

Table 4.4-6 Proposed Preliminary Remediation Plan for the Former Chemical Factory Site

No.	Item	Contents
1	Urgent measures	- Prevention of pollution dispersion - Set the cover for the highly contaminated waste and soil to prevent from discharge by rain water
2	Further detailed analyses and studies	- Detailed hazardous maps within the polluted areas - Detailed depth of contamination - Detailed groundwater flow and PCBs contamination extension - Evaluation of the pollution extent under roads and concrete objects - Detailed risk assessment - Preparation of the final remediation plan
3	Decommissioning and demolition of buildings and infrastructures	- Inclusion of sorting of waste and proper waste disposal eventually on hazardous waste found
4	Soil remediation	- Evaluation of several options for soil remediation from heavy metals (including mercury). Selection of soil washing as the most technical/economical solution based on available data. - Evaluation of several options for soil remediation from PCBs. Selection of chemical oxidation as the most technical/economical solution based on available data.
5	Groundwater remediation	- Prevention of contaminated groundwater (barrier well, etc.) - Cleanup of contaminated groundwater (water pumping in situ, treatment, etc.)
6	Post remediation activities	- Monitoring of soil and groundwater

Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

The preliminary cost estimation for the suggested remediation measures is shown in Table 4.4-7.

Table 4.4-7 Preliminary Cost Estimation of Remediation Measures for the Former Chemical Factory Site

Measure	Unit	Quantity	Unit Cost (BAM)	Total Cost (BAM)
Development of detailed design of the final closure of the site	Lump sum	1	10,000	10,000
Decommissioning and demolition of existing buildings and infrastructure and the final disposal of construction waste	m^3	7,785	236	1,837,000
Full-scale remediation of the soil contaminated by heavy metals	m^3	15,000	162	2,430,000
Full-scale remediation of the soil contaminated by PCBs	m^3	4,800	108	519,000
Final disposal of other waste from the site	t	100	5,000	500,000
Total				5,296,000

Note: Preliminary analyses and post remediation activities are not included in this preliminary cost estimation.
Source: "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

(7) Conclusions and Issues to be Considered

The results of the site survey at the former chemical factory site are summarized as follows:

- Some parts of the surface soil are contaminated by Hg, Cd, Pb, Zn, and PCBs at levels higher than the reference values for soil adopted in this survey. The high concentration of PCBs (4.7 μg/L) was detected in groundwater at the monitoring well.

- The results of risk assessment showed the high risk of soil exposure because of high toxicity and concentration of heavy metals and PCBs.

The following issues were identified through the site survey of the former chemical factory site:

- Due to repeated restructuring, privatization, and bankruptcy, the history of the site of the former chemical factory site appears to be very complex, and a large part of valuable documents to trace back the causes and distributions of historical pollution were not readily available for this survey. A lot of uncertainty made the site survey difficult.

- Pollution in an industrial site is usually highly localized. A sampling point that is not contaminated does not necessarily mean that the area close-by is not contaminated. Thus, sampling design is very important. However, there is no technical guideline which can be applied to site investigation in FBiH. Depending on the sampling design, the results can be quite different, and this could make a big difference in the remediation plan. Therefore the development of a technical guideline is required.

- There are not many standard values, such as an intervention threshold for contaminated soil or groundwater, which one can use to evaluate the results of a site survey and decide on the need for remediation.

- In this target site, drums containing hazardous waste are still left in the damaged building or in open-air spaces. Environmental risk can be reduced with simple emergency measures, such as covering the source to prevent further spread of pollution.

(8) Waste from TDI Production (Cruks)

One of the serious environmental issues discussed in Tuzla Canton is the chemical waste, known as cruks (or kruks), buried in one part of the former industrial complex site as mentioned above. The buried waste is believed to be a kind of polymerized TDI which is a residue of the distilling process of TDI produced in the former chemical factory. In this site survey, sampling and chemical analysis of cruks were not carried out because cruks had already been investigated and partially removed in the past. However, when remediation of this industrial complex is considered, disposal of such hazardous waste is an inevitable problem. Because of this situation, the existing report was reviewed and a hearing survey was conducted to examine the way forward.

1) Collected information

Basic information was provided by the preliminary survey report of this project (Faculty of Technology, University of Tuzla, 2011) as well as information provided by the cantonal government, and cantonal inspectorate. The findings are summarized in Table 4.4-8.

Table 4.4-8 Background and Basic Information of Waste from TDI Production

Item		Description
Disposal area and volume		- Located in the site of former industrial complex. The area is a part of the land of the detergent company (being in the process of bankruptcy) and the land of the former polyurethane factory (currently managed by bankrupt trustee).[*3] - Assessed surface area is about 1,000 m^2 [*1] – 1500 m^2 [*3] - Estimated volume of waste: about 4.500 m^3 [*3] - Depth: 2.5-3.0 m [*3]
Waste description		- Solid waste, namely cruks (also known as crux or kruks), coming from the manufacturing process of TDI in the former isocyanate chemical company. - Reaction residues of distilling reactor. - Regulations on categories of waste with lists (OG of FBiH, No 9/05) classify this waste in the category of waste from organic chemical processes, key number 07 01 08 [*3]
Description of TDI (original product [*2]	General	- Formula: $CH_3C_6H_3(NCO)_2$ - TDI products is usually composed of 2,4-TDI(80%) and 2,6-TDI(20%) - Used as a chemical intermediate in the production of polyurethane products such as foams, coatings, and elastomers

Item		Description
	Effect of 2.4-TDI, as a representa-tive of TDI	- Chronic inhalation exposure to 2.4-TDI of workers has caused significant decrease in lung function, an asthma-like reaction characterized by wheezing, dyspnea, and bronchial constriction. - No available information on the carcinogenic effects of 2,4-TDI to humans. USEPA has not classified 2,4-TDI for carcinogenicity.
	Physical properties of 2.4-TDI	- Colorless, yellow, or dark liquid with a sharp, pungent odor - The vapor pressure for 2,4-TDI is 0.01 mm Hg at 80 °C, and it has a log octanol/water partition coefficient (log Kow) of 0 to 1 (estimated).
History of waste		- In the past, cruks were burned in incinerators - After the incinerators have been destroyed, cruks were disposed on other landfill sites - Waste were being deposited in the current site during the period around 1988-1990[*1]
Way of disposal in the current site		Judging from the manufacturing processes of TDI, cruks can be highly hazardous, but to determine the disposal method, information on physical and chemical compositions are essential. To decontaminate TDI, neutralizer is used to destroy the isocyanate and thus minimize the exposure risk (see Allport et al., 2003[*4]) and perhaps a similar approach is considered. This is a special hazardous waste, and it is important to consult a specialist in the industry (e.g., ISOPA (European Diisocyanate and Polyol Producers Association)). In Tuzla, the composition of cruks was investigated, and it was buried after neutralization. The following final disposal process was anticipated by documentation:[*1,*3] - Below the waste, filter layer (drainage and pipes) was laid down. - Plastic film and thermal paper were grounded. - Disposed cruks in steel barrels were put in and compacted. - The waste from the chemical processes of the factory was put in between barrels as well. - Plastic sheeting and TEL-paper were laid. - Covered by soil of 0.5 m thickness.
Past study	Past study activity	- In the activity of the commission for management of cruks waste (2004), all related documentation was reviewed and site investigation was carried out for chemical analysis. As a conclusion, a thermal treatment or disposal with pretreatment (conditioning) was proposed.
	Past site investigation	- Excavation and taking of two samples from the cruks landfill to analyze the physical and chemical properties (2004) [*3] - Sampling of waste in 2009/2010
	Findings in the past investigation [*1, *3]	- Depth of landfill was about 2.5-3.0 m when it was excavated by backhoe. - In the excavated portion of the landfill, containers were not stacked, but scattered. A part of the cruks were deposited in tin barrels, while a part were scattered around. Cruks between the barrels were also in scattered condition. Most barrels were corroded and many of them are being deteriorated. - PVC foil was already broken and in a decomposition state. - The waste was in liquid, pasty and solid state (solids were formed by cooling). - Solid waste had a glassy shine and tar color. Liquid waste had a thick, oily and yellow brown, pungent smell.
	Analysis in the past investigation [*1, *3]	- Elemental composition and waste solubility were confirmed. - No radioactivity was determined in the material. - The ratio of composition was almost similar with TDI except for chlorine (from the JET's point of view).

*1) Ministry of Spatial Planning and Environmental Protection and Ministry of Industry, Energy and Mining in Tuzla Canton, Commission Proposal for Management of Cruks Waste, 2004
*2) USEPA, http://www.epa.gov/ttn/atw/hlthef/toluene2.html (confirmed on 7th of March 2014)
*3) Faculty of Technology, University of Tuzla, "The Survey on Selected Environmental Hotspots in Bosnia and Herzegovina", May 2011
*4) Allport, D., Gilbert, D. and Outterside, S., MDI and TDI, Safety, Health and Environment, 2003.
Source: JET

2) Disposal of cruks

It was confirmed through a hearing survey that following characterization of the physical and chemical properties of cruks, a part of such waste had been disposed in the past. The disposal method was established by a local hazardous waste management company following the advice of experts from a European firm. In this method, a part of the waste is stabilized with a kind of chemical and then disposed. However, due to limited budget, not all of the waste has been treated.

3) Recommendation for waste from TDI production

As the site was proposed as one of the nine candidate remediation projects for seriously polluted sites in BiH (the Netherlands' funded project entitled "Strengthening capacities in BiH to address environmental problems through remediation of high priority hot spots"), urgent treatment of the buried waste is required. It was confirmed by a past study that the buried container and sheet of waste have been seriously damaged and the substance is leaking out of the barrel. The issues on the site are that the land owners have announced bankruptcy and the disposal site has been left uncontrolled. Since the past study has already been carried out, financial support and securing of remediation budget are required as soon as possible to facilitate cleaning up of the site.

4.4.3 Former Soda Factory Site in Lukavac, Tuzla Canton

(1) General Site Information

The site is a former facility of a soda factory used as a settling pond to treat wastewater stream before discharge into the nearby river. There are four settling ponds in the area. One of them, which has been constructed most recently, is the only one in use, while the three remaining are filled with settled material and no longer in use. The site survey focused on the settling pond which had been used by the former soda factory. The current soda factory that took over the business from the former soda factory owns and manages this site.

The target settlement pond is filled with waste from the soda factory by the Solvay process. The majority of compounds are calcium carbonate and calcium hydroxide, and heavy metal content seems to be low. Table 4.4-9 below provides basic description of the site based on the desk review and site visit.

Table 4.4-9 Baseline Data on the Former Soda Factory Site

Item	Description
Current site conditions	- In the target settling pond, the total volume of settled material is about 40,000 m^3 (60,000 t assuming the average density of wet paste is 1,500 kg/m^3) - The river besides the site is polluted due to industrial and urban wastewaters from upstream. River water does not even satisfy the national requirements for wastewater. - The first constructed pond (part of the scope of the Project) encompasses an area of about 10 ha (about 300 m x 330 m based on an orthophoto). It was constructed as a simple flat pond with earth embankments and no specific containment barriers at the bottom. - The surface of the target site of the former settling pond is already dry. Vegetation development on the site is poor though some calciphile plant species have been observed.
Water use	The water supply system around the site takes water from several sources, such as the following: - Lake Modrac - 19 wells located downstream of the site - Regional water supply system
Hydrology	- The nearby river is downstream of Modrac Lake and watercourse in Tuzla City. - There is a possibility that the underground drainage system was not constructed according to the employee's account. Seeping water in other neighboring operating ponds is discharged to the river through underground drainage piping.
Public health issues	- General overview of Tuzla Canton is mentioned in Section 4.4.2. - Specific public health issues which are caused by the target site (former disposal site) have not been confirmed. Rather, other operating factories in this industrial area are recognized as main pollution sources.
Note	- This site is categorized as an industrial waste disposal site and it is not a typical legacy pollution site. - The current soda factory already has plans to renovate the site.

Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

Former disposal site of soda factory waste

White sludge waste

Source: Taken by JET in September and October 2013

Figure 4.4-5 Site Photos of the Former Soda Factory Site

(2) History of the Site

The former soda factory was operated from the pre-Bosnian War period. However, after its bankruptcy, another soda factory took over in 2006. The total surface area of the disposal site owned by the current soda factory is approximately 600,000 m^2, and it has been divided into several settling ponds. Settling pond 1 started its operations in 1979 and was used by the former soda factory. The disposed waste includes residual solution/suspension originated after recovery of ammonia by reaction of ammonium chloride with hydrated lime in the regeneration column. The solution/suspension originated during the precipitation of calcium carbonate in the production of caustic soda.

The current site owner is actively engaged in reducing the impact of the factory to the surrounding environment. An environmental permit was obtained early in 2010, and among other quality standards, an Environment Management System (EN ISO 14001:2004) was introduced in 2012.

(3) Site Investigation Plan

It seemed that the sludge of this site has not been so heavily contaminated by hazardous substances according to the past analysis report. The current site owner has a plan to reuse and recycle sludge waste as a soil conditioner for agricultural lands or as a deicing agent, and to rehabilitate waste disposal sites. Therefore, the investigation plan, as described in Table 4.4-10, focused on the confirmation of the contents of heavy metal, salt, and other compounds which might interfere with the said goals.

Table 4.4-10 Site Investigation Plan for the Former Soda Factory Site

Item	Description
Suspected contamination	- Heavy metals, though in the past analysis, were not detected - Alkaline component - Salt
Sampling quantities	- Four soil samples were taken: three from the abandoned settling pond 1 (BM-1, BM-2, and BM-3), while the fourth sample (BM-4) was taken at the active tailings pond 3. Note) Since the sample is the sludge waste from the industrial process and it is considered as a homogenized sample compared with the other general contaminated sites such as the former chemical factory site, the sampling number in the target settlement pond can be limited. - Surface water was sampled from the two points of upstream and one point of downstream in the adjacent river
Measurement parameters	- Main parameters are heavy metal, sulfate ion, chloride ion (Cd, Pb, Cr, Hg, Cu, Ni, Zn, As, Se, Co, Ca, Na , Mg, K, Al, P, N, F, Cl-, density, ignition loss, particle size distribution, etc.)

Source: JET

(4) Site Investigation Result

The results of site investigation are summarized in Table 4.4-11. The concentrations of heavy metals in waste are lower than the reference values except those in the range of 56-90 mg/kg.

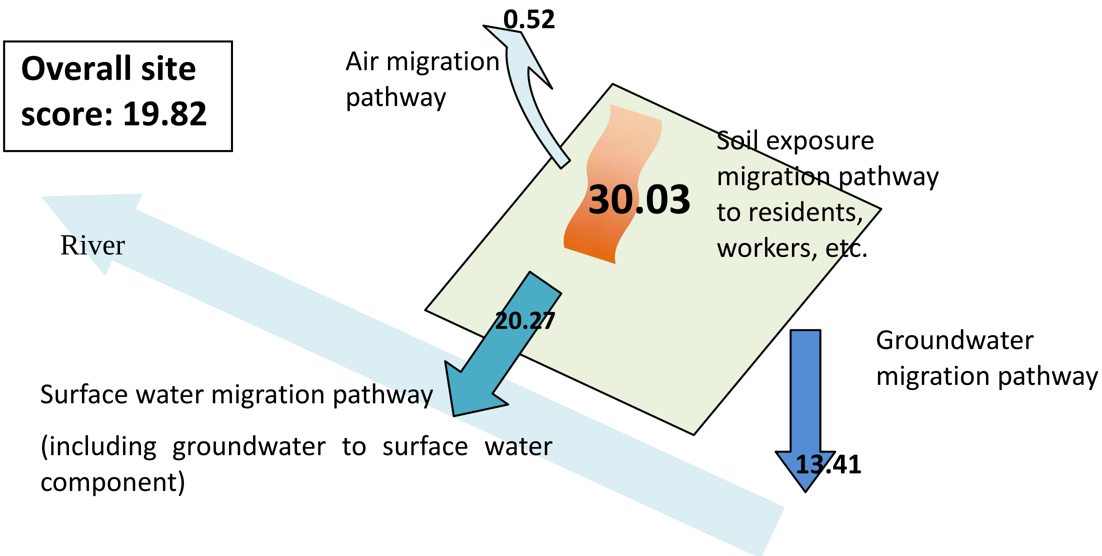
Table 4.4-11 Summary of the Analysis Results

Sample Type/ Parameter		Results	Remarks/Suspected Pollution Source
Sludge waste	Heavy metal	Arsenic was found in samples BM-3 (56 mg/kg) and BM-4 (94 mg/kg) in concentrations which exceeded the reference values for soil in this survey (50 mg/kg). Concentrations of other heavy metals were not higher than the reference values for soil.	It is more likely that increased concentration of heavy metals such as As is caused by residues from the Black Sea.
	Others	High concentration of inorganic dissolved components including chloride was detected as expected.	-
River water	Heavy metal	The concentration of some heavy metals (Cd, Pb, Cr, and Hg) at the upstream point is already higher than the prescribed water quality criteria due to the industrial water.	It is difficult to clearly identify the impact of settling pond 1 (which is the target site of the study) to the river.
	Others	The values of pH (7.8-11), EC (1,409–9,900 µS/cm), chloride (max. 3,244 mg/L), fluoride (max. 0.79 mg/L) were high from upstream to downstream.	

Note) Sampling date: 21 and 23 October 2013
Source: JET

(5) Risk Analysis

The results of risk analysis are shown in Figure 4.4-6, and the total score was 19.82, which is less than the cutoff score. The results of risk assessment did not indicate high priority issues related to this particular site.



Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

Figure 4.4-6 Results of Risk Assessment of the Former Soda Factory Site by HRS Method

(6) Preliminary Remediation Plan

The proposed preliminary remediation measures and the cost estimation are provided in Table 4.4-12 and Table 4.4-13, respectively. However, the site owner is responsible for the management of this site, is exploring different ideas for remediation. They already secured an environmental fund and has made contract with Lukavac Municipality regarding the management/disposal of waste from these sites.

Table 4.4-12 Proposed Preliminary Remediation Plan for the Former Soda Factory Site

Step	Contents
Step 1	- Coverage of the settled material with a 20 cm layer of gravel and a 80 cm second layer of soil. The surface of the soil cover should be graded in a gentle slope towards the river.
Step 2	- Usage of calciphillous plant species for the site revegetation, which need the presence of calcium in the soil for their successful survival and development. Option 1 Re-use as acid soil modifier Option 2 Re-use as construction/filling material Option 3 Re-use in the cement factory

Source: Prepared by JET based on HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table 4.4-13 Preliminary Cost Estimation for Remediation Measures for the Former Soda Factory Site

Measure	Unit	Quantity	Unit Cost	Total Cost (BAM)
Development of detailed design for the final closure of the site	Lump sum	1	6,000	6,000
Technical recultivation: covering settled material with a layer of gravel and a second layer of soil, grading of the surface soil	ha	10	96,000	960,000
Biological recultivation: vegetation of the site	ha	10	2,000	20,000
Total	-	-	-	986,000

Note: Preliminary investigation and post remediation activities are not included in this cost estimation.
Source: "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

(7) Conclusions and Issues to be Considered

This case study implies the following conclusions:

- It is difficult to clearly identify and assess the impact by past pollution after the new owner has taken over the business.
- This site presented a good case in which sludge material from the site may be used for other purposes in mutually beneficial ways. However, it has been taking time to explore such options. While finding a solution is the responsibility of the site owner, further facilitation of initiatives by the government might help resolve the problem quickly.

4.4.4 Lake Modrac in Tuzla Canton

(1) General Site Information

Lake Modrac is a reservoir that has several purposes such as the following:

- Provision of water for the population and industries (about 300 L/s for the Municipality of Tuzla and 75 L/s for the Municipality of Lukavac),
- Flood protection of areas downstream of the Modrac Dam,
- Electricity production of a small hydropower plant (SHPP) in Modrac,
- Development of tourism, which is hindered due to allocation of priority to provision of drinking water.

Lake Modrac, which is a source of drinking water, is considered as one of the environmentally important sites in Tuzla Canton. The lake's major concern is inflow of sediments which decrease the storage volume in the lake as well as contamination of sediments because the lake is the receiver of pollutants from mining and other pollution sources in the upstream. Deterioration of water quality and eutrophication of the lake are also issues to be resolved. The current status of the site is described in Table 4.4-14 and Figure 4.4-7.

Table 4.4-14 Baseline Data on Lake Modrac

Item	Description
Current site conditions	- The surface area is approximately 17.10 km² with maximum length of 10.70 km and maximum width of 1.60 km - The catchment area of the lake is approximately 1.180 km^2. - Main environmental problem is the inflow of suspended solids into the lake from the Spreca and Turija rivers. - The deterioration of water quality (water transparency, DO, COD, N, P Fe, Mn, Pb, Zn, Cr, Cu, and Al) and eutrophication of some parts of the lake are reported (Tuzla University, the Survey on Selected Environmental Hotspots in BiH, 2011). - Local people do some sport fishing. It is reported that the lake is inhabited by 22 fish species.
Water use	- Lake Modrac is a water source of the cities of Tuzla and Lukavac. - Currently drinking water taken from Lake Modrac is treated by membrane filtration.
Hydrology	- The Spreca River and the Turija River provide the principal flow in to the lake. - The inflow and outflow of the lake is estimated at 19.2 m^3/s.
Main suspected polluters in the catchment area	- Sewage (population density in the catchment area is approximately 110 inhabitants/km^2), solid waste disposal sites, open-pit mining, metal industry, coal mine, depot of oil and oil derivatives, wood industry, asphalt plant, laminating plant
Public health issues	- General overview of Tuzla Canton is given in Section 4.4.2. - The protection of water quality of Lake Modrac, as a water source, is of important concern in Tuzla Canton, in association with the report of a certain case of intestine epidemic diseases.
Note	- This site is not categorized as a typical legacy pollution site. - There is an ongoing environmental project financed by the European Bank for Reconstruction and Development (EBRD) that involves construction of sewage system and dredging of sludge on the bottom of the lake.

Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

Source: Taken by JET in September 2013

Figure 4.4-7 Site Photo of Lake Modrac

(2) History of the Site

Lake Modrac was formed in 1964 with the construction of a high, reinforced concrete arch dam on the Spreca River in Modrac. The initial purpose of this reservoir was to supply water to industrial facilities in Tuzla and Lukavac, primarily the Tuzla Thermal Power Plant, and to enable flood protection for settlements and agricultural areas in the Spreca River valley, downstream of the dam.

Bathymetric measurements carried out in 1985 and 2002 indicated that Lake Modrac is under the process of excessive sedimentation due to high loads of solid matter from the catchment which enters the lake. Data from different maturity stages of Lake Modrac indicated that the morphometric characteristics of the lake have been changing over time. In the first 38 years after the formation of the lake, its total volume was reduced by 13 x 10^6 m^3, or 13.3%. It can be inferred that the average annual sediment flux from the catchment was 342,000 m³. If the sedimentation trend is extrapolated to this date, the volume of sediments in the lake can be estimated at 16.42 x 10^6 m³ at present.

(3) Site Investigation Plan

Possible pollution problems of Lake Modrac were identified as heavy metals, PCBs and PAHs in sediment, sediment flow, and eutrophication and H_2S in lake water. Therefore, the site investigation was planned to confirm the contamination statuses of lake water, inflow, outflow, and sediment.

Table 4.4-15 Site Investigation Plan for Lake Modrac

Item	Description
Suspected contamination	- Heavy metal, PCBs and PAHs in sediment - Eutrophication in water
Sampling quantities	- Four samples of sediment - Seven samples of water were analyzed
Sampling point	- Inside the lake (lower or upper of water layer), near dam site, near river mouths of the Spreca River and the Turija River in accordance with the location of regular monitoring in Lake Modrac.
Measurement parameter	- Heavy metals, COD, T-P, T-N, etc.

Source: JET

(4) Site Investigation Results

The high concentration of nutrients in the water confirmed the occurrence of eutrophication phenomena. The Pb, Cu and CN values were almost equal to or higher than the prescribed standard for surface in water class II, but less than one in water class III-IV. As for sediment, Hg (1.8–1.9 mg/kg) and Cr (190–265 mg/kg) were higher than the Probable Effect Levels (PEL) of freshwater sediment as stated in the Canadian Sediment Quality Guidelines.

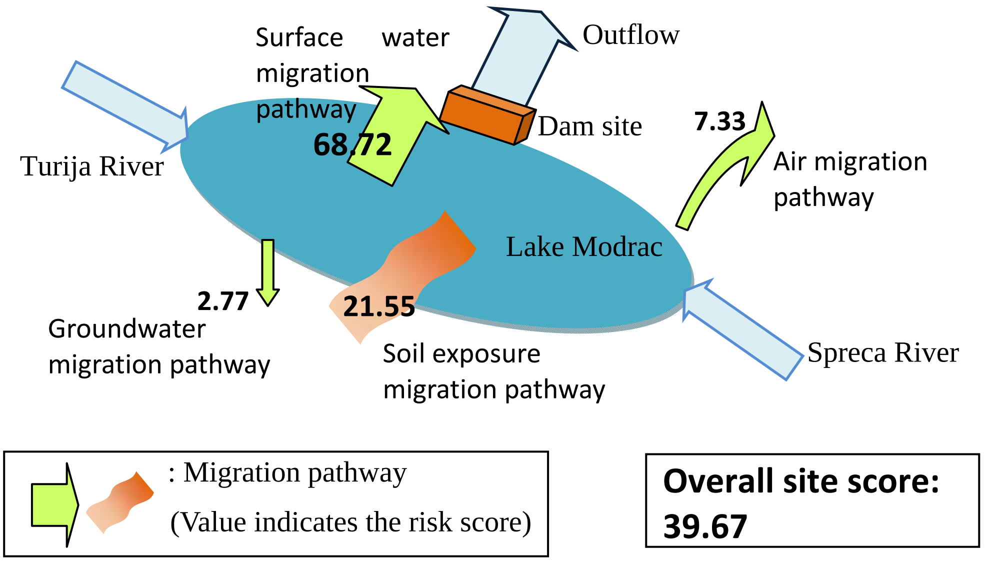
Table 4.4-16 Summary of Analysis Results of Lake Modrac

Sample Type/ Parameter		Result
Water Quality	Heavy metals	Increased concentrations in several sites, but less than the levels prescribed for IV class - Pb: 0.0057–0.016 mg/L - Hg: < 0.005 - CN: 0.001–0.003 mg/L Note) Limit value of Class I-II - Class III-IV is; - Cd: 5–50 ug/L - Pb: 0.002–0.08 mg/L - Hg: 0.00002–0.01 mg/L - CN: 0.001–0.003 mg/L
	Dissolved oxygen (DO)	- Dissolved oxygen (DO) supersaturation in the area close to the mouth of the Spreca River
	Nutrients (N, P) and COD	- Increased concentrations
Sediment	Hg	- Sediment in the central part of the lake contains 1.8–1.9 mg/kg of mercury, which is above the PEL (0.486 mg/kg) and might imply hazardous condition for aquatic life Note) PEL in Canada: 0.486 mg/kg Tentative removal standard in Japan: 25 mg/kg
	Cr and Ni	- Sediment contains high concentration of Cr (max. 265 mg/kg, PEL = 90 mg/kg) and Ni (max. 319 mg/kg), especially in the area close to the Turija River.
	Organic matter and nutrients	- Sediment sampled at locations close to the Spreca River is contaminated with more organic matter and nutrients, while oxygen/reduction conditions indicate anoxic state.

Note) Sampling date: 22 October 2013
Source: JET

(5) Risk Analysis

HRS was used for risk analysis, but HRS is designed to evaluate the contaminated sites and applicability of the model to Lake Modrac which requires more scrutiny. The overall risk assessment score was 39.67. The surface water migration pathway score (68.72) made the most significant contribution to the overall risk score. The high potential contamination values for drinking water threats as well as the high value for sensitive environment factor in environmental threat within surface water migration pathway had the greatest impact on this particular pathway.



Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

Figure 4.4-8 Results of the Risk Assessment of Lake Modrac by HRS Method

(6) Preliminary Remediation Plan

The objectives of lake remediation are to improve the water quality and to ensure that the lake keeps its main functions in the future. Thus, the dredging of bottom sediment, development of watershed protection measures plan, and countermeasures against pollution sources including coal mining and sediment discharge from upstream are required. The dredging plan and general proposal for water basin management are described in Table 4.4-17 and the cost estimation in Table 4.4-18. The ongoing EBRD project has already covered the essential measures, such as construction of sewage system.

- Phase I. Cleaning of sediments in the area near the mouths of the Spreca and Turija rivers. Large volume of the bottom load from the Spreca and Turija rivers is settled at these locations.
- Phase II. Systematic cleaning of the sediments from the littoral zone of the lake, which is carried out during dry periods of the year.
- Phase III. Systematic cleaning of the sediments from the limnetic zone of the lake.

Table 4.4-17 Implementation Phases of Proposed Preliminary Remediation Plan for Lake Modrac

Item	Implementation Phase		
	Phase I	Phase II	Phase III
Part subject to cleaning	Shoals at the Spreča and Turija River mouths	Littoral zone up to the lowest water level	Limnetic zone
Sediment volume (m^3)	Approximately 2.0 x 10^6	Approximately 7.2 x 10^6	Approximately 7.2 x 10^6
Execution method	In the dry	In the dry	In the wet
Equipment	Construction machinery (excavators-dumpers)	Construction machinery (excavators-dumpers)	Hydraulic dredgers
Implementation period	Summer period-low water level in the lake	Summer period-low water level in the lake	Summer period-low water level in the lake
Transportation method to the disposal site	Trucks	Trucks	Slurry by pipeline to settling pond; sediment by trucks
Disposal site	Abandoned mining site	Abandoned mining site	Abandoned mining site

Note 1) If high level of hazard substances in sediments are found, costs will be higher.
Note 2) Preliminary analysis and post remediation activities are not included in cost estimation.
Source: "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

Table 4.4-18 Preliminary Cost Estimation for Remediation Measures of Lake Modrac

Measure	Unit	Quantity	Unit Cost	Total Cost (BAM)
Phase I				
Construction or repair of local roads.	m	10,000	15	150,000
Excavation of the sediments from shoals at the mouths of the Spreča and Turija rivers.	m³	2,000,000	4.5	9,000,000
Transport of excavated material to the disposal site.	m³	2,400,000	7	16,800,000
Total Phase I				25,950,000
Phase II				
Excavation of sediments from the littoral zone of the lake in the dry period, up to the minimum water level in the summer period.	m³	7,200,000	4.5	32,400,000
Transport of excavated material to a disposal site.	m³	8,640,000	7	60,480,000
Total Phase II				92,880,000
Phase III				
Construction of settling ponds for dewatering of the slurry.	unit	6	120000	720,000
Dredging of sediments from the limnetic zone of the lake.	m³	7,200,000	10	72,000,000
Transport of dry excavated material to a disposal site.	m³	8,640,000	7	60,480,000
Total Phase III				133,200,000
Grand Total				252,030,000

Note) Only the cost for dredging of sediments is included. The costs of land acquisition for the construction of settling ponds and right of way are not included. If high level of hazardous substance is found at the detailed investigation, the cost will be higher.
Source: "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

(7) Conclusions and Issues to be Considered

This case study implies the following conclusions:

- As a result of the investigation, any significant pollution with hazardous substances was not confirmed, and a dredging plan was proposed in order to ensure the accumulation volume of water. However, the concentrations of mercury and other metals in the sediment are above the PEL for protection of aquatic life. Further investigation about the impact of these metals to the aquatic creatures is recommended. Also, when the dredging work is carried out, the concentration of hazardous substances in the dredged sediment shall be checked before dredging, at the temporary storage space of sediment, and when it is transported or disposed.

- Further investigation of evaluation criteria for sediment is needed. While the Canadian Sediment Quality Guidelines could be used for the protection of aquatic life, there are other evaluation criteria, such as sediment as source of contamination of lake water and drinking water and criteria for disposal of dredged sludge.

- The pollution mechanism of the lake is quite different from the pollution mechanism of a typical contaminated site where the party that is liable for remediation can be identified.

4.4.5 Abandoned Mining Sites in Vares, Zenica-Doboj Canton

(1) General Site Information

The target mining sites include an abandoned open-pit pond, processing plant facility, and tailings pond and dam in Vares. The abandoned open-pit pond was formed in an abandoned iron mine pit. The other two sites are both part of a former lead, zinc, and barite processing plant which is no longer in operation. Each site is described in Table 4.4-19.

Table 4.4-19 Baseline Data on the Abandoned Mining Site

Item	Site name	Description
Abandoned open-pit pond	Current site conditions	- A 100 m deep pond in the abandoned mine pit was formed by accumulation of stormwater and groundwater. The lake area is around 125,000 m^2. - According to the spatial plan of the Zenica-Doboj Canton from 2009, the area around the pond is officially foreseen for recultivation. The municipality plans to develop a tourist complex in this site.

Item	Site name	Description
		- After the site was abandoned, there had been no rehabilitation measure carried out in the area. The abandoned machinery had been left in the open-pit, and was later submerged after the pond was formed. Around the pond there are several abandoned buildings and pieces of equipment that were used during the mining operation. - The ownership of this site has not been resolved.
	Water use	- Today the pond is used for recreational purposes, especially during the summer period, e.g., for fish breeding and swimming by local residents.
	Hydrology	- There are few data on water level fluctuations in the pond or data on inflow to and outflow from the pond in current conditions. - The level of the lake is regulated by drainage tunnel, which assures drainage of the water from the pond to the downstream river.
	Public health issue	- There are no indications that public health is threatened by this site.
Processing plant facility (former lead, zinc, and barite processing plant)	Current site conditions	- The processing plant was designated in the past as an economic (industrial) zone. The official spatial plan of the Zenica-Doboj Canton from 2009 foresees the same land use. - The facilities are partly or completely demolished, except a few settling tanks that still hold water and can be considered usable if needed in the future production process. - Several metal barrels of the flotation agent are stocked in an open space over a small concrete platform. The barrels are in very bad condition and few are completely corroded and the liquid spread over the concrete surface. Pungent odor (which is assumed as a xanthate, a kind of flotation reagent) was confirmed.
	Water use	- Neaby habitants use the municipality's water supply system. - No information was available regarding sanitary and stormwater management at the flotation plant.
	Hydrology	- Surface waters from this area flow into two catchment areas since the plant is situated at the catchment border of two different rivers.
	Public health issue	- Substantial information relevant to public health conditions in this site were not confirmed, although some residents have complaints about the fine dust and spreading of odor from the site.
Tailings pond and dam	Current site conditions	- The dam was supposedly designed and constructed as a homogeneous dam; a 15 m high central clay core was constructed and backfilled by rocks. - The crest is damaged, probably by wind and water erosion. In addition to sheet erosion, traces of rill and gully erosion are also evident.   (Photos show the damaged crest)
	Water use	- Same as the processing plant facility site
	Hydrology	- During the operation of the former lead, zinc, and barite processing plant, watercourses which had flown towards the mine pit were intercepted by a tunnel and discharged into the river downstream of the site. - Three drains of 200 mm diameter each were designed and constructed at the downstream section of the dam. The total length of the drains is approximately 345 m. - The outflow structure of the pipe culvert and the immediate downstream section of the open channel are covered with vegetation, sediments and various waste. - There is a possibility of seepage through the dam.
	Public health issue	- Public health issue in this area is menthioned above as information of the processing plant facility.

Source: Prepared by JET based on “HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014”
Photos were taken by HEIS.


Abandoned open-pit pond


Processing plant facility


Tailings pond and dam

Source: Taken by JET in September and October 2013

Figure 4.4-9 Site Photos of the Abandoned Mining Sites in Vares

(2) History of the Site

1) Abandoned open-pit pond

The open iron mine started operations in 1975. With its reserves of more than 135 million tonnes of iron ore, the mine was the largest in the former Yugoslavia. As a result of the mining, the width of the pit kept growing and reached 750 m just before the war in BiH in 1992-95. The excavated raw ferrous ore was processed at a simple gravity processing plant nearby. The target pond was formed in the abandoned open-pit of this iron mine.

2) Processing plant facility

The lead, zinc and barite mining site had been operated by an engineering company, which was taken over by another mining company after its bankruptcy.The current site owner, which recently acquired the site through concession, plans to remediate the site with environmental permission to be acquired after the environmental impact assessment (EIA) study for their future plan of revitalization.

This processing plant was built to enrich by flotation of the original ore from the mine, which is located about 2 km away from the plant. The average composition of the ore is 23%-30% barite and 3.51%-4.41% total zinc and lead sulfides. During its operation period, the flotation plant had a design capacity of 100 t/h, although the crushing section was designed for 450 t/h capacity and on average was able to produce about 12 t/h of barite concentrate (purity about 90%), 0.4 t/h lead concentrate, and 0.3 t/h zinc concentrate. Enrichment of the ore at the processing plant was accomplished through six main process steps: crushing and storing of raw ore, separation unit, wet grinding, collective flotation unit, barite separation, and lead and zinc separation.

3) Tailings pond and dam

The tailings dam made out of sand was designed and constructed as an embankment dam. The crest was designed at 940 m above the sea level, thus creating a 65 m high dam. This tailings dam was originally used for lead, zinc, and barite mining. After its bankruptcy, the municipality has been managing this site.

After the processing of the ore containing lead, zinc and barite by flotation, mine tailings were generated as waste. The tailings were composed of original silicate/carbonate matrix from where barite and sulfide minerals have been extracted. However, high residual concentrations of lead, zinc, and barite (for example, 10%-20% of barite) are still present. The tailings waste, which is about 87% of the raw ore collected from the thickener, is produced into two particle size classes. The fines are transported as slurry to a tailings pond constructed on the bottom of the valley, where settling occurs. The rougher fraction was temporarily stored nearby the separation building and then transported by truck to the nearby tailings dumpsite located less than 1 km southwest of the flotation plant and downstream of the tailings pond. Also in the case of the tailings dumpsite, water accumulation was formed upstream and the creek flowing in the valley was tunneled under the pond.

4) Site Investigation Plan

Regarding the abandoned open-pit pond of the iron mine, there is a possibility for acid mine drainage (AMD), meaning that heavy metals might be dissolved due to acid drainage, though the pH level of water in the pond's shore was neutral during the site visit. At the site of the processing plant of the lead, zinc and barite mine, JET focused on the issue of heavy metal contamination around the flotation facility. On the other hand, the main concern of the tailings dam is the erosion of the dam, and an emergency measure to reinforce the structural integrity of the dam would be required in addition to the control of heavy metal contamination of surface water and groundwater.

Table 4.4-20 Site Investigation Plan for the Abandoned Mining Sites

Target sites	Item	Description
Abandoned open-pit pond	Suspected contamination	- Heavy metal contamination of sediment and water from iron ore
	Sampling point and quantity	- One sample of sediment and four samples of water were taken from the pond.
	Measurement parameters	- Heavy metals and other general parameters
Processing plant facility	Suspected contamination	- Contamination with heavy metal (Pb, Zn, As, etc.) caused by sulfide ore and chemicals used at flotation process - Copper sulfate and cyanide are the most suspected chemical pollutants
	Sampling point and quantity	- Six samples of soil - The locations where the high contamination is suspected were selected as the sampling points.
	Measurement parameters	- Heavy metals, CN, etc.
Tailings pond and dam	Suspected contamination and risk	- Heavy metal contamination in groundwater and overflow water caused by tailings - Environmental accident risk of clashing of bank and heavy metal contamination of the downstream basin
	Sampling point and quantity	- Five samples of surface water - One sample of sediment - Two dam materials
	Measurement parameters	- Heavy metals, and soil property test (viscosity, particle size distribution, etc.) of the tailings dam
Background in Vares	Sampling point and quantity	- Three soil samples - Three water samples
	Measurement parameters	- Same as the other samples

Source: JET

(3) Site Investigation Results

It should be noted at first that the background data in the Vares sites indicated that the concentrations of heavy metals (especially As, Pb, and Fe) in soil were much higher than those in Tuzla. The groundwater contained some amount of background heavy metals (Cd, Pb, Cu, etc.) as well. There are no specific environmental criteria for water and sediment to be applied to this site, making the interpretation of the results difficult.

1) Abandoned open-pit pond

The significant point in the analysis result is that pond water did not contain serious amount of heavy metal. Also, it was not acidic therefore the solubility of natural heavy metal in water is not high. The other main results are given in Table 4.4-21.

Table 4.4-21 Summary of the Analysis Results for the Abandoned Open-pit Pond

Type of Contamination		Result	Reference Value
Water	Heavy metals	- 0.0008–0.0015 mg/L of Cd - 0.013–0.016 mg/L of Pb - The concentrations of detected heavy metals were not higher than the one of the background sample.	- 0.005–0.005 mg/L of Cd (Criteria for surface water in FBiH*) - <0.001–0.0019 mg/L of Cd in the background samples - 0.002–0.08 mg/L of Pb (Criteria for surface water in FBiH*) - 0.013–0.032 mg/L of Pb in the background samples
	pH	- pH level of 8.14-8.17	- 6.0–9.0 (Criteria for surface water in FBiH*)
	Sulfate	- Quite high (506–615 mg/L) - It can be suspected that sulfate originates from barium sulfate, which is present in the ore around the pond. Barium sulfate is very slightly soluble in water, but some small concentration is present in water after the equilibrium state with deposition. High concentration of sulfate was also found in one of the background samples, so it can be assumed that sulfates are of natural origin.	No threshold level for sulfates in surface water.
Sediment	Heavy metals	- 1.34 mg/kg of Cd - 176 mg/kg of Pb - 1.83 mg/kg of Hg As a reference of foreign standard, the Canadian Sediment Quality Guidelines for protection of aquatic life can be used, but the background samples already exceed the Canadian standard value.	- The standard value of sediment is not specified in BiH.

* Decree on Hazardous and Noxious Substances in Water was adopted in 2007 (Official Gazette of FBiH, No. 43/07)
Note) Sampling date: 24 October 2013
Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

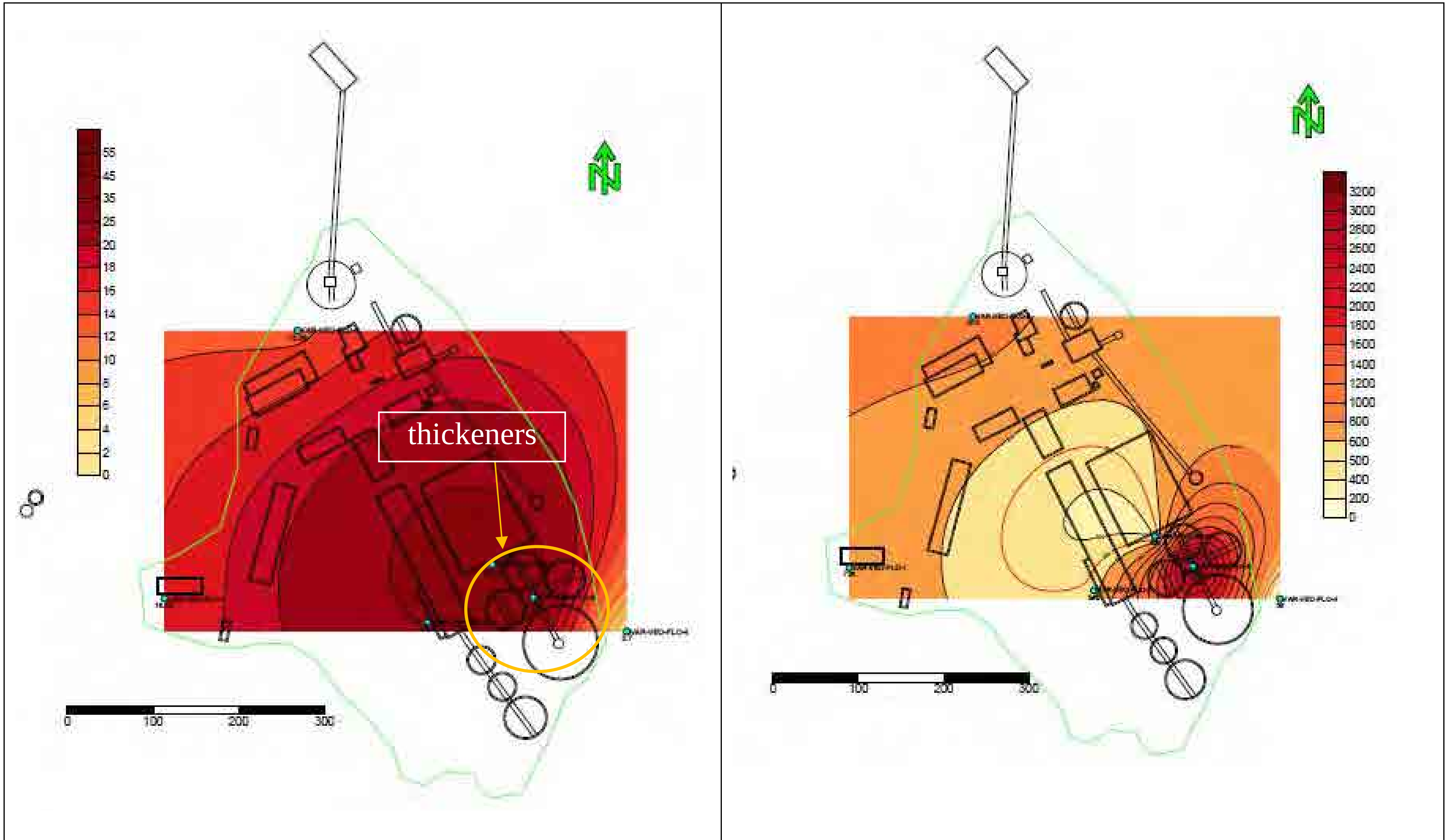
2) Processing plant facility

Elevated levels of heavy metals, such as Cd and Pb, in soil around the processing plant facility, especially at the sampling point between thickeners were confirmed. The analysis results are given in Table 4.4-22. The negative impacts from cyanide and copper sulfate, which are common at a typical processing facility, were not confirmed. If detailed investigation is planned in the future, more sampling points for heavy metals and additional parameters on organic chemicals used in the processing facility should be proposed.

Table 4.4-22 Summary of the Analysis Results for Processing Plant Facility

Type of Contamination		Result	Reference Value
Surface Soil	Cd	- Max. 36 mg/kg at near thickeners	- 10 mg/kg (reference value for soil in this survey)
	Pb	- Max. 3,005 mg/kg at near thickeners	- 500 mg/kg (reference value for soil in this survey)
	Others	- Ni, Zn, Mn, and As were also higher than the reference values for soil in this survey.	-

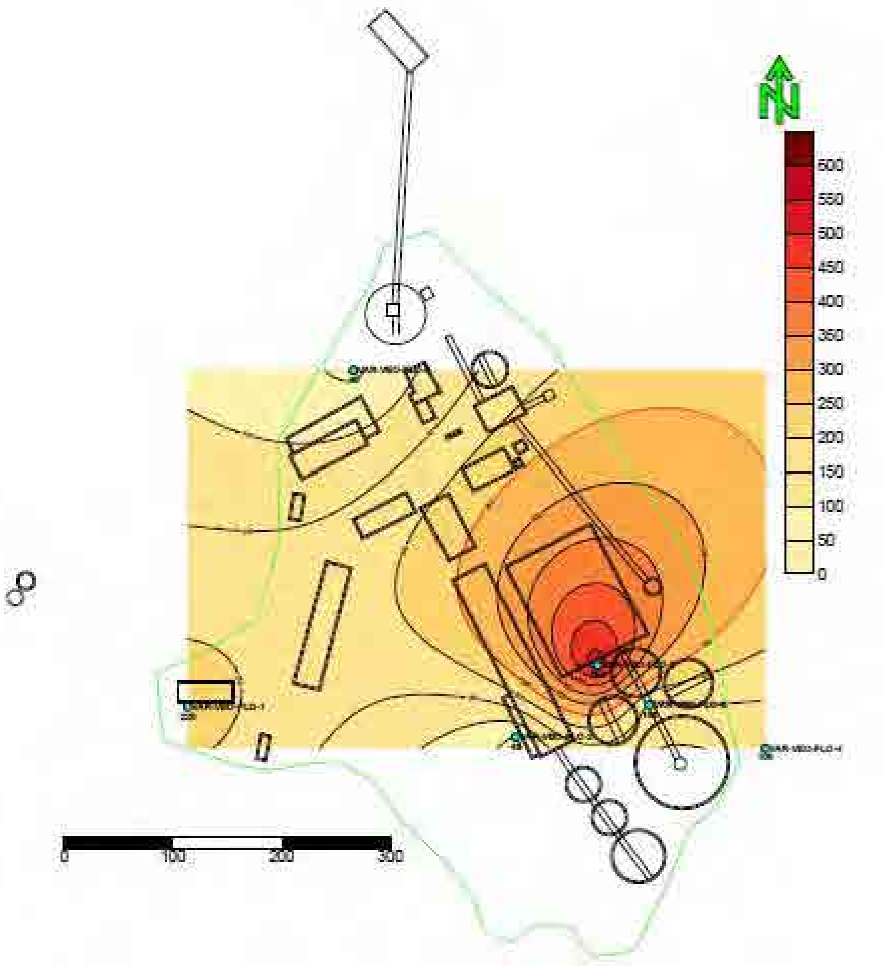
Note) Sampling date: 24 and 25 October and 7 November 2013
Source: JET



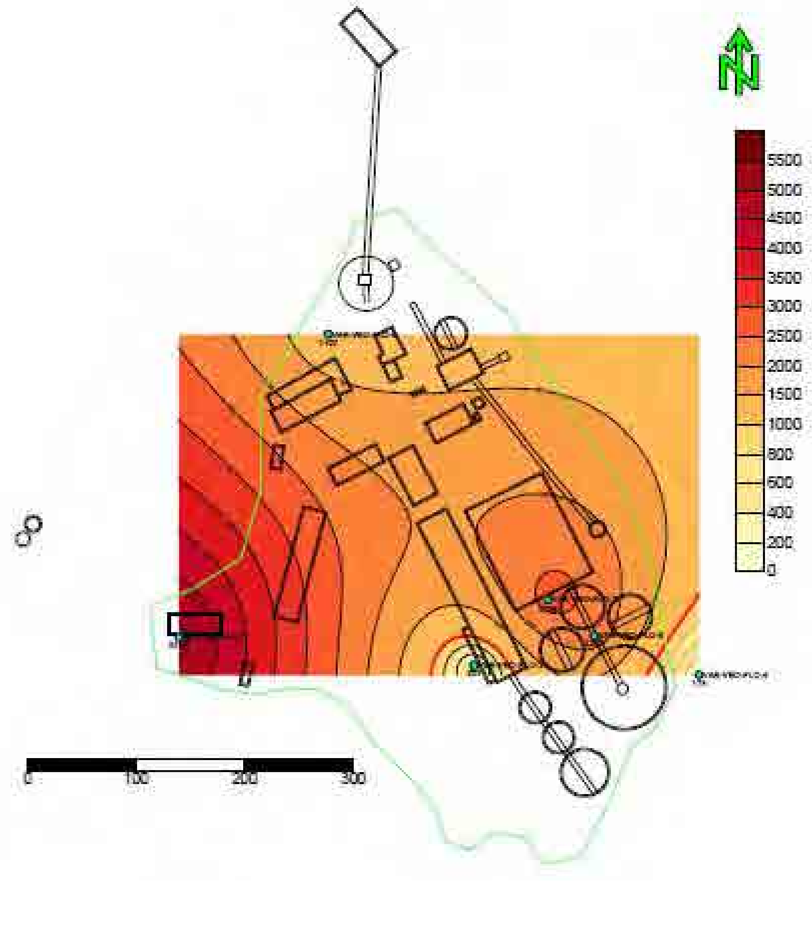
Cd (mg/kg D.W., Soil Concentration)

Pb (mg/kg D.W., Soil Concentration)

Figure 4.4-10 (1) Hazardous Maps of the Former Processing Plant Facility

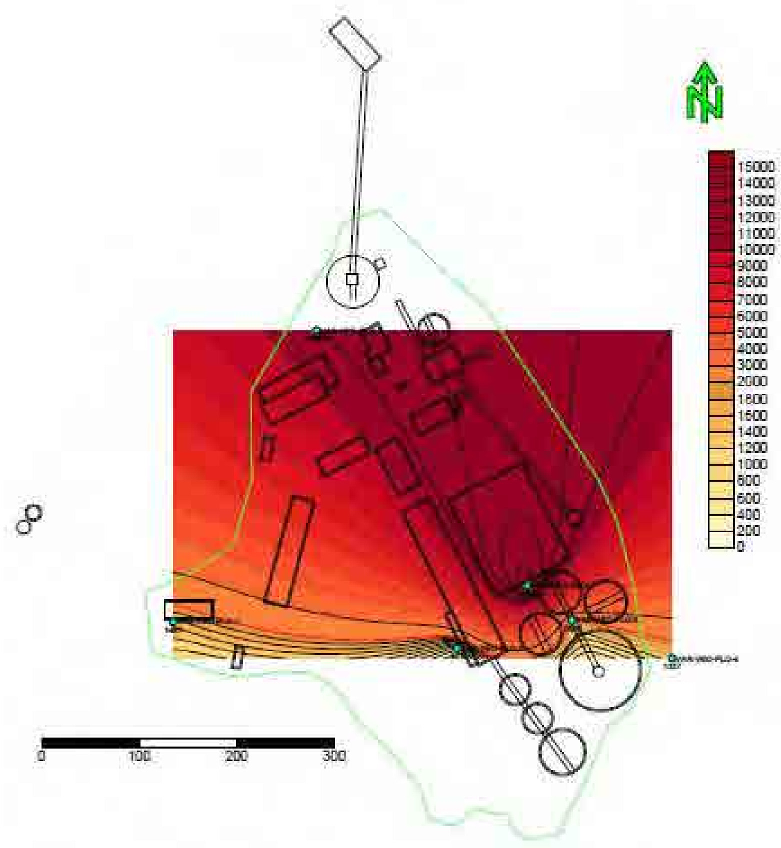


Cr (mg/kg D.W., Soil Concentration)

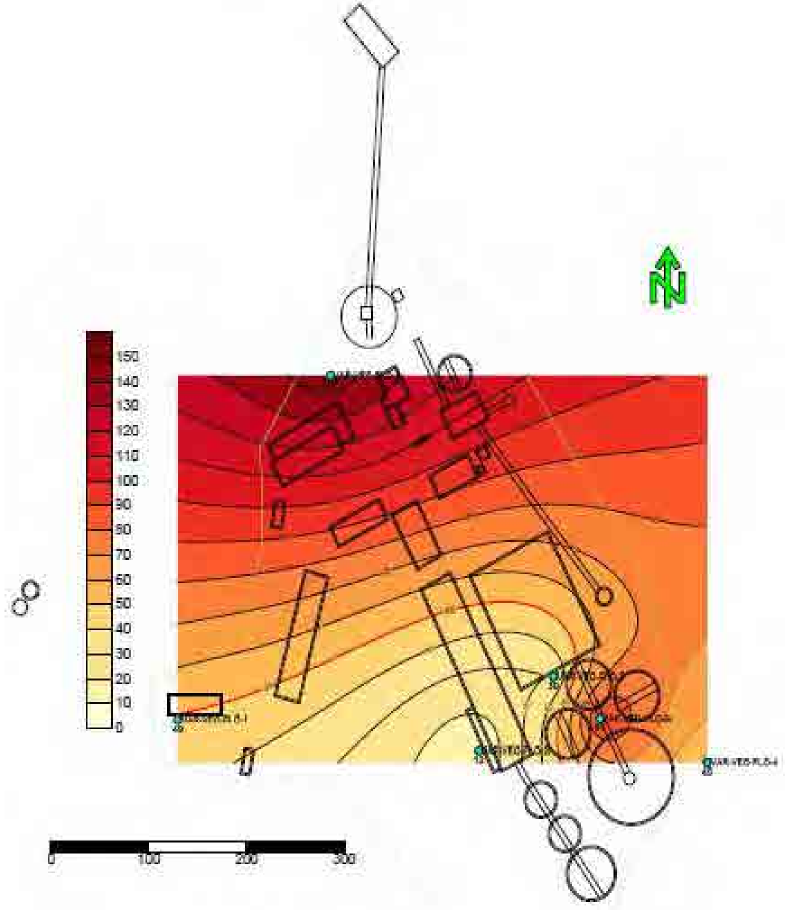


Zn (mg/kg D.W., Soil Concentration)

Figure 4.4-10 (2)   Hazardous Maps of the Former Processing Plant Facility



Mg (mg/kg D.W., Soil Concentration)



As (mg/kg D.W., Soil Concentration)

Note) In this hazardous map, the concentration of un-sampled area is estimated by interpolation. Generally, when the sampling number is limited, the accuracy of equal-concentration line is low. Extension of the polluted areas, especially when far from sampling points, should be considered only as indicative and it will require being checked during future investigation.

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure 4.4-10 (3) Hazardous Maps of the Former Processing Plant Facility

3) Tailings pond and dam

The tailings contained elevated concentration of Pb (around 3,000 mg/kg). No serious pollution problems were confirmed with water samples, although values of some heavy metals were slightly higher than the criteria for surface water in FBiH pursuant to the Decree on Hazardous and Noxious Substances in Water (Official Gazette of FBiH, No. 43/07). Therefore, the proposed measures focused on reinforcement of the dam, although continuous monitoring of AMD is still required.

Table 4.4-23 Summary of the Analysis Results for the Tailings Pond and Dam

Type of Contamination		Result	Reference Value
Water	Heavy metal	- Cd, Pb, Cu, and Zn etc. exceeded the surface water quality criteria in FBiH. However, the exceedance is small and it is assumed that it originated from a natural source.	-
Soil (tailings) and sediment	Heavy metal	- At the tailings dam, Pb, Zn, and As of soil exceeded the reference values for soil in this survey. Sediment also contained high concentrations of Pb, Zn and As. - In addition, the samples are enriched by iron and manganese as compared to the background values.	500 mg/kg (Pb), 1000 mg/kg (Zn), 50 mg/kg (As) (Reference values for soil in this survey).
Sediment	Heavy metal	- The concentrations of Pb, Zn, Fe, and Mn were over 1,000 mg/kg. - There is a significant difference in the chemical composition of the pond sediment and the tailings dam material, which confirmed the supposition that the dam was made of the tailings from the processing plant.	-

Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

(4) Risk Analysis

The result score of risk assessment by HRS method did not indicate high priority issues related to the target sites in Vares. On the other hand, the risk of physical collapse of the tailings dam should be assessed separately in a further study because of lack of enough data to evaluate the current strength of the dam structure.

Table 4.4-24 Results of Risk Assessment of the Abandoned Mining Sites in Vares

Pathway	Abandoned Mining Pond	Processing Plant Facility and Tailings Dam
Groundwater migration	0.07	33.51
Surface water migration	9.91	33.84
Soil migration	33.51	15.69
Air	0.07	3.14
Total	17.47	25.52

*) Cutoff value for risk: 28.5

Source: Prepared by JET based on "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master for Remediation of Hotspots in Bosnia and Herzegovina, 2014"

(5) Preliminary Remediation Plan

1) Abandoned open-pit pond

The site survey did not detect any significant pollution in the surface water of the pond, therefore the remediation objectives are as follows:

1) Improve the present landscape around the pond, which is the result of past mining operations, and

2) Control and monitor environmental conditions at the site in order to avoid any risk to human health

Thus, it is suggested that remediation measures at this open-pit pond should include the following points:

1) Biological recultivation (reclamation) of the slopes around the pond where the soil and vegetation had been lost due to mining operations.
2) The most important measure is to establish a regular monitoring program that would provide reliable data regarding the ecological and chemical status of the water body.
3) The program should include sampling and analysis of fish in order to check the environmental impacts of heavy metals found in the pond sediments.

Table 4.4-25 summarizes the proposed preliminary plan and cost estimation.

Table 4.4-25 Proposed Preliminary Remediation Plan for and Cost Estimation of the Abandoned Open-pit Pond

Measure	Unit	Quantity	Unit Cost (BAM)	Total Cost (BAM)
Development of a detailed design for biological recultivation of the site	Lump sum	1	6,000	6,000
Biological recultivation: vegetation of the site	ha	105	3,000	315,000
Total				321,000

Note: The cost of preliminary investigations and monitoring after remediation is not included.
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master for Remediation of Hotspots in Bosnia and Herzegovina, 2014

2) Processing plant facility and tailings dam

The abandoned processing plant facility will be rehabilitated by the current site owner. In the site survey, the following were proposed as outputs of the case study: (i) removal of polluted soil seriously contaminated with heavy metals and (ii) re-treatment by the concentration plant.

1) STEP 1: Decommissioning and demolition of existing buildings
2) STEP 2: Prevention of further soil contamination

Option 1 is transport and temporary disposal of contaminated soil at a nearby location and processing of the same at the new plant. This option will include the extraction of heavy metals and permanent disposal of the remaining material with the tailings.

Option 2 is removal of contaminated soil from the site and disposal of the same at the tailings pond. This may be an environmentally acceptable option because the chemical composition of the soil is similar to the pond sediment.

Table 4.4-26 Preliminary Cost Estimation of Decommissioning of the Processing Plant Facility

Measure	Unit	Quantity	Total Cost (BAM)
Preparatory works: development of a demolition plan, separation of materials that have economic value which should be preserved from demolition, preparation of location for demolition works, and implementation of safety measures	Lump sum	1	7,000
Decommissioning of buildings and structures and preparation of construction waste for transportation			
Thickeners	m^3	130	35,000
Flotation building (mill, flotation, and regents preparation)	m^3	250	75,000
Building for filtration, drying, ready-made warehouse and pumping station	m^3	80	25,000
Workshop building	m^3	30	9,000
Main building	m^3	1,000	220,000
Crusher building	m^3	100	30,000
Auxiliary and ancillary facilities and equipment	m^3	200	40,000
Separation of steel waste for recycling	t	50	2,000
Disposal of the inert construction waste at a local disposal site	m^3	1,600	40,000
Disposal of contaminated construction waste at the Veovača tailings	m^3	190	2,000
Total			485,000

Note: The cost of preliminary investigations and monitoring after remediation is not included.
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Regarding the tailings dam, the safety of the tailings dam is of primary concern because the structural integrity of the dam needs to be restored immediately. Monitoring of the tailings dam should be done, aiming to ensure safety of the dam. Inspection and monitoring at the dam have to be carried out regularly by a specialized institution that is experienced with observation of high dams. The expected measures include control of inflow of rainwater (construction of drainage at hillside), countermeasure against dam failure by rehabilitating the eroded surface with soil and vegetation, monitoring and management of groundwater by piezometer at the dam, and construction of emergency drainage channel.

At the stage of rehabilitation and revegetation of the tailings dam, the following measures are proposed:

1. Rehabilitation of the dam
2. Revegetation of the downstream slope of the dam.

For measure 1, the dam should be rehabilitated using the same or similar materials that were used for the construction of the original dam. It is preferred that locally-borrowed materials are used for the remediation.

As for measure 2, the downstream slope should be protected from erosion by grass vegetation and/or other vegetation with a very shallow root system. Trees and bushes are not permitted on the embankments as deep root systems provide seepage paths for water, especially after the roots decay.

Table 4.4-27 gives the preliminary cost estimation of remediation measures of the processing plant facility and tailings dam.

Table 4.4-27 Preliminary Cost Estimation of Remediation Measures of the Processing Plant Facility and Tailings Dam

Measure	Unit of Measure	Quantity	Unit Cost	Total Cost (BAM)
Decommissioning and demolition of existing buildings and infrastructure and final disposal of construction waste	m^3	1,790	271	485,000
Excavation and disposal of soil contaminated with heavy metals at the Veovača tailings	m^3	22,500	17	360,000
Remediation of the tailings dam: geotechnical investigation, detailed design, civil and other works, vegetation of the downstream slope, repair/replacement of piezometers, and installation of survey benchmark	Lump sum	1	380,000	380,000
Construction of two interception ditches	m	1,600	87.5	140,000
Total				1,365,000

Note: The cost of preliminary investigations and monitoring after remediation is not included.
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master for Remediation of Hotspots in Bosnia and Herzegovina, 2014

(6) Conclusions and Issues to be Considered

The results of the site survey are summarized as follows:

- The abandoned open-pit pond site did not indicate any serious problem of contamination.
- At the abandoned processing facility, some parts of the site were contaminated by heavy metals. However, further detailed investigation will be required because the number of the samples was too small to clarify the extent of the contaminated area.
- Securing the safety and stability of the tailings dam is the most pressing issue among all the target sites in the survey because it could result in a catastrophic accident. Monitoring and emergency measures should be done as soon as possible.

The following points were suggested through the site survey of the abandoned mining site in Vares:

- The area of the mining site is originally rich with heavy metals. The investigation results need to be evaluated considering the background level of heavy metals. It is difficult to evaluate such site in the same way with other sites.
- Remediation of the mining site is regulated both by the Law on Mining (Official Gazette of FBiH, No. 26/10) and by the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03, 38/09); however, further strengthening of legal requirements and enforcement is desired because environmental impacts from mining operation are significant.

4.5 Major Issues Identified through the Site Survey

Through the site survey activities for the four target sites, the following main issues were identified:

4.5.1 Technical Issues

- Insufficiency of criteria for defining a contaminated site makes site characterization difficult. Without concrete concepts and definitions of a “contaminated site” and a “non-contaminated site”, it is difficult to prepare site investigation and evaluate the results. For example, the Rulebook on Determining Permissible Amounts of Harmful and Hazardous Substances in Soil and their Method of Testing (Official Gazette of FBiH, No. 72/09) is often used for soil contamination surveys in FBiH because it is the only standard applied to soil in FBiH. However, the aim of this rulebook is to protect agricultural land. When contamination in other land uses, such as industrial land or residential land, is in question, sensitivity of receptors and exposure routes are different from those for agricultural land and food or plant. The allowable amount of harmful substance shall be set considering land use, receptors and exposure pathways.
- Management of environmental information on contaminated sites (especially information on soil and groundwater) should be improved. When the site survey was implemented, it was difficult to acquire past data and reports even though several studies had been carried out for each site. Establishing a baseline database system or at least improving information sharing among different organizations will make the desktop review at the preliminary investigation stage more efficient and practical.
- Soil contamination tends to be localized around the pollution source, and the exact locations of the sources are usually difficult to know a priori. On the other hand, if pollution spreads into the groundwater, the pollution might travel far and wide, possibly to the area outside of the immediate vicinity of the site. Because of this complexity, clarification of the pollution mechanism is very important. All potentially contaminated media and area/depth should be investigated. However, the cost of investigation can be formidable if the investigator takes many samples and analyzes all the parameters. Thus, an efficient survey plan shall be designed. Introduction of simplified analysis kits or measurement on site (e.g., portable XRF) will help reduce the cost.
- Pollution mechanism of a contaminated site is generally very complicated. The investigator is required to have wide knowledge on several scientific areas (hydrology, geology, chemistry, etc.) and a lot of experience. Also, a soil sample contains various substances interfering with analysis so that chemical analysis of soil is difficult. An accident of sample contamination at the site and during analysis sometimes happens unexpectedly. Thus, it is recommended to develop a system for quality control, such as certification and/or licensing of investigators, analytical experts and laboratories, and technical guidelines and best practice guidance on different steps of site investigation.
- The target site in Vares represented a typical geographic feature in the mining area and provided a good example of soil contaminated by naturally-occurring heavy metals. The evaluation method for a site where both man-made and natural impacts are significant needs to be systematized.

- Further study of risk assessment methodologies, and their uncertainties and limitations are needed if risk assessment is used to evaluate the sites and compare remediation priorities. Risk scores can be strongly influenced by how the receptors are chosen (e.g., risk associated with drinking of water from Modrac), and some risks are not taken into consideration in the methodology (e.g., risk of collapse of the tailings dam in Vares). Also, available information for risk assessment is too limited to warrant accurate risk characterization.
- Each site is unique, and strategies and plans for investigation, evaluation and site remediation should be developed case by case. For a seriously contaminated site, establishment of a special committee is recommended to discuss specific issues and measures based on the site characterization.
- In FBiH, readily available remediation technologies are limited and this will make speedy implementation of remediation more difficult. Investigation and piloting of different techniques to efficiently reduce risks should be at low cost.

4.5.2 Legal and Regulatory Issues

- A contaminated site is not defined by current laws of FBiH. It has to be defined in order to legally control contaminated sites.
- There are many regulations governing related fields in environmental management (e.g., waste disposal, transport of hazardous substances, industrial activities, drinking water, agricultural land) as well as responsibilities and duties of different stakeholders (e.g., polluter, holder of waste, different governmental organizations). However, issues on contaminated sites, especially legacy pollution sites, are somewhat different from the typical settings on which these regulations were designed (e.g., management of waste by somebody who produced waste, discharge of wastewater by operating industry, etc.). In order to manage contaminated sites effectively, it is necessary to either develop new regulations for the purpose, or reframe existing regulations in order to control contaminated sites.
- In principle, the site owner is responsible for the implementation of remediation. However, this approach is not working well for many contaminated sites in FBiH. Many abandoned sites and sites of bankrupt owners have to be investigated and controlled, but due to unclear responsibility and other pressing issues, environmental problems caused by such sites are often neglected. Also, when the site owner changes frequently, the whole process is put on hold and repeated again because each site owner has different visions, different business plans, and different approaches to environmental management. This was one of the reasons why the problems at the former chemical factory site in Tuzla and the abandoned mining site in Vares have been left unsolved for a long time. If appropriate, a mechanism of governmental intervention and cost recovery should be considered.
- Most stakeholders are aware of the issues of the targets site, but implementation of remediation has been difficult due to lack of funding. Funding mechanisms should be strengthened in parallel along with stricter enforcement of the laws.

4.5.3 Organizational Issues

- Various stakeholders are involved in the management of contaminated sites. In addition to site owners and neighbors, they include ministries at the federal level, inspectorate, cantonal ministries, municipalities, relevant technical agencies, among others. When a new regulatory framework is developed to manage contaminated sites, the roles and responsibilities of these stakeholders should be streamlined, and mechanisms for information sharing and stakeholder involvement should be built into the framework.

CHAPTER 5 OVERALL FRAMEWORK OF THE DRAFT MASTER PLAN

5.1 Introduction

This chapter briefly summarizes the proposed draft master plan for the remediation of environmental hotspots in FBiH, which will be elaborated further in Chapters 6 to 10. The situations of environmental hotspots in FBiH can be summarized as follows:

- There are potentially hundreds of environmental hotspots in FBiH, and at least some of these sites have to be remediated, or at least some urgent measures have to be taken, as soon as possible.
- The exact magnitude of the problems of hotspots in FBiH is unknown because information on such sites is too limited. A comprehensive survey of hotspots in FBiH is desirable.
- There are a number of important laws and regulations pertaining to the management of environmental hotspots, such as the Law on Environmental Protection (Official Gazette of FBiH Nos.33/03 and 38/09) and the Law on Waste Management (Official Gazette of FBiH Nos. 33/03 and 72/09). These laws provide a general foundation for the remediation of environmental hotspots.
- There is no legal definition of a contaminated site. Also, different aspects of environmental liability, such as the liability of a party who did not cause the pollution but owns the site, the liability of a party who polluted the site long time ago, or the liability for a site contaminated by more than one party, are unclear, or at least not widely recognized. Such gaps in the regulatory systems make it difficult to officially control contaminated sites through legal and administrative instruments. A new legal framework for management of hotspots is needed in line with the existing laws.
- Similarly, there are no technical guidelines for remediation activities, such as site investigation, evaluation of contamination, development of remediation goals, and implementation of remediation measures. To control quality of remediation activities, it is suggested to develop technical guidelines and best practice guidance documents.
- Also, there is no place in FBiH where to dispose hazardous wastes, which is a serious obstacle to implement remediation measures. Proper hazardous waste disposal sites should be established in FBiH.
- The number of technical and legal experts who are familiar with environmental remediation is very limited, and there are not many firms with specialized technologies and experiences in remediating contaminated sites. Capacity development of environmental officers and stakeholders is desirable.
- Financial sources for remediation are generally limited. Expanding the bases of public environmental funding and providing financial support mechanisms for private sectors are suggested.

5.2 Overall Framework of the Draft Master Plan for Remediation of Hotspot

5.2.1 Overall Framework of the Draft Master Plan

(1) Goals of the Draft Master Plan

In accordance with the polluter-pays-principle, remediation of environmental hotspots in FBiH should be carried out by the party responsible for remediation. However, to make this possible, FBiH has to develop technical and regulatory systems. Also, many sites have been left abandoned for years, and environmental risks of priority sites have to be controlled urgently. These tasks require efforts of trained professionals and support of other stakeholders. Hence, this draft master plan was developed to support the relevant authorities of FBiH to:

- Develop technical and regulatory framework for remediation of environmental hotspots;

- Remediate some of the priority sites; and
- Develop capacities of environmental officers and other stakeholders.

(2) Target Year

The target year is set in 2020. The plan will cover only six years, but as this is the most critical period for the development of the regulatory framework, and to control most serious environmental risks at the priority sites, this was considered sufficient. It was noted that in accordance with Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09), an environmental protection plan is developed for a period of five years.

(3) Target Sites

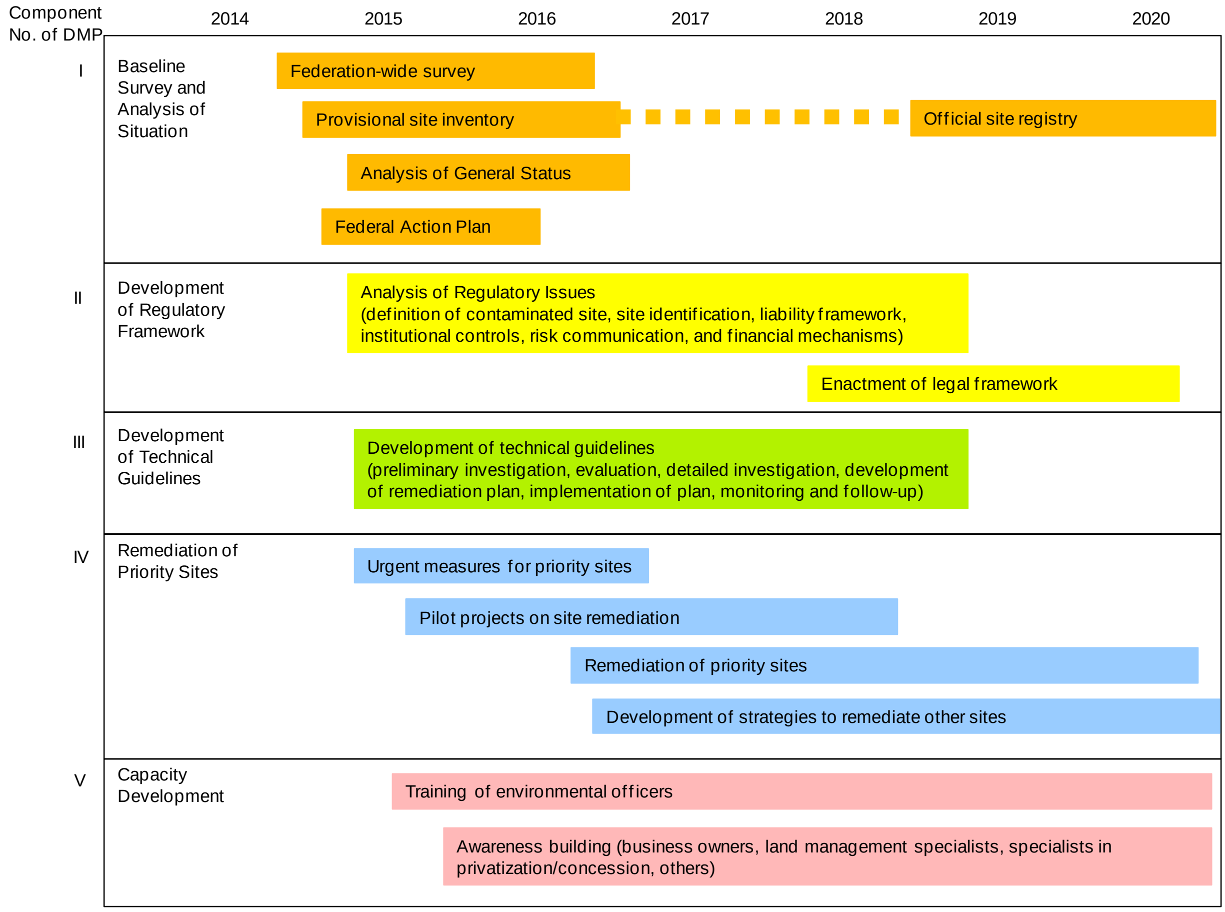
This draft master plan will cover, in principle, all sites in FBiH contaminated with hazardous substances, which will include the following sites:

- Industrial sites;
- Mining sites;
- Waste disposal sites; and
- Others (military sites, dry cleaning shops, sites polluted with PCBs and other POPs, storage of hazardous materials, sites with large leaky underground storage tanks, and other sites of special interest).

Selecting the target sites to be covered in this draft master plan is not trivial because there is no legal definition of “hotspots” or “contaminated sites”. These sites are regulated under the different laws and by-laws, such as the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09), Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09), Law on Mining (Official Gazette of FBiH, No. 26/10), and Law on Agriculture (Official Gazette, Nos. 88/07, 4/10, 27/12 and 7/13). Some contaminated sites are under strict control, as it is the case of some sanitary landfill or controlled stockyard of hazardous waste, and they should be exempted from being called as hotspot or contaminated site. The distinction between a legacy pollution site and a current site is also blurred in light of the current environmental and liability regulations. Hence, all of the sites mentioned above are considered as the target of this draft master plan, until a clearer definition of a hotspot or a contaminated site is developed.

(4) General Framework

The draft master plan has five major components, i.e.: (i) baseline survey and analysis of situation, (ii) development of regulatory framework, (iii) development of technical guidelines, (iv) remediation of priority sites, and (v) capacity development, as summarized in Figure 5.2-1. For each component, specific activities until 2020 have been proposed as summarized below.

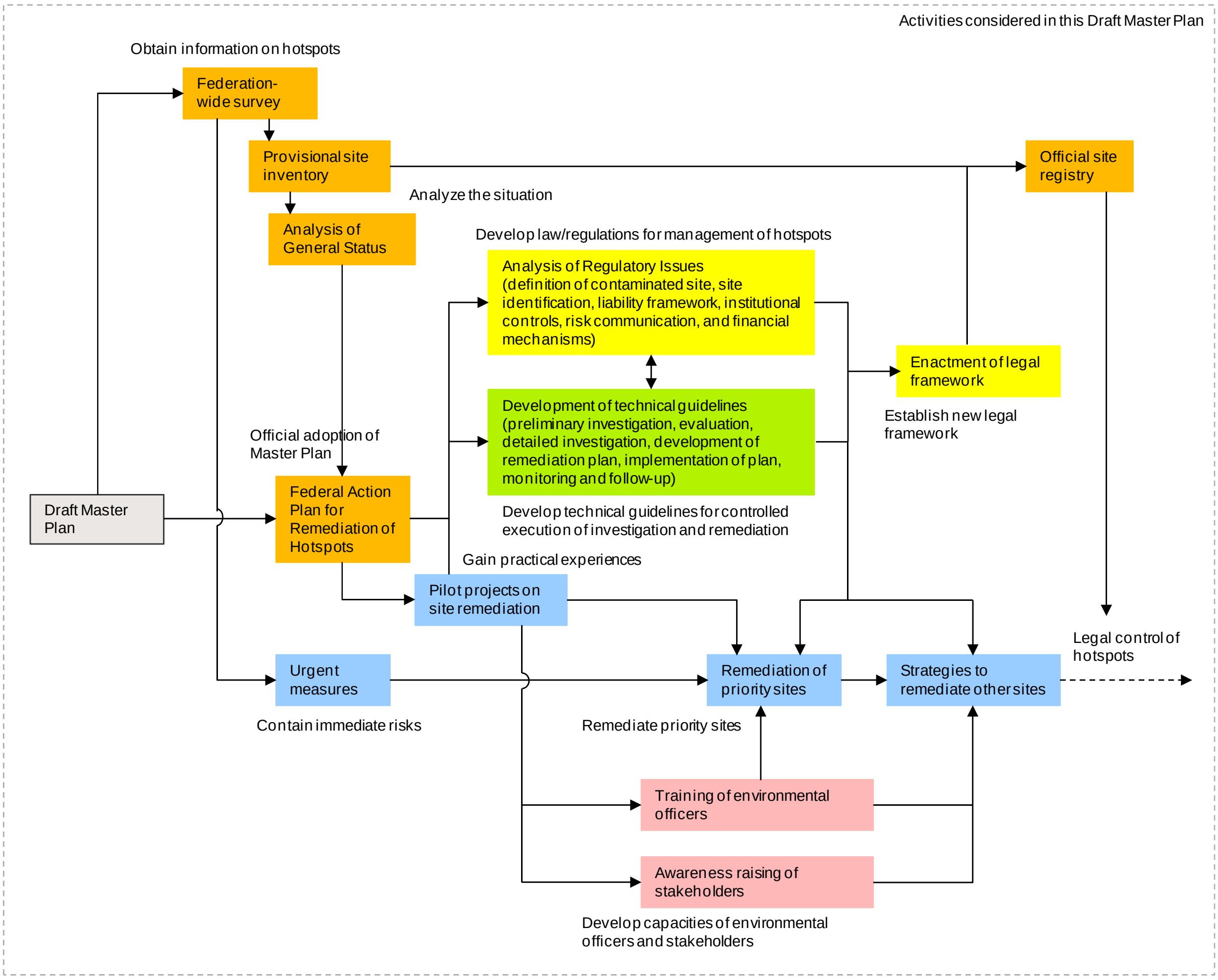


Source: JET

Figure 5.2-1 Overall Framework of the Draft Master Plan

5.2.2 Summary of Proposed Activities

Figure 5.2-2 summarizes how activities proposed in the draft master plan are inter-related. Each activity is summarized below, and explained in Chapters 6 to 10. In order to officially implement the activities, it is suggested to re-organize and further revise the draft master plan as Federal Action Plan for Remediation of Environmental Hotspots, and to implement all activities under the framework of the said action plan.



Source: JET

Figure 5.2-2 Activities Proposed in the Draft Master Plan

(1) Baseline Survey and Analysis of Situation (Chapter 6)

This component proposes the following activities to investigate the general status of contaminated sites in FBiH and develop an inventory/registry of contaminated sites:

- Federation-wide survey of contaminated sites,
- Development of provisional site inventory and official site registry,
- Analysis of general status of contaminated sites in FBiH, and
- Development of the Federal Action Plan for Remediation of Environmental Hotspots.

It starts with a quick survey of contaminated sites in the entire FBiH. Then, the data and information collected in the survey will be compiled into a provisional site inventory, and analyzed with respect to the general status of the hotspots in FBiH. The results will give rough ideas about the number of sites in FBiH, which sites are considered priority, technical capacities available in FBiH, required financial sources, foreseeable problems with environmental liability and risk communication, among others. Once the legal framework has been developed, an official registry of contaminated sites should be developed. Also, in order to officially adopt the activities proposed in the draft master plan, it suggested to redevelop the draft master plan as Federal Action Plan for Remediation of Environmental Hotspots.

(2) Development of Regulatory Framework (Chapter 7)

This component covers analysis of the following regulatory issues and subsequent development of relevant laws and bylaws:

- Definition of contaminated sites,
- Site identification,
- Liability framework for contaminated sites,
- Institutional controls,
- Risk communication and stakeholder involvement,
- Financing of remediation projects, and
- Enactment of the legal framework.

With respect to the definition of contaminated site, it is suggested to develop a provisional legal definition based on screening values together with discretional powers of the environmental authority in order to accommodate the concept of risk assessment. For identification of potentially-contaminated sites, who is responsible for identification of different types of sites (e.g., industrial, mining, waste disposal etc.), the method of reporting, and the system of keeping the record of reported sites, should be decided. For environmental liability, loopholes in the current liability framework, such as support for innocent site owner, support for site owner without capacity to remediate site, retrospective liability, and issue of burden of proof will be considered. For institutional controls, various administrative tools, such as restrictions on land use and water use, should be developed in order to supplement the effectiveness of engineering measures and ensure safety of the site. For risk communication, model responses to key questions on liability, health risks, remediation methodologies, and other questions should be analyzed. For financing remediation projects, the possibility of using government budget, Environmental Protection Fund of FBiH, and other financial resources for different types of remediation projects should be analyzed including justification for public intervention.

(3) Development of Technical Guidelines (Chapter 8)

The draft master plan proposes development of technical guidelines and best practice documents for different stages of remediation so that in the future, all remediation projects can be implemented in a structured and well-controlled manner. These technical guidelines and best practice documents may be developed through the proposed pilot projects. The following stages of remediation project will be covered:

- Preliminary investigation,
- Preliminary evaluation of contamination,
- Detailed investigation,
- Development of remediation plan,
- Implementation of remediation plan, and
- Monitoring and follow up.

The main objective of the early stages of remediation, namely preliminary investigation and preliminary evaluation, is to identify sites that require official control due to the environmental risk associated with the site. For this, development of technical guidelines for preliminary investigation and preliminary evaluation are suggested. Development of a legal definition of contaminated site becomes a prerequisite for site evaluation.

The tasks of detailed investigation, risk assessment and development of remediation plan are interrelated, which have to be implemented in a coordinated manner. The draft master plan suggests development of a technical guideline for detailed investigation, a step-by-step introduction of risk assessment approaches, discussions on the ways to set remediation goals, and development of prototype remediation plans for some sectors for which many remediation projects are anticipated.

For implementation of a remediation plan, one has to ensure proper execution of the site works without causing secondary pollution, and the draft master plan suggested development of a prototype quality control plan that contractors can follow to control site works. Similarly, for monitoring, development of a prototype monitoring plan was proposed in order to confirm attainment of the remediation goal.

(4) Remediation of Priority Sites (Chapter 9)

In parallel to the development of regulatory framework and technical guidelines, some priority sites in FBiH should be remediated as soon as possible. Hence, the draft master plan suggests the following activities based on the results of the Federation-wide survey mentioned above:

- Urgent measures for priority sites,
- Pilot projects,
- Remediation of priority sites, and
- Development of plans for other sites.

For sites where environmental risks are considered high, urgent measures should be implemented by the site owners or the environmental authorities. Examples of urgent measures include restricting access to site, prohibiting drinking of contaminated water, and covering waste with plastic sheet. Next, implementation of pilot projects is recommended to gain much needed experiences in remediating sites and identifying key technical and regulatory issues. The experiences gained through the pilot projects should be used to remediate the priority sites, and also to develop the regulatory framework and technical guidelines. Also, strategies for remediating other sites should be developed.

(5) Capacity Development (Chapter 10)

Remediation of contaminated sites require the efforts of many stakeholders, and the following capacity development activities are included in the draft master plan:

- Capacity development of environmental officers, and
- Awareness building of stakeholders.

Some capacity development activities should be tailored for environmental officers, environmental inspectors, consultants, and other people who will manage and implement remediation projects. Also, awareness raising activities shall be implemented for site owners, business owners, land management specialists, privatization/concession specialists, among others.

CHAPTER 6 DRAFT MASTER PLAN: PART I – BASELINE SURVEY AND ANALYSIS OF SITUATION

6.1 Introduction

This chapter proposes a series of activity to gather basic information on the contaminated sites in FBiH, compile data into a provisional inventory, and broadly analyze the current status of contaminated sites in FBiH. The provisional inventory later becomes the basis of an official site registry to manage legally contaminated sites, after the regulatory framework for contaminated site is formally established. The following activities are covered:

- Federation-wide survey of contaminated sites;
- Development of a provisional site inventory and an official site registry; and
- Analysis of general status of contaminated sites in FBiH.

6.2 Federation-wide Survey of Contaminated Sites

6.2.1 Introduction

There could be hundreds of contaminated sites in FBiH. However, information on such sites are limited, and it is difficult to understand the overall extent of the problems, such as the approximate number of potentially contaminated sites in FBiH, sectors/activities, key pollutants, priority sites that have to be controlled urgently, anticipated remediation costs, and capacities of site owners to clean the sites. Thus, a Federation-wide survey of potentially contaminated sites should be implemented in FBiH. The results of the survey are used to establish a provisional site inventory and analyze the general status of contaminated sites in FBiH, as proposed later in this chapter. A similar activity has already been suggested in the Federal Waste Management Plan 2012-2017, i.e., to define and develop a list of hot spots with the budget of BAM 200,000, but has not been implemented. Thus, the Federation-wide survey should be implemented as soon as possible.

6.2.2 Suggested Activities of Federation-wide Survey

Table 6.2-1 summarizes the objectives, responsible organizations, period, methodology, and suggested key activities of the Federation-wide survey.

The target sites are those where contamination with toxic substances are suspected. They include industrial sites, industrial or domestic waste disposal sites, mining sites, storage of hazardous materials, sites where pollution with POPs (e.g., PCBs) is suspected, military sites, dry cleaning shops, sites where large leaky underground storage tanks are suspected, and other sites of special interest.

There could be hundreds of such sites in FBiH, and in order to broadly characterize them, a review of past studies on such sites and a questionnaire survey to local environmental officers are suggested. Some sites may be heavily contaminated and could pose significant environmental risks to local residents and the environment. For such sites, a simple site survey should be implemented to evaluate the priorities of remediation. Because this survey requires coordination with various organizations at the federation, canton, and municipality levels, it might be implemented as part of an international cooperation project, in which the donor can facilitate the coordination.

Table 6.2-1 Suggested Activities of Federation-wide Survey

Category	Remarks
Objectives	- To broadly identify situations of potentially contaminated sites in FBiH. - To gather information necessary to develop a provisional site inventory. - To identify priority sites that need urgent measures and urgent remediation. - To identify sites for pilot activities.
Responsible Organization	- FMoET with support of all cantons - A team of experts should be organized for the task.
Period	- 2014-2016

Category		Remarks
Methodology		- Review of past studies; - Questionnaire survey to environmental officers at the federation, canton, and municipality levels (federal and cantonal environmental inspectors, Cantonal Ministry for Spatial Planning and Environment, Cantonal Ministry for Agriculture, Water Management and Forestry, Cantonal Public Health Office, and perhaps public service sections of municipalities); and - Basic site survey (site surveys with sampling of limited numbers of water and soil samples; on-site investigation to confirm existence of pollution and survey of groundwater or surface water to examine impact on local community). Because analysis of samples in the laboratory is expensive, the analysis may be supplemented with the use of portable XRF equipment and other portable devices.
Key Activities (Design Considerations)	Target Sites	Target sites to be investigated are as follows: - Industrial sites (former/abandoned and current); - Mining sites (former/abandoned and current); - Waste disposal sites (former/abandoned and current); and - Other sites (former/abandoned and current; sites where pollution with POPs is suspected, military sites, storage of hazardous materials, leaky underground storage tanks, other sites of special interest).
	Items to be Investigated (tentative, should be developed considering the site inventory to be developed)	General information on sites - Name of the location - Address of the location, map of the location - Geographic coordinate - Official, competent authority, contact address, data source - Date of filling the questionnaire
		Economic activities - Name of the current owner - Contact address of the current owner - Past owners of the site - Information on privatization, concession, and other types of transactions - Type of industrial/commercial activities conducted at the site - Major products and by-products and production processes - Number of employees - Site layout - Future plans
		Polluting activities - Suspected activities that caused pollution - Reference period for polluting activity - Measures taken to contain the pollution
		Site conditions - Physical type of pollution source: landfill/dumpsite, impoundment, contaminated soil, chemical storage, underground tank, tailings dam, etc. - Estimated amount of pollution: volume (m^3), surface (ha) and/or depth (m) - Past site investigations (preliminary, detailed) - Past remediation activities - Information on concentrations of pollutants in soil, groundwater, surface water, and air - On-site survey (portable XRF, other portable testing kits)
		Impact on humans and natural environment - Possible receptors: local residents, workers, sensitive area - Possible exposure routes to receptors - Information on concentrations of pollutant in the pathways (drinking water, dermal contact, agricultural products) - Information on public health and environmental conditions
		Regulatory information and administrative activities - Relevant laws and regulations - Histories of administrative activities (environmental, water, land use and other permissions, inspection, environmental violations, complaints from local residents)
	Reporting	- A brief report of the situation of each site should be prepared.
	Related Activities	The results of this survey will be used in the following activities proposed in this draft master plan: - Development of the provisional site inventory - Analysis of general status of contaminated sites in FBiH

Source: JET

6.3 Development of Provisional Site Inventory and Official Site Registry

6.3.1 Introduction

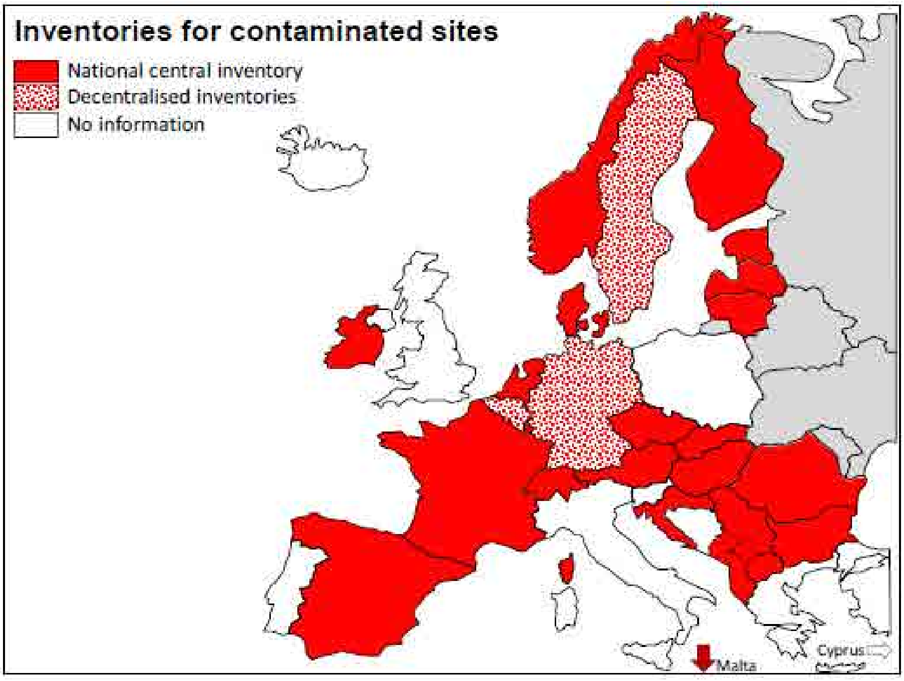
As stated in Chapter 2, a number of isolated studies on contaminated sites have been conducted in FBiH, but currently there are no official and comprehensive inventories of contaminated sites. This makes it difficult to evaluate the extent of problems and to prioritize the remediation works according to the urgency for remediation. An inventory of contaminated sites has to be developed urgently.

The concept of environmental inventory is not new in FBiH. Article 28 of the Law on Environmental Protection of FBiH (Official Gazette of FBiH, Nos. 33/03 and 38/09) requires the ministry responsible for environmental affairs to keep a register of installations and of pollution. By law, the register is public and any person can access the register. Also, Article 22 of the Law requires establishment of the environmental information system, and Article 23 requires the extent and nature of permanent environmental damages to be entered into the land registry. Rulebook on Registries of Plants and Pollution (Official Gazette of FBiH, No. 82/07) requires the development of the registry of (i) discharge of pollutants into air, water, and soil, (ii) off-site transfer of pollutants, and (iii) consumption of resources and energy in the plant. Development of a list of contaminated sites has been proposed in the Federal Waste Management Plan 2012-2017.

The inventory should be developed carefully for a number of reasons. First, disclosing information on a contaminated site could bring anxiety to the local residents, and thus, before making the information public, the polluter as well as the government should be ready to explain to the stakeholders the extent of pollution and environmental risks associated with each site. Second, by making the site information available to the public, the market value of the site and its surrounding area may be reduced. This is important for the landowners adjacent to the site, and possibly for the local economy. Third, as soon as the inventory becomes public, activities of both parties liable for the pollution as well as the local government will be closely watched by the stakeholders. If remediation is not implemented in a timely manner, even if the environmental risk of the site is insignificant or available resources for remediation are limited, the legal responsibility of the site owner and the government might become an issue. The inventory should be prepared considering such potential implications.

6.3.2 Inventories in the European Union (EU) and Other Countries

Figure 6.3-1 shows a map of European countries that have national or decentralized inventories of contaminated sites. The data is based on a questionnaire survey implemented by the European Environment Information and Observation Network (EIONET). While information on several countries, including the United Kingdom (UK) and Italy which both have inventories of contaminated sites, is missing, it is evident that most European countries have some kind of inventories at the national or local level. Under the Aarhus Convention, local authorities have to collate, update, and disseminate environmental information, including pollution inventories. Similarly, the Mining Waste Directive (2004/35/EC), Recast of IPPC Directive (2010/75/EU), E-PRTR, Soil Thematic Guideline (COM (2006) 231), and a number of related regulations in EU require an inventory of contaminated sites or related inventories. Japan, the United States, and Canada also have national and local inventories.



Source: ESDAC, 2012 version of the EEA indicator CSI015 "Progress in the Management of Contaminated Sites", 2012.

Figure 6.3-1 Countries with Inventories of Contaminated Sites

The comprehensiveness of the inventories varies significantly from country to country. Countries that have well-established legal framework for the management of contaminated sites generally maintain official registries of thousands of sites, and such registries are used as an indispensable tool to manage legally contaminated sites. Those countries that are yet to establish a legal framework usually develop a tentative inventory to evaluate the overall picture of the problem, and to develop a legal framework that is realistic and enforceable. FBiH is still in the latter stage, and an inventory or a registry of contaminated sites has to be developed step-by-step, in parallel with the development of relevant legislative systems.

6.3.3 Suggested Development of Inventory and Registry of Contaminated Sites in FBiH

One of the main objectives of developing a register of legally contaminated sites is to manage contaminated sites in accordance with relevant laws and regulations. However, in FBiH, there are no laws and regulations that legally define and regulate contaminated sites. Thus, it is suggested that the inventory or registry of contaminated sites is developed in two steps, in parallel with the development of relevant legislative systems:

- Stage 1: Development of a provisional site inventory of contaminated sites.
- Stage 2: Development of an official register of contaminated sites.

(1) Stage 1: Development of Provisional Site Inventory of Contaminated Sites

In this stage, information on contaminated sites collected through the Federation-wide survey (see previous section) is compiled in an inventory. The inventory constructed in this stage becomes a valuable source of information to analyze the general situation of contaminated sites in FBiH (see next section), to prioritize the sites for further investigation, to design laws and regulations, and to develop long-term plans.

Table 6.3-1 summarizes the suggested methodology for data collection. It was noted that the development of a list of contaminated sites has already been suggested in the Federal Waste Management Plan 2012-2017 (Define and Develop a List of Hot Spots, 2012, BAM 200,000), but it has not been implemented. Thus, it should be implemented as soon as possible. Serbia took a similar approach to develop its national inventory of contaminated sites with the support of EU's Twinning Project (see e.g., Vidojevic et al., Inventory of Contaminated Sites in Serbia, 2013).

Table 6.3-1 Development of Provisional Site Inventory of Contaminated Sites

Category		Remarks
Objective		- To develop a provisional site inventory of contaminated sites in FBiH.
Responsible Organization		- FMoET, Canton, Municipalities and Inspectorate
Period		- 2014-2016
Methodology		- Compilation of data and information collected through the Federation-wide survey proposed in the previous section, in which necessary data and information are collected through interview survey and limited site investigations.
Key Activities	Items to be Inventoried	General information to be inventoried: - See the description of items to be investigated for the activity of the Federation-wide survey.
	System Design	- Development of a small database with GIS maps that is consistent with the requirements of EU INSPIRE Directive. - Brief summary report
References		- Common Forum, Inventories & CSI015 Indicator for Management of (Potentially) Contaminated Sites, 2013. - M. van Liedekerke et al., EIONET, 2012 Version of the EEA Indicator CSI015 Progress in the Management of Contaminated Sites, 2012. - European Commission, Commission Decision of 20th of April 2009 on the definition of the criteria for the classification of waste facilities in accordance with Annex III of Directive 2006/21/EC of the European Parliament and of the Council concerning the management of waste from extractive industries.

Source: JET

(2) Stage 2: Analysis of Requirements for Official Register

There is no doubt that the provisional site inventory developed in Stage 1 will become a valuable source of information for policy development. Nevertheless, the provisional site inventory is not adequate to legally manage contaminated sites because the information in the provisional site inventory is not sufficiently accurate for legal use and may not be fully consistent with the regulatory systems, which are yet to be developed. Thus, once the regulatory framework is established, FBiH has to develop an official register of contaminated sites by revising/improving the provisional site inventory. This register becomes a part of the environmental information system defined in Chapter V of the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09).

There is no standard set of objectives for establishing official registers of contaminated sites, and each country has to develop its own registry considering the regulatory and administrative needs (see Goidts and Caps, 2013[1]).

Table 6.3-2 summarizes some of the issues that have to be considered in developing an official registry.

[1] Goidts, E. and Capus, S., Inventories & CSI015 Indicator for Management of (potentially) Contaminated Sites, Common Forum Meeting, Bratislava – May 31st, 2013.

Table 6.3-2 Suggested Activities for the Development of an Official Registry of Contaminated Sites

Category		Remarks
Objectives		To develop an official registry of contaminated sites in order to fulfill the following objectives: - To register and manage legally contaminated sites; - To store record of a wide range of contaminated sites, such as potentially contaminated sites and remediated sites; - To store information on contaminated sites such as sector, types of pollution (contaminants, site type), ownership (polluter, historical and current owner), stage of investigation and remediation (site identification, preliminary investigation, main investigation, completion of measures), and remediation costs so that the information can be used for policy making; - To fulfill the requirements of the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and No. 38/09) and other regulatory requirements including the Aarhus Convention; and - To provide environmental statistics requested by EU (CSI015 data) and others.
Responsible Organization		FMoET and/or cantons
Period		2018-2020
Methodology		Development of a registry system based on the legal framework to be established.
Key Activities	Definition of Contaminated Site	Define the legal definition of a contaminated site (this will be done in a separate activity, i.e., "development of legal definition of contaminated sites", to be implemented in this draft master plan.) All legally contaminated sites should be registered and controlled, but the definition of legally contaminated site differs significantly depending on the laws and regulations of the country and the locality.
	Classification of Contaminated Site	Decide how to classify contaminated sites based on the legal definition. The classifications in selected countries are as follows: - Serbia adopted three categories - Category A (not relevant for classification as potentially contaminated site because probability of contamination is low and potential hazard, if contaminated, is low), Category B (relevant for classification as potentially contaminated sites but as the probability of contamination is medium and potential hazard, if contaminated, is low, there is no urgent need for verification/action), and Category C (potentially contaminated sites with urgent need for verification/action because probability of contamination is high and potential hazard is medium to high). - In Japan, contaminated sites are classified into two types: (i) contaminated site that has to be remediated urgently because it is already affecting the surrounding environment and (ii) site that is contaminated but contained, and the site owner has the obligation to notify the local authority when the site is disturbed. - Canada has five levels, namely: Class 1 (high priority for action), Class 2 (medium priority for action), Class 3 (low priority for action), Class N (not a priority for action), and Class INS (insufficient information). - For mining sites, EU has a decision based on Directive 2006/21/EC on the management of waste from extractive industries.
	Minimum Risk Criteria for Inclusion of Marginally Contaminated Sites in the Inventory	This determines how many sites are to be legally registered and controlled. The minimum criteria should be decided carefully considering the available budget and other administrative resources.
	Collection of Site Information	Site information may be gathered either by private business owner or landowner as part of the legal requirement, or by the local government, or by both.
	Information Disclosure	The policy for information disclosure should be decided. In principle, site information should be public, but some information, e.g., manufacturing processes, might be considered proprietary. Site information can influence the market value of the site and its surrounding area. Thus, how information is presented to the public should be considered carefully.
	Relation with Other Databases	Relation of the site registry with other government databases, such as land registry, land use database, database of pollution sources, PRTR, court decision Considering the need to cross-reference information and to avoid duplicated/conflicting information, the relation with other databases should be taken into consideration.
	System Design	A web-based GIS system with database

Source: JET

6.4 Analysis of the General Status of Contaminated Sites in FBiH

6.4.1 Introduction

Once the provisional site inventory of contaminated sites is developed, it becomes possible to evaluate the general status of contaminated sites. The results of the analysis will then help environmental authorities develop new policies and regulations, develop realistic action plans, and also convince decision makers about the importance of addressing the issues of contaminated sites.

6.4.2 Suggested Activities

Table 6.4-1 summarizes the suggested activities for the analysis of the general status of contaminated sites in FBiH. Through the analysis, the overall extent of the problems should be clarified. In addition, the analysis should identify priority sites that need urgent measures and/or urgent remediation, and prospective sites for the pilot projects.

Table 6.4-1 Suggested Activity for the Analysis of the General Status of Contaminated Sites in FBiH

Category		Remarks
Objectives		The main objectives of the analysis are to clarify the following issues: - Overall extent of the problems of contaminated sites in FBiH. - Priority sites that require emergency measures and/or urgent remediation. - Policy and regulatory issues to be investigated in the subsequent phase. - Selection of pilot projects.
Responsible Organization		A team of specialists led by FMoET
Period		2014-2016
Methodology		Analysis of the provisional site inventory of contaminated sites with respect to the items mentioned below. Findings should be compiled as reports, and used for policy development in the subsequent phase.
Key Activities (Items to be Analyzed)	Overall Extent of the Problems of Contaminated Sites	Based on the information in the provisional site inventory, the overall extent of the problems of contaminated sites in FBiH should be identified, and a report should be prepared. Some of the important aspects to be analyzed and reported are: - Number of contaminated sites; - Industrial sectors; - Major contaminants; - Suspected mechanisms of contamination; - Suspected environmental risks; - Need for urgent measures; - Stages of remediation activities; and - Responsibility for remediation.
	Identification of Priority Sites that Require Emergency Measures and/or Urgent Remediation	Priority sites that require emergency measures to minimize exposure or sites that require urgent investigation because of their environmental risks have to be identified. With respect to emergency measures, they do not have to be expensive and extensive. For example, the following measures can effectively reduce environmental risks quickly and without incurring substantial costs: - Notifying local residents and workers regarding the risk associated with the site; - Controlling access to the site; - Controlling drinking/regular use of contaminated water and cultivation of crop on contaminated soil; and - Covering exposed waste material with plastic sheet or other material. Ideally, the priority sites are selected based on proper risk assessment. However, readily available information for each site will be limited, and it takes time to implement a detailed investigation. Hence, the experts should place emphasis on reducing the risk quickly, using expert judgment considering the possible exposure pathways.

Category		Remarks
	Identification of Policy and Regulatory Issues to be Investigated in the Subsequent Phase	Based on the provisional site inventory, the policy and regulatory issues to be investigated in the subsequent phase have to be clarified. The most critical issues are as follows: - Definition of legally contaminated site; - Framework for environmental liability; - Methodologies for site investigation; - Methodologies for risk assessment; - Methodologies for selection of remediation measures; - Approaches to risk communication; - Approaches to institutional controls; - Requirements for funding; and - Requirements for capacities of environmental authorities and other stakeholders.
	Selection of Pilot Projects	In FBiH, experiences in remediation of contaminated sites are desperately lacking. FBiH has to quickly resolve different aspects of remediation, such as the definition of legally contaminated site, framework of environmental liability, and selection of remediation measures. This is most effectively achieved by implementing pilot projects and building technical as well as institutional experiences to manage the contaminated sites. Out of the sites identified in the provisional site inventory, FBiH is encouraged to select a few representative sites for the pilot projects, and to implement the pilot projects.
Reference		- M. van Liedekerke et al., EIONET, 2012 Version of the EEA Indicator CSI015 Progress in the Management of Contaminated Sites, 2012.

Source: JET

6.5 Development of the Federal Action Plan for Remediation of Environmental Hotspots

6.5.1 Introduction

In order to officially implement the activities suggested in the draft master plan, it is suggested to officially adopt the activities as the Federal Action Plan for Remediation of Environmental Hotspots.

6.5.2 Suggested Activities

Table 6.4-1 summarizes the suggested activities for the development of the Federal Action Plan for Remediation of Environmental Hotspots. Though the draft master plan already contains substantial information required in the federal action plan, the budget for each activity, implementing agencies, and other details have to be worked out. The results of the Federation-wide survey will help develop a realistic federal action plan. If proposing a new action plan is difficult, amending the Federal Waste Management Plan 2012-2017 may be an option.

Table 6.5-1 Suggested Activity for Development of Federal Action Plan for Remediation of Environmental Hotspots

Category		Remarks
Objectives		The main objective of the activity is to: - Develop the Federal Action Plan for Remediation of Environmental Hotspots so that activities proposed in the draft master plan can be implemented officially.
Responsible Organization		FMOET in consultation with cantons and municipalities
Period		2014-2015
Methodology		- Detailed review of the draft master plan - Detailed review of the results of the Federation-wide survey and subsequent analysis of general status of contaminated sites in FBiH.
Key Activities (Items to be Analyzed)	Estimation of Budget and Implementing Structure	- Budget for each activity should be estimated. - For each activity, lead organization and supporting organizations should be agreed upon.

Source: JET

CHAPTER 7 DRAFT MASTER PLAN: PART II –DEVELOPMENT OF REGULATRY FRAMEWORK

7.1 Introduction

This section discusses the activities to develop an regulatory framework in FBiH in order to legally manage the contaminated sites. There are many important issues, but the following aspects are considered most pertinent:

- Legal definition of contaminated sites;
- System of site identification
- Liability framework;
- Institutional controls;
- Risk communication and public involvement; and
- Financing of remediation projects.

These issues should be analyzed thoroughly in order to develop relevant regulatory provisions and other mechanisms to support remediation of contaminated sites in the most efficient and safest way. Because many issues are inter-related to each other, Federal Ministry for Environment and Tourism (FMoET) could organize a special committee composed of environmental experts, lawyers and legal experts, social scientists, and other specialists. Specific issues may be discussed by different subcommittees, but there should be some core members who will ensure that the frameworks developed by these subcommittees are internally consistent.

7.2 Definition of Contaminated Sites

7.2.1 Introduction

In order to legally control contaminated sites, there is a need to define what site is considered “legally” contaminated. This definition has to be developed considering the acceptable environmental risks to humans and ecosystems, availability of administrative resources, impact on those who become liable for the contamination, and other aspects. For site owners, workers, local residents, and other stakeholders, it is a serious matter if the site that he/she owns, where they work, or in their neighborhood is designated as “an officially contaminated site”. Also, control of legally-contaminated sites will fall under the responsibility of the local environmental authorities, regardless of the availability of administrative resources. If they fail to properly control and manage these sites, their administrative competence might be questioned. Definition of a contaminated site has to be developed considering such consequence.

7.2.2 Definition of Contaminated Sites in Other Countries

In general, most countries legally identify contaminated site based on a combination of some kind of screening or intervention values (concentration of hazardous substance in soil or water) and risk-based methodologies. Table 7.2-1 summarizes the intervention values used in various countries. The approach based on intervention values involves a comparison of a measured concentration against the standard. It is easy and straightforward, but it cannot properly evaluate environmental risk because it does not consider different mechanisms of exposure.

Table 7.2-1 Examples of Intervention Values Used in Various Countries

Source/Country	FBiH	UK	Austria	Italy	Netherlands	Germany	Poland
Year	2009	2009	2000	2006	2009	1999	2002
Type	Limit	Screening	Intervention	Limit	Intervention	Trigger	-
Soil use	Agric.	Comm.	No agri.	Industrial	-	Industrial	Industrial
Cadmium (Cd)	1.5	230	10	15	13	60	15
Lead (Pb)	100	-	500	1,000	530	2,000	600
Total chromium (T-Cr)	100	-	250	800	78[*2]	1,000	500
Total mercury (T-Hg)	1.5	26[*1]	10	5	36[*3]	80	30
Copper (Cu)	80	-	600	600	190	-	600
Nickel (Ni)	50	1,800	140	500	100	900	300
Zinc (Zn)	200	-	-	1,500	720	-	1,000
Manganese (Mn)	-	-	-	-	-	-	-
Arsenic (As)	20	640	50	50	76	140	60
Selenium (Se)	-	13,000	-	15	-	-	-
Cobalt (Co)	60	-	-	250	190	-	200
Tin (Sn)	-	-	-		-	-	350
Fluoride (F)	350	-	1,000	2,000	-	-	-
Cyanide	-	-	50	100	20[*4]	100	40

Abbreviations: Scr. – Screening; Interv. – Intervention; Trig.-Trigger; Agric. – Agriculture; Indust. – Industrial; No agri. – No agriculture
Note: [*1]: elemental mercury; [*2]: hexavalent chromium; [*3]: inorganic mercury; [*4]: free cyanide
Note: These values should be used in accordance with specific regulations which stipulate analytical methodologies, applicable soil types, corrections of values depending on the local conditions, and other requirements.
Source: JET based on Rulebook on Determining Permissible Amounts of Harmful and Hazardous Substances in Soil and their Method of Testing (Official Gazette of FBiH, No.72/09); Environmental Agency, Soil Guideline Values, 2009; the Netherlands, Soil Remediation Circular, 2009; Germany, Federal Soil Protection and Contaminated Sites Ordinance, 1999; other values were taken from Hydro-Engineering Institute Sarajevo, Sampling Survey and Analysis, conducted under this project, 2014; JRC, Derivation Methods of Soil Screening Values in Europe: A Review of National Procedures towards Harmonization, 2007; Common Forum, Compilation of standards for contamination of surface water, ground water, sediments and soil, Synthesis of the answers received after Roman's request, (Slovak Republic request) (19/11/2009), updated on December 1st, 2009

A risk-based approach attempts to quantify environmental risks by estimating exposures through different pathways, such as drinking, ingestion, inhalation, and dermal contact. This approach will be preferred if relevant data and information are readily available and if the methodology is implemented properly. The Environmental Liability Directive (2004/35/EC) requires the use of risk-based approach to evaluate risk associated with land damage. However, it is highly resource intensive, and could also entail various uncertainties associated with assumptions to estimate exposure.

Based on the screening and risk-based approaches, Japan, EU countries, and the US define contaminated sites as summarized below.

- In Japan[1], a land will be considered contaminated and will require remediation (i) if an investigation done in accordance with the regulation reveals that the concentration of a hazardous substance at the site does not conform to the standard (screening value) prescribed by the Ordinance of the Ministry of Environment, and (ii) the site is classified as harmful to human health or posing a threat of such harm, e.g., groundwater is used by local residents or the site is accessible to the public.
- The Netherlands[2] uses the background value (soil) or the target value (groundwater) and intervention values (soil and groundwater) to classify sites to three categories, namely, clean site, slightly contaminated site, and seriously contaminated site. For seriously contaminated site, urgency of remediation is evaluated through a three- tiered risk assessment. If the risk is considered as 'acceptable', control measures can be taken to reduce or eliminate exposure. If the risk is considered as 'unacceptable', a remediation plan has to be carried out.
- Germany[3] uses trigger values and action values. If the action value exceeds, remedial actions will be needed. If the trigger value is exceeded, further investigations will be required to determine

[1] Soil Contamination Countermeasures Act, Act No. 53 of 2002, Ministry of Environment, Japan
[2] Soil Remediation Circular of 2009, Ministry of Infrastructure and the Environment, the Netherlands
[3] Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV) of 1999, Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Germany

whether site contamination exists, and human health risks and land use risks are considered in the context of pathway models.

- Under the Superfund Act in the US[1], a risk assessment model (Hazard Ranking System) is used to screen sites of national importance and listed on the Superfund List. Then, at the detailed investigation level, more detailed risk assessment is carried out.

7.2.3 Development of the Definition of Contaminated Sites in FBiH

(1) Approach to the Development of a Definition of Contaminated Sites

Theoretically, a risk assessment is the preferred approach to come up with the definition of contaminated site. However, most countries use screening values to screen sites before the risk assessment. This will be practical especially if there are thousands of sites to manage. Based on the experiences in the site survey (Chapter 4), for FBiH, relying fully on risk assessment is not recommended at the moment for the following reasons:

- At the most contaminated sites in FBiH, information necessary to carry out risk assessment, such as concentrations of hazardous substances in soil/surface water/groundwater/air at and adjacent to the site, information on groundwater regime, subsurface geology, local surface hydrology, wind, situation of local residents and other receptors, information on natural environment, etc., is too limited. It will take a lot of time and resources to characterize environmental risks of contaminated sites in FBiH.
- To officially introduce risk assessment, environmental officials and environmental consultants who will implement, manage, and/or interpret risk assessment should be familiar with toxicities of different classes of pollutants, fate and transport of toxic substances in the environment, mode of exposure for different receptors, short-term and long-term impacts to people and different types of biota, etc. However, at the moment, there are not many experts and officials who are familiar with such issues.

In FBiH, the use of provisional screening values for soil in conjunction with some discretionary power of environmental authorities to officially designate contaminated sites (e.g., based on condition of the source of pollution, public access to the site, use of groundwater, opinion of public health officer, etc.) is recommended at least until stronger technical capacities are developed. While there are probably hundreds of potentially-contaminated sites in FBiH, problems at some sites are more serious than the others. Hence, in developing the definition of the contaminated sites, it is suggested to create at least two classes of contaminated sites, i.e., (i) seriously contaminated sites and (ii) contaminated sites. This way, the authorities can concentrate their efforts on the seriously contaminated sites.

This does not preclude the authority to use risk-based approaches to evaluate what pathways are crucial in order to control the exposure in a specific site, or to prioritize sites to be remediated first. In fact, local authority is strongly encouraged to adopt the risk-based approach, and to make decisions considering the actual risk that the site poses on local people and environment.

The definition, including the provisional screening values and the discretional power of environmental authorities, should be clearly stated in a legal act, and a technical guideline should be prepared (see Section 8.3).

(2) Suggested Activities to Develop the Definition of Contaminated Sites

In order to develop the legal definition of contaminated sites in FBiH, it is suggested that a team of technical and other experts should be organized, in order to carry out the activities summarized in Table 7.2-2.

[1] The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1990 and related laws, EPA, United States

Table 7.2-2 Activities to Develop the Definition of Contaminated Sites

Category		Remarks
Objective		- To clarify and develop the legal definition of contaminated sites in FBiH.
Responsible Organization		- FMoET
Period		- 2016-2018
Methodology		- Compilation of data and information collected in the course of the Federation-wide survey to be implemented. Necessary data and information are collected through the interview survey and limited site investigations.
Key Activities	Review of the definition of contaminated sites in other countries	Review the definition of contaminated sites in other countries considering different approaches: - Media-specific environmental standards, including intervention values, cut-off values, and other standards; - Different types of risk assessment approaches; and - Discretion given to the local authority to designated site.
	Analysis of requirements for FBiH	Analyze the requirements from the viewpoints of: - Statuses of contaminated sites in FBiH based on the results of the analysis of provisional site inventory; - Existing regulatory frameworks for the protection of public health and environment; and - Availability of administrative and other resources for regulatory management of the sites.
	Identification of possible issues	Analyze the possible issues, such as: - Reaction of site owners, - Impact on the market price, - Increased administrative tasks, and - Exempting the contaminated sites covered under different legislation (e.g., current waste disposal sites) and contaminated sites that do not pose environmental risk because the risk is contained (e.g., properly lined chemical storage).
	Preparation of report	Prepare reports on the subjects

Source: JET

7.3 System of Site Identification

7.3.1 Typical Process of Site Identification

(1) Types of Site Identification

The first step of site remediation is identification of the site where contamination is suspected. Unless the site is reported and officially recognized, no regulatory action can be taken. Thus, it is important to decide the responsibilities of identification of different types of sites, the method of reporting, and the system of keeping the record of reported sites.

Table 7.3-1 gives a summary of how contaminated sites are usually identified. A site may be identified either (i) through a dedicated investigation based on a regulation for the purpose of identifying such site, or (ii) through other mechanisms, such as by complaints of local residents about local health issues or environmental problems, or by topographical survey, demolition of facility, or other activities not directly related to the identification of a contaminated site. Also, responsible organizations for implementing investigations can be private firms or government organizations.

Table 7.3-1 Types of Site Identification

Regulation	Investigator	Types of Investigation
Based on regulations	Government	- General survey, and site inventory - Regular monitoring
	Private	- Regulatory survey when constructing or closing designated factories - Regulatory survey for land transaction
Others	Government	- Research purpose
	Private	- Complaints by local residents - Individual survey on land transaction by landowner, developer, and others

Source: JET

(2) Government Survey Implemented under Regulations

There are countries wherein their governments have official duties to investigate suspected contamination sites such as in the US by CERCLA (1980), in Germany by the Federal Soil Protection Act (1998), and the UK under Part IIA of the Environmental Protection Act (1990).

Also, other types of government surveys may be used to identify contaminated sites. Monitoring of water resource wells is a good example. This kind of groundwater monitoring survey is implemented in many countries as a duty of the local government. There are two kinds of groundwater observation methods by the Water Pollution Control Act in Japan, according to different purposes for investigations as shown in Table 7.3-2.

Table 7.3-2 Groundwater Contamination Identification in Japan

Method	Purpose	Target
Fixed Point	To observe new pollution or monitor concentration of contamination in important areas.	[Area] Area with high ratio of groundwater use, high risk for contamination of groundwater, high necessity for prevention [Period] Once per year or more. [Substances] All specified substances.
Random Point	To observe unknown contamination.	[Area] Choose one point per 1-2 km mesh in urban area, 4-5 km in suburban area. Cover all points in several years. [Period] Once per year or more. [Substances] All specified substances.

Source: JET

(3) Private Survey Implemented under Regulations

In many countries, owners/operators are regulated to implement an investigation of site contamination when they start and/or finish the operation of their facilities that use hazardous substances. In Japan, through the Soil Contamination Countermeasures Act (2002), any person who is an owner, manager, or occupier of a site of a plant or workplace designated as a specified facility[1] where hazardous substances are used has to conduct soil contamination investigation on their respective land and report the results to a regulatory authority. An investigation has to be implemented in the following cases:

1) When operation at a specified facility which involved hazardous substances is terminated;

2) When excavation or other changes on the land of more than 3,000 m^2 is carried out and when a regulatory authority finds threats of contamination; and

3) When a regulatory authority finds the existence of land which poses threats of harm to human health due to soil contamination.

Similarly, under the new IPPC Directive (2010/75/EU) to control industrial activities, reporting of the state of soil and groundwater contamination became mandatory. In some states in the US, where management of information and procedure of soil contamination are relatively strict, it is necessary to investigate soil contamination even when the land title is transferred. Similarly, in the Flemish Region of Belgium, a landowner first need to obtain a soil certificate from the respective authority to transfer land.

(4) Survey Implemented in Other Cases

There are many cases in which a contaminated site is identified by private investigation not based on laws and regulations. In Japan, the number of sites identified in this manner is about 38% of all contaminated sites identified by 2011. This is largely because property buyers/owners are acutely aware of possible liability issues associated with their property, and in order to clarify the liability, they carry out site survey, especially during land title transfer, even though the law does not require it. In order to avoid unauthorized remediation of contaminated sites following such private investigations, it is important to establish a system of reporting, registration, and management of the site using a database.

[1] Specified Facility: a registered facility where hazardous substance designated in Article 2, paragraph (2) of the Water Pollution Control Act, Japan (Act No. 138 of 1970) is used.

7.3.2 Approaches to Site Identification in FBiH

(1) Present Situation in FBiH

In FBiH, contaminated sites have been identified through hearing surveys by donors, investigations by the governments and non-governmental organizations (NGOs), and the environmental impact assessment (EIA) studies by private companies. In the case of a large buyout or privatization process, the buyer often carries out site investigation before purchasing the property, and an EIA is mandatory. Also, if waste of unknown composition is found, a cantonal inspector is supposed to investigate and request necessary regulatory actions in accordance with the Rulebook on the Treatment of Hazardous Waste Not on the Waste List or Whose Content is Unknown (Official Gazette of FBiH, No. 33/03).

However, many of the sites identified through such mechanisms are large-scale factory sites whose risks of contaminations are obvious. It is expected that numerous contaminated sites are still left unattended because of small-scale operation or absence of site owners. The number of illegal dumping sites in FBiH alone is estimated to be at least 340 to over 2,000. These relatively small contaminated sites are often located adjacent to residential areas, and potentially pose risks to human health of local residents especially if they are located near local water sources or play grounds.

(2) Proposed Approach in FBiH

Contaminated sites in FBiH should be identified through a number of different ways. Some suggestions are given below. Once the legal definition of contaminated sites is developed and the liability framework for site remediation is clarified, the details of the responsibility as well as timing and the procedure of reporting have to be decided and reflected in relevant bylaws.

1) Reporting of Contaminated Sites

<u>Industrial sites</u>: Based on the “polluter-pays-principle”, contamination of industrial sites, mining sites, and other sites where hazardous material is used should be reported by the owner of the business or the site when they apply for an environmental permit, when there was an accident, and as part of regular reporting. Table 7.3-3 shows the example of facilities with potentially contaminating activities and possible contaminants to be paid attention for site identification.

Table 7.3-3 Potentially Contaminating Activities

Activities	Possible Contaminants
• Acid or alkali plant and formulation	Heavy metals, organic contaminants
• Agricultural or horticultural activities	Organic contaminants
• Airports	Heavy metals
• Asbestos production and disposal	Heavy metals
• Chemicals manufacturing and formulation	Heavy metals, organic contaminants
• Defense works	Heavy metals
• Drum reconditioning works	Heavy metals, organic contaminants
• Dry cleaning establishments	Organic contaminants
• Electrical manufacturing (transformers)	Heavy metals, organic contaminants
• Electroplating and heat treatment processes	Heavy metals, organic contaminants
• Engine works	Heavy metals, organic contaminants
• Explosives industry	Heavy metals, organic contaminants
• Gas works	Heavy metals, organic contaminants
• Iron and steel works	Heavy metals
• Landfill sites	Heavy metals, organic contaminants
• Metal treatment	Heavy metals, organic contaminants
• Mining and extractive industries	Heavy metals, organic contaminants
• Oil production and storage	Organic contaminants
• Paint formulation and manufacture	Organic contaminants
• Pesticides manufacturing and formulation	Organic contaminants
• Power stations	Heavy metals, organic contaminants
• Railway yards	Heavy metals
• Scrap yards	Heavy metals
• Service stations	Heavy metals

Activities	Possible Contaminants
• Sheep and cattle dips	Organic contaminants
• Smelting and refining	Heavy metals, organic contaminants
• Tanning and associated trades	Heavy metals
• Waste storage and treatment	Heavy metals, organic contaminants
• Wood preservation	Heavy metals, organic contaminants

Source: JET based on the Department of Urban Affairs and Planning and Environment Protection Authority (1998) Managing Land Contamination: Planning Guidelines, DUAP, Sydney.

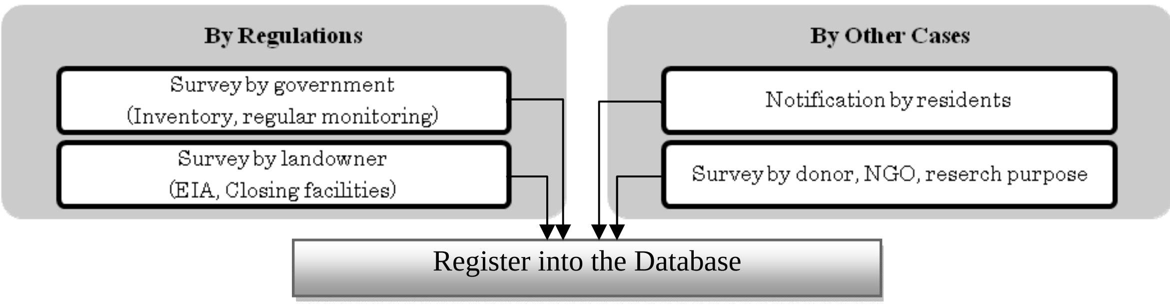
Waste disposal sites: A municipality is responsible for identification of contamination of municipal waste disposal sites including the groundwater in its territory. For other types of waste disposal sites, holder of the waste is considered responsible based on the Law on Waste Management (Official Gazette of FBiH, Nos.33/03 and 72/09).

Other sites where contamination is suspected: For other sites where contamination is suspected, such as an abandoned industrial site, or a site about which local residents filed a complaint, cantonal government based on the Rulebook on the Treatment of Hazardous Waste Not on the Waste List or Whose Content is Unknown (Official Gazette of FBiH, No.33/03) or perhaps the federal government, should investigate.

Other sites found accidentally: A mechanism should be established for reporting of a contaminated site found accidentally during other activities, such as a topological survey, groundwater survey, construction, well drilling, and agriculture. For such occasion, the person who found the potentially-contaminated site should report to the environmental authority.

2) Mechanism of Registration of Contaminated Sites

It is necessary to set up a framework for registration of sites identified through different ways, and to manage gathered information in a database as summarized in Figure 7.3-1. This should be done in line with Article 28 of the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09). If the contamination of site is confirmed during the site investigation, the site should be registered in the official register of contaminated sites (see Section 6.3 for related activity on the development of an official register of contaminated sites). Also, it is suggested that the fact of contamination is noted in the land cadastre maintained by the cadastre office of municipality.



Source: JET

Figure 7.3-1 Identification and Registration Process of Contaminated Sites

Table 7.3-4 summarizes the suggested activities for development of systems of site identification.

Table 7.3-4 Suggested Activities for the Development of Systems of Site Identification

Category	Remarks
Objective	- To develop an institutional system of site identification
Responsible Organization	- FMoET and cantons
Period	2015 - 2017
Methodology	- Clarification of the responsibilities - Development of the method of site identification and reporting procedures - Development of a registration system - Establishment of a legal framework for site identification

Category		Remarks
Key Activities (Items to be Considered)	Clarification of the Responsibilities	Based on the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09), Law on Waste Management (Official Gazette of FBiH, Nos.33/03 and 72/09), other relevant laws and the liability framework for remediation, responsibility of site identification should be clarified for different types of sites: - Industrial sites, mining sites and other sites where hazardous substance has been used; - Waste disposal sites - Other sites where contamination is suspected - Accidental discovery of site
	Development of the Method of Site Identification and Reporting Procedures	For each type of site, develop the method of site identification and reporting procedures considering the legal definition of the contaminated sites. Suggested items for reporting are: - General information on site ✓ Location: address, geographic coordinates ✓ Ownership: name, contact numbers ✓ Land use: years of operation, types of facility, regulatory involvement - Information on contamination ✓ Source type description: drums, tanks, contaminated soils, landfill, surface impoundment, and others ✓ Hazardous substances description: materials, volume, size ✓ Pathway type description: groundwater, surface water, soil exposure, air, biota ✓ Groundwater/ surface water use and characteristics ✓ Receptor type description: number of resident, student, worker, and others ✓ Summary of existing samples and analytical data (if any) ✓ Emergency or removal actions ✓ Important source and environments on or near the site ✓ Photos
	Development of a Registration System (also see the section on Official Registry in Section 6.3)	The system to register potentially-contaminated sites should be developed considering the relevance with the following aspects: - Land use control by cantonal Ministry for Spatial Planning and Environment - Control of industrial activities by FMoET and/or cantonal Ministry for Spatial Planning and Environment - Land cadastre maintained by municipality - Other administrative systems (e.g., water permitting)
	Establishment of a Legal Framework for Site Identification	- The requirements should be built into relevant legal and administrative documents, such as environmental permit, permit for waste management, operational procedures for waste disposal sites, regulations on land use control, water permit, and public health regulations.
Reference and Source of Information		- EPA (1991), Guidance for Performing Preliminary Assessments Under CECLA

Source: JET

7.4 Liability Framework for Contaminated Sites

7.4.1 Introduction

This section examines the liability issues related to management and remediation of contaminated sites. Issues of liability are extremely broad and complicated because they are related to damages to health, damages to personal property including land value, responsibility of sellers and buyers of a contaminated site, administrative responsibility of public offices, criminal intent of the operator, etc., in addition to the issues of damages to the natural functions of the environment. For this reason, the liability issues should be addressed considering their implications under civil, contractual, administrative, criminal, and environmental laws. Because this project is not designed to address such wide issues, and because most of the participants in this project are not legal experts, it is beyond the scope of this project to review the liability issues in detail. Nevertheless, it is impossible to resolve the issues of contaminated sites without resolving the liability issues. Hence, they are discussed briefly here from the perspective of technical experts.

7.4.2 EU Environmental Liability Directive

The EU Environmental Liability Directive (2004/35/EC) (ELD) is a good starting point to examine the legal requirements on environmental liability. Even though the directive does not address historical pollution, but addresses only liabilities for environmental damages, the directive addresses some of the most important aspects of liability issues related to contaminated sites as follows:

- Aim of ELD: ELD aims to prevent and remedy environmental damage caused by economic activities. The main underlying principle of ELD is the polluter-pays-principle.
- Environmental damages: The targets of ELD are categorized into three types of environmental damages, namely, “damages to protected species and natural habitats”, “water damages”, and “land damages”. Water damage is defined as “any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential of the waters concerned. Land damage is defined as any land contamination that creates a significant risk to human health being adversely affected as a result of the direct or indirect introduction, in, on, or under land, of substances, preparations, organisms, or micro-organisms. ELD does not address the damages of civil and criminal nature.
- Operator: Center to the issues of liability is the question of “who is liable for the damages caused by environmental pollution?” ELD stipulates that “an operator whose activity has caused the environmental damage or the imminent threat of such damage is to be held financially liable, in order to induce operators to adopt measures and develop practices to minimize the risks of environmental damage so that their exposure to financial liabilities is reduced.”, and thus the “operator” is liable for the environmental damages. ELD defines an operator to be “any natural or legal, private, or public person who operates or controls the occupational activity or, where this is provided for in the national legislation, to whom decisive economic power over the technical functioning of such an activity has been delegated, including the holder of a permit or authorization for such an activity or the person registering or notifying such an activity”. This might look clear for manufacturing industries or other businesses in operation. However, when it comes to the liability of a parent company, financier, landowner, employees, etc., the concept of the “operator” becomes unclear. Similarly, ELD does not cover historical pollution that occurred before the expiry of the deadline for the implementation of ELD, and thus, the issue of how far back in time this concept of the “operator” should be extended is beyond the scope of ELD. These issues are left to the discretion of each member state.
- Strict liability against high risk activities: ELD specifies certain occupational activities against which strict liability applies if environmental damage is caused. They include installations subject to the Integrated Pollution Prevention and Control Directive (96/61/EC), waste management operations subject to the Waste Framework Directive (75/442/EEC) and Hazardous Waste Directive (91/689/EEC), discharges of wastewaters that require authorization under Wastewater Directive (76/464/EEC), manufacturing, use, storage, processing, filling, release into the environment, and onsite transport of dangerous substances controlled under Directive 67/548/EEC, and other activities.
- Defenses: ELD stipulates that “an operator should not be required to bear the costs of preventive or remedial actions taken pursuant to ELD in situations where the damage in question or imminent threat thereof is the result of certain events beyond the operator's control.”
- Competent authority: ELD also stipulates the roles of competent authority to prevent and remedy environmental damages. In principle, the competent authority shall require that the remedial measures are taken by the operator. However, if the operator fails to comply with the obligations, or cannot be identified or is not required to bear the costs under ELD, the competent authority may take these measures itself, as a means of last resort.

7.4.3 Clarification of Liability Framework in FBiH

In transposing the requirements of ELD, the member states had to consider how the issues of environmental liability could be merged with more traditional liabilities issues in the territories of civil, contractual, criminal, and administrative laws. In FBiH, the concepts of the ELD, such as liability of operator, strict liability, polluter-pays-principle, roles of competent authority, etc., have already, at least partially, captured in the Law on Environmental Protection (Official Gazette of FBiH, Nos.33/03 and 38/09). Nevertheless, the consistencies with other relevant laws, such as the Law on Obligations, Law on Privatization, Law on Concessions, Criminal Code, Law on Administrative Procedure, etc., are not entirely clear. This is because there have been very few cases of environmental litigations in FBiH in the past, and the legal problems of overlapping or lack of appropriate provisions have not been contested. Hence, the Project requested local lawyers to review the current state of environmental liability issues in FBiH from the environmental, civil, contractual, administrative, and criminal aspects.

Although it is beyond the scope of this Project to give precise legal overview of these issues, in general, the current legal frameworks assumed that the liability of contaminated site lies with the current site owner. As the site owner is the owner (holder) of the hazardous material in question and has control over the land, it is expected that the site owner will remediate the site. If he/she is not satisfied with this injunction, he/she can sue other parties for their liabilities and the remediation costs incurred.

From the viewpoint of environmental experts, the current liability frameworks have numerous problems to effectively resolve issues of contaminated sites. Some of the important issues and possible directions of solutions are summarized in Table 7.4-1 and Table 7.4-2.

It is suggested that a team of environmental lawyers and other legal and policy experts should look at these issues of liability closely, and develop a better framework of environmental liability.

Table 7.4-1 Activities for the Clarification of the Environmental Liability Framework

Category		Remarks
Objective		- To clarify the framework of environmental liability
Responsible Organization		- FMoET
Period		- 2015-2018
Methodology		- Organize a team of environmental lawyers and other specialists to examine the key issues associated with liability.
Key Activities	Issues to be Examined	Examine the following issues. See table below for the details: - Complexity and lack of recognition of environmental liability issues - Innocent site owner - Competency of liable operator - Retrospective liability - Governmental intervention - Multiple polluter - Former waste disposal site - Responsibility of public authorities - Damage to the environment

Source: JET

Table 7.4-2 Issues of the Current Frameworks of Environmental Liability

Issues	Problems	Possible Solutions
Environmental liability issues are complex and are not well recognized.	Environmental liability and related issues are covered in a highly complex manner in different domains of the legal systems, including general civil liability, commercial/contractual, criminal, administrative, and environment. Also there have not been many cases of environmental litigations in FBiH, and most business owners, environmental officials, environmental victims, and others are not fully aware of how liability issues are treated.	Guidance documents on environmental liability issues should be developed for different target groups, such as environmental officials, business owners, developers, NGOs, etc. The legal review paper developed within the scope of this project will be a good starting point. In the future, development of a clearer, specific law for management of contaminated sites is recommended.
Innocent site owner	Under the current legal framework, the current site owner who did not cause pollution to the site	Perhaps a special provision for innocent site owner, such as condition where a site owner is

Issues	Problems	Possible Solutions
	becomes liable because he/she is the current owner of the hazardous substances. This is consistent with how laws are set up, but many site owners are simply incapable of fully investigating his/her liability when he/she purchases a property.	exempted from the liability, is included in the legal framework.
Many current site owners are not competent to remediate the site	Many site owners are not financially competent to remediate the site he/she owns.	A financial mechanism for site owners who do not have sufficient resources should be considered. Also, governmental intervention should be considered if environmental risk is serious.
Burden of proof	Many site owners cannot prove to the court the causal relationship of pollution to the damage.	The role of the environmental authority to prove environmental pollution should be considered.
Retrospective liability of previous site owners	It is not clear how liabilities of historical site owners are defined.	For historical sites with serious environmental risks, governmental intervention may be needed. Develop the criteria for governmental intervention.
Liability of multiple parties	Some sites are contaminated by more than one polluter. How to deal with such cases should be clarified. Also in FBiH, many companies are jointly owned (e.g., as joint-stock company). Liability of different members of such ownership should be clarified.	While joint and several liability is the basis of the legal proceedings, how to resolve such cases should be clarified in an official guideline or guidebook.
Damage to the environment	The current legal framework does not clearly describe how the damage to the environment (e.g., loss of habitat and contamination of lake) is evaluated, and how the operator should take responsibility for the damage.	This issue may be resolved by FMoET together with the issue on how to resolve the liability issue of an environmental accident.
Governmental intervention	There are no clear criteria with respect to under what circumstances the government should intervene, and when the government should recover the cost of intervention.	It is suggested to develop criteria for governmental intervention, perhaps based on the seriousness of environmental risks, capacity of liable party, history of site, need to induce proper land use by controlling a brownfield problem and encroachment of greenfield, etc.
Former waste disposal sites	There are hundreds of former waste disposal sites where municipal and industrial wastes had been dumped without proper control.	The liability issues and solutions to the problems of former waste disposal sites are probably similar. Hence, it is suggested to develop a guideline for remediation of former waste disposal sites.
Responsibility of public authorities	Responsibilities of public authorities have to be clarified at all levels, such as environmental inspectors, environmental ministries, water ministries, health ministries, environmental protection fund, privatization office, and others, with respect to the different aspects of management of contaminated sites.	Clarify the responsibilities of public authorities, and possible consequences of inaction, failure to prevent, failure to intervene, inappropriate administrative guidance, etc., in relation to the Law on Administrative Procedure and the Law on Administrative Disputes.

Source: JET

7.5 Institutional Controls

7.5.1 Introduction

This section examines a set of legal and administrative tools, known as Institutional Controls (ICs). They are used in combination with hard, engineering-type remediation measures to maintain the protection of human health and the environment at the sites.

In remediating a contaminated site, full-remediation to the pre-pollution condition is the preferred choice. However, in reality, full remediation is often not technically and financially feasible. In such cases, a temporal measure to contain immediate risks, e.g., by partially removing the contaminant or by paving the contaminated surface and installing sheet piles to hydrologically isolate the site, etc., has to be adopted. The site is then managed, for years to come, until a more complete remediation becomes possible. Because the contaminant will still be left at the site, possible release of contamination has to be carefully avoided, and this is where non-technical ICs, such as control of future land use, control of access to the site, restriction of groundwater abstraction, and placing of public notice regarding the enduring pollution, become necessary.

Without such control, unwanted exposure could occur. This was the case of the Love Canal Disaster in New York in the US, where schools and houses were built on a former hazardous waste dumpsite contaminated with dioxins and other chemicals despite the existence of hazardous waste had been known (see Pendergrass and Probst, 2005[1]). Similar incidents, which might be characterized as a management failure, could happen in BiH.

Despite obvious needs, ICs are not simple to implement because organizations in charge of physical remediation works, land use control, property management, water permitting, public health, etc., are generally different, and such activities are governed by different legislations. Thus, in order to provide a comprehensive control against accidental exposure, ICs have to be built into the overall remediation plan from the early stage of planning, and implemented in a coordinated manner.

7.5.2 Institutional Controls in Other Countries

The ICs have been formally built into regulatory procedures of management of contaminated sites in the US, and a number of official guidelines have been published by US EPA. There are four types of ICs as shown in Table 7.5-1 depending on who administers the control and based on what legal framework. Judging from the mechanism of ICs in the US, coordination among relevant authorities and stakeholders is paramount, because what one agency or organization can control is generally limited.

Table 7.5-1 Institutional Controls in the US

Type	Explanation	Examples
Government Controls	Local laws or permits	Zoning, building permit, ban on fishing, taking over the title of the property
Proprietary Controls	Property use restrictions based on private property laws	Easement to prohibit well-drilling by landowner, agreement not to dig on a certain portion of the property, reversionary interest to maintain hydrological cap
Enforcement Tool	Administrative tools that require individuals or companies to conduct/prohibit specific actions	Administrative order by EPA or consent decrees signed by a judge to restrict well drilling
Information Devices	Notices or public advisories that alert and educate people about the site	Deed notice on public land record, registry of hazardous waste sites, advisory issued by the public health agency

Source: JET based on USEPA, Institutional Controls, A Citizen's Guide to Understanding Institutional Controls at Superfund, Brownfields, Federal Facilities, Underground Storage Tanks, and Resource Conservation and Recovery Act Cleanups, 2005; USEPA, Institutional Controls: A Site Manager' Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCEA Corrective Action Cleanups, 2000.

In Europe and Japan, ICs are not used as a collective tool for management of contaminated sites. Instead, they are implemented separately, in accordance with specific regulatory systems and procedures. For example, in Japan, a contaminated site that does not pose immediate environmental risk is registered in a special public inventory, and the owner will submit another document if he/she disturbs the site for construction or other activity.

7.5.3 Suggested Institutional Controls in FBiH

In this report, land use and water use were selected as the primary areas for institutional control because under a normal situation, environmental risks are highest for those who frequently access the contaminated site or who use water for drinking and other daily purposes. The general ideas of ICs in these areas can be summarized as follows:

[1] Pendergrass J. and Probst, K.N., Estimating the Cost of Institutional Controls, Resources for the Future, 2005.

- Land Use Control: The suggested ICs include registration of the site in canton's land-use registry and municipality's land register, installation of public notice, addition of land use restriction to the land use permit, easement regarding prohibited activity and access to the site for remediation/monitoring work, further revision of the permit after remediation work, etc. These are implemented perhaps within the framework of the Law on Spatial Planning and Land Use in FBiH (Official Gazette, Nos. 2/06, 72/07, 32/08, 4/10, 13/10 and 45/10), cantonal laws on spatial planning and land use, or related regulations. As for easements or covenants that are not covered within the existing legal framework or that could infringe land use rights of the parties to be affected, the competent authority should consult legal experts of the organization.
- Water Use Control: For water use control, issuance of an advisory, suspension of water permit, and easement on ban on water abstraction, are suggested. These are implemented within the framework of the Law on Waters (Official Gazette of FBiH, No. 70/06), Law on Health Protection (Official Gazette of FBiH, Nos. 46/10 and 75/13), or cantonal laws.
- Environmental Control: It is suggested that ICs are built into the environmental impact study for the remediation work as part of the risk minimization plan, so that risks can be controlled comprehensively. Public consultation, issuance of environmental permit, issuance of completion of remediation work, and perhaps issuance of no further action letter, are among the suggested ICs.

Environmental authorities that issue environmental permits and supervise the remediation works should coordinate with authorities of these two areas, and ensure that local residents and other stakeholders, including those who move into the area after the remediation work, are not exposed to the contamination. At the cantonal level, ministries in charge of land use control and environmental control are the same, but it is still important to coordinate with the Ministry of Agriculture, Water Management and Forestry, public health offices, and environmental inspectors. Perhaps the most critical part of the ICs is the exchange of information and coordination among relevant governmental organizations. For this, the organization of a site remediation committee is suggested. Also, mandating the site owner to coordinate with all relevant authorities (e.g., by appointing an independent quality assurance team, see Section 8.7) is necessary.

Table 7.5-2 and Table 7.5-3 summarize the activities to develop ICs and suggested ICs in FBiH. Because the risks as well as the relevant authorities are different on a case-by-case basis, they should be treated only as an example. There are other administrative areas that need ICs, such as the process of privatization and concession, which are not covered here.

Table 7.5-2 Activities for the Development of Institutional Controls

Category		Remarks
Objective		- To develop a set of protocols for institutional controls.
Responsible Organization		- FMoET and cantons
Period		- 2015-2018
Methodology		- Organize a team of environmental lawyers and other specialists to develop appropriate framework of institutional controls.
Key Activities	Issues to be Examined	Examine the following aspects of institutional controls. See table below for the details: - Land Use Control (registration of site, restriction of access, land use permit, easement or permitting on land use change, and others.) - Water Use Control (clarification of safety and need to restrict water use, health advisory, suspension of water permit, monitoring, and others.) - Environmental Control (review of environmental permit application, site evaluation, issuance of environmental permit, issuance of certification of completion of work, issuance of waiver for further liability, etc.)

Sourcr:JET

Table 7.5-3 Suggested Institutional Controls in FBiH

Stage	Land Use Control	Water Use Control	Environmental Control
Relevant Authority	- Cantonal ministries in charge of spatial planning and environmental protection - Cantonal inspectors for environment/land use - Municipality	- Cantonal ministries in charge of agriculture, water and forestry - Cantonal ministries in charge of health - Cantonal water inspectors - Municipality/water company	- Federal Ministry of Environment and Tourism - Federal Environmental Inspector (Depending on the situation, cantonal ministry and inspector are also involved)
Investigation/ Planning Stage	Registration of the site as contaminated site.	Clarification of safety and need to restrict water use.	Review of the application document for environmental permit.
	Clarification of the need to restrict future land use and access to the site.	Issuance of advisory on water pollution.	Site visit and evaluation of adequacy of proposed measures and post-remediation monitoring.
	Restriction on access to the site (public notice).	Flagging of the water resource as contaminated.	-
	Addition of land use restriction to land use permit.	Suspension of water permit; provision of alternative water source.	
	Public consultation as part of EIA.		
	Decision on remediation goal and remediation measures with description of risk management plan including ICs.		
	Easement or permitting to prohibit land use change and construction without authorization, and access to the land for remediation/monitoring work.	Easement to prohibit groundwater abstraction or cultivation.	Environmental permitting for remediation work.
Implementation Stage	Monitoring of progress and information disclosure.		
	Access control.	Provision of alternative water source.	Issuance of certificate of completion of remediation.
Follow-up Stage	Evaluation of need for further land use restriction.	Continuous monitoring and evaluation of need for further water use restriction.	Checking of monitoring data for possible environmental problems.
	Revision of easement or permit; revision of the status of the site in the registry.	Revision of easement.	Issuance of waiver for further liability and obligation (no further action letter), if applicable.
	De-registration of the site as contaminated site, lifting of land use restriction.	Lifting of water use restriction.	-

Source: JET

7.6 Risk Communication and Stakeholder's Involvement

7.6.1 Introduction

In order to manage and remediate a contaminated site, at least the following people have to be involved:

- Land owners;
- Business owner;
- Regulatory and planning authorities (primarily FMoET, federal inspector, Cantonal ministries in charge of spatial planning and environment, Cantonal ministries in charge of agriculture, public health offices, etc.);
- Site users, workers, and visitors;
- Financial community (banks, founders, lenders, insurers);
- Site neighbors (tenants, dwellers, visitors);

- Campaigning organizations and local pressure groups; and
- Consultants, contractors, and possibly researchers.

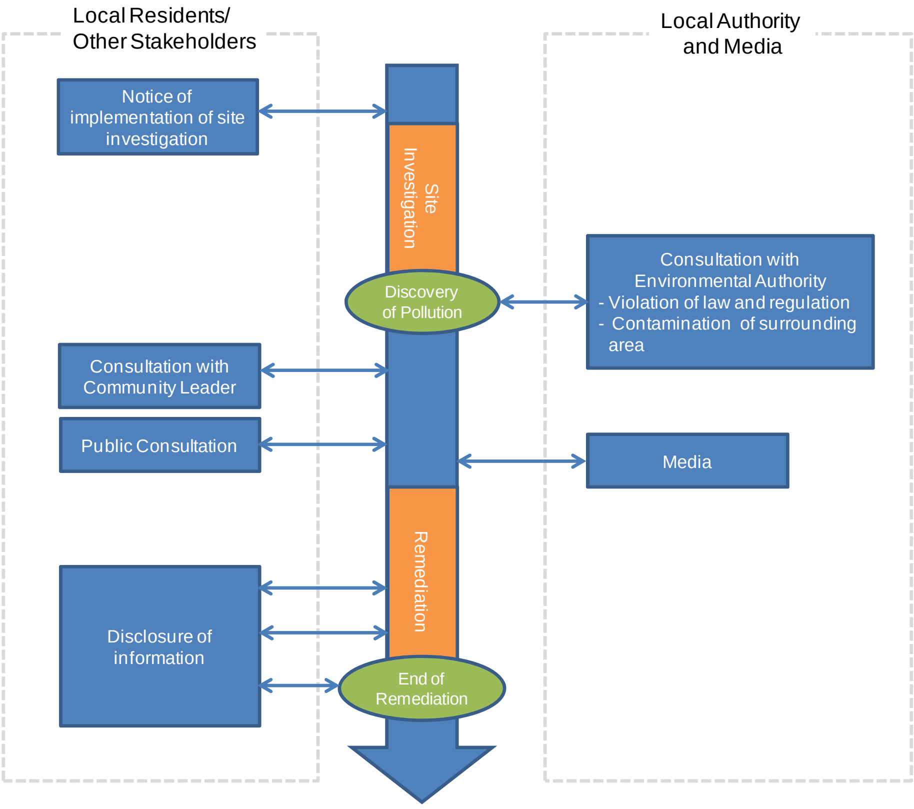
They all have different roles, responsibilities, and/or interests. Thus, risk communication and stakeholder's involvement should be implemented considering the needs of each stakeholder.

7.6.2 Risk Communication in Other Countries

(1) Risk Communication Process

This section discusses the risk communication with local stakeholders, in particular, local residents and local workers, who are affected by contamination and remediation of a particular site. As for awareness raising of general stakeholders, please see Section 10.3.

Figure 7.6-1 summarizes the typical risk communication for management of a contaminated site in Japan. In Japan, remediation of contaminated site is governed by a specialized law, known as the Soil Contamination Countermeasures Act (2002), but the general process of risk communication is similar to the public consultation process in an environmental impact assessment. Risk communication often starts before a site investigation by notifying local stakeholders about the site investigation. If contamination is discovered, the polluter/operator will consult with the local environmental authority as well as community leaders. Then, public consultation sessions (workshop or house-to-house consultation) are held to inform the local residents about the contamination found, and the plan to remediate the site and to contain possible exposure. Information on the situation of the contamination and the progress of the remediation work is disclosed through media (e.g., local newspaper) and internet. In principle, risk communication processes are similar in other countries.



Source: JET based on the Ministry of Environment of Japan, Guideline for Risk Communication for Soil Contaminated Site: Risk Communication by Industrial Operator, 2008.

Figure 7.6-1 Typical Risk Communication for Contaminated Site in Japan

(2) Getting Trust and Cooperation of Stakeholders

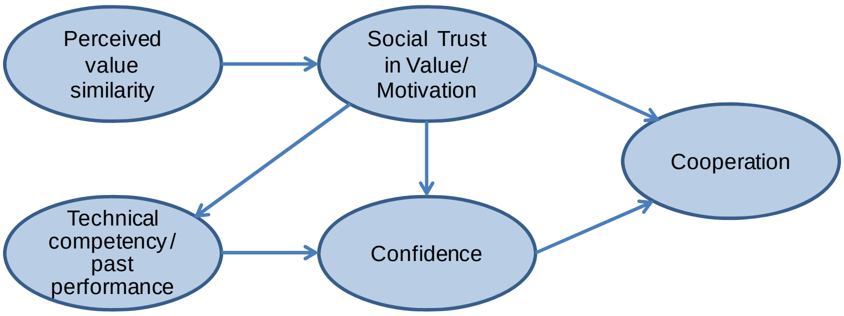
One of the most important goals in risk communication is to make stakeholders feel assured regarding the way environmental risk is managed, and for this, nurturing the "trust" of stakeholder is the key to a successful risk communication. Experiences showed that stakeholders trust people based on three traits, namely, (i) technical capacity to control risks, (ii) attitude towards risk management or motivation, and (iii) similarity in values, as explained in Table 7.6-1. Expertise or qualification are important, but trust cannot be built if those who are involved in risk management are unwilling to engage in active communication or act on behalf of their own interest.

Table 7.6-1 Classification of Financial Mechanisms for Remediation of Contaminated Sites

Category	Capacity to Control Risk (Competency)	Attitude Towards Risk Management (Motivation)	Similarity in Values
Key Words	Expertise, technical knowledge, skills, experiences, qualification	Conscientiousness, reliability, seriousness, commitment, fairness, neutrality, honesty, transparency, compassion	Background, common interest, common social issues, culture, political view

Source: JET based on Kazuya Nakayachi, Safe but does not feel safe: psychological aspect of trust (in Japanese), 2008.

Figure 7.6-2 explains further how cooperation by stakeholders are developed. This model shows that similarity in values, motivation, and technical competency boost stakeholders' trust and confidence in those involved in risk management, and lead the stakeholders to cooperate with environmental authority and others involved in risk management. Trust cannot be built overnight, hence, it is important to develop a strategy for building good and resilient long-term relationship with the stakeholders.



Source: JET based on Kazuya Nakayachi, Safe but does not feel safe: psychological aspect of trust (in Japanese), 2008; Siegrist,M., Earle, T.C., and Gutscher, H., Trust in Risk Management: Uncertainty and Skepticism in the Public Mind, 2010.

Figure 7.6-2 Development of Stakeholders' Cooperation in Risk Management

In line with such understanding of people's risk perception and development of trust, the seven cardinal rules of risk communication used in the Superfund Program of US EPA[1] are as follows:

- Accept and involve the public as a legitimate partner;
- Plan carefully and evaluate your efforts;
- Listen to the public's specific concerns;
- Be honest, frank, and open;
- Coordinate and collaborate with other credible sources;
- Meet the needs of the media; and
- Speak clearly and with compassion.

[1] USEPA, Superfund Community Involvement Handbook, 2005.

In Japan, a system of alternative dispute resolution (ADR) is widely used to resolve environmental disputes in addition to official resolution by the judiciary. This involves mediation of environmental dispute by public officers specialized in environmental issues. Large cases are handled by the Environmental Dispute Resolution Commission at the central level and local cases are handled at the local government level. This process has many advantages. First, a dispute is usually resolved quickly. Second the commission can gather and assess evidences easing the plaintiff's burden of proof. Third, a dispute resolution through ADR is often less expensive.

(3) Communicating Technical and Non-technical Issues

Those who deliver risk communication have to explain both technical and non-technical issues. Environmental authority tends to place emphasis on technical issues, such as risk evaluation and the choice of remediation measures. Sometimes they believe that such technical issues could somehow resolve public concerns about site remediation, and get frustrated when the public does not seem to see the technical issues the way experts do. However, the public is much more concerned with non-technical issues, such as whether there is a bias in decision making, how cost is shared, whether some people receive unfair treatment, who controls the process, and who is left outside of the decision making circle. These differences in view are important to recognize. For communicating technical information to the public, the following general suggestions are useful:

Table 7.6-2 Suggestions for Communicating Technical Information to the Public

- Do not underestimate the ability of the public to assimilate technical information. Keep in mind that if there is a compelling reason for people to learn new information, they will make an effort to acquire an understanding of a new subject, even if it is technical. - Try to determine what risk information people need and in what form. This determination means the spokesperson should take the time to —know his/her audience. Be willing to summarize information that the audience needs, rather than present everything the communicator knows. - Anticipate and respond to people's concerns about their personal risk. Remember the factors driving the public's concern. - Be sure to provide adequate background when explaining risk numbers. Use non-technical language as much as possible. - Be prepared to provide information in foreign languages as needed. - Provide information responsive to public concerns that is neither too complex nor patronizing.	- Put data in perspective and try to express the risk in different ways. - Use language consistent with the expertise of your audience and avoid jargon and words that may mean one thing to one group and something else to another. For example, agency personnel often say they use a —conservative model to estimate risk, meaning that the model tends to overestimate the likely risk. The public, however, may probably think of —conservative in its political sense as favoring the preservation of existing conditions. - Explain the process (the steps in the Superfund Risk Assessment Process). Be willing to discuss uncertainties. Reviewing this process with the public will demonstrate that the risk numbers are not derived from a —black box. Use graphics and visual aids. - Collaborate with other credible experts. - Be careful when comparing environmental risk to other risks.

Source: New Jersey Department of Environmental Protection, Improving Dialogue with Communities, 1987 cited from USEPA, Superfund Community Involvement Handbook, 2005.

(4) Community Involvement

So far this section has discussed how an environmental authority or those who implement a remediation measure in Japan, the US, and other countries communicate with local residents or other stakeholders regarding the environmental risks and remediation measures. In real site remediation, however, the dimensions can be much broader. Aside from the issue of improving the public health status of the local community, a remediation project sometimes involves issues related to the conversion of a brownfield to a more attractive land, strategic redevelopment of the area, revitalizing local economy, increasing local business opportunity, impact on land price, community welfare in general, poverty reduction, and funding for such changes. A local community is highly interested in such issues, and people are willing to participate in the decision making process. This is why community involvement is vital in many remediation projects.

Opportunities for community involvement have been built into the Superfund Program in the US from as early as the preliminary assessment and site investigation stage. In the Superfund Program, a Community Involvement Coordinator (CIC) is appointed for each site, and a Community Involvement Plan is developed to ensure participation of the local community in the site remediation program. Empowered by the Small Business Liability Relief and Brownfields Revitalization Act of 2002, redevelopment of brownfields is envisioned as a win-win approach to improve the local environmental situation and also to revitalize the local economy, and there are various financial and regulatory incentives to support the local community in promoting remediation and redevelopment of the brownfields.

In Europe, where the right for public participation has long been established, community involvement is an integral part of local agenda, such as urban development and land use planning. This is how the development of brownfields is pursued in many European countries, which is an important issue especially in regions where land is intensely used and the pressure on greenfields is high.

7.6.3 Development of Risk Communication Strategies in FBiH

In BiH, remediation of contaminated site is generally implemented within the framework of environmental permit and related EIA. Hence, risk communication can be built into the framework of EIA. The process of risk communication is similar to public consultation in an EIA, and FBiH already has the basic framework of risk communication in place. Thus, the main focus should be placed on developing the standard practice of risk communication. Table 7.6-3 summarizes the typical questions often raised during public consultation, and some of the issues that have to be examined in order to establish the standard practice.

Table 7.6-3 Typical Questions Raised during Public Consultation and Issues of Risk Communication to Be Examined

Category	Typical Questions	Issues to be Considered by the Committee
Site Survey	- Is the site survey comprehensive and covers all aspects of pollution? - The issue of contamination has been known for a long time. Why did it take so long to investigate the site? - Who carried out the survey, and do they specialize in such survey? - Is my land contaminated? Please investigate my land.	- General requirements for the technical guideline for the survey as the basis to respond to the questions of stakeholders, such as objectives, area to be investigated, overall quality control of laboratory results and others, management of uncertainty, licensing of contractor, etc.
Causes of Pollution and Liability	- What are the causes of pollution? - When did the problem started? - Who is responsible for the pollution?	- Ways to communicate technical issues with non-technical stakeholders. - How to explain the liability frameworks of the polluter, site owner, various public authorities, and other stakeholders. How to explain the legal procedures.
Health Risks	- How toxic is the pollutant? - There are many sick people in this area. Is this related to the pollution? - We would like the government to implement a comprehensive health check. - Are the groundwater and agricultural products in the area safe to consume?	- General health risk standards to be used within the framework of risk communication, including drinking water quality standard, standard for food, standard for bathing, occupational, and others. - Methodologies of risk assessment and public health assessment. - Development of a Federation-wide (or nationwide) database of public/environmental health information including local cases of cancers, miscarriages, birth defects, lung disease, and others. - How to gain the trust of stakeholders in risk communication.
Compensation	- What is the policy for compensation of the suspected health damage? - How much compensation am I going to receive for the reduced value of my property? - I want to move out of this contaminated area. Will the company or the government pay for it?	- General policies for compensations for different types of damages in accordance with the civil, environmental, and other laws.

Category	Typical Questions	Issues to be Considered by the Committee
Remediation Measure	- Please explain how the site will be remediated? - Complete removal of pollution should be achieved. - How do you stop the spread of pollution during remediation? - Can you remediate more quickly? - Removal of pollution is not enough. The area should be redeveloped.	- Policy and requirements for site remediation, including how to set the objectives (e.g., containing pollution, complete removal, and redevelopment of site), how to control the issue of zero tolerance, justification to implement temporary measure, risk management during remediation, and others.
Others	- How the information related to site remediation will be released to the stakeholders?	- Policy for information disclosure related to remediation of contaminated site.

Source: JET. Typical questions are based on the Ministry of Environment Japan, Guideline for Risk Communication in Remediation of Contaminated Sites: For Risk Communication Implemented by Business Owner, 2008.

It is suggested that a team of experts should be organized, and based on the experiences of pilot projects and EIAs of similar projects, analyze how to address these issues typically raised during risk communication. Subsequently, develop a guideline for risk communication to be implemented by those who are responsible for risk communication or by the local authority, as summarized in Table 7.6-4.

Table 7.6-4 Suggested Activities for the Development of Risk Communication Strategies

Category		Remarks
Objective		- To develop a set of protocols for institutional controls.
Responsible Organization		- FMoET and Cantons
Period		- 2016-2018
Methodology		- Organize a team of environmental specialists to examine how to respond to the typical concerns of local residents, to develop a manual for risk communication, and to examine how to set the hotspot information system.
Key Activities	Issues to be Examined	Examine how to respond to typical concerns of local residents related to the following categories of site remediation: - Site survey - Causes of pollution and liability - Health risks - Compensation - Remediation measures - Others

Source: JET

7.7 Financing of Remediation Projects

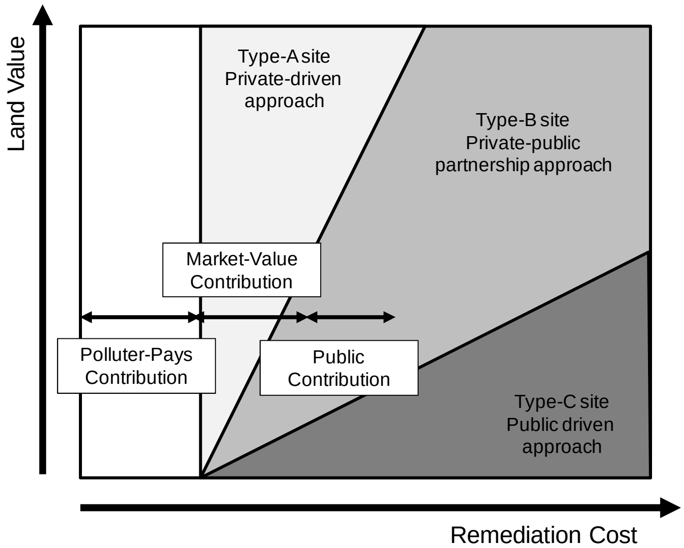
7.7.1 Introduction

In principle, the cost for remediation should be borne by the polluter in accordance with the polluter-pays-principle. However, polluter-pays-principle alone is not sufficient to mobilize enough funding.

In many cases, the pollution in FBiH occurred before the war, thus, the polluter no longer exists. Such site is usually referred to as an “orphan site”. Even if the polluter or its successor exists legally, they are often insolvent or financially incompetent, and cannot cover the remediation cost in a timely manner. Also, sites are often contaminated by multiple polluters over a long period, and resolving the responsibilities among polluters takes time. Therefore, to facilitate remediation, public intervention with public funding is often needed.

Another important dimension is the benefit of remediation. Remediation is often initiated, e.g., to increase the market value of the land, to sell the land at a higher price, to improve the corporate image, to avoid environmental litigation, to improve relation with local residents, and to make the work space safer. These factors could strongly affect the objective, design, cost, and how fast the remediation project may be implemented. Other stakeholders, such as the developers and local government, are also motivated in re-developing the contaminated land and promoting local economy.

In order to implement a remediation project, these different interests of many stakeholders have to be taken into account. Figure 7.7-1 depicts a conceptual model of financing a remediation project, based on the A-B-C model of the Concerted Action on Brownfield and Economic Regeneration Network (CABERNET), which is a network of experts engaged in the redevelopment of brownfields in Europe. The A-B-C model shown here is a version modified by the Network for Industrially Contaminated Land in Europe (NICOLE), which is a forum of industrial groups, academics, and other members.



Source: JET based on NICOLE, Environmental Liability Transfer in Europe: Divestment of Contaminated Land for Brownfield Regeneration, 2011

Figure 7.7-1 Conceptual Model of Funding for Remediation of Contaminated Site

In this model, remediation cost comprises three contributions, namely, (i) polluter-pays contribution, (ii) market-value contribution, and (iii) public contribution. The polluter-pays contribution is the amount that the polluter/operator has to bear in accordance with the polluter-pays-principle, and is equivalent to the reduction in the land sales value equivalent to the cost of remediation. Public contribution is the amount borne by the public expenditure in cases when the polluter cannot be identified or urgent public intervention is needed. Market-value contribution is the amount covered by the polluter/operator in relation to the benefit of the remediation measure in the form of increased land value and the availability of the de-contaminated land for different purposes.

In some sites, private-driven approach to remediation with private funding may be possible if the land value is high and the remediation cost is relatively low. Cooperation between the private sector and the government would also be an attractive option, if redevelopment of the area is sought. On the other hand, if the land value is relatively low and remediation cost is high, public-driven approach, namely, some kind of public intervention with or without cost-recovery mechanism may be needed, especially to remediate high-priority orphan sites.

7.7.2 Overall Remediation Expenditures

This section examines the overall funding needs in FBiH. To analyze the funding needs, an inventory of contaminated sites that cover an estimate of remediation cost for each site, anticipated availability of funding from both private and public sectors, and priority for remediation, is desirable. However, there is no such inventory in FBiH at the moment. Hence, in depth analysis of funding needs is impossible. Nevertheless, it is of interest to understand how much money other countries are spending on remediation and management of contaminated sites. Table 7.7-1 summarizes the estimated public and private expenditures for the management of contaminated sites in selected countries.

Table 7.7-1 Estimated Allocation of Public and Private Expenditures for the Management of Contaminated Sites in Selected Countries

Country	Annual Management Expenditure (EUR in millions)	Breakdown (%)		Annual Expenditure per Capita (EUR)	Reference Year
		Public	Private		
France	470.0	30	70	7.2	2010
Netherlands	324.0	50	50	19.5	2009
Belgium (Flanders)	159.6	25	75	25.9	2011
Switzerland	131.0	40	60	16.6	2011
Denmark	118.7	58	42	21.3	2009
Hungary	81.0	-	-	8.1	2011
Finland	60.0	41	59	11.2	2011
Slovakia	49.5	75	25	9.1	2006
Estonia	42.5	90	10	31.7	2011
Austria	32.6	75	25	3.9	2011
Serbia	14.3	-	-	2.0	2010

Source: ESDAC, 2012 version of the EEA indicator CSI015, “Progress in the Management of Contaminated Sites”, 2012

As these data are based on a limited questionnaire survey, compilation of such is very difficult therefore the values should be interpreted with care. It is evident that the expenditure varies significantly from country to country. In many Western European countries, the annual expenditure is about EUR 20 per capita, while in Eastern Europe it is in the range between EUR 2 and EUR 10. It is also noted that in Western European countries, the share of private expenditure is large. This is partly because in such countries, a clear and realistic regulatory system on financial responsibility of polluter/operator has already been accepted, and also partly because private firms in such countries have strong motives to minimize: a) environmental litigation, b) devaluation of its property due to pollution, and c) liability related to future land transaction; and also to maintain good environmental reputation and good public relation with local residents.

Assuming that the population of BiH is estimated to be approximately four million[1] and per capita expenditure of EUR 3 per year, the total expenditure required for the management of contaminated sites in the whole BiH at a level similar to other countries in the region is EUR 12 million annually. Similarly, assuming the population of FBiH to be 2.5 million and per capita expenditure of EUR 3 per year, the total expenditure in FBiH is EUR 7.5 million. Probably, a large part of such expenditure has to be covered by the government budget, because many sites in FBiH are legacy pollution sites (e.g., former dumpsites) and the financial responsibilities of private parties are unclear. Of course this overall remediation expenditure estimate is not highly reliable, and it should be refined in the future. It should be noted that remediation cost for a site will require millions of euros as shown in Chapter 4. Though the number of contaminated sites in FBiH is relatively limited, many sites are still waiting for funding, and even EUR 7.5 million may not be sufficient to manage such sites adequately.

7.7.3 Financial Mechanisms Used in Other Countries

Because problems of contaminated sites are ubiquitous and remediation projects are often expensive, various financial mechanisms are used in Europe, the US, Japan, and other countries. Table 7.7-2 summarizes the typical financial mechanisms used for remediation of contaminated sites. As stipulated in Article 11 of the Law on Environmental Protection of FBiH (Official Gazette of FBiH, Nos. 33/03 and 38/09), the polluter-pays-principle is the fundamental principle for funding environmental remediation, similarly, this applies in other countries. However, because remediation of contaminated sites has different dimensions, such as remediation cost is often formidably expensive and liability issues are often difficult to resolve, various financial mechanisms are available in other countries.

[1] According to the preliminary results of the “2013 Census of Population, Households and Dwellings in Bosnia and Herzegovina”, the total number of enumerated persons in BiH is 3.791.622, out of which 2.371.603 persons in FBiH. Source: Agency for Statistics of BiH, First Release, 2013

Table 7.7-2 Classification of Financial Mechanisms for Remediation of Contaminated Sites

Name	Approach	Remarks
Private Financing	Polluter or its successor funds the remediation project to comply with relevant environmental law and to improve the value of the land.	This may be possible if the scale of the pollution is small or the polluter is a large company and capable of mobilizing enough financial resources. Also if the benefit of the remediation (e.g., alternative use of the land for expansion of the business or sale of the land after remediation) is significant, the remediation will become self-financing.
Mandatory Fund for Remediation	Use of a specialized fund created by mandating relevant industries to pool money (e.g., tax on hazardous waste, mining development)	This approach is similar to the Environmental Protection Fund of FBiH. Examples of this approach include the levying on hazardous wastes for remediation of orphan sites in France, the abandoned mine reclamation fund levied on surface mined coal in the US, and the environmental protection and water management fund in Austria.
Voluntary Fund for Remediation	Use of a specialized fund created on voluntary basis through cooperation of the government and stakeholders, such as association of industries.	This approach is possible if industries are organized and are willing to deal with pollution issues with their own initiative. Japan's fund for remediation of soil pollution, the oil company compensation fund to clean up contaminated petroleum service stations in Finland, and the BSB Covenant in the Netherlands are among the examples.
Environmental Insurance	Specialized insurance for remediation of contaminated site	In Europe, the US, and Japan, various types of insurances are available to cover contaminated sites, businesses and contractors against claims and unexpected remediation costs. They include environmental insurance to cover damage caused by an accident, white field guarantee to guarantee that the site is clean after investigation, remediation cost-cap or "finite risk" package to cover unexpected remediation cost, and liability guarantee after remediation. In BiH, the domestic market may be too small to develop a package, but international insurances may be available.
Public-led Collective Approach	Government provides financial and planning incentives and may provide some relevant infrastructure such as roads. Polluter (or subsequent owner) carries out remediation (perhaps without admission of liability).	This will involve discussions with relevant parties – without necessarily admission of liability by any of those associated with the source of pollution – in order to find practical options. Collaborative clean-up approaches would typically include actions by the private sector, encouraged by financial incentives such as tax breaks, planning exemptions, or load guarantee; by local governments, such as provision of infrastructure (for example, disposal sites); with inputs from community or non-governmental groups. The test for government support for actions under this approach is whether they can achieve public benefits in a cost-effective manner. Examples are the land remediation relief, which is a tax relief for restoring derelict or contaminated land in the UK, and the federal brownfields expensing tax incentive for exemption of cleanup costs in the US.
Brownfields Redevelopment with Public Sector Support	Private sector, typically developer, invests in remediation of the site in order to create high land values. Government (especially if the nominal owner of the site) supports remediation by negotiating planning and other conditions. Process must be carried out in a transparent and public manner in order to avoid potential abuse of discretion.	This form of collective solution may apply particularly in the case where the original site or source of pollution was a large industrial facility belonging to a government entity that no longer exists. In such cases, a process of redevelopment that generates enough revenue to cover the remediation costs may be a good solution for all parties. Where development land is in demand, typically in urban fringes where old industrial areas are being transformed into commercial and residential uses, it may be possible to recover the costs of remediation. In order to initiate brownfields redevelopment, the government may finance some of the most urgent interventions, with a view to attract private sector funding for subsequent stages, where the risks are then lowered. For example, EU has the European Regional Development Fund (ERDF), which may be used to regenerate a brownfield. The US also has, in accordance with the Small Business Liability Relief and Brownfields Revitalization Act, a set of support mechanisms, such as the brownfield assessment grants, brownfields revolving loan fund grant, brownfields job training grants, and brownfields cleanup grant.

Name	Approach	Remarks
Public Funding with Cost Recovery	Government establishes administrative structure and provides adequate funding to cover most urgent remediation expenditures. Costs recovered through legal action, including taking ownership of (or a lien on) the land, as payment for the costs of remediation.	Where the need for intervention is urgent, and administrative and legal actions are ineffective, the government may undertake the most urgent remediation works using its own funds and recover the costs (with administrative overheads) from the responsible party. This approach, which is drawn from the concept behind the U.S. Superfund Model, would require significant legislative and administrative capabilities. It would be appropriate for countries where there is a large number of legacy or other hazardous sites and where a multi-year program of interventions can be justified. In practice, it must be considered that the full costs could unlikely be recovered for all cases.
Public Funding of Priority Interventions	Government directly funds the priority interventions required to protect health and environment. Public consultation and community involvement are required in order to set priorities, in the context of other government funding demands.	In cases where there is no prospect of recovering any of the costs from the polluter or a successor body, the government may be forced to take action because of the seriousness of a particular case. Government should establish the necessary legislative and administrative frameworks to undertake such projects, in order to ensure that necessary interventions are identified and carried out as effectively as possible. In such cases, given the competing demands on public funds, a careful cost-effectiveness analysis must be carried out to determine the sequence and timing of priority actions, with the objective of initially removing the most immediate threats to health and the environment.

Source: Compiled by JET based on the World Bank, Getting Green, A Sourcebook of Pollution Management, Policy Tools for Growth and Competitiveness, 2012; EEA, Management of Contaminated Sites in Western Europe, 2000; REVIT, Financing Techniques for Brownfield Regeneration - A Practical Guide, 2006, and other documents.

7.7.4 Financial Mechanisms Available in FBiH

In principle, the following financial sources are available for remediation of contaminated sites in FBiH:

- Private;
- Governmental budget (entity, canton, municipality);
- Environmental Protection Fund of FBiH; and
- International cooperation.

Among them, this section focuses on the Environmental Protection Fund of FBiH (FEPF) and the Instrument for Pre-accession Assistance II (IPA II) fund, because FEPF is the official financial mechanism for remediation of contaminated sites, and IPA II is the most anticipated fund.

(1) Environmental Protection Fund of FBiH

The FEPF of FBiH was established based on the Law on Environmental Protection Fund (Official Gazette of FBiH, No. 33/03). According to the Law, the fund will be utilized to support the following activities:

- Implementation of tasks arising from the obligations and responsibilities towards the international community on environmental protection;
- Minimizing damage to the environment in case when the principle of responsibility for environmental damage (polluter-pays principle) cannot be applied;
- Prevention or elimination of the damage to the environment which requires immediate intervention;
- Implementation of measures which aim to protect the environment, particularly in the field of development of information systems, education, and information dissemination;
- Development of an economic structure that is favorable to the environment;
- Preservation of protected natural areas;
- Promotion of environmental awareness and environmental research;
- Conservation, sustainable use, protection, and improvement of the environment;

- Preparation, implementation, and development of software; and
- Implementation of similar activities in areas of preservation, sustainable use, protection, and improvement of the state of the environment and use of renewable energy sources.

As made evident by this list, remediation of contaminated sites is one of the main purposes of the Fund. FEPF is a non-profit public institution, and is structured as a legal entity with rights, obligations, and responsibilities stipulated in the Law and its Statute. The FEPF is being managed by a steering committee (seven members), and the control of the fund is being carried by the supervisory committee (three members).

In accordance with the Law on Environmental Protection Fund of FBiH, the main revenue of the Fund is ensured through the following economic instruments as shown in Table 7.7-3. Funding required by the Law on Waste Management is under preparation, and the fees coming from vehicle registration and water tariff are the main sources of FEPF.

Table 7.7-3 Sources of Environmental Protection Fund of FBiH

No.	Type of Fees	Regulation	By-laws
1	Special environmental charge paid by legal entities and individuals in each motor vehicle registration	Law on Environmental Protection Federation (Official Gazette of FBiH, Nos. 33/03 and 38/09)	Decree on Special Environmental Fees to be Paid during the Registration of Motor Vehicles (Official Gazette of FBiH, Nos. 14/11 and 26/11).
2	Compensation for air pollutants based on the emission of sulphur dioxide, nitrogen oxide, and particulate matter (dust)	Law on Environmental Protection Federation (Official Gazette of FBiH, Nos. 33/03 and 38/09)	Rulebook on the Method of Calculation and Payment, and Terms for Calculation and Payment of Charges for Air Pollutants (Official Gazette of FBiH, No. 79/11). Decree of the Types of Fees and Criteria for Calculating Fees for Air Pollutants (Official Gazette of FBiH, No. 66/11)
3	15% of the total water tariff	Law on Waters (Official Gazette of FBiH, No. 70/06)	-
4	General benefits for manufacturers and importers to manage the wastes of electrical and electronic products	Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09)	Rulebook on Managing Waste from Electrical and Electronic Products (Official Gazette of FBiH, No. 87/12)
5	Fee for managing waste from electrical and electronic products for network manufacturers and importers, who are not involved and organized system through system operator	Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09)	Rulebook on Managing Waste from Electrical and Electronic Products (FBiH Official Gazette No. 87/12)
6	Fee for the management of packaging and packaging waste	Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and No. 72/09)	Rulebook on the Management of Packaging and Packaging Waste (Official Gazette of FBiH, Nos. 88/11 and 28/13)

Source: JET

The collected fund is distributed in the ratio of 30% to the Federation and 70% to the cantons. Table 7.7-4 summarizes the projects financed under FEPF during the period of FY2010 – FY2012.

Table 7.7-4 Projects Financed by the Environmental Protection Fund of FBiH in 2010-2012

Area	Value of the Projects (BAM)
Wastewater management	18,182,400.00
Water source protection	11,091,847.55
Regulation of water courses	3,276,864.25
Area of solving problems in water supply	2,978,000.00
Area of reducing harmful emissions from traffic	250,000.00
Improvement, conservation, and monitoring of air quality	2,505,000.00
Field of scientific research and public awareness	1,449,000.00
Intervention funds	400,000.00
Total	40,133,111.80

Source: BiH, State of the Environment Report of Bosnia and Herzegovina, 2012.

Wastewater management such as construction of sewerage systems, and water source protection are among the main areas for investment. Also, some part of the budget is spent on air monitoring. This seems to reflect the fact that water tariff, tariff on air pollution, and vehicle registration are the main sources of funding. At the moment, waste management including hazardous waste management, mine closure, and remediation of contaminated are not the main targets of the fund partly because these areas are not the sources of funding, though fund may be use to deal with emergency cases.

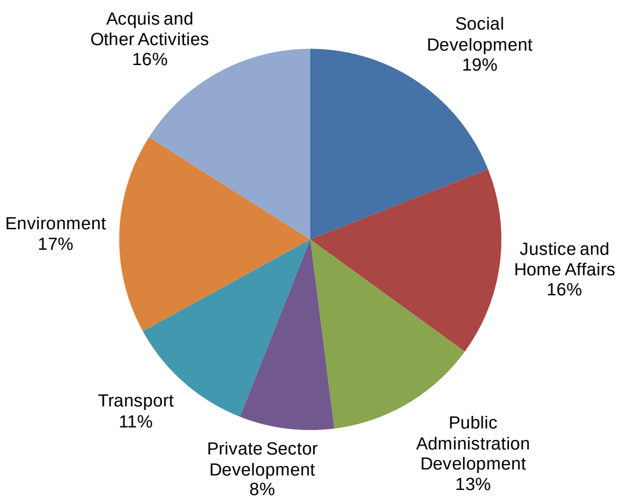
(2) IPA Fund

The Instrument for Pre-accession Assistance (IPA) is the main financial instrument to support countries engaged in the accession process to EU. Under IPA I, which covered the EU budget period of 2007-2013, BiH, as a potential candidate country under the stabilization and association process, was eligible for the first two components of IPA, namely, Component I (Support in the transition and institution-building) and Component II (Cross-border cooperation). During 2007-2012, a total of EUR 546.7 million was allocated to BiH, of which 17% was for environment (see Table 7.7-5 and Figure 7.7-2). For FY2013, EUR 108.8 million is anticipated.

Table 7.7-5 IPA I Fund Spent for BiH 2007-2013

Year	2007	2008	2009	2010	2011	2012	Total (2007-12)	2013*
Support in the transition and institution-building (million EUR)	58.1	69.9	83.9	100.7	102.7	102.7	478	103.5
Cross-border cooperation (million EUR)	4.0	4.9	5.2	4.7	4.7	5.2	28.7	5.3
Total (million EUR)	62.1	74.8	89.1	105.4	107.4	107.9	546.7	108.8

Note: *: The program for 2013 has not been finalized at the time of writing.
Source: EU Delegation to Bosnia and Herzegovina, Instrument for Pre-Accession Assistance (IPA) to Bosnia and Herzegovina, 2013.



Source: EU Delegation to Bosnia and Herzegovina, Instrument for Pre-Accession Assistance (IPA) to Bosnia and Herzegovina, 2013.

Figure 7.7-2 IPA Assistance to BiH by Sector during 2007-2012

As for the new IPA II, which covers the period of 2013-2020, apparently EU has introduced the policy areas, and it is likely that BiH becomes eligible for all of the five policy areas, namely:

a. Process of transition towards membership and capacity building (former IPA Component I-Transition Assistance and Institution Building);

b. Regional development (former IPA Component III-Regional Development);

c. Employment, social policy, and human resources development (former IPA Component IV-Human Resources Development);

d. Agriculture and rural development (former IPA Component V-Agriculture and Rural Development); and

e. Regional and territorial cooperation (former IPA Component II-Cross-border Cooperation).

Regional development is one of the main policy areas for environmental issues. Because of the Sejdic-Finci issue, the availability of IPA II fund to BiH is uncertain. IPA II fund may not also be available for remediation projects which polluters responsible for the damage should pay for the cost.

Aside from IPA, EU has a number of programs to support accession countries, such as the Technical Assistance and Information Exchange Instrument (TAIEX), which is a special unit within the Directorate General for Enlargement (DG Enlargement) of the European Commission, and Twinning, which is an instrument for the cooperation between public administrations of EU member states (MS) and of beneficiary countries.

7.7.5 Suggested Expansion of Financial Mechanisms for Remediation of Contaminated Sites in FBiH

(1) General Considerations

In principle, the cost for remediation of the site should be borne by those legally responsible for site remediation, which is likely to be the current site owner under the current framework of liability. However, many current site owners do not have enough funds to remediate their sites. Thus, even if the liability framework is clear, it will be difficult to remediate the sites. The liability issues could further complicate and delay remediation. Thus, the government has to intervene and remediate or at least implement emergency measures to contain pollution at the sites that are considered dangerous to the public. The cost may be recovered later from the party who is legally liable for the site. Also, some sites, such as the former waste disposal sites, which are publicly owned must be remediated by the government. Considering these situations, the following approaches to funding are suggested:

Table 7.7-6 Site Type and Suggested Funding Sources

Site Type	Suggested Funding Sources	Remarks
Federation-wide survey, urgent measures	- Public (funding from federal, cantonal, and municipality funds) - FEPF	- For the Federation-wide survey proposed in the draft master plan, funding from FMoET may be available as it was proposed in the Federal Strategy for Waste Management. - For urgent measures, funding from federal, cantons, or municipalities may be used. This is essential to prevent further spreading of contamination. Also, FEPF may be used for this purpose.
Remediation of priority sites	- Private - Public (funding from federal, cantonal, and municipality funds) - FEPF - International	- For priority sites, remediation may be implemented by both private and public financing. If the site is privately owned, of course the responsibility of the liable party should be pursued. Nevertheless, if the site is posing a serious threat to the local residents and workers, and if the liable party is not capable of controlling the site, the use of public intervention shall be considered.
Other privately owned sites	- Private - FEPF	- If the site is privately owned and the environmental risk is contained, the site should be remediated by the party who is liable for the contamination.
Other publicly owned sites	- Public - FEPF - International	- As for public owned sites, it is the responsibility of the government to remediate the site. - In order to resolve the issues of historical pollution, many countries have their own laws in making the government responsible for remediation of historical pollution. FBiH should also consider how to resolve issues of historical pollution.

Source: JET

(2) Public Budget for Remediation of Priority Sites

Considering that FBiH has many contaminated sites, and other countries spend roughly EUR 2–20 per person per year to remediate contaminated sites, it is suggested that the Federation, cantons, and municipalities have to set aside a small portion of their budget for investigation, urgent measures, and remediation of such sites. This is already considered in the Federal Waste Management Plan (2012-2017), but after the analysis of generation situations of contaminated sites in FBiH as proposed in this draft master plan, more concrete estimates for budget become possible.

(3) Expanding Revenue Base of Federal Environmental Protection Fund

Many countries have financial mechanisms to support private parties that do not have enough financial resources to remediate a site. In FBiH, FEPF has already been established, and thus FEPF can be used to run such financial mechanism, but two reforms may be needed, i.e., (i) expand the revenue base of FEPF and (ii) clarify the grant/lending criteria.

The current revenue base of the Environmental Protection Fund of FBiH is largely limited to water tariffs, vehicle registration, and some fees related to air pollution. Activities directly related to site contamination, such as use and disposal of hazardous substances are not covered as sources of revenue. Thus, it is suggested that the revenue base of FEPF is expanded to such activities, and conditions to use FEPF for remediation of contaminated sites be clarified.

Examples of economic activities that may become targets of expansion of the fund include:

- Import, use, storage, and disposal of hazardous substances.

This is already being considered, and FMoET is developing relevant by-laws related to the management of hazardous waste. Other activities, such as disposal of non-hazardous industrial waste, use of petroleum oil, dry cleaning, and purchase of industrial estate could also be considered. Expanding the revenue base should be done carefully. First, all of these activities are governed by other laws and regulations, and it might be appropriate to resolve the issues of contamination caused by such activities within the framework of such laws and regulations. Second, in principle, use of the fund raised from particular activity should be earmarked to resolve issues related to that activity, and this could make the management of the fund difficult. Third, establishment of a sizeable fund might send a message to polluters that it is alright to contaminate a site because they pay fees to cover such expenses.

Clarifying the conditions to use the fund is also important. Perhaps only the remediation of priority sites, sites owned by financially incompetent owners, or public sites, may be justified. For remediation of other sites, development of a low-interest environmental loan program under FEPF rather than a grant program, should also be considered.

As for the mining sites, it is desirable to set up a special fund for mine closure. Mining activities often affect vast area, and closing of the mining site is very expensive. Thus, it is safe to set aside some funds during the life of the mining operation. In case a mining company decides to stop operation, funds of mine closure are available.

(4) International Cooperation

To facilitate remediation, FBiH could also request the international communities to support its activities. It should be borne in mind that issues of contaminated sites should be resolved based on polluter-pays-principle, and for international community, it is difficult to support activities that have parties liable for such problems.

(5) Clarifying Liability Issues

Finally, FBiH should clarify the general legal framework of liability so that responsibilities of a polluter, a landowner, and other parties become widely accepted by the society, and financing of remediation by a liable party becomes the acceptable norm. This should be done in parallel to the development of the mechanisms to support those who are legally liable but innocent and/or those who cannot afford to remediate his/her site, so that the liability issue do not cause unwanted anxieties among landowners and possible lawsuits among liable parties or against the government.

Table 7.7-7 Suggested Activities for Expansion of Financial Mechanisms for Remediation of Contaminated Sites in FBiH

Category		Remarks
Objective		- To improve the funding capacities for remediation of contaminated sites in FBiH.
Responsible Organization		- Entities, cantons, and municipalities - Environmental Protection Fund of FBiH - MoFTER
Period		- 2016-2018
Methodology		- Secure budget for remediation of contaminated sites at the levels of entities, cantons, and municipalities. - Expand the funding base of the Federal Environmental Protection Fund. - Secure funding from international donors.
Key Activities	Secure public budget for remediation	Based on relevant federal, cantonal, and municipality plans and the results of the analysis on the extent of contaminated sites problems in FBiH, secure budgets to remediate priority sites.
	Expand the revenue base for FEPF	Expand the revenue base for the Environmental Protection Fund of FBiH that can be used or earmarked for remediation of contaminated sites: - Import, use, storage, and disposal of hazardous substances
	Secure international funding	Discuss with international donors regarding the possibility of technical and financial supports for remediation of contaminated sites.

Source: JET

7.8 Enactment of the Legal Framework

7.8.1 Introduction

Based on the results of the development of technical guidelines and analysis of regulatory issues discussed above, a legal framework to manage contaminated sites in FBiH has to be developed. It should be noted that the impact of such legal framework can be substantial, because it could affect not only those who own a contaminated site, but those who use hazardous substances, and even regular land owners, property managers, investors, developers, banks and other financial institutions, bankruptcy trustees, people who are involved in the privatization and concession processes, and various segments of the government. Hence, the legal framework should be developed considering the far-reaching impact of the issues.

7.8.2 Suggested Activities

Under the current framework of environmental laws, issues of remediation of contaminated sites are covered under the federal-level Environmental Protection Law (Official Gazette of FBiH, Nos. 33/03 and 38/09) for general issues of environmental permit and liability, especially for remediation of privately owned industrial sites, and the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09) for management of waste disposal sites. Hence, it is assumed that the new regulatory frameworks are organized under the same legal structures. However, it is an option to enact a new law on contaminated sites, which is the case in many European countries. Also, certain issues may be covered under different legislations. For example, remediation of contaminated mining sites may be covered under the Law on Mining (Official Gazette of FBiH, No. 26/10). Such decision has to made considering the development of laws and regulations in other sectors, plans for harmonization of local laws with the EU acquis, and thus beyond the scope of this Project.

Table 7.8-1 Suggested Activities for the Enactment of the Legal Framework for Management of Contaminated Sites in FBiH

Category		Remarks
Objective		- To enact and/or amend laws and regulations relevant to the management of contaminated sites
Responsible Organization		- Federal Ministry of Environment and Tourism - MoFTER
Period		- 2018-2020
Methodology		- Review the results of the analysis of general status of contaminated sites in FBiH, experiences gained through urgent measures, pilot projects and remediation of priority sites, development of technical guidelines, and analysis of regulatory issues, as proposed in this draft master plan. - Develop regulatory documents and reviews by legal and technical committees. - Public consultation and other consultation processes. - Submit documents to appropriate decision making bodies.
Key Activities	General frameworks	Clarification of roles and responsibilities of different parties considering: - General principles, such as polluter-pays-principle - Consistency with current legal frameworks, especially in light of the responsibility of polluter/owner of waste under the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09), responsibility of operator under the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09), as well as responsibility of federal, cantonal, and municipality governments under these laws.
	Technical guidelines	Development of rulebooks and best practice guidelines as suggested in this draft master plan, in the areas of: - Site identification - Preliminary investigation - Preliminary evaluation of contamination - Detailed investigation - Risk assessment - Development of remediation plan - Implementation of remediation plan - Emergency measures - Monitoring and follow up
	Institutional frameworks	Clarification of the following issues in a law or sub-laws: - Legal definition of contaminated sites - Liability framework - Institutional controls - Risk communication and public involvement - Financing of remediation projects

Source: JET

CHAPTER 8 DRAFT MASTER PLAN: PART III –DEVELOPMENT OF TECHNICAL GUIDELINES

8.1 Introduction

(1) Process of Site Remediation

There are no technical guidelines for the remediation of contaminated sites in FBiH, therefore making quality control of remediation works difficult. Thus, this chapter proposes activities to develop technical guidelines and best practice guidance documents for remediation of contaminated sites. Table 8.1-1 summarizes the general processes of site remediation. The technical guidelines and best practice documents should cover in order to support proper execution of the entire activities of remediation works.

Table 8.1-1 Process of Site Remediation

Category		Remarks
Key Process	Preliminary Investigation	- Investigate potentially contaminated sites by site description and site inspection.
	Preliminary Evaluation	- Screen potentially contaminated sites and register them on the official site registry.
	Detailed Investigation	- Investigate contaminated sites to collect information for risk assessment and remediation plan.
	Risk Assessment	- Evaluate risks by toxicity and exposure assessments.
	Development of Remediation Plan	- Develop remediation plan of target, method, and finance.
	Implementation of Remediation Plan	- Implement tentative urgent remediation and complete remediation.
	Monitoring and Follow-up	- Monitoring during and after remediation measure and follow-up until the completion of remediation. - Deregistration of site.

Source: JET

Because the number of contaminated sites in FBiH is relatively limited, detailed technical guidelines are not required. Nevertheless, it is also important to note that technical guidelines developed in other countries are not necessarily practical in FBiH, because they were developed to fulfill regulatory requirements of other countries. Thus, guidelines and best practice guidance documents that are tailored to the conditions of FBiH should be developed.

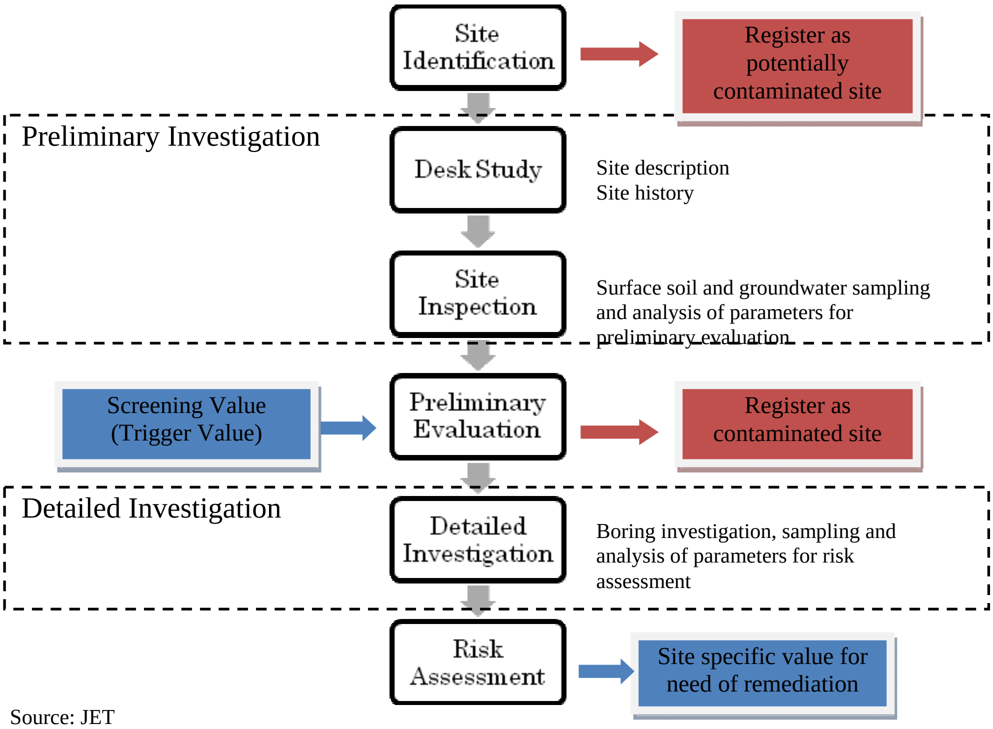
(2) Organizational Aspect of Remediation Activities

Unless otherwise mentioned, in this chapter it is assumed that remediation activities are carried out by a private party responsible for remediation of the site within the framework of environmental impact assessment (EIA) and environmental permit issued by Federal Ministry of Environment and Tourism (FMoET) based on the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09). For certain cases, such as remediation of public waste disposal sites or other publicly owned sites, remediation is carried out by a public organization, and the framework of responsibility is different. Nevertheless, the actual investigation, planning and implementation are carried out environmental specialists, such as environmental consultants and hazardous waste management specialists, and the technical aspects of site remediation are very similar.

8.2 Preliminary Investigation

Site investigation is a process of carrying out an investigation to determine whether there is contamination present and to collect sufficient and suitable data for the purpose of risk assessment. The site investigation is normally carried out in two steps as follows:

- Preliminary Investigation: Investigation with desk study and site inspection for preliminary evaluation by generic quantitative risk assessment; and
- Detailed investigation: Investigation with sampling and analysis for quantitative risk assessment in order to develop a remediation plan.



Source: JET

Figure 8.2-1 Proposed Site Investigation Process

8.2.1 Typical Process of Preliminary Investigation

The first phase of site investigation usually involves a desk study to collect relevant information from a variety of sources relating to the geological and hydrological setting of the site (i.e., the nature of the ground beneath the site and of local ground and surface water) and historical uses of the site (i.e., likely contaminants and activities). This review is intended to identify possible sources of contamination, receptors, and pathways at the site.

Subsequent to the desk study, a site investigation is performed. This is intended to obtain detailed information that is needed for preliminary evaluation. A surface soil sampling and groundwater survey will usually provide details on the current condition of the site, such as evidence of potential contamination of hazardous substances.

The output of the preliminary investigation is usually an interpretive report that contains a summary of the site setting and history as well as analytical data. The information will be the input data for generic quantitative risk assessment in the next stage.

Table 8.2-1 shows the example of scopes of site investigation in other countries. European Union (EU) countries and the US have relatively wider range of scopes for site investigation than that of Japan.

Table 8.2-1 Preliminary Site Investigation in Other Countries

Country	Organization to Implement Investigation	Organization In Charge of Investigation	Scope (Receptor)	Use of Output
Germany	Authority	Land owner, occupant, manager, transporter, disposal supporter	Soil, groundwater, environment (ecosystem, water resource)	Used to create conceptual model and risk assessment
US (under the Superfund program)	EPA	Land owner, occupant, manager, transporter, disposal supporter	Soil, groundwater, environment (ecosystem, water resource)	Information for HRS Scoring[1] and NPL Listing[2]
Japan	Land owner	Land owner	Soil, groundwater	Used to judge contamination possibilities

Source: JET

In Japan, contamination risks are initially determined by site history. A potentially contaminated site is classified as one of three categories: (1) site without potential for contamination, (2) site with less potential for contamination, or (3) site with much potential for contamination. The definition of each category is shown in Table 8.2-2.

If the site is either (2) or (3), further investigation will be implemented by site inspection and sampling analysis of surface soils and/or soil gases. The sampling points are designed that one sample per 100 m^2 for site with much potential for contamination (land under category (3)), and one composite sample per 900 m^2 for site with less potential for contamination (land under category (2)) in order to roughly examine the spatial distribution and degree of contamination. Analytical data will be evaluated by comparing with the standard value for screening in the stage of preliminary evaluation. If any concentration of contaminant exceeds the standard value, the site is referred to as a contaminated site, then, detailed investigation such as boring survey is conducted to examine vertical distribution and volume of contaminated soils and groundwater to be remediated.

Table 8.2-2 Definition of Contamination Potential by Site History in Japan

Category	Definition of Contamination Potential by Site History	Needs Further Investigation	Sampling Design in the Preliminary Investigation
(1) Land without potential for contamination	Land used dependent from specified facilities* such as forest, green buffer zone, resident area, parking area, and play ground.	No	-
(2) Land with less potential for contamination	Land not directly used for specified facilities*, but not independent from them such as office, stockyard, court, and passage for works.	Yes	1 sample/900 m^2
(3) Land with much potential for contamination	Other land directly used for specific facilities* and related facilities such as pipes and treatment plant, stockyard and workshop of designated hazardous substances	Yes	1 sample/100 m^2

* Facilities which use or produce designated hazardous substances
Source: JET

8.2.2 Approaches to Preliminary Investigation in FBiH

(3) Present Situation in FBiH

Preliminary investigations have been conducted in FBiH mainly by landowners as part of an environmental impact study (EIS). Normally, EIS reports are submitted to the environmental authority of the Federation. However, in many cases, the information collected in investigations for EIS is not enough for evaluating the contamination risks by hazardous substances. The main problems which have been revealed during this Project are the following:

1 HRS Scoring: Hazard Ranking System
2 NPL Listing: National Priorities List. Site will be listed when HRS score is more than 28.5.

- The number of samples are not enough to identify contamination sources, which are often highly localized;
- Target substances are limited and not all potential substances are covered; and
- The target area is limited and the extent of contaminated land is not clear.

Site investigation can be costly. According to a recent questionnaire survey conducted in ten countries in Europe, site investigation, which include both preliminary and/or detailed, typically cost EUR 5,000–50,000 per site and often EUR 50,000–500,000. On average, 15% of the remediation cost is spent on investigation (ESDAC, 2010[1]). Given that spending a large amount of money on survey is not easy, and since there is no technical regulation for site investigation in FBiH, it is not surprising that the quality of site investigation significantly varies from investigation to investigation. It is important to implement site investigation based on a unified standard.

(4) Proposed Approach in FBiH

1) Development of the Technical Guideline on Preliminary Investigation

Because characteristics of contaminated sites differ widely from site to site, it is not easy to develop a one-fits-all technical guideline. In order to develop a practical guideline for preliminary site investigation, the following three activities are suggested:

- Review of methodologies and requirements of preliminary investigation in other countries.
- Using the pilot projects proposed in Section 9.3 as opportunities, discuss practical approaches to preliminary investigation in FBiH.
- Development of a general guideline

One of the worst things that could happen to a preliminary investigation is failing to detect contamination due to the limited number of samples, determinands and/or investigation area. To avoid this, adopting the rigorous methodologies in the US, Japan or some European countries is desirable. Nevertheless, it is very costly to densely cover a site and analyze many samples. Thus, one should understand the tradeoff between a rigorous approach that has less chance of missing contamination and a less-rigorous approach that has higher risk of not detecting contamination. To make this process structured, adopting the approach of seven-step Data Quality Objectives (DQO) for hazardous waste site investigation[2] is recommended. For each pilot project (see Section 9.3) site, the preliminary investigation should be designed using the following seven steps as summarized in Table 8.2-4

Table 8.2-3 The Activities of Data Quality Objective for Site Investigation

Steps of DQO	Activities
Step 1: State the problem	- Develop the conceptual site model. - Define exposure scenarios - Specify available resources and constraints
Step 2: Identify the decision	- Identify the decision to be made based on the results of the investigation, which is something like “determine whether site contamination poses an unacceptable risk to human health and the environment and requires further consideration or a response action, or recommend that no further investigation is necessary.” - Define alternative actions that may be taken based on the investigation, e.g., recommend no further investigation.
Step 3: Identify the input to decision	- Identify the information that will be required to support the decision. - Determine the source of information. - Identify the information needed for the government or other party to take action (e.g., drinking water standard) - Confirm that appropriate analytical methodology exists for the information
Step 4: Define the	- Specify the receptors

[1] European Soil Data Center (ESDAC), 2012 version of the CSI015 indicator “Progress in the Management of Contaminated Sites”, 2012.
[2] USEPA, Data Quality Objectives Process for Hazardous Waste Site Investigations, 2000. Also see Monitor Environmental Consultants, Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, R&D Technical Report P5-066/TR, Environmental Agency of England and Wales, 2000.

Steps of DQO	Activities
boundaries of the study	- Define the spatial boundary of the decision statement - Define the temporal boundaries of the decision - Define the scale of the decision making (risk, regulation, technology, finance, etc.) - Identify any practical constraints on data collection
Step 5: Develop a decision rule	- Specify the action level for decision. - Confirm that measurement detection limits will allow reliable comparisons with action level - Combine the outputs from the previous DQO steps and develop a decision rule.
Step 6: Specify the tolerable limits on decision errors	- Define possible decision errors and their potential consequences and select the baseline condition - Examine when decision errors occur.
Step 7: Optimize the design for obtaining data	- Review the DQO outputs and existing environmental data. - Develop general data collection design alternatives. - Select the most resource-effective design that satisfies all DQOs. - Document the operational details and theoretical assumptions of the selected design in the Quality Assurance Project Plan (QAPP).

Source: JET based on USEPA, Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW, 2000.

Through these steps, the investigation team can be more confident in determining the details of investigation, such as the area to be investigated, density of sampling, number of determinands, optimization of sampling design considering the conceptual model of the site-level pollution mechanism, possible use of simplified analytical methodologies (e.g., on-site analysis with portable X-ray fluorescent analyzer (XRF)[1] or soil gas testing) for screening, etc. After the investigation, the investigation team should re-examine whether the results of the preliminary investigation were sufficient and the decision error was within the expected level.

Then, the experiences gained are compiled into the technical guideline.

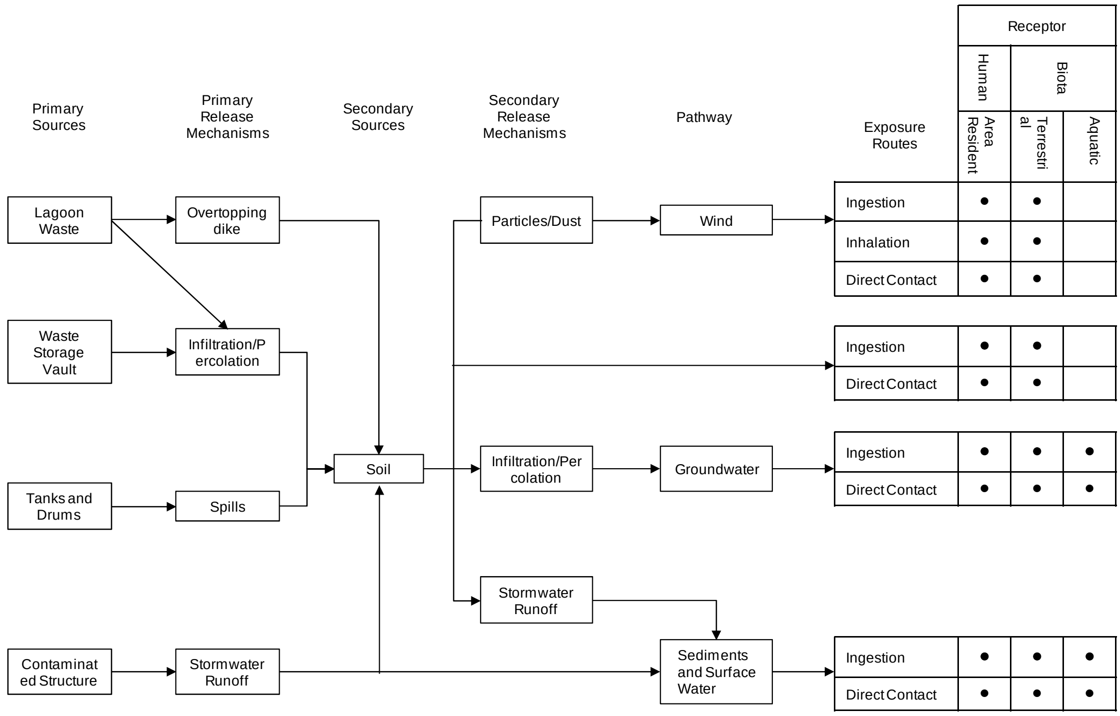
2) Introduction of Conceptual Site Model

Risk assessment is considered a very useful tool in environmental management because it promises a rational and objective basis for priority setting and decision making. It is widely used in the management of contaminated sites, and under the Environmental Liability Directive (2004/35/EC), the use of risk assessment procedures is required for remediation of land damage. Among the most common uses of risk assessment include the following:

- To screen a site to be registered for legal control;
- To set remediation priorities among different sites;
- To set a remediation goal based on acceptable risk; and
- To evaluate the most effective remediation alternatives to achieve a risk-based remediation goal.

Risk assessment is a very powerful tool for management of contaminated sites, but it requires significant amount of site information, technical expertise and administrative resources. Hence, risk-based management of contaminated sites should be introduced to FBiH step-by-step. As the first step, it is suggested to introduce a conceptual site model in environmental impact studies related to management of contaminated sites. An example of a conceptual site model is given in Figure 8.2-2. Such conceptual model will help investigators to focus on the source-pathway-receptor framework, and it is the first step of the DQO-based site investigation mentioned above.

[1] Because an XRF uses x-ray to analyze heavy metals and other elements, those who use a XRF should be properly trained.



Source: USEPA, Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW, 2000.

Figure 8.2-2 Example of a Conceptual Site Model

Table 8.2-4 summarizes the suggested activities for development of a technical guideline on preliminary investigation.

Table 8.2-4 Suggested Activities for the Development of a Technical Guideline on Preliminary Investigation

Category		Remarks
Objective		- To develop a technical guideline on preliminary investigation.
Responsible Organization		- A team of technical experts led by FMoET
Period		2015-2017

Methodology		- Development of a technical guideline on preliminary investigation through the following three steps:
		  - Review of methodologies and requirements of preliminary investigation in other countries.
		  - Using the pilot projects proposed in Section 9.3 as opportunities, examine practical approaches to preliminary investigation and detailed investigation in FBiH.
		  - Development of a general guideline on preliminary investigation
		- Introduction of a conceptual site model based on the source-pathway-receptor framework.

Items to be Considered	Review of Methodologies and Requirements in Other countries	- Review site investigation methodologies in the USA, Western European countries, Japan, and countries around BiH.
	Examination of Practical Approaches through Pilot Activities	- Using the pilot projects as opportunities, examine practical approaches to preliminary investigation and detailed investigation using the following seven-steps DQO approach for hazardous waste site investigation: - Step 1: State the problem - Step 2: Identify the decision - Step 3: Identify the input to decision - Step 4: Define the boundaries of the study - Step 5: Develop a decision rule - Step 6: Specify the tolerable limits on decision errors - Step 7: Optimize the design for obtaining data

Category		Remarks
	Contents of Preliminary Investigation	Desk study - Site description - Site history: operation history, waste characteristics - Review of existing analytical data (if any) - Collection of non-sampling data Site inspection, sampling activities - Contamination source sampling - Groundwater sampling - Surface water sampling - Soil sampling - Background sampling - Analysis Technical procedures - Designate contamination substances - Determine target receptors - Sampling plan (location, number of samples) - Sampling and analysis method - Prepare checklist for site inspection - Safety instruction for site investigation Administrative frame - Procedure for administrative site inspection and confirmation
	Introduction of a Conceptual Site Model	- FMoET should require proponents of all remediation projects that require an EIS to prepare a conceptual site model in the EIS.
Reference and Source of Information		- USEPA, Guidance for Performing Preliminary Assessments under CECLA, 1991. - USEPA, Guidance for Performing Site Inspection under CECLA, 1992. - USEPA, Data Quality Objectives Process for Hazardous Waste Site Investigations, 2000. - Monitor Environmental Consultants, Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, R&D Technical Report P5-066/TR, Environmental Agency of England and Wales, 2000. - Kasai et al., Soil Contamination Countermeasures in Japan, 2011. - Environmental Agency UK, Model Procedures for the Management of Land Contamination, 2004.

Source: JET

Table 8.2-5 shows the sources of information about site description and site history during desk study.

Table 8.2-5 Sources of Information during Desk Study

Type of Information	Sources
Geo-environmental Information	• Geological and groundwater vulnerability maps • Aerial photographs • Other survey maps
Historical Information	• Past aerial photographs • Administrative records - town planning, development and building applications, complaints, pollution incident reports • Local historical publications • Current and previous site owners • Current and previous site workers • Long-term residents • Past and present telephone books • Chemical trading companies and waste disposal companies • Local and national archives and newspapers • Registers held by relevant regulatory agencies and interviews with former staff, neighbors or regulators • Annual report and company history publications
Other Information	• Land use plan • Business plan • Manifests or waste records

Source: JET

8.3 Preliminary Evaluation of Contamination

8.3.1 Preliminary Evaluation of Contamination in Other Countries

Using all available information collected during the preliminary investigation, a preliminary evaluation of contamination is conducted. The preliminary evaluation have the following two objectives: (i) to determine whether the site in question should be officially regulated to control environmental risks, and (ii) to determine the next course of actions in order to contain immediate risks and to clarify requirements for detailed investigation and development of remediation plans.

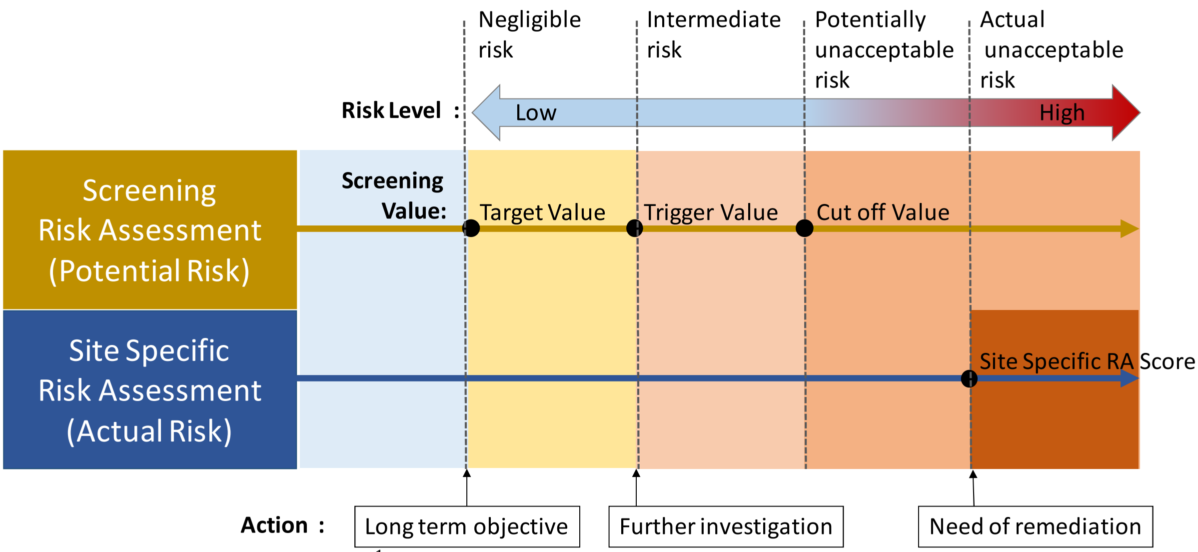
For preliminary evaluation, screening values are used as generic quality standards in many countries. They are usually in the form of concentration thresholds (mg/kg) of contaminants in soil. Although soil screening values have been given various names in their original languages, their concepts are similar and grouped into three risk levels as summarized in Table 8.3-1.

Table 8.3-1 Example of Screening Values in Other Countries

Negligible Risk	Intermediate Risk	Unacceptable Risk
- Target value - Reference value - Background	- Trigger value - Guidance value - Threshold value - Further investigation	- Cutoff value - Intervention value - Limit value - Clean-up standard - Action level - Maximum permissible concentration - Soil guideline value

Source: JET based on Carlon, C. (ed.), 2007

During the preliminary evaluation, a trigger value is used for evaluation. If the values of soil samples exceed the trigger value, the site is officially registered as a contaminated site. Then, further investigations shall be carried out in the next stage (see Figure 8.3-1).



Source: JET based on Carlon, C (ed.), 2007[1].

Figure 8.3-1 Screening Risk Assessment and Site-specific Risk Assessment

As shown in Table 8.3-2, scopes of the preliminary evaluation are different among nations, especially in target land type, target substances, and evaluation method. In many countries, there are different screening values for each scope of land type.

[1] Carlon, C. (ed.), Derivation methods of soil screening values in Europe, a review and evaluation of national procedures towards harmonization, Joint Research Center (JRC), 2007.

Table 8.3-2 Preliminary Risk Assessment of Contamination in Other Countries

Country	Scope of Land Type	Target Substance	Evaluation Method
UK	Regulated according to land use 1) Industrial area, 2) Agricultural area, 3) Residential area, 4) Recreational area, and 5) Nature area	50-100	Site-specific risk assessment If the value exceeds the Soil Guideline Values (SGVs), risk assessment will be conducted.
US	Regulated according to land use 1) Industrial area, 2) Recreational area, and 3) Residential area	More than 1,000	Site-specific risk assessment -Scoring by HRS
Japan	Generic regulation	25	Screening evaluation

Source: JET

At this point, it is important to mention that screening values rely solely on the concentration of pollutant in soil, and they are not based on actual risks. Also, screening with a trigger value usually overestimates the risk due to conservative assumptions. By taking full account of local circumstances (e.g., soil type and soil properties, climate, specific use of the land, human behavior patterns, background intake), the site-specific risk assessment allows the reduction of conservatism (JRC, 2007[1]).

Under the framework of the Superfund program in the US, sites are scored using a risk evaluation system known as the Hazard Ranking System (HRS), based on the data from preliminary investigation including preliminary assessment (PA) and site inspection (SI). The HRS scoring process is the primary mechanism for determining the sites to be included in the National Priorities List (NPL) and, therefore, the sites eligible for Superfund-financed remedial action. The HRS is a numerical scoring model that is based on many factors affecting risks at a site (EPA, 1989). This approach was experimented during site investigation in this Project (see Chapter 4).

In the UK, a quantitative health and environmental risk assessment is also carried out based on data from preliminary investigation. This process is implemented based on a concept model of pollution linkage. The linkage consists of a pollution source or hazard and a receptor, together with an established pathway between the two. Through preliminary risk assessment, if the analyzed value exceeds the Soil Guideline Values (SGVs), a site-specific risk assessment is conducted using this conceptual model.

8.3.2 Approaches to Preliminary Evaluation of Contamination in FBiH

(5) Present Situation in FBiH

In FBiH, there is no legal definition of a contaminated site. Also there is no soil quality standard other than for agricultural soil. Hence, screening values in European countries, such as Germany, the Netherlands, or Austria, are often used to roughly evaluate the level of contamination.

(6) Proposed Approach in FBiH

Table 8.3-3 summarizes the suggested activities for development of technical guidelines on preliminary evaluation. The following two activities are suggested.

1) Technical Guideline for New Legal Definition of a Contaminated Site

Currently there is no legal definition of a contaminated site in FBiH, but as proposed in Section 7.2, a definition should be introduced in the future in order to control contaminated sites legally. This has significant impact to the society because the definition will make some sites "officially" contaminated. Thus, it is very important to develop an official technical guideline regarding how to determine whether a site is considered contaminated or not. Section 7.2 proposed introduction of at least two provisional screening values to classify contaminated sites into (i) seriously contaminated sites, and (ii) contaminated sites. Thus, the guideline should clarify technical issues for the screening, such as how to take samples, how many samples should be analyzed, how to analyze

[1] Joint Research Center (JRC), Derivation methods of soil screening values in Europe, a review and evaluation of national procedures towards harmonization, Carlon, C. (ed.), 2007.

samples, who is authorized to analyze samples, and how to interpret data if the background level of contaminant is high. In addition to the criteria based on screening values, Section 7.2 suggested to give local authority an administrative discretion to decide whether a site is contaminated or not considering the possible environmental risk at the site (e.g., based on condition of the source of pollution, public access to the site, use of groundwater, level of pollutant in groundwater and/or other environmental media, opinion of public health officer, etc.). The guideline should explain how such discretion is used.

2) Guidance Document on Evaluation of Results of Preliminary Investigation

In addition to the technical guideline on legal definition of contaminated sites, it is suggested to develop a technical guidance document on how to evaluate the results of preliminary investigation. Based on the results of pilot projects, this document shall show relevant information and/or good examples and bad examples useful for field officers and environmental specialists. The following information may be of interest:

- Source characterization: e.g., conditions of different types of pollution sources and their containment, control of surface runoff, situations where urgent measure should be considered
- Pathway analysis: e.g., examples of a conceptual model, mobility of different pollutants, half-life of organic pollutants, evaluation of surface runoff, and evaluation of groundwater
- Exposure analysis: e.g., characterization of receptors, environmental standards/screening values for different environmental media (soil, groundwater, surface water, air) in FBiH and other countries, information on administrative requirements for protection of receptors, sources of toxicity data
- Contact addresses: a list of local experts in different fields

This document may be developed as a part of the technical guideline for preliminary investigation.

Table 8.3-3 Suggested Activities for the Development of Technical Guidelines for Preliminary Evaluation

Category		Remarks
Objective		- To develop a technical guideline for the new definition of a contaminated site - To develop a guidance document on evaluation of results of preliminary investigation.
Responsible Organization		- A team of technical experts led by FMoET
Period		2014-2017

Methodology		- Technical guideline for new legal definition of a contaminated site
		  - Analysis of requirements of new legal definition of a contaminated site.
		- Guidance document on evaluation of results of preliminary investigation
		  - Review of international guidelines on site investigation and risk assessment
		  - Examination of the results of preliminary surveys of the pilot projects

Items to be Considered	Technical guideline for new legal definition of a contaminated site	- Analysis of requirements of new legal definition of a contaminated site, which include: sampling method, sampling density, analytical method, related environmental risks, possible exemptions
	Guidance document on evaluation of results of preliminary investigation	- Review of international guidelines on site investigation and risk analysis - Analysis of the results of preliminary surveys of the pilot projects - Review of administrative requirements in FBiH related to pollution control, public health control, protection of natural environment, others
Reference and Source of Information		- Carlon, C. (ed.), Derivation methods of soil screening values in Europe. A review and evaluation of national procedures towards harmonization. European Commission, Joint Research Centre, Ispra, EUR 22805-EN, 306 pp., 2007. - Falconi et al., Towards an EEA Europe-wide assessment of areas under risk for soil contamination Volume III PRA.MS: scoring model and algorithm Final version, European Environmental Agency, 2005. - USPEA, Guidance for Performing Site Inspections Under CERCLA, 1992. - Kasai et al., Soil Contamination Countermeasures in Japan, 2011.

Source: JET

8.4 Detailed Investigation

8.4.1 Typical Process of Detailed Investigation

The main objective of a detailed investigation is to collect detailed information for site-specific risk assessment and subsequent development of a remediation plan. Based on the results of a detailed investigation, one should be able to estimate, for example, the distribution of pollutants in and around the site, exposure of hazardous substance to different receptors, the volume of soil to be removed, and the extent of an aquifer to be treated. Requirements for detailed investigation is highly dependent on the site condition as well as regulatory requirements, but in general, the following activities are carried out during the detailed investigation:

1) Setting the objectives of site investigation

The investigation plan is designed to gather necessary information for the contamination conceptual model describing pollutant linkage and risk assessment for designing a remediation plan in the next stage.

2) Determine what, where, and extent of investigation

- What are the target media (soil, groundwater, air, biota) and target substances
- Where is the investigation area
- Extent of investigation depends on the hazardous substances and pathway

It is important to make an investigation plan based on the following characteristics of contaminants:

- Heavy metals tend to remain at the surface of the ground. It is less likely to cause groundwater contamination except for substances which are easily dissolved in water such as hexavalent chromium; and
- Volatile organic compounds (VOCs) have properties as poorly-soluble, low viscosity, and irresolvable. Also, they are heavier than water except benzene. Once it percolates into soils, it tends to move downward and cause groundwater contamination.

3) Designing sampling strategy

- Soil sampling point (purposive, random, or systematic sampling)
- Types of soil samples (grab sample or composite samples)
- Well location and depth, well design and construction materials
- Types of water samples (filtered or unfiltered)
- Sampling timing (single, annual, or seasonal sampling cycle)
- Sampling devices
- Sampling methods and techniques
    - Field sampling
        - Direct push sampling
        - Sampling based on drilling methods
        - Passive diffusion bag samplers
        - Soil gas sampling
        - Single and continuous water sampling
        - Integral pumping tests
    - Field analytical methods
        - In-situ analysis (e.g., fiber optics, laser induced fluorescence, geophysical measurements, and gamma radiation measurements)
        - Ex-situ (e.g., detector tubes, field bio-assessments, photo- and flame-ionization detectors)
    - Laboratory analytical methods
        - Gas chromatography
        - Spectroscopy
        - Immunoassays
        - Toxicity tests

4) Designing analytical strategy

- Analytical method (wet or dry soil sample, elution amount, or content amount)
- Designated analysis organization or laboratory

5) Executing site investigation

- Designated experts or consultant
- Safety strategy

These activities will be designed and executed by experts or consultants according to site-specific situation and objective of the investigation. Table 8.4-1 summarizes detailed investigation in different countries.

Table 8.4-1 Detailed Investigation in Other Countries

Country	Organization to Implement	Regulator	Types of Risk Assessment	Advantage	Disadvantage
UK	Authority	Authority	Assessment by risk analysis	Flexible for site-specific condition	Difficult to control quality
US	EPA	EPA	Assessment by risk analysis	Flexible for site-specific condition	Difficult to control quality
Japan	Landowner	Prefectural Government	Assessment by screening method	Easy to control quality	Not flexible for site-specific condition

Source: JET

8.4.2 Approaches to Improve Detailed Investigation in FBiH

(1) Present Situation in FBiH

Detailed investigations for designing a remediation plan have not been conducted yet in a systematic manner in FBiH. In order to conduct detailed investigation in a systematic manner, it is necessary to prepare technical guidelines and to train the experts and consultants who will implement investigations as well as regulators who will inspect investigations.

(2) Proposed Approach in FBiH

Suggested activities for development of technical guideline on detailed investigation are summarized in Table 8.4-2. The methodology is the same as the one for preliminary investigation, namely:

- Review of methodologies and requirements of detailed investigation in other countries.
- Using the pilot projects proposed in Section 9.3 as opportunities, examine practical approaches to detailed investigation in FBiH.
- Development of a general guideline

However, the decision to be made based on a detailed investigation is quite different from that for preliminary investigation. At the stage of detailed investigation, the main focus is design of remediation measures that attain the remediation goal, and thus the investigation should be able to provide all necessary information to design remediation measures and to evaluate their adequacies. Thus, the technical guideline on detailed investigation is quite different from that on preliminary investigation.

Table 8.4-2 Suggested Activities for the Development of a Technical Guideline for Detailed Investigation

Category	Remarks
Objective	- To develop a technical guideline on detailed investigation.
Responsible Organization	- A team of technical experts led by FMoET
Methodology	- Review of methodologies and requirements of preliminary investigation in other countries. - Using the pilot projects proposed in Section 9.3 as opportunities, examine practical approaches to preliminary investigation and detailed investigation in FBiH. - Development of a general guideline on detailed investigation

Category		Remarks
Items to be Considered	Review of Methodologies and Requirements in Other countries	- Review detailed site investigation methodologies in the USA, Western European countries, Japan, and countries around BiH.
	Examination of Practical Approaches through Pilot Activities	- Using the pilot projects as opportunities, examine practical approaches to preliminary investigation and detailed investigation using the following seven-step DQO approach for hazardous waste site investigation.
	Development of a Technical Guideline	- Develop a technical guideline based on the results of the activities.
Reference and Source of Information		- EPA, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, 1988. - USEPA, Data Quality Objectives Process for Hazardous Waste Site Investigations, 2000.

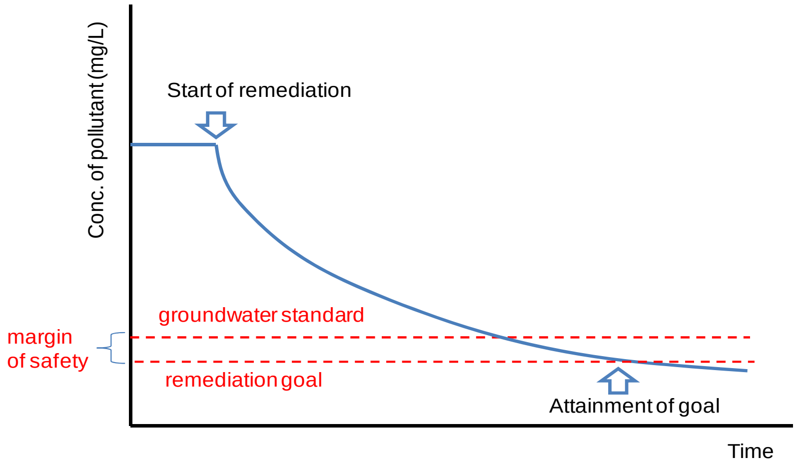
Source: JET

8.5 Development of Remediation Plan

The next step in remediation is the development of a remediation plan, which involves setting of a remediation goal, and selection of remediation measures to achieve the remediation goal.

8.5.1 Remediation Goal and Reasonableness of Remediation

Before starting the design of a remediation plan, one has to select the remediation goal. The goal depends on the objective. If pollution is localized and removing contaminated soil ensures safety of the local people and environment, removal of soil contaminated beyond the prescribed standard becomes a goal. If groundwater is contaminated, and the concentration of pollutant in nearby well for drinking water is above the groundwater (drinking water) standard, the goal would be to reduce the concentration to the level below the standard, considering a margin of safety, as illustrated in Figure 8.5-1.



Source: JET

Figure 8.5-1 Illustrative Example of the Attainment of a Remediation Goal

Similarly, any other regulatory requirements (e.g., environmental standard, drinking water standard, and soil quality standard) or risk-based target (e.g., acceptable level of risk) may be set as a remediation goal[1].

In reality, however, setting a remediation goal is not so straightforward. For example, containment of the source may be equally effective as removal of the source in attaining the reduction on the level of pollutant in a nearby well. Thus, the containment approach may be acceptable from the point of view of protecting the receptors. However, the containment approach, although generally less expensive, does not remove contaminants from the site, and does not completely remove the liability issue from the site

[1] See, e.g., Environmental Agency (England and Wales), Remediation Target Methodologies: Hydrogeological Risk Aassessment for Land Contamination, 2006.

owner. Hence, the environmental authority has to consider the reasonableness of reasonableness of the goal of and the approach to remediation. Table 8.5-1 gives a summary of the examples of criteria for the evaluation of reasonableness.

Table 8.5-1 Criteria for the Evaluation of Reasonableness of Remediation Measures

Category	Criteria
Threshold Criteria	- Overall protection of human health and the environment - Compliance with regulatory requirements
Primary Balancing Criteria	- Long-term effectiveness and permanence - Reduction of toxicity, mobility, or volume through treatment - Short-term effectiveness - Implementability - Cost
Modifying Criteria	- Government acceptance - Community acceptance

Source: USEPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, 1999.

In the UK, the criteria are as follows: (a) practicability, effectiveness, and durability of remediation; (b) health and environmental impacts of the chosen remedial options; (c) financial cost which is likely to be involved; and (d) benefits of remediation with regard to the seriousness of the harm or pollution of controlled waters in question; and perhaps (e) community acceptance and other aspects (see, DEFRA, 2012[1]). The issue of reasonableness of remediation requires further discussions because the environmental authority is in the position of authorizing remediation measures, and should be able to advise those who are going to remediate a site about the possible consequences.

8.5.2 Risk Assessment for Optimization of Remediation Measures

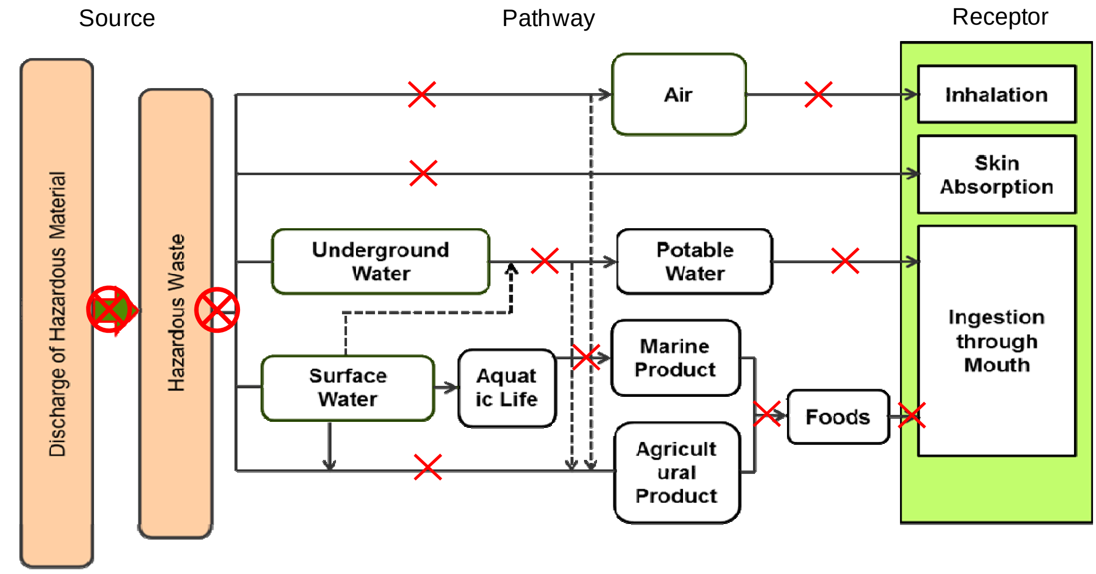
In the risk-based approach to management of contaminated sites, the ultimate goal of remediation is to reduce the risk to the acceptable level, and remediation measures are designed considering how to reduce risk in the most efficient manner. Figure 8.5-2 shows the source-pathway-receptor framework for risk assessment. In order to reduce risk, a remediation measure has to cut the exposure route, and conceptually, there are three approaches for this as follows:

(a) Reducing or treating the source part of the linkage (e.g., by physically removing contaminants or contaminated soil). This is shown with a red ⊗ in the figure;

(b) Breaking, removing, or disrupting the pathway parts of the linkage (e.g., by covering or containing the source). This is shown with a red × in the middle of the figure; and

(c) Protecting or removing the receptor (e.g., by providing alternative water source or by supporting the receptor to move to a safer place) This is shown with a red × in the receptor side of the figure.

[1] Department for Environment, Food and Rural Affairs of UK (DEFRA), Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, 2012.

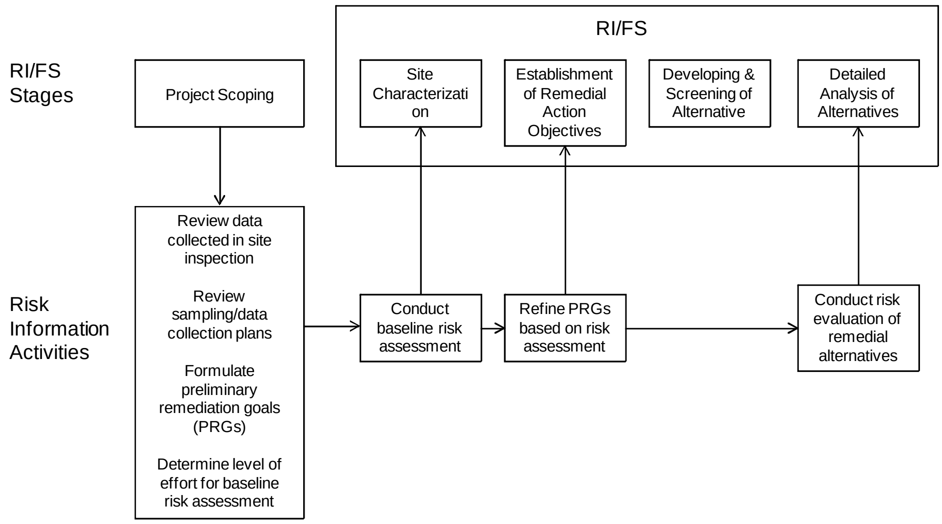


Source: JET

Figure 8.5-2 Cutting Off the Exposure Pathways

In designing remediation measures, it is desirable to cut the most upstream point of the exposure route in order to minimize the spread of pollution.

The risk-based approach has been used widely in the world to optimize remediation design. For example, at the stage of detailed investigation/development of remediation measures under the Superfund program in the US (known as remedial investigation/feasibility study or RI/FS stage, see Figure 8.5-3), preliminary remediation goals are set considering target concentrations based on regulatory requirements (e.g., environmental standard for groundwater and drinking water standard) and/or risk-based goal (e.g., probability of getting cancer for carcinogenic effect or hazard index for non-carcinogenic effect). Subsequently, site-specific risk is evaluated for human health risks and ecological risks. Then, the remediation goal is refined further, and remediation alternatives are analyzed considering the risks.



Source: USEPA, Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual, 1989.

Figure 8.5-3 Process of Risk Assessment in the Superfund Program

Similarly, risk assessment of contaminated site has been accepted in European countries since the 1990s. It has been used mainly to set priorities for remediation, and also to set site-specific remediation goals. While most counties have adopted a common framework based on the source-pathway-receptor approach, there have been some differences with respect to the underlying assumptions, geographical scale, choice of endpoint of evaluation (e.g., life expectancy, death rate, and no observed effect concentration), acceptable risks, and so forth. In the late 1990s and early 2000s, there have been a number of attempts to harmonize approaches to risk assessment and risk management in Europe. Among the most well-known initiatives are as follows:

- Concerted Action on Risk Assessment for Contaminated Sites in the European Union (CARACAS);
- Contaminated Land Rehabilitation Network for Environmental Technologies (CLARINET); and
- Network for Industrially Contaminated Land in Europe (NICOLE).

Under these initiatives, the member countries discussed the practices of risk assessment and risk management. In 1998 and 1999, CARACAS released a series of review reports entitled "Risk Assessment for Contaminated Sites in Europe", in which different aspects of risk assessment methodologies [1] (e.g., evaluation of impacts on human health/ecosystem, soil and source characterization, pathways, models, and screening values) and policy frameworks[2] for risk assessment were studied. This led to further evaluation of risk assessment methodologies under the European Environmental Agency (EEA, 2004), and efforts to develop a common risk assessment model[3]. Despite such efforts, risk-based approach to management of contaminated sites in Europe has not been harmonized, and each country has its own methodology.

8.5.3 Selection of Remediation Technologies

There are numerous remediation technologies for different types of contaminated sites, and the technologies have to be selected considering its effectiveness, maturity of technology, cost, time, and other aspects. In Japan, the technical guidelines for soil remediation[4], which is over 700 pages, presents different remediation technologies and how to use them under different conditions. Examples of sources of information in other countries include the following:

- Federal Remediation Technologies Round Table in the US (http://www.frtr.gov/)
- EUGRIS (http://www.eugris.info/)
- NICOLE in Europe (http://www.nicole.org/)
- CLAIRE in the UK (http://www.claire.co.uk/)

Table 8.5-2 gives a summary of the selected remediation technologies for soil remediation. Similar tables for different types of contamination are presented in Annex 5 together with the characteristics of different pollutants, brief explanations about different technologies, and cost information.

[1] CARACAS, Risk Assessment for Contaminated Sites in Europe, Volume 1 Scientific Basis, 1998.
[2] This report is not available on the Internet. See, Ferguson, C.C., Assessing Risks from Contaminated Sites: Policy and Practice in 16 European Countries, Land Contamination & Reclamation, 7 (2), 1999.
[3] EEA, Towards an EEA Europe-wide assessment of areas under risk for soil contamination, Volume III, PRA.MS: scoring model and algorithm, 2005.
[4] Ministry of Environment Japan, Guideline on investigation and remediation measures in compliance with Soil Contamination Countermeasures Act, Ver.2, 2012.

Table 8.5-2 Examples of Soil Remediation Technologies

Soil,Sediment,Bedrock and Sludge									
Rating Codes ++: Above Average +: Average -: Below Avelage N/A: Not applicable I/D: Insufficient Data ●: Level of Effectiveness highly depend upon specific contaminant and its application		Development Status	Treatment Train	Relative Overall Cost & Performance					Availability
				O&M	Capital	System reliability &	Relative costs	Time	
1. In Situ Biological Treatment									
1.1	Bioventing	++	++	++	++	++	++	+	++
1.2	Enhanced Bioremediation	++	++	-	+	+	++	+	++
1.3	Phytoremediation	++	++	++	++	-	++	-	+
2. In Situ physical / Chemical Treatment									
2.1	Chemical Oxidation	++	++	-	+	+	+	++	++
2.2	Electrocinetic Separation	++	-	-	+	+	-	+	+
2.3	Fracturing	++	+	+	-	+	+	+	++
2.4	Soil Flushing	++	++	-	+	+	+	+	++
2.5	Solidification / Stabilization	++	++	+	-	++	++	++	++
3. In Situ Thermal Treatment									
3.1	Thermal Treatment	++	-	-	-	++	+	++	++
4. Ex Situ Biological Treatment(assuing excavation)									
4.1	Biopiles	++	++	++	++	++	++	+	++
4.2	Composting	++	++	++	++	++	++	+	++
4.3	Landfarming	++	++	++	++	++	++	+	++
4.4	Slury Phase Biological Treatment	++	-	-	-	+	+	+	++
5. Ex Situ Physical / Chemical Treatment (assuming excavation)									
5.1	Chemical Extraction	++	-	-	-	+	+	+	++
5.2	Chemical Reduction -Oxidation	++	+	+	-	++	+	++	++
5.3	Dehalogenation	++	+	-	+	+	-	+	+
5.4	Separation	++	+	-	+	++	+	++	++
5.5	Soil Washing	++	-	-	-	++	+	++	++
5.6	Solidification / Stabilization	++	++	+	-	++	++	++	++
6. Ex Situ Thermal Treatment (assuming excavation)									
6.1	Hot Gas Decontamination	-	++	-	-	++	++	++	+
6.2	Incineration	++	++	-	-	+	-	++	++
6.3	Open Burn / Open Detonation	++	++	-	-	++	++	++	++
6.4	Pyrolysis	++	++	-	-	-	-	++	++
6.5	Thermal Desorption	++	++	-	-	+	+	++	++
7. Containment									
7.1	Landfill Cap	++	++	+	-	++	++	-	++
7.2	Landfill Cap Enhancements / Alternatives	++	++	+	-	++	++	-	++
8. Other Treatment									
8.1	Excavation, Retrieval, Off- Site Disposal	++	++	++	++	++	●	++	++

Source: FRTR, 2007

In addition, there are numerous guidelines on remediation technologies for different industrial sectors. For example, for the mining sector, there is a basic guideline concerning environmental pollution caused by mining activities, entitled “Report on International Round Table on Mining and Environment”, also known as “Berlin Guideline” (1999). Many instructions and guidelines on the mining sector were reported to have followed this “Berlin Guideline” after those discussions. The guideline covers the following areas of mining operations:

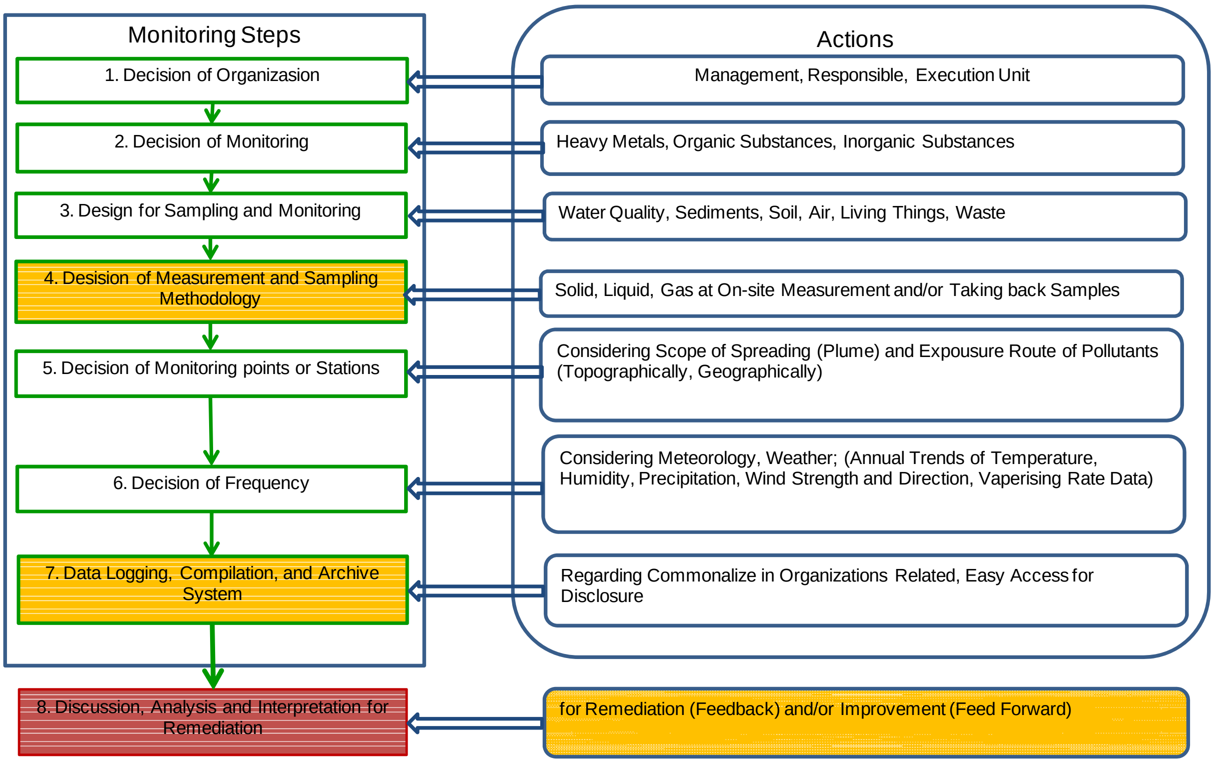
- Disposal of overburden and waste rock;
- Ore processing and plant-site operations;
- Tailings containment, treatment, and disposal;

- Infrastructure, access, and energy; and
- Construction work camps and operational town sites.

Some noteworthy remediation technologies are explained in Annex 5. They include technologies that have never been tried in BiH and may be useful for resolving environmental pollution issues in BiH.

8.5.4 Monitoring Plan in Remediation Plan

In addition to the main remediation plan, a monitoring plan and risk communication/community involvement plan have to be developed in order to ensure safe and controlled implementation of the remediation works and attainment of the remediation goal. Figure 8.5-4 illustrates how a monitoring plan is developed. A typical monitoring plan covers target pollutants and hazardous materials, discharge state (liquid, solid, gas, etc.), migration and flow direction, locations and frequencies of monitoring, reporting requirements, feedback, and feed forward systems with follow-up.



Source: JET

Figure 8.5-4 Development of Monitoring Plan

A monitoring plan is a very important plan for remediation because it is used to control the quality of site works during implementation and to verify the performance and completion of remediation[1]. It usually progresses as shown in Table 8.5-3. Considering the importance of quality control during the implementation stage and verification of remediation during the monitoring and follow-up stage of remediation, these issues are discussed separately in the later sections of this report.

[1] Environmental Agency of England and Wales, Verification of remediation of land contamination, 2010.

Table 8.5-3 Monitoring Plans in Different Stages of Remediation

Stage of Remediation	Development of Remediation Plan	⇨	Implementation of Monitoring Plan	⇨	Monitoring and Follow-up
Plan	Monitoring Plan	⇨	Site Works Quality Control Plan	⇨	Monitoring and Maintenance Plan (Verification Plan)
Objective	To set the overall framework for monitoring the attainment of remediation goals and quality of remediation works.	⇨	To ensure proper execution and quality control of the remediation works according to the remediation plan.	⇨	To ensure proper execution of the follow-up works and verification of remediation.

Source: JET

For risk communication and community involvement, please see the Section 7.6 on risk communication and community involvement as well as Chapter 11 on environmental and social considerations..

8.5.5 Approaches to Improve Development of Remediation Plan in FBiH

(1) Present Situation in FBiH

FBiH already has some capacity to develop remediation plans. There are a dozen of environmental consulting firms, and some of them have experiences, though still limited, in developing plans to control and remediate contamination. In addition, there are nine firms that have permits to treat different types of hazardous wastes[1], and they are capable of handling and shipping hazardous substances abroad for final disposal based on the requirements of the Basel Convention. These firms can provide specialized knowledge in development of remediation plans.

Nevertheless, remediation of contaminated sites in FBiH is still relatively new, and remediation plans are not developed in a structured way. There are a number of reasons for this.

- First, there is no specific law in FBiH that governs remediation of contaminated sites. Thus, what is required of a remediation project is not very clear, even though most people agree that contaminated sites should be cleaned up somehow in the future. Many of these sites have been left unattended for decades, and there is no time line for remediation. Also, there is no clear requirement regarding the goal of a remediation project, such as how clean is considered clean enough, or what to do if there is no applicable administrative requirements. These uncertainties make the design of remediation options difficult.
- Second, available remedial options in FBiH are too limited. In FBiH, there is no disposal site for hazardous waste, and the only option for final disposal of heavy metals is to ship abroad, which is very costly. Other remediation technologies to reduce waste, such as soil washing, or in-situ treatment, such as enhanced bioremediation, are also new in FBiH. Hence, while a wide range of technologies are available in the world, there is large uncertainty about the possible choices, and those who develop a remediation plan has to consider various risks of proposing technologies that have not been proven in FBiH.
- Third, risk assessment in the field of management of contaminated sites is new in FBiH. The effort of the Hydro-Engineering Institute Sarajevo under this Project (see Chapter 4) is one of the first attempts to characterize environmental risks of contaminated sites in FBiH. While the concept of risk assessment has been embraced in FBiH, it has not been used regularly in characterizing environmental risks of contaminated site and optimizing remediation options.
- Finally, the demand for well-controlled remediation projects has been too limited in FBiH, and opportunities to develop remediation plans are scarce. Thus, while environmental specialists are generally competent, they still have to make many try-and-errors to develop a well-structured, reliable remediation plans.

[1] FMoET, Federal Waste Management Plan, 2012-2017.

(2) Proposed Activities to Improve Development of Remediation Plans in FBiH

FBiH has to gain more experiences in developing and organizing standard ways to develop remediation plans. To facilitate this, it is highly recommended to develop a standard format of remediation plan, and also, clarify how a remediation goal should be set and how measures are evaluated. For selected sectors in which many remediation projects have to be implemented in the future, it is a good idea to develop a guideline on how to develop a remediation plan. The suggested activities until 2020 are as follows:

- Development of a standard format of a remediation plan. Through the pilot projects to be implemented as part of the draft master plan, develop a standard format of a remediation plan, perhaps within the general framework of EIA, that can be used as a template for remediation plans in the future. Conformity with the requirements for environmental permitting and appraisal for funding (e.g., Environmental Protection Fund of FBiH) should also be taken into consideration;
- Discussion on the criteria for setting remediation goals and evaluating remediation plans. In the course of the development of remediation plans in the pilot projects, discuss how to set remediation goals and how to evaluate remediation measures; and
- Development of prototype remediation plans for selected sectors. Draft a sample remediation plan for selected sectors for which many remediation projects have to be implemented in the future, such as waste dumpsite, coal ash disposal site, and gas station. Such sectors will be identified through the Federation-wide survey, development of a site inventory, and analysis of the general status of contaminated sites in FBiH, which are activities proposed in the draft master plan.
- Discussions among environmental, public health, and other experts on the current regulatory requirements for risk management and methodologies of risk assessment in FBiH. Similarly, dialogues with the EU as well as with neighboring countries are suggested for the adoption of a risk-based approach in the management of contaminated sites considering the approximation of the Environmental Liability Directive (2004/35/EC) and other EU acquis.

Table 8.5-4 shows the recommended activities related to the development of a remediation plan.

Table 8.5-4 Suggested Activities to Improve Development of Remediation Plan in FBiH

Category		Remarks
Objective		- To develop a prototype remediation plan.
Responsible Organization		- FMoET, environmental consultants, and hazardous waste management companies
Period		- 2015-2018
Methodology		- Development of standard format of a remediation plan. - Discussion on criteria for setting remediation goals and evaluating remediation plans. - Development of prototype remediation plans for selected sectors. - Discussions among relevant experts on risk-based approach to management of contaminated sites
Items to be Considered	Development of a Standard Format of Remediation Plan	- Through the pilot projects, develop a standard format of a remediation plan, such as the standard table of contents, and key items to be described in a remediation plan on some details. These include site background, site conditions, scope of remediation work, goals of remediation, alternatives, evaluation of alternatives, preferred option, monitoring plan, contingency plan in the event of an accident, and public participation/information disclosure. - The contents of a remediation plan should be consistent with the existing regulatory requirements of environmental permitting and EIA.
	Discussion on the Criteria for Setting Remediation Goals and Evaluating Remediation Plans	- During the course of the pilot projects, all regulatory requirements related to the site and remediation (e.g., environmental, land use, water use, and waste management) should be clarified. Then, develop the remediation goal for each pilot project after discussing the requirements with relevant authorities. - Develop different alternatives to achieve the goal, discuss issues associated with each alternative. Then, based on experiences gained, determine what aspects of remediation measures should be used to evaluate a remediation plan. The criteria given in Table 8.5-1 are examples. In addition, the criteria for qualification of remediation design professional, quality assurance requirements, and requirements for inspection for the completion of measure, should be considered.

Category		Remarks
	Development of a Prototype Remediation Plans for Selected Sectors	- For some sectors for which many remediation projects are expected, a prototype remediation plan should be developed. The results of the Analysis of General Status of Contaminated Sites in FBiH to be implemented within the draft master plan will provide some insight in selecting the sector for which a prototype remediation plan is desired. - The prototype remediation plan should include a monitoring plan and a risk communication/public involvement plan. - Waste dumping sites where mixed waste including hazardous wastes had been dumped are an example of such sector. Gas stations, metal mining, metal plating, and dry cleaning shops, are also of interest.
	Discussions among Relevant Experts on Risk-based Approach to Management of Contaminated Sites	- FMoET, Federal Ministry of Health, and other organizations should discuss the current regulatory requirements for management of environmental risks and possible adoption of risk assessment methodologies for evaluation and prioritization of contaminated sites. - Similarly, a series of dialogue with EU and neighboring countries are suggested to discuss introduction of risk-based approach for the management of contaminated sites to harmonize the policy of FBiH with EU acquis.
Reference and Source of Information		- USEPA, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, 1999. - Environmental Agency (England and Wales), Remediation Target Methodologies, Hydrogeological Risk Assessment for Land Contamination, 2006. - CARACAS, Risk Assessment for Contaminated Sites in Europe Volume 1 Scientific Basis, 1998. - Ferguson, C.C., Assessing Risks from Contaminated Sites: Policy and Practice in 16 European Countries, Land Contamination and Reclamation, 7 (2), 1999. - USEPA, Risk Assessment Guidance for Superfund, Volume I Human Health Evaluation Manual, 1989. - USEPA, Data Quality Objectives Process for Hazardous Waste Site Investigations, EPA QA/G-4HW, 2000 - UNDP, National Risk Assessment of Bosnia and Herzegovina Regarding Natural or Other Disasters, 2011 - Environmental Agency (England and Wales), Human Health Toxicological Assessment of Contaminants in Soil, 2009. - UNIDO, Survey of Soil Remediation Technology - USEPA, Guidance for Monitoring at Hazardous Waste Sites: Framework for Monitoring Plan Development and Implementation, 2004.

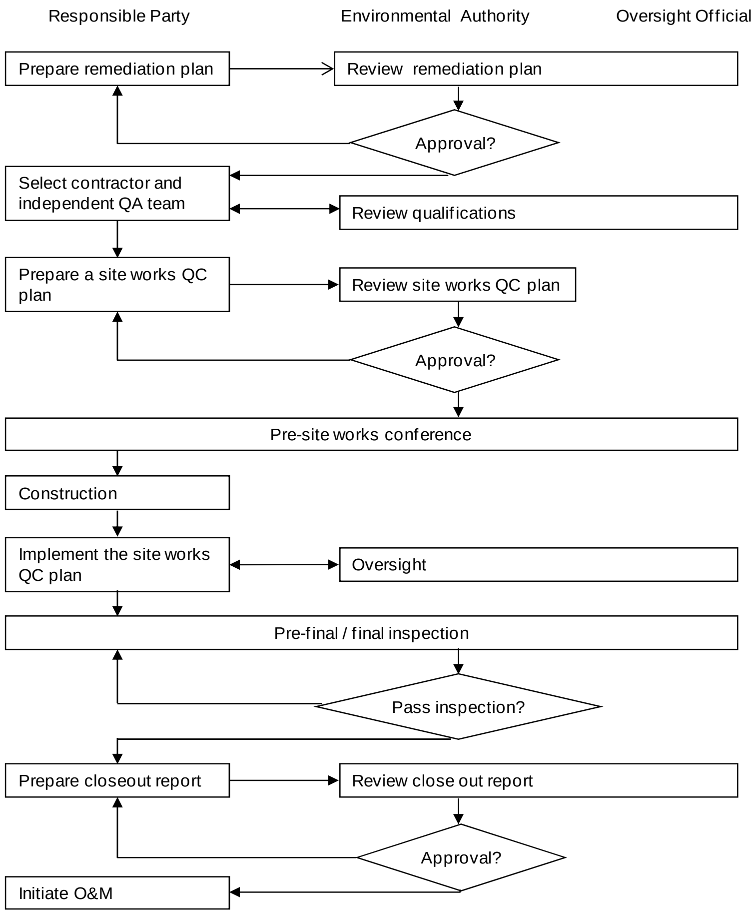
Source: JET

8.6 Implementation of Remediation Plan

8.6.1 Process of Implementation of Remediation Plan

(1) Overall Flow of Remediation Plan Implementation

Figure 8.6-1 shows the typical process for implementation of a remediation plan by a private party responsible for remediation (e.g., company responsible for pollution or site owner) and its supervision by the environmental authority. This diagram was originally developed by USEPA to support environmental officials in supervising the implementation of a remediation plan by a private party under the Superfund program. The process of implementation is very similar to any construction project. However, remediation involves a large amount of hazardous materials, and quality control of the work is crucial.

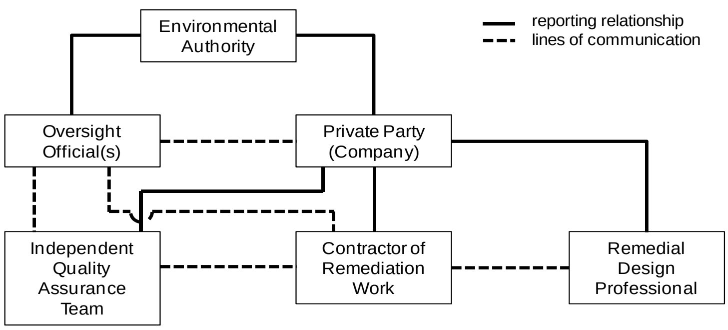


Source: JET based on USEPA, Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, Interim Final, 1990.

Figure 8.6-1 Oversight Process of Implementation of Remediation Plan

(2) Quality Control of Remediation of Contaminated Sites

In order to ensure the quality of remediation work, it is essential that all people involved in remediation are qualified for the work. Furthermore, it is better to appoint independent expert(s) (or a team of independent quality assurance team) in charge of quality control (QC) in addition to the official overseeing the operation (e.g., environmental inspector), as shown in Figure 8.6-3.



Source: Modified by JET based on USEPA, Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, Interim Final, 1990.

Figure 8.6-2 Example of Organizational Setup for Implementation of Remediation Plan

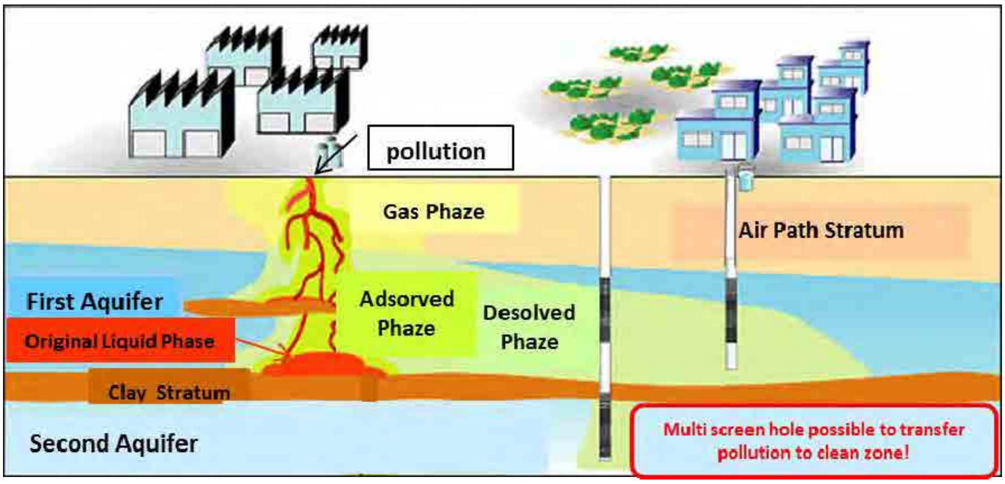
Also, it is important to develop a QC plan for site works in order to control different aspects of remediation works. This is usually developed by remedial design professionals so that the plan is consistent with the remediation plan, but alternatively, by the contractor who is familiar with the actual site works involved. The monitoring plan discussed in the previous section becomes an important part of the QC plan. The QC plan should cover, among other items, the following:

- Organizational setup, lines of authority, name, qualifications, duties and responsibilities of each person;
- Methods of performing the quality control inspections and auditing;
- Control testing procedures for each test, including required certificate or license, equipment and standards; and
- Reporting procedures.

Ensuring the analytical quality of the laboratory is one of the important requirements of QC because the attainment of concentration-based goal, separation of contaminated soil from non-contaminated soil, etc., are all dependent on the analytical results from the laboratory. Currently environmental analysis for water, soil and air is controlled under different regulatory systems, and there are different certifications. These requirements should be somehow unified and only those laboratories that have demonstrated competency should be allowed to analyze environmental samples. Also, it is important to check the site access, movement/safe transport/disposal of contaminated wastes, conditions of temporary facilities (e.g., stockpile), stormwater, and safety measures for workers and local residents.

(3) Risk of Secondary Contamination

Sometimes soil contamination investigation and remediation actions cause secondary contamination. Figure 8.6-3 shows an example of secondary contamination. This figure indicates that it is dangerous to perform boring works without knowing the number of aquifers or setting multiscreen boreholes which tend to connect a polluted aquifer with a clean phase. Secondary contamination also occurs when contaminated waste by improper control on site, illegal dumping offsite by a waste managing company, or by accident. Various measures should be taken to prevent secondary contamination.



Source: JET

Figure 8.6-3 Example of Secondary Contamination

8.6.2 Approaches to Improve Implementation of Remediation Plan in FBiH

(1) Present Situation in FBiH

There are evidences showing remediation was done successfully by concerted efforts of many specialists. Among the examples are:

- Hazardous substances abandoned in a mining facility in Vares in 2010 were removed under the direction of FMoET.

- Dangerous organic chemicals left from a large organic chemical factory in Tuzla have been disposed using special technology imported from a European country. For this difficult task, a team of experts explored a number of different technical options for disposal.
- Some waste disposal sites have been rehabilitated under the Solid Waste Management Program Project I and II funded by the World Bank.

Also, there are nine firms in FBiH specializing in the management of hazardous wastes. Moreover, many environmental officers, including environmental inspectors and officers of the Environmental Protection Fund of FBiH, have good understanding about environmental issues at some contaminated sites, which is a sign that various efforts have been made to remediate such sites.

On the other hand, most of the activities carried out so far, especially those for the management of industrial sites contaminated with hazardous wastes, are of small-scale to contain immediate problems. To embark on large-scale remediation projects, it seems FBiH still lacks the capacity to control activities and minimize secondary pollution.

(2) Proposed Activities to Improve Implementation of Remediation Plans in FBiH

A proper planning is paramount for proper implementation of a remediation plan. Thus, for this component, development of a prototype QC plan is suggested. The QC plan will help not only the contractor, but also the overseeing official (e.g., inspector) and environmental authority. It will also help minimize secondary pollution. The suggested activities are summarized in Table 8.6-1.

Table 8.6-1 Suggested Activities to Improve Implementation of Remediation Plan in FBiH

Category		Remarks
Objective		- To develop a prototype QC plan to assist proper implementation of a remediation plan.
Responsible Organization		- A team of experts lead by FMoET, - Cantons, inspectorate
Period		- 2015-2018
Methodology		- To develop a prototype QC plan to make sure that a remediation work is implemented according to the plan and the remediation goal is achieved.
Items to be Considered	Development of a Prototype QC Plan	- Through the pilot projects that will be implemented as part of the draft master plan, develop a QC plan, follow the QC plan during the implementation, revise the QC plan, and develop a prototype QC plan that can be used in various remediation projects. The proposed process is as follows: - Clarify the remediation goal as well as other requirements that could affect the successful implementation of the remediation (e.g., proper separation of contaminated waste from non-contaminated waste, prevention of secondary pollution, proper public consultation and timely information disclosure, appropriate decision about the termination of remediation, time management, and reporting); - Considering the requirements, develop a QC plan to be followed; - Propose and organize a small team of experts as the QC team; - Implement the QC procedures during the course of the pilot project; - At the end of the pilot project, review the appropriateness of the QC plan and improve the plan; and - Finalize the prototype QC plan.
Reference and Source of Information		- USEPA, Guidance on EPA Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, Interim Final, 1990. - Environmental Agency of England and Wales, Verification of Remediation of Land Contamination, 2010.

Source: JET

8.7 Monitoring and Follow-up

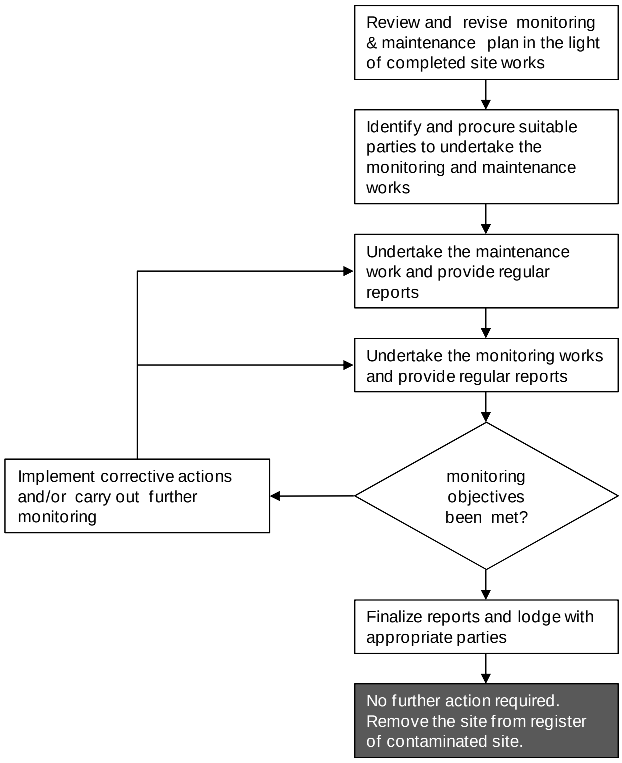
As discussed in the previous section, monitoring has to be performed even during the on-going remediation stage confirming achievement of target level and to get approval on the completion of the remediation works in accordance with the QC plan. Once this stage is done, the post-site works monitoring and follow-up will commence, which is the focus of this section.

8.7.1 Typical Process of Monitoring and Follow-up

The main purposes of the post-site works monitoring and follow-up are as follows:

- To monitor the effectiveness of remediation;
- To maintain remediation to ensure continued performance and effectiveness in accordance with the original design;
- To take corrective actions, if necessary; and
- To decide whether no further action is required and deregister the site from the registry of contaminated sites.

Figure 8.7-1 shows the typical procedures of post-site works monitoring and follow-up based on the model procedures in the UK. Following the completion of site works, the monitoring and maintenance plan is revised reflecting any modifications made on the original remediation plan and expected performance of the completed site works. Then, based on the plan, maintenance works should be performed to ensure proper operation and performance of site works, namely, the attainment of the remediation target (e.g., attainment of the environmental standard or risk-based goal). The performance is monitored through the monitoring works, which have to be continued for a long term. If any problems are detected, corrective actions should be taken. After the proper performance of the remediation measure is demonstrated based on long-term monitoring, the authority issues a certificate of completion of remediation, and deregisters the site from the registry of contaminated sites.



Source: Environmental Agency of England and Wales, Model Procedures for the Management of Land Contamination, 2004

Figure 8.7-1 Process of Post-Site Works Monitoring and Maintenance

Parties responsible for remediation naturally prefer that monitoring and verification be finished immediately after the completion of site works because monitoring requires cost, and they do not want a monitoring timescale that is open-ended or unclear remediation endpoints to limit future use of the site. Thus, the timeframe for monitoring and verification should be set and agreed in the early stage of remediation, and clearly stated in the monitoring plan (verification plan). Some measures, such as removal of contaminated soil off the site may not require monitoring, and a verification report may be issued once the site works are completed and removal of the soil is demonstrated. On the other hand, some technologies, such as monitored natural-attenuation and pump-and-treat, need long-term monitoring.

Another important aspect of monitoring and follow-up is the implementation of corrective measures in case the performance of the implemented measure does not meet expectation. Again, how to deal with the situation should be agreed and stated in the monitoring plan.

The monitoring program of the party responsible for remediation may be supplemented by a regular monitoring program of public institutions, such as testing of drinking water by the public health authority and environmental monitoring of air and water by the environmental authority.

8.7.2 Approaches to Improve Monitoring and Follow-up in FBiH

(1) Present Situation in FBiH

Monitoring of an environmental measure is usually included in the system of environmental permitting. Also, FBiH has a monitoring system for the transport and disposal of hazardous substances. Thus, the concept of monitoring and follow-up or verification of performance is not new in FBiH. Nevertheless, FBiH does not have much experience in large-scale remediation of sites contaminated with hazardous substances, and full-fledged monitoring of a remediation project is probably new.

(2) Suggested Activities to Improve Monitoring and Follow-up in FBiH

Similar to the suggested activities for improving development of remediation plan and implementation of remediation plans, development of a prototype monitoring and maintenance plan through the pilot projects is recommended. Table 8.7-1 shows the proposed activities for improving monitoring and follow-up in the post-site works stage of remediation.

Table 8.7-1 Suggested Activities to Improve Monitoring and Follow-up in FBiH

Category		Remarks
Objective		- To develop a prototype monitoring and maintenance plan.
Responsible Organization		- A team of experts led by FMoET
Period		- 2015-2018
Methodology		- Development of a prototype monitoring and maintenance (M&M) plan that describes the plan of verification, timeframe, required maintenance activities, required monitoring activities, reporting, and corrective actions to be taken if the result deviated from the expected behavior.
Items to be Considered	Development of a Prototype Monitoring and Maintenance Plan	- In the post-site works stage of the pilot project, an M&M plan is developed, followed, and based on experiences, develop a prototype monitoring and maintenance plan. The procedures are as follows: - The monitoring plan developed during the development of remediation plan is reviewed and revised in light of the completed site works as the M&M plan. In particular, how to verify the remediation and decide the completion of remediation and when/how to take corrective measures are the main focus of the M&M plan; - The maintenance and monitoring activities are implemented in accordance with the M&M plan; and - The results of the maintenance and monitoring activities are reviewed, and the M&M plan is revised as the prototype M&M plan.
Reference and Source of Information		- Environmental Agency of England and Wales, Model Procedures for the Management of Land Contamination, 2004. - Environmental Agency of England and Wales, Verification of Remediation of Land Contamination, 2010. - USEPA, Guidance for Monitoring at Hazardous Waste Sites: Framework for Monitoring Plan Development and Implementation, 2004. - Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills/British Colombia, Canada - Environmental Monitoring Report Guidelines/South Florida, USA - Standard Guidelines for the Environmental Monitoring of Chemicals/ ME, Japan

Source: JET

CHAPTER 9 DRAFT MASTER PLAN: PART IV – REMEDIATION OF PRIORITY SITES

9.1 Introduction

In Chapter 6, a Federation-wide survey of environmental hotspots was proposed. The results of the survey would probably reveal some seriously contaminated sites whose remediation is considered a priority. Also, in some sites, urgent measures are needed to contain immediate risks. Remediation of these sites has to be implemented as soon as possible. For safe and efficient remediation of seriously contaminated sites, environmental officials, consultants and other stakeholders need to obtain more practical experience. Hence, implementation of pilot projects is recommended. The experiences gained through the pilot activities will also help FMoET and other authorities to develop a realistic regulatory framework and technical guidelines. To satisfy these needs, the following activities are proposed in this chapter:

- Urgent measures
- Pilot projects
- Remediation of priority sites
- Development of strategies for other sites

9.2 Urgent Measures for Priority Sites

9.2.1 Introduction

Based on the results of the Federation-wide survey mentioned in Chapter 6 or the preliminary investigation discussed in Chapter 8, an urgent measure shall be taken if the site is endangering the health of local people. Though full remediation of priority sites will follow soon after, there are things that one can do to reduce the immediate risks, and the delay could only aggravate the already serious situation.

(1) Examples of the Urgent Measures

The basic concept of the urgent measure is the same as the ones for the remediation measures mentioned in Chapter 8. It is important to cut the direct pollution route to human beings. For example, in case groundwater contamination would be found, the use of well water around the target sites should be stopped. In addition, immediacy and assuredness of effect, easiness of installment, and availability, etc. will be the key factors to select the adequate measure. An easy and simple way is more useful to be applied urgently.

(2) Responsibility and Governmental Intervention

In accordance with the polluter-pays-principle, and hence in accordance with the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/09 and 38/09) and the Law on Waste Management (Official Gazette of FBiH, Nos. 33/03 and 72/09), the polluter or the holder of waste has the primary responsibility to take measure. In many sites, however, the polluter or the holder of waste does not take appropriate action in a timely manner, is simply not capable of taking action, or is nowhere to be found. In such cases, the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/09 and 38/09) stipulates that FMoET and the cantonal ministry are also responsible to prevent environmental damage and eliminate hazards. Also, the cantonal ministry has the administrative competency to monitor and organize activities to prevent and minimize adverse environmental consequences according to the law.

However, governmental intervention is not simple because the site owner has the primary responsibility in the first place, public funding is limited, and there is no strong driving force to push the government to take initiative. In this regard, it is of interest to note that in some countries, most notably in the US with its Superfund Program, the government has an active duty to take actions to control problems and remediate sites if necessary. The Superfund Program has suffered from the difficulty of cost recovery and problems with environmental litigation. These problems should be noted. In Japan and European countries, the approaches are generally more moderate, and are the combination of the polluter-pays-principle with governmental support.

It seems that government intervention against soil contamination or hazardous waste management in FBiH has not been clearly institutionalized as compared with emergency measures on other environmental issues (e.g., air pollution, industrial accident). FBiH has to develop a practical strategy for governmental intervention on the most pressing issues without compromising the principles of environmental management and the liability framework.

9.2.2 Suggested Activities

(1) Necessity of Urgent Measures

The necessity of implementation of urgent measures for priority sites shall be evaluated as soon as possible even before the detailed investigation in order to prevent further damage due to delay in implementing such measures. The decision on urgent measures will be made basically based on the data or information gathered from the investigation in the Federation-wide survey. Though it is difficult to define the specific criteria for implementation of urgent measures, it needs to be considered reasonably depending on the level of risk and urgency.

(2) Planning and Implementation of Urgent Measures

In principle, the measure shall be done by the polluter or the site owner. However, to facilitate the initiative of the responsible party or to allow governmental intervention in case the responsible party is not capable of carrying out the necessary measure, it is suggested that some part of the Environmental Protection Fund of FBiH is earmarked for emergency measures and used to contain immediate and most serious risks or to implement a quick investigation of the situation of high priority sites.

Table 9.2-1 Suggested Activities of Urgent Measures for Priority Sites in FBiH

Category		Remarks
Objectives		The main objectives of urgent measure for priority sites are to: - Reduce extremely high risk of damage to human health by priority sites. - Acquire experience on urgent measures so as to reflect lessons in developing technical guidelines.
Responsible organization	Investigator/ Implementer	Polluter takes emergency countermeasures under the instruction of the environmental section of the canton and inspector, or municipality. In case the polluter is unknown, the canton takes responsibility with the cooperation of inspector.
	Regulator	Environmental section of the canton and inspectors requesting assistance from FBiH, if necessary, and FMoET is in charge with support from the Environmental Protection Fund of FBiH.
Period		2014-2016
Methodology		- Select the urgent measures based on data and information acquired by the Federation-wide survey or other investigations. Additional and urgent monitoring shall be implemented in advance, if needed. - Implement the urgent measures and confirm their effects. - Cooperate and share information with relevant authorities and residents who might be a receptor of risk. - Administrative direction to the polluter or land owner.
Items to be implemented	Measures at the pollution source	- Prohibition of someone to enter the restricted area and placement of fences, warning plates, etc. - Covering of contaminated site with appropriate materials (ceiling, plastic sheet etc.), if the contaminated area is open-air. - Paving or earth filling of contaminated site to prevent the dispersion of contaminated soil. - Safety measures for workers at/near the contaminated site (mask, glove, safety glasses, etc.).

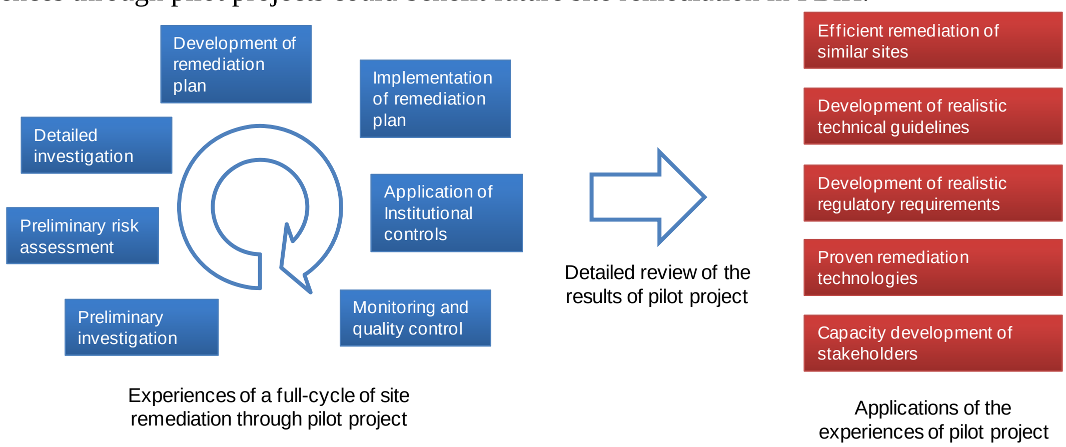
Category		Remarks
	Against exposure to surface water	- Stop of water intake if downstream water use is confirmed. - Setting of culvert or settling pond if polluted water discharges in to the public water area.
	Against exposure to groundwater	- Prohibition of drinking of groundwater if the well used is around the target site. - Supply of alternative water source (water tank truck, etc.).
	Against exposure to plant/livestock/fish	- Checking of contamination of agricultural crops, livestock food, fish, etc. - Stopping of shipment of food products.
	Physical hazard such as sediment discharge, landslide, etc.	- Evacuation of residents. - Sandbagging or strengthening work, etc.
	Communication with related authorities and residents	- Warning to residents. - Warning or administrative measure against the polluter or site owner. - Communication with related authorities about emergency issues.
	Monitoring	- Checking of contamination. - Checking of human health.

Source: JET

9.3 Pilot Projects

9.3.1 Introduction

Although the Project provided valuable opportunities to examine various practical issues important for remediation of contaminated sites, remediation of contaminated sites is a relatively new field in FBiH, and environmental policy makers, officers, and specialists need more opportunities to learn the technical, institutional, and organizational aspects of site remediation. This is efficiently achieved through participation in pilot project activities. The practical experiences gained through pilot projects could be used to develop legal and institutional frameworks for management of contaminated sites, to mobilize technical and financial resources, to design effective remediation measures, and to implement measures without causing unwanted confusions and conflicts of interest. Figure 9.3-1 summarizes how experiences through pilot projects could benefit future site remediation in FBiH.



Source: JET

Figure 9.3-1 Organizational Structure of the Project

9.3.2 Suggested Activities

Table 9.3-1 gives a summary of the suggested framework of the pilot projects. The main objective of the pilot projects is to gain experience in a relatively short time and within limited budget. Thus, several representatives, small- to medium-scale sites of different types, i.e., chemical factory and mining site, should be selected. As for the funding source, it is assumed that the Environmental Protection Fund ofFBiH or governmental fund is used for the implementation of the pilot projects.

Table 9.3-1 Suggested Activities of the Pilot Projects

Category		Remarks
Objective		The main objective of the pilot projects is to: - Gain experience on implementing the entire course of site remediation, starting from preliminary investigation to final remediation at several representative sites.
Responsible Organization		FMoET or canton will organize a team of consultants. Environmental officials, environmental lawyers, and others will participate as active members or as observers.
Period		2015-2018
Methodology		The following steps are envisaged: - Selection of pilot project sites based on the results of the Federation-wide survey and analysis of general status of contaminated sites in FBiH, to be implemented as part of the master plan. It is proposed to select the following types of contaminated sites: a chemical factory site, a mining site, a former dumping site, and one more site of interest. - Implementation of preliminary investigation, detailed investigation, risk assessment, development of remediation measures, and implementation of measures.
Items to be Implemented	Preliminary Survey	Implement a preliminary survey, and identify the requirements at the stage of the preliminary survey: - Issues of identifying site history, liabilities, land ownership, etc. - Sampling design to detect contamination with minimal cost. - Rapid identification of receptors and environmental risks. - Possible implementation of emergency measures and institutional controls to minimize risks.
	Detailed Survey	Implement a detailed survey, and identify the requirements at the stage of detailed survey: - Sampling design to accurately estimate the volume of contaminated soil and water. - Other requirements to design remediation measures. - Information needed for risk assessment.
	Design of Remediation Measures	Design remediation measures, and identify the requirements at the stage of remediation measures: - Setting the remediation target including the case that full remediation is not feasible. - Related issues, such as future land use, impact on local economy, compensation to victims, etc. - Technical options available in FBiH. - Possible special arrangements with waste disposal site in FBiH and use of hazardous waste disposal sites abroad. - Possibility of inviting international experts/companies to demonstrate technologies within the pilot projects. - Funding for remediation.
	Implementation of Remediation Measures	Implement the remediation measures, and identify the requirements at the stage of remediation: - Effectiveness of various technical options. - Coordination among relevant organizations for implementation. - Risk communication and institutional controls. - Control of accidental spreading of hazardous substances. - Mobilization of resources.
	Monitoring	Monitor the results of the remediation, and identify the requirements at the stage of post-remediation: - Frequencies, parameters, and other technical aspects of monitoring. - Administrative procedures to complete the remediation and close the liability issues.
	Other	- In all the steps of the activities, there should be opportunities for environmental officers and other specialists to participate in the pilot projects .

Source: JET

9.4 Remediation of Priority Sites

9.4.1 Introduction

Because information on contaminated sites in FBiH is scarce, it is not possible to identify the priority sites right now. Nevertheless, it is highly conceivable that some sites in FBiH should be remediated soon without waiting for the development of regulatory frameworks. Thus, as soon as the results of the preliminary survey and analysis of general status of contaminated sites are completed, and key environmental officers gain practical experience through the pilot projects, it is suggested to begin remediation of priority sites.

9.4.2 Suggested Activities

The priority sites are to be identified as part of the activity of analysis of general status of contaminated sites in FBiH. Table 9.4-1 summarizes the suggested activities, but because the priority sites are yet to be identified, it is not possible to design the activities. It was noted that remediation of some sites have already been proposed under other initiatives. For example, some illegal landfills may be remediated and closed based on the activity proposed in the Federal Waste Management Plan 2012-2017 (Remediate and close landfills, 2017, municipalities, BAM 250,000). Hence, coordination with such initiatives is important.

Table 9.4-1 Suggested Activities for Remediation of Priority Sites

Category		Remarks
Objective		- The main objective is to remediate the priority sites.
Responsible Organization		Site owner. However, considering the acute environmental risks at the priority sites, public intervention by FMoET, canton, municipality, and possibly other public organizations should be considered. Actual remediation work is contracted out to a team of consultants specializing in environmental survey and site remediation/disposal of hazardous substances.
Period		2016-2020
Methodology		The standard processes for site remediation as discussed in Chapter 7 are as follows: - Preliminary investigation - Evaluation of contamination - Detailed investigation - Risk assessment - Development of remediation plan - Implementation of remediation plan - Monitoring and follow up
Items to be Implemented	Preliminary Survey	- Funding is the major issue.
	Other	- Some of the sites may be remediated under different initiatives. For example, some illegal landfills may be remediated and closed based on the activities proposed in the Federal Waste Management Plan 2012-2017 (Remediate and close landfills, 2017, municipalities, BAM 250,000).

Source: JET

9.5 Development of Plans for Remediation of Other Sites

9.5.1 Introduction

Under this activity, plans for remediation of other sites are developed based on experiences gained through implementation of urgent measures, the pilot activities, remediation of priority sites, among others. In principle, the plan should be developed for each site by the party responsible for site remediation. Nevertheless, there are rules applicable to different types of remediation, and it is important that remediation activities are coordinated. Among the possible approaches are the following:

- A large number of sites in FBiH are expected to be former waste disposal sites. Because many of such sites are probably publicly owned, remediation should be implemented in a systematic manner within the same program based on the Federal Waste Management Plan 2012-2017.
- Industrial sites are usually privately owned. Because the approaches could be different from sector to sector, and from site to site, it is probably difficult to deal with them under the same framework. Nevertheless, some sites, such as gas stations or dry-cleaning shops, may be remediated collectively or at least in a coordinated manner.
- Some derelict sites in an urban or semi-urban setting may have the potential to be redeveloped into an industrial complex or a commercial complex, and contamination issues can be addressed within a larger framework of redevelopment.
- With respect to mining, some technical guidances by the Federal Ministry of Energy, Industry and Mining may be good.

9.5.2 Suggested Activities

Table 9.5-1 gives a summary of the suggested activities for development of plans for remediation of other sites.

Table 9.5-1 Suggested Activities for Development of Plans for Remediation of Other Sites

Category		Remarks
Objective		The main objective of the activity of development of plans for remediation of other sites is to: - Develop site specific remediation plans for major contaminated sites that are not remediated as priority sites.
Responsible Organization		Site owners for private sites, and FMoET, cantons, or municipalities for public sites. It is suggested that for a large site, a committee consisting of the site owner, environmental inspector, and environmental/water/health officers of appropriate level is organized to discuss relevant issues and to develop a plan.
Period		2016-2020
Methodology		Discuss at least the following issues: - Situation of pollution of soil, groundwater, surface water, and air - Liability - Important stakeholders, and victims - Future land use - Approach to remediation - Regulatory processes - Others
Activities to be Implemented	Former waste disposal sites	- Probably a large number of sites in FBiH are former waste disposal sites. For this type of site, it is good if FMoET issues a general guideline and sites are remediated under a common program because the issues of former waste disposal sites, such as liability, pollution, and measures, are similar. Funding authorized by the Federal Waste Management Plan 2012-2017 may be available.
	Industrial site	- Many industrial sites are privately owned. Thus communication with the site owner is essential. Remediation may be included in the condition for environmental permit.
	Brownfield redevelopment	- Some sites in urban area or urban fringe might have a potential to be redeveloped as a commercial or industrial complex. Such investment may be worth implementing to minimize encroachment in greenfield land and to revitalize local economy. The cantonal ministry for physical planning should examine such possibility.
	Gas stations/ storage of petroleum oil	- For gas stations, it may be possible to work with the sector because the issues (e.g., oil pollution of soil and groundwater due to leaky storage tanks) and solutions are similar, and also many gas stations are under the same management structure.
	Dry cleaning	- If many cases of site contamination with chlorinated solvent used in dry cleaning are found, it is suggested that the entire sector is consulted with.
	Mining	- For the mining sector, it is suggested that the Federal Ministry for Energy, Industry and Mining works closely with FMoET, and provide general guidance to mining companies as well as local environmental authorities.
	Other	- There are other types of contaminated sites, such as military sites, chemical storage, etc.

Source: JET

CHAPTER 10 DRAFT MASTER PLAN: PART V – CAPACITY DEVELOPEMNT

10.1 Introduction

This chapter presents proposed capacity development programs for environmental officers and other stakeholders in order to ensure successful implementation of activities proposed in the draft master plan. The number of contaminated sites in FBiH is still limited compared with those in some European countries, the US, or Japan. Nevertheless, issues on contaminated sites should be treated seriously because many contaminated sites are privately owned, and because the site remediation cost is often formidably expensive for site owners, the problem over liability often escalates to environmental litigation. Also, remediation of contaminated site requires many specialists with different expertise, such as environmental engineers, civil engineers, analytical chemists, public health experts, toxicologists, lawyers and legal experts, social scientists, etc. Having a team of such experts is not possible for most environmental authorities in FBiH because environmental management in FBiH is highly fragmented and most officers are expected to carry out multiple tasks as a generalist. Considering these situations, the best approach is probably to build capacities of a limited number of specialists, who may become the core members for site remediation in FBiH. Then, other members receive much broader training necessary to work with site owners as well as specialists. Awareness building of owners of contaminated sites, investors and developers, local residents, and other stakeholders are another important area of capacity development.

10.2 Capacity Development of Environmental Officers

10.2.1 Introduction

In FBiH, environmental authorities are familiar with environmental impact studies (EIS) for economic activities, which typically include reviews of environmental conditions, site survey, assessment of environmental impact, development of mitigating measures and environmental management plan, and monitoring plan. Nevertheless, many aspects of site remediation are quite different from a typical environmental impact assessment (EIA) and subsequent pollution prevention and control. At a contaminated site, pollution has already occurred, and it has to be contained quickly. Any delay or inaction could make the situation even worse. Thus, special training of environmental officers is needed. Some of the responsibilities that environmental officers have to assume include the following:

- Identify sites that might be potentially contaminated;
- Oversee thorough investigation of the site;
- Evaluate environmental and health risks;
- Direct emergency measures and implement institutional controls;
- Ensure proper risk communication and support victims;
- Identify responsibilities of different parties;
- Authorize remediation plan proposed by the polluter/operator;
- Oversee implementation of remediation works and subsequent monitoring;
- Decide whether the remediation is complete and the site is safe; and
- Develop necessary technical, legal, and administrative frameworks to implement such tasks.

Similarly, raising the awareness of owners of contaminated sites, owners of businesses that handle hazardous substances, land owners, investors and developers, local residents, and other stakeholders, is essential because these parties could become liable for site contamination, or victims of contamination.

10.2.2 Proposed Activities for Capacity Development of Environmental Officers

Table 10.2-1 gives a summary of suggested capacity development activities for environmental officers. The pilot projects proposed as part of site-level activities (Chapter 7) will provide good opportunities for the officers to learn from real remediation activities. Meanwhile, other opportunities should be created in the process of developing the regulatory framework (Chapter 7).

Table 10.2-1 Suggested Activities of Capacity Development of Environmental Officers

Category		Remarks
Objective		The main objective of capacity development of environmental officers is to: - Build the capacity of environmental officers who are responsible for managing such sites on the ground and for developing relevant regulatory frameworks.
Responsible Organization		- FMoET and cantons - Civil Service Agency of FBiH - Academic institutions
Period		2015-2020
Methodology		At least two types of programs should be developed considering the needs of different groups of environmental officers, as follows: - General program: This is for a wide range of environmental officers to become familiar with different stages of site remediation, such as site investigation, risk assessment, development of remediation plan, implementation and monitoring. This program may be implemented within the pilot projects proposed in Chapter 7. - Specific program: Different programs tailored for specific needs of policy makers, permit issuers, environmental inspectors, and others. These should be given as parts of the proposed activities of development of regu;atory frameworks in Chapter 7.
Items to be Implemented	General Program	The targets include policy makers in FMoET and MoFTER, permit issuers (environment, water, mining, land, etc.) in FMoET and cantons, inspectors (environment, water, mining, etc.) at the Federal and cantonal levels, public health officers, and others. Officers are to participate in the pilot projects, and learn, among others, the following issues: - Site history review: adequacy of relevant information, such as land registry, relevant permitting, environmental and public health records, manufacturing processes, chronic and accidental pollution, liability issues, etc. - Preliminary and site investigation: how to identify source/pathway/receptor, how to develop a conceptual model for pollution, how to design a sampling plan, and how to implement the sampling. - Risk assessment and evaluation: exposures through different pathways, evaluation of contamination level, and need for regulatory control. - Development and implementation of remediation measures: setting of remediation targets, design of remediation measures to minimize environmental risks, different technical options, implementation of measures, implementation of various institutional controls, monitoring of progress, etc. - Environmental liability and legal responsibilities of public officers: legal responsibilities of different parties involved in remediation work, in particular responsibilities of public officers. This course may be offered by civil services of FBiH as a standard course for civil servants in the field of environment.

	Specific Program	- This program is designed considering the specific needs of different officials. Examples of selected issues to be covered in the program include the following:
		  - Policy makers: general policy frameworks for management of contaminated sites in other countries, definition of contaminated sites, liability issues, registration and management of contaminated sites, social and environmental impacts.
		  - Permit issuers: pathways and exposures for different receptors, site investigation methodologies, setting remediation target, remediation technologies, cost for remediation, monitoring of progress, different types of institutional controls, and liability issues.
		  - Inspectors: environmental and health risks, pathways and exposures for different receptors, site investigation methodologies, remediation technologies, emergency measures, liability issues, institutional controls.

Source: JET

In addition to these programs, environmental authorities in FBiH are urged to work closely with academic institutions, such as universities and specialized institutions. Environmental authorities could seek specialized technical and other advices from academic communities, and involve them in remediation activities. Academic communities should offer specialized courses at the graduate school-level in areas related to remediation of hotspots, such as fate and transport of pollutants in the environment, remediation technologies, and environmental laws.

10.3 Raising Awareness of Stakeholders

10.3.1 Introduction

Issues on contaminated sites can be quite controversial because they can be related to health risks, liability of property owners, and land value in and around the site. Hence, it is very important that owners of contaminated sites, business owners, land owners, investors and developers, local residents, and other stakeholders properly understand the issues on and procedures of management of contaminated sites.

10.3.2 Proposed Activities for Raising Awareness of Stakeholders

Table 10.3-1 gives a summary of the proposed activities for raising awareness of such stakeholders. Four programs are suggested for (i) owners of contaminated sites, (ii) business owners, (iii) investors, developers, privatization/concession specialists, and (iv) general land owners and the general public.

Table 10.3-1 Suggested Activities for Development of Technical Guidelines on Pilot Projects

Category		Remarks
Objective		The main objective of raising awareness of stakeholder is to: - Raise awareness of different stakeholders, such as owners of contaminated sites, business owners, land owners, investors and developers, local residents, and the general public.
Responsible Organization		FMoET and cantons
Period		2015-2020
Methodology		Different types of programs should be developed considering the needs of different stakeholders using different types of media to reach out to stakeholders, such as administrative guidance, guidebooks, brochures, and websites.
Items to be Implemented	Specific Programs	The targets include owners of contaminated sites, business owners, land owners, investors and developers, local residents, and other stakeholders. - Owners of contaminated sites: owners of contaminated sites need special administrative guidance with respect to liability, legal rights, regulatory requirements and institutional controls, administrative procedures, funding and other public supports, and other aspects. For many environmental officers, giving such administrative guidance is difficult. Thus, it is suggested that FMoET to prepare a document on general guidance. Also, a special consultation desk may be set up in FMoET or the Environmental Protection Fund of FBiH to support specific needs of site owners. - Business owners: for owners of potentially risk-laden businesses, such as storage and use of hazardous substances, manufacturing of chemicals, and mining of heavy metals, FMoET or other environmental authority could prepare a guidance booklet explaining general risks, liabilities, cases of actual contamination and remediation in FBiH, available expertise, financial support, among others. - Investors, developers, privatization/concession specialists: for those involved in transfer of land and business ownership, the development of guidelines regarding liabilities, handling of contamination in transaction, regulatory requirements, and financial support, is suggested. - General land owners and the general public: a website explaining general issues on contaminated sites, situation in other countries, liability of land owner, responsibility of the general public, what to do if contamination of soil and water is suspected, who to contact, among others.

Source: JET

CHAPTER 11 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

11.1 Introduction

In accordance with the JICA Guidelines for Environmental and Social Consideration (April 2004), Chapter 11 identifies potential environmental and social issues that might arise from the implementation of the draft master plan, and suggests the safeguard measures to be incorporated into the plan based on the concept of the strategic environmental assessment (SEA). This task is done based on the above mentioned JICA guidelines, and not based on the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09) or other relevant laws in FBiH, or the requirement of Protocol on Strategic Environmental Assessment (Kiev, 2003).

11.2 Necessity of SEA

(1) Requirement by JICA Guidelines

This Project is classified as Category C according to the JICA Guidelines for Environmental and Social Consideration (April 2004) because it is likely to have minimal or little adverse impacts. As the draft master plan is a kind of guiding document for policy development, and does not make any specific site-level project or activity, the concept of SEA, which is applied at the stage of policy, plan, and program, is applied to this Project rather than a project-level environmental impact assessment (EIA).

(2) Legal framework in FBiH

In FBiH, EIA including SEA is regulated by the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09). In line with Article 51 of the Law on Environmental Protection, if plans, programs, and strategies in the field of mining, industry, waste management, and others provide a framework for projects that can have adverse environmental impacts, they are obliged to develop the SEA. As a reference, the transposition score of the SEA Directive (2001/42/EC) in FBiH is reported as 5% (2011)[1] and the establishment of a bylaw and detailed regulation of FBiH to harmonize with the SEA Directive is expected in the future.

On the other hand, FBiH acceded to the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters in 2008. The Law on Environmental Protection in FBiH stipulates that every person and organization must have adequate access to environmental information including information on hazardous materials and activities in their communities and be enabled to participate in the decision-making process.

FBiH’s legislation of SEA and EU’s SEA Directive do not refer to policies. Thus, this draft master plan, as a document prior to policy making, is not regulated by the legal procedure of SEA in FBiH. Nevertheless, it is necessary for the draft master plan to take appropriate considerations for the requirements of SEA, information disclosure and public participation system, and other national and local legislations. The proposed activities in the draft master plan should follow these considerations at the appropriate stages of their implementation in the future.

11.3 Target and Objective

(1) Target of SEA

The target of SEA is the draft version of the draft master plan as of early March 2014. The target area for SEA is the whole territory of FBiH.

[1] EC IPA 2007 Programme for Bosnia and Herzegovina, Strategy for Transportation of the Legislation in BiH with the EU water acquis, 2011(http://www.fmpvs.gov.ba/texts/313_532_1029_e.pdf, confirmed on 15th March 2014)

(2) Objective of SEA

The SEA in this Project is implemented in order to integrate and promote environmental and social considerations in the development of the draft master plan. Among the goals of the SEA are as follows:

1) Reflecting the concept of sustainability to the policy decisions by incorporating environmental and social considerations into the objectives, strategies, methods, alternative plans, project component and schedule of the proposed master plan;
2) Considering cumulative and significant impacts from the early stage of the policy development;
3) Supporting assessment of environmental and social impacts of individual activities at the stage of implementation; and
4) Ensuring the transparency of the decision making process at the stage of policy and plan making.

11.4 Methodology of SEA

The draft master plan has many components for which environmental and social considerations should be taken. When a pilot remediation project is carried out in the future as a result of the draft master plan, adverse impacts of remediation works on the neighborhood and local area might arise. An unexpected revelation of a contaminated site may result in harmful rumors or a sharp decline in land prices. Also, when an institutional framework for a contaminated site will be drawn, public participation in the decision-making process shall be secured. As the draft master plan refers to neither any specific site nor project and covers various areas of activities, the SEA focuses on the identification of potential issues or adverse environmental and social impacts which might arise from the implementation of policy, program, plan, and other site-level projects derived from the draft master plan. The summarized contents of the SEA in this Project are listed below:

1) Review of environmental and social background
2) Review of legal and institutional framework
3) Review of the draft master plan
4) Scoping and identification of major environmental and social issues to be encountered resulting from the draft master plan
5) Mitigation measures
6) Stakeholder engagement plan and information disclosure system
7) Stakeholder meeting
8) Feedback on the draft master plan

This chapter describes the identified stakeholders and environmental and social issues, measures against such issues including the suggested stakeholder engagement plan, and the result of the stakeholder meeting held in March 2014. The details of the SEA are shown in Annex 6.

11.5 Stakeholders of the Draft Master Plan

Stakeholders of the draft master plan are individual persons or group of persons who may become affected by implementation of the activities proposed in the draft master plan directly or indirectly, as well as those who may have interests in the proposed activities and/or the ability to influence their outcome either positively or negatively. As one of the results of the review of the draft master plan, the stakeholders in FBiH related to the draft master plan were identified as listed in Table 11.5-1.

Table 11.5-1 List of Suggested Stakeholders

No.	Stakeholder	Key issues, interests, or roles related to the draft master plan
1	Site neighbors (tenants, dwellers, and visitors)	- Direct risks to human health - Decrease in commercial land value of adjacent land plots/properties
2	Local communities	- Environmental human health risks to the community - Dangers of living conditions - Constraints on future land use
3	General public	- Public health hazards - Cost to society
4	Local NGOs dealing with the protection of human health and the environment	- Support for citizens in their access to environmental information and proactive approach in resolving the identified issues in environmental matters
5	Media (local, regional, entity, and state levels)	- Dissemination of information to the public on the implementation of project activities - Raising public awareness
6	Academic institutions	- Scientific contributions and research
7	Site workers	- Occupational health and safety
8	Land owners (including municipalities which are owners of waste disposal land)	- Liable for remediation - Main decision maker of land reuse
9	Business owner (polluter)	- Financial implications of remediation - In charge of compliance with environmental requirements in terms of contamination and remediation management - Land reuse and land redevelopment challenges
10	Potential developers/investors	- Might have liabilities for remediation - Financial implications of assumed liability
11	Ministry of Foreign Trade and Economic Relations of BiH (MoFTER)	- Project counterpart organization and organizer of the Steering Committee for this Project - Responsible for defining the policies and main principles, coordinating the activities, and harmonizing the plans of entity bodies in accordance with international obligations in the field of environmental protection
12	Federal, cantonal, and municipal regulatory, planning, and inspection authorities (including FMoET)	- Recognize remediation and redevelopment as strategic objectives and their significance for economic development; lack of experience in institutional, financial, and technical aspects; and incentives and financing options
13	International organizations	- Support for the implementation of activities in accordance with international environmental protection standards and bringing in international experience
14	Aarhus Centres	- Facilitating access of citizens and institutions to information, providing assistance in exercising the right to participation in decision-making processes in environmental matters and support in the legal protection of human rights in the field of environment
15	Financial community (banks, founders, lenders, insures, etc.)	- Financial support for the implementation of related activities
16	Consultants, contractors, and possibly researchers	- Consulting services for the development of legal and institutional framework - Implementation of related investigation and survey which is outsourced by the responsible parties - Development of remediation plan and its implementation which is outsourced by the responsible parties

Prepared by Enova and revised by JET
Source: Enova d.o.o. Sarajevo, Final Report of "Survey for Strategic Environmental Assessment (SEA) for the Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina", 2014

11.6 Major Environmental and Social Issues

The draft master plan is composed of more than 20 activities in total under the five components as mentioned in the previous chapters. Therefore, a variety of impacts or issues which might be derived from those activities is expected. Likely environmental and social issues, both positive and negative, are identified for each component of the draft master plan. The following activities are considered to be the most important as they represent the key actions for hotspot remediation that might cause substantial impacts:

- Preliminary survey (Federation-wide survey) of contaminated sites and development of provisional site inventory and official site registry;
- A series of activities for the development of regulatory framework and technical guidelines; and
- All site investigation and remediation activities for the pilot project, priority sites, and other sites.

Table 11.6-1 lists only the major negative issues for each category of the abovementioned activities.

Table 11.6-1 Identification of Major Environmental and Social Issues

No.	Possible Negative Impact
Development of provisional site inventory and official site registry	
1	Anxiety and panic within the local communities or the general public after the revelation of a seriously contaminated site or/and environmental issue
2	Decrease in the asset value of neighboring land plots/structures
3	Serious damage to the image of the polluting company
Development of regulatory framework and development of technical guidelines	
4	The requirement of investigation and remediation is too strict for compliance.
5	The investigation cost is too expensive in compliance with the new regulation and technical guideline.
6	The remediation cost will be very expensive due to the new legal requirement that remediation will not be promoted.
7	The task of administration (related federal and cantonal government and agencies) will increase.
8	After many sites have been defined as “contaminated site”, brownfields in FBiH might increase. Economic and land development might be inhibited. Note: If the land owner cannot pay for the remediation cost and if the remediation cost is higher than the land price, the land cannot be sold and the land owner would leave the contaminated site not remediated. This issue is called as “brownfield issue”.
9	The number of litigation cases will increase.
Site investigation and remediation activities	
10	Hazardous waste will increase, while there is no place for the treatment of contaminated soil or waste in FBiH.
11	Soil and groundwater contamination during the site survey including sampling and remediation activities. e.g. The construction of a monitoring well might unexpectedly contaminate groundwater.
12	Hazardous work environment including work safety during the site survey, sampling activities, and remediation.
13	During the remediation activities, the following might occur: - Air pollution such as soil dust, exhaust gases, and asbestos fibres in the air due to earthworks, construction works, vehicle, etc.; - Surface water pollution due to suspended solids or discharged material containing potentially hazardous chemicals; - Noise and vibration due to construction works and vehicles; and - Offensive odour.
14	Natural environment (sensitive and protected flora and fauna and hydrological situation) near or downstream of a hotspot might be harmed as a result of any kind of negative impact caused by remediation activities
15	Other kinds of social problem might arise at the regional community. For example: - Land acquisition due to temporary expropriation for construction works might be necessary; - Vulnerable groups tend to be more affected by negative impacts; - Conflict of local interest about land use, etc. might arise; - Living environment of residents might be harmed as a result of any kind of negative impact mentioned above; and - Historical and cultural heritage near the target site might be damaged.

Source: JET

Since this stage is very early for impact assessment, the SEA focused on the analysis and prioritization of impacts identified during the stakeholder meeting mentioned in Section 11.9, although every expected impact should be considered carefully as a matter of course. During the stakeholder meeting held in March 2014, questionnaires were distributed to the participants in order to obtain their insights into the prioritized areas of major negative impacts. Although some of the stakeholders listed in Table 11.5-1.

were not represented during the stakeholder meeting, and the opinions of participants do not necessarily reflect the opinion of their respective organizations, the major negative impacts/interests recognized by the participants, who are mainly administrative officers of several organizations, are as follows:

- Increase in the amount of hazardous wastes from remediation processes despite that there are no facilities for treatment of contaminated soil or waste in FBiH;
- The brownfield issue (inability of landowners to pay for remediation costs and/or sell the land in case the remediation costs are higher than the price of land, thus, leaving the contaminated site not remediated); and
- High costs of site investigation (too expensive to comply with the new regulation and technical guideline).

These findings can be interpreted as that those highlighted issues are specific to the problems of contaminated sites and are not covered by the existing framework of environmental and waste management.

On the other hand, it can be said that the most significant and worst impact for all the stakeholders is the actual human health damage. From that standpoint, the site workers and neighbors would have the highest and direct risk. Also, the site owner is one of the key stakeholder as a party/person who has direct liability and financial implications for remediation. The importance of impact to these stakeholders shall be considered in the development of mitigation measures in the succeeding sections.

11.7 Mitigation Measures

With respect to the identified negative impacts, the proposed mitigation measures aim to eliminate or reduce these impacts to the greatest extent possible as indicated in Table 11.7-1. Most of the negative impacts caused by site investigation and remediation activities will be minimized by the existing framework of environmental impact assessment, which is currently adopted for all major remediation works. Therefore, the institutional and legal measures in mitigating negative impacts on site neighbors and workers shall be emphasized in this chapter. In order to sufficiently ensure these considerations, a stakeholder engagement plan needs to be prepared to have enough opportunities to reflect their opinions.

Table 11.7-1 Proposed Mitigation Measures

<table>
<tr><th>No.</th><th>Impact</th><th>Mitigation Measures</th><th>Implementing Agency</th></tr>
<tr><td colspan="4">Preliminary survey (Federation-wide survey) of contaminated sites and development of provisional site inventory and official site registry</td></tr>
<tr><td>1.</td><td>Anxiety and panic within the local communities or the general public after the revelation of seriously contaminated site or/and environmental issue</td><td rowspan="3">Public dissemination of information should be established in the early phases of the project and continue throughout the entire project lifecycle through disclosure via the internet and other media as deemed necessary.
An information contact point should be formed with the relevant authorities in order to address issues/questions regarding community concerns related to real or perceived environmental and human health impacts associated with contamination and/or environmental effects and nuisance conditions arising from remediation and management.
Any technical information should be disclosed to the public in plain and understandable language.
In cases of significant site contamination or controversial sites, proper and timely information disclosure to affected local communities should be ensured, and evaluation and feedback from all involved parties on the effectiveness of the consultations should be planned.</td><td rowspan="3">FMoET and cantonal authorities</td></tr>
<tr><td>2.</td><td>Decrease in asset value of neighboring land plots/structures</td></tr>
<tr><td>3.</td><td>Serious damage to the image of the polluting company</td></tr>
</table>

No.	Impact	Mitigation Measures	Implementing Agency
4.	Soil contamination during basic site survey	Depending on the method of sampling, special attention must be given during sampling activities in order to avoid possible cross-contamination. Extra care is needed to ensure that the surrounding area will not be affected by excavated soil and that this process will not leave contaminants exposed on the surface.	Companies/experts engaged in basic site survey (sampling)
5.	Work environment including work safety during basic site survey	Consideration must be given to appropriate occupational health and safety measures for people working within sites from the time of the preliminary site assessment up to the completion of remediation. Workers who perform site survey activities must be trained and informed on the following: ▪ Types of chemicals present on site, their nature and characteristics, and their likely health impacts; ▪ Toxicity of chemicals (via all exposure routes) as well as specific safety hazards (e.g., explosion from specific gases or vapors); and ▪ Types of operations to be carried out on site, equipment to be used, ways of dealing with chemical materials, residues and/or wastes, specific tasks of workers on site, etc.	Companies/experts engaged in basic site survey (sampling)
6.	Increase in administrative work (related federal and cantonal governments and agencies)	The works of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities to be involved in the Project
Development of institutional framework and development of technical guidelines			
7.	Brownfield issue (inability of landowner to pay for the remediation costs or sell the land)	The expert teams involved in developing new regulations should take the brownfield issue into particular consideration, and organize consultation meetings with affected landowners as necessary in order to fully evaluate all the challenges faced and the proposed options. Such regulations should provide for assistance/incentives to landowners who are unable to pay for remediation costs. Clear identification of the criteria for such assistance/incentives must be developed carefully.	FMoET
8.	Increased number of litigation cases	A grievance mechanism may be established through the new regulatory framework to address such disputes. Relevant authorities should attempt to amicably and efficiently resolve any arising dispute related to remediation.	FMoET and cantonal authorities
9.	Costs of activities related to the development of a regulatory and institutional framework	The financial sources necessary to cover the expected costs need to be clarified and agreed upon prior to the commencement of all actions.	FMoET and cantonal authorities
10.	Impacts on vulnerable groups (children, unemployed population, population with very low or without income, the elderly or population living in isolated areas which may be located within the vicinity of hotspots)	In the process of developing a legal and regulatory framework, vulnerable groups need to be identified and their rights, needs, and interests need to be taken into consideration and properly addressed. The stakeholder engagement mechanisms need to involve special provisions for vulnerable groups, such as the identification of vulnerable groups on a case-by-case basis and special consultation meetings with vulnerable persons.	FMoET
11.	Increase in administrative work (related federal and cantonal governments and agencies)	The work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities to be involved in the Project
12.	Site investigation and remediation requirements are too strict	The regulatory framework and technical guidelines should be developed by expert teams with relevant experience in contaminated site remediation in order to develop adequate regulations applicable in FBiH. A public consultation process involving particular owners of polluted sites should be carried out.	FMoET
Site investigation and remediation activities			
13.	Costs of site investigation and/or remediation are too high to comply with the new regulations and technical guidelines	The institutional framework and technical guidelines should provide assistance/incentives for remediation activities on a case-by-case basis.	FMoET

No.	Impact	Mitigation Measures	Implementing Agency
14.	Air pollution	**Dust**. Prior to and during remediation activities, the following issues must be considered: ▪ Sources of dust generation; ▪ Toxicity of dust (e.g., silica, asbestos, and chemicals); ▪ Size of the remediation area; ▪ Timing of remediation works (remediation undertaken at the end of the rainy season is likely to minimize dust exposure because of soil moisture content); ▪ Choice of remediation techniques; ▪ Distance to the nearest sensitive receptors; ▪ Dust monitoring (appropriate methodologies/protocols); ▪ Background measurements of concentrations of dust (before and during remediation); ▪ Methods used to minimize or eliminate dust generation, e.g. management practices; and ▪ Weather station monitoring (before and during remediation). For large projects, the local conditions well before starting work should be taken into account. Also, good housekeeping practices should be implemented such as minimizing traffic and its speed on exposed soils, minimizing exposed working areas during remediation, minimizing loose soil, light application of water spray to dampen the soil but not saturate it, and effective covering of stockpiles of excavated soil. **Exhaust gases.** In order to minimize air pollution caused by exhaust gases from construction vehicles and other machineries on site, a maintenance plan for equipment and vehicles needs to be prepared in advance and mitigation measures during remediation activities need to be implemented. **Asbestos fibres.** Asbestos that may be found on site requires specialized skills and care in its handling, removal, transportation, and disposal in order to prevent the likelihood of asbestos fibres becoming airborne that may cause harmful health impacts to workers and communities nearby. Asbestos-specific knowledge and management skills may also be needed in addressing potential impacts to workers and the community.	Site owner, company engaged in site remediation
15.	Surface water pollution	Management of surface waters during remediation activities is an essential part of protecting the quality of waterways and preventing their pollution. Negative impacts on surface waters associated with remediation activities should be reduced by strict implementation of mitigation measures, and application of adequate working and housekeeping practices (e.g., use of temporary rainproof covers, temporary bunding around stockpiles, location of stockpiles on waterproof surfaces such as asphalt or concrete, minimizing the area being treated at any given time, installation of temporary barriers (e.g. hay bales, geo-fabric or similar), excavation of drainage or runoff water diversion trenches, and collection or absorption pits). Remediation activities within water bodies must be carefully planned and implemented in order to reduce negative environmental impacts. Prior to and during remediation activities, the following issues must be considered: ▪ Local weather patterns and expected direction and pathways of run-off flow, ▪ Location and size of the affected area, ▪ Sensitivity of surrounding environments and proximity of nearby watercourses, ▪ Remediation work methods and works plans, ▪ Likely causes of surface water pollution (for example, caused by stockpiled, pre-excavated materials run off and/or leakage), ▪ Any on-site or off-site areas susceptible to negative impacts, and ▪ Requirements under the FBiH Law on Water.	Site owner, company engaged in site remediation

No.	Impact	Mitigation Measures	Implementing Agency
16.	Groundwater pollution	When undertaking remediation, specific requirements must be complied with in order to ensure that water quality is protected. Such impacts should be eliminated or mitigated by strict implementation of mitigation measures and good working and housekeeping practices. For some remediation projects, off-site groundwater monitoring may be necessary to assess the effectiveness of remediation activities or the extent of remediation required. Prior to and during remediation activities, the following issues must be considered: ▪ Geology and hydrogeology (type and number of aquifer systems, depth to groundwater, hydraulic pressures, flow directions and velocities); ▪ Type of soil and organic content (adsorption characteristics); ▪ Physical properties of chemicals disposed in hotspots; ▪ Potential for contaminated site chemicals spreading in soil and/or groundwater; ▪ Size and structure of the contamination source (e.g. if remediation implies construction of tailing impoundments); ▪ Dewatering; and ▪ Treatment, reuse, or disposal of extracted leachate. Assessment of groundwater conditions and characteristics requires specialized knowledge. The abovementioned issues need to be considered depending on the type and location of a remediation project.	Site owner, company engaged in site remediation
17.	Waste generation (construction and demolition debris, excavated soils, and/or excavated deposited waste)	Adverse impacts associated with waste generation and its temporary storage on site are expected to be temporary and they could be eliminated or mitigated by strict implementation of mitigation measures and good working practices based on the activities specified in the waste management plan. Major issues that need to be solved during remediation activities include management of: ▪ Hazardous construction and demolition wastes, which includes contaminated material from remediation activities; ▪ Other hazardous wastes (such as oil, lubricants, fuel, oily rags, and oil filters); ▪ Municipal wastes generated on site, including packaging waste; and ▪ Inert wastes (construction and demolition waste) and wastes that can be recycled (wood, various metals, and plastic materials). Appropriate handling, collection, and temporary storage of hazardous waste during on-site remediation activities should be implemented in order to protect the health and well-being of workers and nearby residents and to ensure that further site contamination is avoided.	Site owner, company engaged in site remediation
18.	Soil contamination	During sampling activities and based on the method of sampling, special attention must be given to avoiding possible cross-contamination. Selection of appropriate sampling methods and protocols should be implemented. Surrounding areas should be protected from improper management of excavated soil. Negative impacts on soils during remediation activities should be eliminated or minimized by strict implementation of mitigation measures and good working and housekeeping practices (e.g., adequate waste management, covering of exposed soil to prevent losses from wind or water erosion and vertical migration of chemical substances in the soil during rainfall events, adequate management of contaminated soil and stockpiles, and adequate wheel-wash operations). Prevention of contamination of nearby soils should be prevented to reduce the spread of chemical materials and to minimize the amount of contaminated soil needing to be treated. Attention should also be given on the prevention of contaminated liquid (such as leakage) generated from contaminated sites to be discharged on soils nearby. Prior to and during remediation activities, the following issues must be	Site owner, company engaged in site remediation

No.	Impact	Mitigation Measures	Implementing Agency
		considered: ▪ Likely sources of cross-contamination; ▪ Types and concentrations of chemical materials deposited onto and/or into the contaminated site; ▪ Extent of remediation area needed; ▪ Duration and timing of remediation works; ▪ Choice of remediation technique; ▪ Work methods and plans of remediation; ▪ Classification and management of waste generated and/or excavated during remediation activities; and ▪ Sensitivity of surrounding environments and proximity of nearby watercourses.	
19.	Damages to the environment caused by mining activities	Negative environmental impacts that may occur during remediation of mining sites may be reduced through transparent planning, proper and adequate management of remediation activities, as well as taking into account existing knowledge of practices in remediation of mining sites. Prior to and during remediation activities, the following issues need to be considered: ▪ Detailed engineering (geological site investigation); ▪ Zones of potential environmental, health, and safety impacts; ▪ Migration pathways of potentially generated pollution; and ▪ Experience and knowledge on implemented remediation projects.	Site owner, company engaged in site remediation
20.	Noise and vibration	**Noise.** This impact should be temporary and short term and can be prevented through implementation of mitigation measures and good housekeeping practices such as use of noise suppression on machinery or equipment with low sound outputs, restriction of working hours of noisy machinery, proper maintenance of all equipment with special attention to mufflers and other noise control devices, and placing of noisy equipment within the site at maximum distance from neighboring houses Issues that must be considered in addressing noise impacts include: ▪ Identification of likely sources of noise; ▪ Distance to the nearest sensitive receptors; ▪ Noise modelling and monitoring; and ▪ Obligations under FBiH Law on Noise Protection. **Vibrations.** These impacts can be mitigated by implementation of mitigation measures in the design and on-site remediation phases of the Project. Issues that must be considered to address vibration impacts, including: ▪ Identification of the zone of impact, ▪ Identification of the distance to the nearest sensitive receptors, and ▪ Vibration modelling and monitoring.	Site owner, company engaged in site remediation
21.	Ground subsidence	Adequate civil engineering practices need to be implemented. Prior to and during remediation activities, the following issues need to be considered: ▪ Identification of the zone of impact, and ▪ Level of compaction required.	Site owner, company engaged in site remediation
22.	Offensive odour and gaseous (volatile) emissions	Prior to and during implementation of remediation activities, the following issues need to be considered: ▪ Potential volatility and toxicity of chemicals disposed onto and/or into the contaminated site; ▪ Weather conditions; ▪ Location and extent of potentially affected areas; ▪ Distance to the nearest sensitive receptor; ▪ Determination of acceptable off-site concentrations of pollutants in the environment; ▪ Duration of potential exposure to pollutants generated by the contaminated site; ▪ Potential soil subsurface migration of volatile sources during remediation; ▪ Environmental and occupational health requirements; and ▪ Contingency planning for unexpected releases. Potential mitigation measures include: undertaking work in favorable	Site owner, company engaged in site remediation

No.	Impact	Mitigation Measures	Implementing Agency
		weather conditions (e.g. lower temperatures, favorable winds), covering exposed surfaces overnight, scheduling excavation activities to minimize off-site nuisance, and immediately and completely removing offensive odorous material offsite. If gaseous emissions are envisaged to be generated during a particular remediation project, an assessment of their potential impacts should be undertaken during the planning stage in order to determine the need for special measures for preventing and controlling these emissions.	
23.	Flora and fauna	Remediation activities need to be undertaken in compliance with all FBiH legislations covering sensitive or threatened species of flora and fauna. Prior to and during remediation activities, the following issues need to be considered: ▪ Size and location of areas of high environmental value in the surrounding areas; ▪ Size and if possible location of populations of possible threatened species; and ▪ Alternative appropriate remediation strategies.	Site owner, company engaged in site remediation
24.	Hydrological situation	The impacts on hydrology can be avoided or reduced in the planning and design stages of remediation activities by the application of special construction measures and implementation of mitigation measures and good working and housekeeping practices.	Site owner, company engaged in site remediation
25.	Land acquisition /Resettlement	Any full or partial (temporary) expropriation activity must be conducted in compliance with the FBiH Law on Expropriation.	
26.	Impacts on vulnerable groups (children, unemployed population, population with very low or without income, the elderly or population living in isolated areas which may be located within the vicinity of hotspots)	Vulnerable groups need to be identified and their rights, needs, and interests should be taken into consideration and properly addressed through the stakeholder engagement and consultation processes. The stakeholder engagement mechanisms need to involve special provisions for vulnerable groups.	FMoET
27.	Restrictions on land use and utilization of local resources	Any temporary land-use restriction that may occur during site-level activities, especially concerning the disposal of materials and/or wastes excavated on site, should be carried out in agreement with land owners.	FMoET
28.	Water usage or water rights	These potential impacts need to be assessed and if possible quantified in the later stages of the Project.	
29.	Living environment of residents	Local communities should be properly informed of the likelihood of any impact on living conditions that may be expected during remediation activities, such as construction works generating nuisances (noise, dust, and odour), including nuisances generated by demolition of buildings and infrastructures.	FMoET
30.	Historical and cultural heritage	Prior to and during remediation activities, the following issues need to be considered: ▪ Significance of heritage structures, archaeological deposits, and artifacts that may be present within a site; ▪ Training and awareness of workers working on site related to historical and cultural heritage values; ▪ Type of remediation activities to be undertaken on such site; and ▪ Procedures to be taken following the discovery of any heritage feature.	FMoET
31.	Work environment including work safety	Consideration must be given to appropriate occupational health and safety measures to be implemented from the time of the detailed assessment of a site up to the completion of remediation works. Special protective measures should be implemented to protect workers from cumulative exposure effects on workers who regularly undertake assessment and remediation works. Consideration must be given to the implementation of adequate and appropriate occupational health and safety measures from the earliest phases of site surveys and is continued all throughout up to the completion of remediation projects. Workers who will perform remediation activities must be trained and informed on the following:	FMoET

No.	Impact	Mitigation Measures	Implementing Agency
		▪ Types of chemicals present on site, their nature and characteristics, and their likely health impacts; ▪ Toxicity of chemicals (via all exposure routes) as well as specific safety hazards (e.g., explosion from specific gases or vapours); ▪ Types of operations to be carried out on site, equipment to be used, ways of dealing with chemical materials, residues and/or wastes, specific tasks of workers on site, etc. **Dangerous/hazardous substances.** Adequate handling, collection, temporary storage, and use of dangerous or hazardous materials during on-site remediation activities should be planned and implemented in order to protect workers and nearby residents and to ensure that further site contamination does not occur. Issues that need to be considered prior to and during remediation include: ▪ Potential for loss of containment (deliberate and accidental) through environmental release; ▪ Types and toxicity of chemicals deposited on site; ▪ Separation of temporary storage and/or disposal of different hazardous materials in order to prevent the occurrence of chemical reactions; ▪ Determination of the minimum distance among sensitive structures (in case of accidental spill, release, or explosion); ▪ Emergency measures and response plans in an event of accident (contingency planning).	
32.	Conflict of local interests	Any potential conflict regarding the future (planned) use of the remediated site/area need to be identified and, if possible, resolved during the stakeholder engagement and consultation processes.	FMoET and cantonal/municipal authorities
33.	Accidents	In case that contaminated materials from the site being remediated cannot be treated or safely disposed of within the vicinity of the site (or even within the territory of FBiH), these materials must be transported for treatment and/or disposal outside the country in accordance with the principles of the Basel Convention. The possibility of occurrence of accidents may be minimized by implementing mitigation measures and good working and housekeeping practices, as well as developing and implementing Emergency Response Plan and Spill Response Plan.	Site owner, company engaged in site remediation
34.	Impacts on human health (increased levels of dust and other air pollutants, and risk of infectious diseases)	Adverse impacts of remediation activities on the health of nearby residents will be reduced or mitigated by implementing mitigation measures and good work and housekeeping practices.	Site owner, company engaged in site remediation
35.	Activities related to site assessment and environmental remediation may be expected to have great financial implications	Financial sources necessary to cover expected site remediation costs must be identified and agreed upon prior to the commencement of all actions among key project stakeholders and depending on the framework of liability to be established.	FMoET
36.	Increase in administrative work (related federal and cantonal governments and agencies)	Work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities involved in the Project
Capacity Development			
37.	Activities related to capacity development may be expected to have great financial implications	Financial sources that would cover the expected costs need to be identified and agreed upon prior to the commencement of all actions among key project stakeholders and depending on the framework of liability to be established.	FMoET
38.	Increase in administrative work (related federal and cantonal governments and agencies)	Work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities involved in the Project

Source: Enova d.o.o. Sarajevo, Final Report of “Survey for Strategic Environmental Assessment (SEA) for the Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina”, 2014

11.8 Stakeholder Engagement Plan and Information Disclosure System

11.8.1 Review of Environmental Information Disclosure Legislation and Procedures

Basically, stakeholder engagement in the general development of the environmental and waste management system has been already set by the existing legal framework in FBiH. The primary law that ensures the rights of citizens to information is the Law on Free Access to Information (Official Gazette of FBiH, Nos. 32/01 and 48/11), which defines the objectives and basic concepts pertaining to access to information. It stipulates that all citizens and legal entities have the right to access information under the control of a public authority, and each public authority has its corresponding obligation to disclose such information. This right of access may only be subject to such formalities and restrictions as prescribed by this law. In addition, the law prescribes the procedures related to requests for obtaining information, the appeal procedures, and the obligations of public authorities regarding information disclosure. Procedures related to environmental information disclosure are further elaborated in the Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09), which defines in detail the type of information considered to be environmental information, those information required to be disclosed by public authorities, the procedure following the submitted request for obtaining environmental information, and the cases in which the requests for environmental information are declined.

The Law on Environmental Protection (Official Gazette of FBiH, Nos. 33/03 and 38/09) stipulates that every person and organization must have adequate access to information regarding the environment at the disposal of public authorities, including information on hazardous materials and activities in their communities, and must be able to participate in the decision-making process. Regulatory bodies and governments are obliged to encourage public awareness and participation, facilitate access to information, judicial and administrative procedures, as well as to registers of installations and polluters in the future. This law also requires the establishment of environmental advisory councils that would assist in the evaluation of strategic environmental assessments, environmental plans, and programs of environmental ministries and government entities. The councils are expected to be composed of various stakeholders (e.g., environmental associations, organizations, and institutions).

The provisions of the Law on Free Access to Information in FBiH are applied to issues that are not regulated by the Law on Environmental Protection of FBiH. Furthermore, FBiH acceded to the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters in 2008, as mentioned earlier in this chapter. This convention regulates the rights related to the environment and links the responsibility of public authorities with environmental protection. It also aims to promote democratic cooperation between the public and public authorities, and introduces a new procedure for public participation in negotiating and implementing international agreements. Under the Aarhus Convention, access to information, public participation in decision-making processes, and access to justice are an integral part of environmental protection management.

11.8.2 Review of Procedures and Responsibilities for Environmental Information Disclosure

The FMoET and cantonal ministries in charge of environmental protection are responsible for disclosing environmental information to the public. FMoET has established and manages the environmental information system for the entire territory of FBiH, whereas the cantonal ministries have established and manage environmental information systems for their respective cantons. Cantonal ministries are required to submit important data for the environmental information system to FMoET. In addition, federal authorities responsible for water management, meteorology, pedology, geology, nature protection, and statistics are required to gather, process, and record environmental data and information and submit such data/information to FMoET. Furthermore, a Pollutant Release and Transfer Register (PRTR) has been developed within FMoET pursuant to the Law on Environmental Protection and the Ordinance on Pollutant Release and Transfer Registers (Official Gazette of FBiH, No. 82/07). The PRTR is open to the public, and contains data on activities, plants, and facilities that endanger or may endanger the environment. Cantonal ministries prepare and submit annual reports on issued permits for plants and facilities to FMoET.

On the other hand, an information disclosure system for the public and public consultations is in place in FBiH with regard to the adoption of laws and by-laws (including guidelines). In the process of adopting laws, public hearings are organized in order to obtain the opinions of citizens, interested bodies, and scientific and expert institutions on the draft law or other issues of special importance to FBiH. The FBiH parliament adopts a conclusion when carrying out a public hearing, which determine the manner of disclosure of information, working body responsible for organizing and facilitating the public hearing, financial means and sources, time frame, and manner of receiving and analysing the opinions and proposals.

In the process of adopting by-laws, public consultations are regulated by the FBiH Government Decree on the Rules of Participation of Interested Public in the Procedure of Developing Federal Regulations and Other Acts (Official Gazette of FBiH, No. 51/12). This decree was adopted for the purposes of ensuring the participation of stakeholders. The key requirements set out by the decree, with regard to the adoption of environmental by-laws by the FMoET, are as follows:

- The ministry may carry out consultations during any phase of the development of the by-laws;
- The ministry is required to keep a list of organizations and persons interested in the legislative and other activities of the ministry, and publish the list on its website (and the website of the FBiH government);
- The ministry is required, following the preparation of the by-law, publish the by-law on its website and allow for online commenting;
- The ministry is required to invite the organizations and persons on the abovementioned list to submit their comments on the by-law;
- The Minister may decide to carry out further consultations by organizing public meetings and round tables, or through work groups involving experts and representatives of stakeholders; and
- The ministry is required to take into consideration all received comments.

11.8.3 Stakeholder Engagement Plan

The draft stakeholder engagement plan includes arrangements for consulting with relevant stakeholders at different stages of the draft master plan implementation. Special attention must be given to affected vulnerable groups and local residents and communities. The draft stakeholder engagement plan has been prepared on the basis of both the existing required procedures in FBiH and the recommended disclosure procedures, as presented in Table 11.8-1.

Table 11.8-1 Proposed Draft Stakeholder Engagement Plan

No.	Key Output/Information	Engagement Plan				
		Method	Responsible Agency	Stakeholder	Timing	Note
1.	Announcement of the commencement of project activities	Online disclosure	FMoET; MoFTER	Public	Prior to start of the Project	All project planning documents should be disclosed on the FMoET website
2.	Information on provisional site inventory and official registry	Online disclosure	FMoET	Public	2014-2016	The public should be advised that further investigations will be undertaken.

No.	Key Output/Information	Engagement Plan				
		Method	**Responsible Agency**	**Stakeholder**	**Timing**	**Note**
3.	Information on analysis of general status of contaminated sites in FBiH	Online disclosure	FMoET	Public; federal, cantonal, and municipal regulatory, planning and inspection authorities	2015-2016	The main findings of the analysis should be communicated to the public in plain language. Information should be provided in the future stages of the process and opportunities for the community to become involved.
4.	Information on technical guidelines related to site investigation and remediation	Public hearings Online disclosure Disclosure in official journals	FMoET	Public, land owners, polluters, developers, and inspectorates	2015-2018	-
5.	Information on developed standard format for remediation plan and prototype plans for selected sectors, as well as prototype QC plan	Online disclosure	FMoET	Land owners, polluters, developers, inspectorates	2015-2018	-
6.	Information on developed prototype monitoring and maintenance plan	Online disclosure	FMoET	Land owners, polluters, developers, and inspectorates	2015-2018	-
7.	Information on commencement and undertaking of urgent measures for priority sites	Online disclosure Local community meetings Public hearings (EIA procedure)	FMoET and cantonal ministries	Public, local communities, land/business owners involved	2014-2016	The options to be evaluated and selection criteria should be discussed with the community.
8.	Information on commencement and undertaking of pilot remediation projects	Online disclosure Local community meetings Public hearings (EIA procedure)	FMoET and cantonal ministries	Public, local communities, and land/business owners involved	2015-2017	
9.	Information on commencement and undertaking of priority site remediation	Online disclosure Local community meetings Public hearings (EIA procedure)	FMoET and cantonal ministries	Public, local communities, and land/business owners involved	2016-2020	
10.	Information on capacity development activities	Online disclosure	FMoET	Public	2014-2020	-
11.	Information on developed regulatory changes related to contaminated site management in FBiH	Public hearing Online disclosure Disclosure in official journals	FMoET	Public; federal, cantonal and municipal regulatory, planning and inspection authorities	2018-2020	-

No.	Key Output/Information	Engagement Plan				
		Method	Responsible Agency	Stakeholder	Timing	Note
12.	Information on developed remediation plans for other sites	Online disclosure Public hearings (EIA procedure)	FMoET and cantonal ministries	Public, inspectorates	2018-2020	-
13.	Data and information on monitoring	Online disclosure Public hearings (EIA procedure)	FMoET; cantonal ministries	Public	Ongoing	The results of remediation validation and/or findings of on-going monitoring should be disclosed to the public.

Source: Enova d.o.o. Sarajevo, Final Report of "Survey for Strategic Environmental Assessment (SEA) for the Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina", 2014

The process which requires stakeholder involvement related to the draft master plan is basically categorized as follows:

a) Process of development of institutional framework and technical guidelines

b) Information sharing of the result of Federation-wide survey and site inventory/registry

c) A series of activities of the investigation and remediation for each environmental hotspot

Regarding item a), there are opportunities for public hearing when the new environmental law and by-law will be prepared in accordance with the current procedures. At the public hearing, the opinions of citizens, interested bodies, and scientific and expert institutions on the draft law or by-law will be collected. Also, SEA will be used to ensure stakeholder engagement for each related plan, program, and strategy when they are developed. Although these chances of stakeholder involvement will be secured through the existing regulations, it is important to have the cross-sectoral consulting to develop feasible outputs considering the relevance with other areas of framework, financial and technical problems, assignment of human resources, and so on because the issues on hotspots involve more sectors and government than the other areas of issues.

The item of b) in the list above is related to the disclosure of information on contaminated sites. It should be developed carefully and appropriately because the information would have great impact on public reaction, the market value of the related area, and government administration. Thus, necessary information disclosure should be secured as it is mentioned in Section 6.3, "Development of Provisional Site Inventory and Official Site Registry". The breadth and depth of disclosed information and its means should be examined as well.

The whole process of individual site investigation and remediation indicated in item c) in the list above will be covered by the existing procedure of EIA in most cases. As their activities are directly involved with the interest and/or conflicts of site neighbors, community involvement in its early stages is very important. The key responsible party would be the landowners or polluters who are in charge of the management of hotspots. They need to have interactive communication and efforts for establishing good relationships with the local residents in order to proceed with the site remediation as explained in Section 7.6 "Risk Communication and Stakeholder's Involvement". The significant point to be emphasized is that not only information on risk but also those required by the site neighbors should be shared. The responsible authorities should lead the formation of community involvement through the technical guideline or administrative guidance.

11.8.4 Information Disclosure System

The proposed policy on information disclosure for any project or activity defined by the draft master plan is presented in Box 11-1. The proposed policy is entirely based on the provisions of the Law on Environmental Protection and the Law on Free Access to Information in FBiH, which were elaborated in detail in Section 11.8.1.

Table 11.8-2 Proposed Information Disclosure Policy for the Draft Master Plan

No.	Contents
1	FMoET is committed to making information about this Project available to the public. FMoET considers public access to information for all stakeholders, including local communities, a crucial component of effective participation.
2	FMoET shall provide timely and clear information to the public in a transparent and efficient manner, particularly information about the environmental and social considerations of the Project.
3	For the purposes of this policy, information means all documents in writing, data, correspondence, handwritten notes, and other materials including a copy or portion thereof, irrespective of its form (in written, visual, audio, electronic, or any other material). Environmental information, in particular, includes information on the state of environmental elements (air, water, soil, biodiversity, etc.); factors such as substances, energy, noise, radiation, activities and measures; the state of human health and safety, living conditions, cultural goods and structures; and the authorities and institutions responsible for environmental protection.
4	The public shall have access to information and be able to participate in decision-making without discrimination based on citizenship, nationality, or residence.
5	FMoET may decide not to disclose information in case the disclosure of such information would have an adverse effect on the following: ▪ International relations, defence, or public security; ▪ The course of justice, the right of persons to a fair trial, and the ability of administrative authorities to conduct criminal or disciplinary proceedings; ▪ Confidentiality of information relating to trade and industry, and information on emissions which are essential for the protection of the environment, if it is determined by a special regulation in order to protect economic interests; ▪ Intellectual property rights; ▪ The confidentiality of personal information and/or documents relating to individuals in the event that such persons have not given consent to the disclosure of this information to the public; ▪ The interests of a third party that has provided the requested information he/she was not required to provide, and if that party does not consent to the disclosure of a given material; and ▪ The environment to which the information is related to, such as breeding sites of rare species.

Source: Enova d.o.o. Sarajevo, Final Report of "Survey for Strategic Environmental Assessment (SEA) for the Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina", 2014

Public disclosure of information should begin in the early stages of the implementation of the activities proposed in the draft master plan. Information will be disclosed throughout the entire lifecycle of the activities, and will involve information on planned activities, activities in progress, and completed activities in accordance with the components of the activities.. In cases of significant site contamination or controversial sites, FMoET, in coordination with relevant cantonal or municipal authorities, will ensure proper and timely information disclosure through affected local communities, and plan for evaluation and feedback from all parties involved on the effectiveness of consultations. In such cases, meetings with local communities will be organized in order to present information, obtain input, and provide an opportunity for information dissemination and exchange.

11.9 Stakeholder Meeting

The stakeholder meeting was organized on 18 March 2014 in Sarajevo in order to present the draft master plan and exchange opinions about the various aspects of the draft master plan. The meeting was moderated by the project coordinator who is a representative of MoFTER. A total of 44 stakeholders participated and had discussions as shown in Table 11.9-1

Table 11.9-1 Summary of the Stakeholder Meeting

Item	Contents
a) Style of stakeholder meeting	Meeting
b) Date	18 March 2014
c) Venue	Sarajevo, Bosnia and Herzegovina
d) Purpose	- To present the draft master plan to stakeholders - To confirm stakeholders' main concerns and issues related to the activities proposed in the draft master plan - To obtain opinions of stakeholders and reflect these in the draft master plan
e) Participants	Representatives from the following: - Ministry of Foreign Trade and Economic Relations of BiH; - Relevant federal ministries; - Relevant municipal and cantonal authorities; - Faculties of mining and technology of universities in FBiH; - Agencies and institutes for water, food safety, geology, hydrology, and inspection; - International organizations (UNEP and OSCE) and Aarhus Centre; - Public health institutes; - Federal Environmental Protection Fund; and - Relevant engineering companies.
f) Summary	- The JICA Expert Team explained the outline of the project. - The technical guidelines for investigation and measures for contaminated sites, and the three key processes were explained together with a case study. - The liabilities, institutional controls, risk communication, community involvement, and funding for remediation were discussed. - It was suggested to include the question of ownership in the legal framework, as many of the properties connected to remediation may be privately owned. - The participants discussed and suggested other important documents and regulations that could support the project. - The type of modeling used for the purpose of project development was discussed together with suggestions on the most appropriate models for future reference.

Source: Enova d.o.o. Sarajevo, Final Report of "Survey for Strategic Environmental Assessment (SEA) for the Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina", 2014

11.10 Feedback on the Draft Master Plan and Recommendation

The most expected adverse impacts suggested in this chapter have already been discussed in the draft master plan. The main issues and measures considered and reflected in the draft master plan of this final report are as follows:

- Stakeholder engagement for the development of institutional framework and technical guidelines will be covered by the existing procedure of legal framework. Some opportunities for public communication stipulated in the current legal framework are not obligated, but such opportunities should be created as many as practically possible, and guidance should be given by responsible authorities because the hotspot issues are relatively new challenges in FBiH.
- The method of information sharing of the Federation-wide survey and site inventory/registry should be considered carefully. Therefore, an additional activity for such consideration of examining the method of information system was proposed for the development of risk communication strategies in the draft master plan as shown in Table 7.6-4.
- With regard to the stakeholder engagement of investigation and remediation activities on each site, it is suggested in Section 7.6, "Risk Communication and Stakeholder's Involvement", that the response to typical concerns of local residents should be examined and a manual for risk assessment should be developed.

In addition, the relevant issues in Section 11.6 are considered as follows:

- The lack of the hazardous waste disposal sites in FBiH has been considered in the approaches to improve the development of remediation plan as shown in Section 8.5.5.
- In response to the brownfield issue which has been indicated in Section 7.4.3 "Clarification of Liability Framework in FBiH", it is suggested in Section 7.6, " Risk Communication and Stakeholder's Involvement", and Section 7.7, "Financing of Remediation Projects", that the

redevelopment of brownfield should be enhanced by using opportunities for community involvement, win-win approach to improve the local environmental situation and revitalize the local economy, and various financial and regulatory incentives to support the local community. The activities for brownfield redevelopment is directly suggested in Table 9.5-1, "Suggested Activities for Development of Plans for Remediation of Other Sites".

- The issue of high costs of site investigation is considered in the activities of the development of remediation plan (Section 8.5). Section 7.7, "Financing of Remediation Projects", also proposes the financial mechanism for securing the source for these expenditures.

In conclusion, the mitigating measures discussed in this chapter should be taken comprehensively against various impacts to local residents, other stakeholders, and the environment. It is recommended that these environmental and social considerations should be taken for each step of the proposed activities in the process of application of the draft master plan.

CHAPTER 12 LESSONS LEARNED AND RECOMMENDATIONS

12.1 Lessons Learned

(1) Project Period

The project period in BiH (July 2013–April 2014) was very short, and the actual project activities started in late September 2013. This left the team with only four months to review the regulatory and organizational systems, implement the site survey, and develop the draft master plan. Despite the tight schedule, all activities of the Project were implemented due to the active participation of the counterpart members. Considering that a lot of time and effort have been put into the development of the Project, and considering that the Project has just started producing various useful results together with the active involvement of many stakeholders, it is unfortunate that this Project has to end. The BiH side is strongly encouraged to continue the efforts initiated by the Project and improve the management of contaminated sites.

(2) Legacy Pollution as the Main Focus of the Project

The main focus of the Project is the remediation of legacy pollution sites where polluters liable for site remediation no longer exist and government-led initiatives are required. However, through the period of joint ownership and privatization, many high priority sites in FBiH are now owned by private companies. Under the current liability regime, these current site owners have the primary responsibility to remediate their site, and it is difficult to define legacy pollution. Recognizing this complexity, the draft master plan developed in this Project covers a much wider scope than originally envisioned.

(3) Remediation of Contaminated Sites

The Project investigated and developed remediation plans for four environmental hotspots in FBiH. Through these activities, various practical experiences and knowledge were gained. If further efforts were made to actually remediate some sites through the Project, it would probably be possible to gain even more experiences and contribute more to the remediation of environmental hotspots in FBiH. It was difficult to conduct in this Project because remediation should be done by the party responsible for remediation (e.g., site owner) in accordance with the laws in FBiH, and a donor cannot assume responsibility for such actions. Nevertheless, all key members are now onboard to coordinate activities, discuss issues with responsible parties, and realize remediation. It is hoped that the BiH side will take up the challenges of actually remediating priority sites as envisioned in the draft master plan.

12.2 Recommendations

(1) Adoption of the Draft Master Plan

The BiH side is strongly recommended to thoroughly review the draft master plan, and adopt the proposed activities in order to improve the management of environmental hotspots. Issues of environmental hotspots are likely to have significant impacts on society because many people could potentially become liable, and the real estate market could be influenced by how contaminated sites are regulated. This is well-known from the experiences in Japan, the US, and many European countries where the legal definition of a contaminated site, liability framework, site registration and information disclosure, and support mechanisms for innocent site owner, are among the issues that could affect a large number of people. Because the site remediation could affect many stakeholders, proper investigation, setting of an appropriate remediation goal, as well as high-level of quality control during site remediation that will also be important. All of these components are covered in the draft master plan.

(2) Securing Enough Administrative Resources to Fulfill Legal Responsibilities

As discussed in Chapter 3, the number of environmental officers in FBiH is surprisingly small considering the work load required to manage environmental issues. Many cantons have only a few environmental officers and only one environmental inspector. The entity level-organizations share the same problem. This could make the management of environmental hotspots difficult. Because disputes over environmental hotspots, such as on those who polluted the site or who should pay for remediation, are often escalated into environmental litigation, environmental authorities should be prepared to deal with such issues. Each government should review their legal competency again, and secure sufficient staff and budget to fulfill its responsibilities and to support victims, site owners and other stakeholders involved in issues of environmental hotspots.

(3) Technical Committee and Unit of Technical Specialist

Remediation of environmental hotspots requires concerted effort of many organizations, which is one of the key factors for a successful remediation. The Technical Committee organized in this Project is a perfect arena to discuss issues that require coordination among different organizations, since nearly 40 people from key organizations are represented. The FBiH side is urged to continue its activities in the future. Also, remediation of environmental hotspots requires expertise in the various fields of environmental engineering, civil engineering, analytical chemistry, toxicology, hydrology, law, social science, etc. Most environmental authorities in FBiH are very much understaffed, and it is not easy to mobilize a large number of experts who can deal with highly technical issues in different disciplines. Hence, instead of dealing with the issues one by one by different organizations in an uncoordinated manner, it is better to organize ad-hoc units of capable technical specialists from academics, consulting companies, and waste management companies, and call them in whenever problems of environmental hotspots arise. After working on several cases, they will become highly experienced experts who can provide good technical services. Meanwhile, environmental officers should build broader knowledge and experiences in dealing with different aspects of hotspot management.

(4) Creating More Opportunities

The Project provided valuable opportunities to learn from real activities of site investigation and development of remediation measures. To provide further opportunities for learning, the draft master plan proposed the implementation of pilot projects which will be used to identify practical issues important for developing a regulatory framework, technical guidelines and best practice documents. The FBiH side can easily create similar opportunities. For example, remediation projects supported by the Environmental Protection Fund of FBiH are good candidates. Every opportunity should be used not only to remediate sites but also to learn and improve the ways of managing environmental hotspots. Of course, implementing more international projects and sharing experiences with neighboring countries are highly recommended.

(5) Exploring Possible Opportunities in Problems

This Project has focused on how to control and remediate environmental hotspots in FBiH in order to protect people and the environment from negative impacts. Because many priority environmental hotspots in FBiH have been left unattended, remediation of these sites are absolutely necessary and have to be done urgently. However, site remediation is often very expensive, and often requires further support and stimulation for it to be realized. This is why the issue of remediation should be seen from a wider perspective. For example, some sites have high economic potential if they are cleaned up; thus, site remediation may be pursued within a local redevelopment project. Similarly, waste material from a contaminated site might have some economic value, or at least can be used in beneficial ways. Hazardous substances may be sold if there is an appropriate technology to recover them. A low-risk waste material could be used on-site in the remediation project, or as construction material if it is used in a controlled manner. Such approaches have become very important in Japan, the US, and many

European countries where numerous contaminated sites have to be remediated. FBiH should explore many ways to turn the problem of environmental hotspots into an opportunity.

Annexes

Annex 1

SCOPE OF WORK

Annex 1 SCOPE OF WORK

THE SCOPE OF WORK

FOR

THE PROJECT FOR

MASTER PLAN FOR REMEDIATION OF HOTSPOTS

IN NORTHERN BOSNIA AND HERZEGOVINA

AGREED UPON BETWEEN

THE COUNCIL OF MINISTERS OF BOSNIA AND HERZEGOVINA

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Sarajevo, 20 December 2012

Ken Yamada
Resident Representative
Balkan Office
Japan International Cooperation Agency

Reuf Hadzibegic
Assistant Minister
Ministry of Foreign Trade and Economic Relations

Muharrem Zejnullahu
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I. INTRODUCTION

In response to the official request of the Council of Ministers of Bosnia and Herzegovina (hereinafter referred to as "the Council of Ministers of BiH") for the technical cooperation on the Project for Master Plan for Remediation of Hotspots in Northern Bosnia and Herzegovina (hereinafter referred to as "the Project"), the Government of Japan decided to conduct the detail planning survey in accordance with "Agreement on Technical Cooperation between the Government of Japan and the Government of Bosnia and Herzegovina" signed on March 1st, 2005.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will jointly undertake the Project with the authorities concerned of the Council of Ministers of BiH.

The present document sets forth the Scope of Work with regard to the Project.

II. OBJECTIVES OF THE PROJECT

1. To formulate a Draft Master Plan for sustainable management and proper treatment of environmental hotspots located in the Federation of Bosnia and Herzegovina (hereinafter referred to as "FBiH")
2. To enhance the capacity of the counterpart personnel and the relevant organizations for the policy planning on environmental management in FBiH

Steering Committee

In order to achieve the objectives of the Project, the Steering Committee will be set and be held periodically. The steering committee consists of the representatives from Ministry of Foreign Trade and Economic Relations (hereinafter referred to as "MOFTER"), FBiH, especially from the ministries relating to environmental and industrial issues, and other relevant organizations.

III. TARGET AREA OF THE PROJECT

The target areas and the materials of the priority on the Project are shown in the table below.

Priority	Target Area	Target Material
1	TE Tuzla, Tuzla	Mercury and PCB
2	Lukavac, Tuzla	Soda related chemical materials
3	Lake Modric, Tuzla	Coal related chemical materials
4	Vares, Zenica-Doboj	Iron forge related chemical materials

IV. SCOPE OF THE PROJECT

In order to achieve the objectives, the Scope of Work for the Project shall cover the followings:

Baseline Survey

1. Legal and institutional background of hazardous waste management in Bosnia and Herzegovina (hereinafter referred to as "BiH") is reviewed.
   1) To review the policies and regulations which have been applied for management of environmental hotspots
   2) To identify the gaps between the current legal framework and EU directives regarding hazardous waste management
   3) To provide recommendations for current hazardous waste management in BiH
   4) To prepare the baseline survey report which includes legal and institutional recommendations to the environmental management in BiH

2. Current status of the hazardous waste management in the environmental hotspots of FBiH is analyzed
   1) To obtain the cadastre map and specify the possible pollution areas in industrial zone of FBiH
   2) To conduct the sampling survey in the suspected pollution areas
   3) To analyze the samples and draft a hazardous waste map with a list of hazardous materials
   4) To assess risk of environmental destruction and human health damage and clarify the hazardous materials which to be addressed immediately.
   5) To set the public hearing to make a master plan more feasible in the target areas
   6) To draft the report which contains the result of analysis and the measures reflecting the public comments

Formulation of Draft Master Plan

The Master Plan for the management and the treatments of the target areas is drafted, which includes the treatment methods and the priorities
   1) To draft the Master Plan which includes the policy recommendations and the possible treatment plan against the major pollutions
   2) To compile the checklist for developing the Master Plan
   3) To elaborate the reference as annex of the Master Plan for the treatment methods against the major hazardous materials and chemicals
   4) To hold the nation-wide seminar/ workshop(s) to share the Master Plan and the project experience

V. SCHEDULE OF THE PROJECT

The Project will be carried out in accordance with the tentative schedule as below. The schedule is tentative so that subject to change when both parties agreed upon any necessity that will arise during the course of the Project.

Month	1	2	3	4	5	6	7	8	9	10
Work in BiH										

Annex 2

LIST OF ENVIRONMENTAL LAWS AND REGULATIONS RELATED TO MANAGEMENT OF ENVIRONMENTAL HOTSPOTS

No.	Document level	Document type		LAWS, Rulebooks, Decrees, Decisions, Instruction	Official Gazette
1	BiH	Rulebook	water	Rulebook on Sanitary Quality of Drinking Water	40/10, 43/10 and 30/12
2	BiH	Law	concession	Law on Concessions	32/02 and 56/04
3	FBiH	Law	environmental protection	Law on Environmental Protection	33/03 and 38/09
4	FBiH	Rulebook	environmental protection	Rulebook on Plants and Facilities Subject to Obligatory Environmental Impact Assessment, and Plants and Facilities That Can Be Constructed and Commissioned Only if Granted An Environmental Permit	19/04
5	FBiH	Rulebook	environmental protection	Rulebook on Drafting Annual/Semi-annual Environmental Protection Inspection Programs	68/05
6	FBiH	Rulebook	environmental protection	Rulebook on the Contents of the Report on the State of Safety, Contents of Information on Safety Measures, and Contents of Internal and External Intervention Plans	48/05
7	FBiH	Rulebook	environmental protection	Rulebook on the Conditions for Submitting Environmental Permit Applications for Plants and Facilities for Which Permits were Issued Before the Law on Environmental Protection	45/09 and 31/12
8	FBiH	Rulebook	environmental protection	Rulebook on Deadlines for Submitting Environmental Permit Applications for Plants and Facilities for Which Permits were Issued Before the Law on Environmental Protection	68/05 and 31/12
9	FBiH	Rulebook	environmental protection	Rulebook on Conditions and Criteria to be Met by Developers of EIS and the Amount of Fees and Other Costs Incurred in the EIA Process	68/05 and 92/07
10	FBiH	Rulebook	environmental protection	Rulebook on Registries of Plants and Pollution	82/07
11	FBiH	Rulebook	environmental protection	Rulebook on Passing the Best Available Techniques - BAT for Achieving Environmental Quality Standards	92/07
12	FBiH	Rulebook	environmental protection	Rulebook on Eco-labels and the Manner of Governing Eco−labeling	92/07
13	FBiH	Law	environmental protection	Law on Protection from Noise	110/12
14	FBiH	Decree	waste management	Decree on Financial Guarantees for Insuring Transboundary Waste Movements	41/05
15	FBiH	Decree	waste management	Decree on the Mandatory Submission of the Annual Report on Meeting the Requirements Set Out in the Waste Management Permit	31/06
16	FBiH	Decree	waste management	Decree on Selective Gathering, Packaging and Labeling of Waste	38/06
17	FBiH	Decree	waste management	Decree on Financial and Other Guarantees for Covering Costs related to Risk of Possible Damages, Rehabilitation and Procedures After the Decommissioning of Landfills	39/06
18	FBiH	Law	waste management	Law on Waste Management	33/03 and 72/09
19	FBiH	Plan	waste management	Federal Waste Management Plan	-
20	FBiH	Rulebook	waste management	Rulebook on Waste Categories with Lists	9/05
21	FBiH	Rulebook	waste management	Rulebook on Issuing Permits for Activities of Small Business Enterprises Dealing with Waste Management	9/05
22	FBiH	Rulebook	waste management	Rulebook on Necessary Requirements for Transferring the Waste Management Liabilities from Manufacturers and Vendors to System Operators for Waste Collection	9/05
23	FBiH	Rulebook	waste management	Rulebook on Treatment of Hazardous Waste Not on the Waste List or Whose Content is Unknown	33/03
24	FBiH	Rulebook	waste management	Rulebook on the Form, Contents and Procedure of Notification Carried out by the ;Manufacturer regarding Important Product Characteristics and Packaging	6/08

No.	Document level	Document type		LAWS, Rulebooks, Decrees, Decisions, Instruction	Official Gazette
25	FBiH	Rulebook	waste management	Rulebook on the Contents of the Waste Management Adjustment Plan for Existing Waste Treatment or Disposal Plants and on Activities Undertaken by the Competent Authority	9/05
26	FBiH	Rulebook	waste management	Rulebook on Medical Waste Management	77/08
27	FBiH	Rulebook	waste management	Rulebook on Animal Waste and Other Non-hazardous Natural Materials that Can be Used in Agriculture	8/08
28	FBiH	Rulebook	waste management	Rulebook on Managing Packaging and Packaging Waste	83/10
29	FBiH	Decision	water	Decision on Characterization of Surface Waters and Groundwaters, Reference Conditions and Parameters for Assessing Water Status and on Water Monitoring	1/14
30	FBiH	Decision	water	Decision on the Boundaries of River Basins and Water Areas in the Federation of Bosnia and Herzegovina	41/07
31	FBiH	Decree	water	Decree on the Types and Content of the Plans of Protection Against the Harmful Effects of Water	26/09
32	FBiH	Decree	water	Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH	SRBiH 18/80
33	FBiH	Decree	water	Decree on the Categorization of Watercourses	SRBiH 42/672
34	FBiH	Decree	water	Decree on Hazardous and Noxious Substances in Wate r	43/07
35	FBiH	Decree	water	Decree on Conditions for Discharging Wastewater Into Natural Recipients and Public Sewer Systems	4/12
36	FBiH	Law	water	Law on Waters	70/06
37	FBiH	Rulebook	water	Rulebook on Limit Values of Hazardous and Harmful Substances for Waters Discharged from the Public Sewer into Natural Recipients after Purification	50/07
38	FBiH	Rulebook	water	Rulebook on Limit Values of Hazardous and Harmful substances for Industrial Wastewater Before Discharging into the Public Sewer or Other Recipient	50/07
39	FBiH	Rulebook	water	Rulebook on the Contents, Form, Requirements, Manner of Issuing and Keeping of Water Acts	6/08
40	FBiH	Rulebook	water	Rulebook on Requirements for Defining Sanitary Protection Zones and Protection Measures for Water Sources Used or to be Used for Drinking Water	51/02
41	FBiH	Rulebook	water	Rulebook on the Contents and Manner of Maintaining Logs and on Submission of Data About Quantities of Abstracted Water	83/08
42	FBiH	Rulebook	water	Rulebook on the Manner of Defining Boundaries of Water Resources and on the Procedure for Determining whether the Land Plot Belongs to the Public Water Resource	26/09
43	FBiH	Rulebook	water	Rulebook on the Manner and Requirements for Limiting the Rights to Use Public Water Resources	26/09
44	FBiH	Rulebook	water	Rulebook on Determining Areas Subject to Eutrophication and Sensitive to Nitrates	71/09
45	FBiH	Rulebook	water	Rulebook on Monitoring Areas Subjects to Eutrophication and Sensitive to Nitrates	71/09
46	FBiH	Rulebook	water	Rulebook on Establishing and Managing a Water Information System	77/09
47	FBiH	Rulebook	water	Rulebook on Requirements that Must be Met by Referenced and Authorized Laboratories for Testing Water and on the Contents and Manner of Granting Authorizations	14/10 and 43/10
48	FBiH	Rulebook	water	Rulebook on the Method of Calculation, Procedure and Time limits for Calculation, Payment and Control of Settlement of Liabilities regarding General Water Fees and Special Water Charges	92/07, 46/09

No.	Document level	Document type		LAWS, Rulebooks, Decrees, Decisions, Instruction	Official Gazette
49	FBiH	Rulebook	water	Rulebook on the Conditions and Criteria to be Met by Specialized and Authorized Legal Entities for Implementing Measures to Eliminate or Prevent Water Pollution in the Event of Accidental Pollution or the Risk of Accidental Water Pollution and on the Method of Granting Authorizations	06/11
50	FBiH	Rulebook	water	Rulebook on Conditions and Criteria that Must be Met by Legal Entities Developing the Documentation on the Basis of which Water Acts are Issued	17/08
51	FBiH	Rulebook	water	Rulebook on the Manner of Determining the Environmentally Acceptable Flow	4/13
52	FBiH	Rulebook	water	Rulebook on the Minimum Contents of the General Legal Act on Maintenance, Use and Monitoring of Water Facilities	18/07
53	FBiH	Rulebook	water	Rulebook on Conditions and Criteria to be Met by Authorized Legal Persons to Perform Professional and Technical Tasks within the Jurisdiction of the Water Agencies and on the Manner of Granting Authorities	75/09
54	FBiH	Instruction	agricultural soil	Instruction on Mandatory Uniform Methodology for Developing Remediation Projects	73/09
55	FBiH	Law	agricultural soil	Law on Agricultural Land	52/09
56	FBiH	Rulebook	agricultural soil	Rulebook on Conditions that Must be Met by Scientific and Professional Institutions and Laboratories to Carry Out Project Preparation, and Soil Testing and Measurement	39/10
57	FBiH	Rulebook	agricultural soil	Rulebook on Conditions and Manner of Using the Funds Generated from the Exchange, Lease and Concession of State Owned Agricultural Land	78/09
58	FBiH	Rulebook	agricultural soil	Rulebook on Determining Permissible Amount of Harmful and Hazardous Substances in Soil and their Method of Testing	72/09
59	FBiH	Law	air	Law on Air Protection	33/03 and 4/10
60	FBiH	Rulebook	air	Rulebook on the Method of Monitoring Air Quality and on Defining the Types of Pollutants, Limit Values and Other Air Quality Standards	1/12
61	FBiH	Rulebook	air	Rulebook on Conditions for Measurement and Control of Sulfur Content in Fuel	6/08
62	FBiH	Rulebook	air	Rulebook on Air Quality Monitoring	12/05
63	FBiH	Rulebook	air	Rulebook on Monitoring the Emissions of Pollutants into the Air	12/05
64	FBiH	Rulebook	air	Rulebook on Working Requirements for Waste Incineration Plants	12/05 and 102/12
65	FBiH	Rulebook	air	Rulebook on Limit Values of Emissions into Air from Incineration Plants	3/13
66	FBiH	Rulebook	air	Rulebook on Emissions of Volatile Organic Compounds	12/05
67	FBiH	Rulebook	air	Rulebook on Phase-out of Substances that Deplete the Ozone Layer	39/05
68	FBiH	Law	energy	Law on Use of Renewable Energy Sources and Efficient Cogeneration	70/13, 5/14
69	FBiH	Rulebook	mining	Rulebook on Keeping Records and Developing a Cadastre of Mineral Deposits, Geological phenomena and Approved Research Areas	38/11
70	FBiH	Rulebook	mining	Rulebook on Categorization, Classification Calculation of Groundwater Reserves and Keeping Records Thereof	47/11
71	FBiH	Decree	spatial planning	Decree on the Uniform Methodology for the Preparation of Spatial Planning Documents	63/04 and 50/07
72	FBiH	Decree	spatial planning and land use	Decree on Structures and Interventions of Importance for FBiH and on Structures, Activities and Interventions that Can Largely Affect Environment, Life and Health of People in FBiH, for which Urban Consent is Issued by the Federal Ministry of Spatial Planning	85/07 and 29/08

No.	Document level	Document type		LAWS, Rulebooks, Decrees, Decisions, Instruction	Official Gazette
73	FBiH	Law	concession	Law on Concessions	40/02 and 61/06
74	FBiH	Law	criminal procedure	Law on Criminal Procedure in FBiH	35/03, 37/03, 56/03, 78/04, 28/05, 55/06, 27/07, 53/07, 09/09, 12/10 and 08/13
75	FBiH	Law	inspection	Law on Inspection	69/05
76	FBiH	Law	obligations	Law on Obligations	29/03 and 42/11
77	FBiH	Law	privatization	Law on Privatization	27/97, 8/99, 32/00, 45/00, 54/00, 61/01, 27/02, 33/02, 28/04, 44/04, 42/06 and 4/09
78	FBiH	Law	public health	Law on Health Protection	46/10 and 75/13
79	FBiH	Law	spatial planning	Law on Spatial Planning and Land Use in FBiH	2/06, 72/07, 32/08, 04/10, 13/10, and 45/10
80	FBiH	Law	mining	Law on Mining	26/10
81	FBiH, Agency	Statute	water	The Statute of Agency for River Sava Watershed	-
82	Tuzla Canton	Law	waste management	Law on Waste	17/00
83	Tuzla Canton	Decision	water	Decision on proclaiming Modrac Accumulation good for general use	6/03-285
84	Tuzla Canton	Law	water	Law on Waters	11/08
85	Tuzla Canton	Law	water	Law on Modrac Accumulation Protection	5/06
86	Tuzla Canton	Regulation	water	Regulation on Cadaster of Water Polluters	2/05
87	Tuzla Canton	Law	mining	Law on Mining of Tuzla Canton	14/11
88	Tuzla Canton	Law	spatial planning	Law on Physical Planning and Construction of Tuzla Canton	6/11, 04/13 and 15/13
89	Tuzla Canton	Law	environmental protection	Law on Environmental Protection Tuzla Canton – abolished	06/98 and 15/00
90	Zenica - Doboj Canton	Law	environmental protection	Law on Environmental Protection of Zenica- Doboj Canton	1/00
91	Zenica - Doboj Canton	Rulebook	environmental protection	Rulebook on Plants and Facilities which Can be Constructed and Put into Operation only if an Environmental Permit is Obtained	12/05
92	Zenica - Doboj Canton	Rulebook	environmental protection	Rulebook on the Conditions for Submission of a Request for Obtaining an Environmental Permit for Plants and Facilities for Which a Permit was Issued before Entering into Force of the Environmental Protection Law	6/06
93	Zenica -Doboj Canton	Decision	water	Decision on approval to the Amendments of the Financial Plan Health Insurance Institute of Zenica-Doboj Canton for 2007	50/07
94	Zenica -Doboj Canton	Decision	water	Decision on the Protection of Drinking Water Sources «Ravna rijeka» with its Sources «Matina voda», «Novo Vrelo» and «Klarića Izvor», «Mala Rijeka», «Ograjina», sources «Bukovik» "Jakovac", "Izvor III" of Žepče Waterworks	3/05

No.	Document level	Document type		LAWS, Rulebooks, Decrees, Decisions, Instruction	Official Gazette
95	Zenica -Doboj Canton	Law	water	Law on Waters of Zenica - Doboj Canton	17/07
96	Zenica -Doboj Canton	Law	mining	Law on Mining of Zenica - Doboj Canton	10/12
97	Zenica -Doboj Canton	Law	mining	Law on Geological Survey	8/12
98	Zenica -Doboj Canton	Law	spatial planning	Law on Spatial Planning and Construction of Zenica - Doboj Canton	1/14

Source: JET

Annex 3

SITE SURVEY

Annex 3 SITE SURVEY

A 3.1 Introduction

This annex 3 complements the contents of Chapter 4 (Site Survey) and shows the detailed background, method and result of the site survey that were not included in Chapter 4. The collected information, data and description in this Annex 3 are cited from the output of the subcontract work of “Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina” done by Hydro-Engineering Institute Sarajevo (HEIS).

A 3.1.1 Confirmation of the Selected Target Sites

The four target sites have been proposed by BiH side originally and were shown in the Scope of Work (S/W) agreed upon between the Council of Ministers of BiH and JICA. In the first phase of the project, JICA Expert Team (JET) examined whether these four sites are appropriate as the target survey sites to be used for this Project or not.

At the beginning of the Project, the following criteria were assumed in selecting the target hotspots: 1) legacy pollution site for which polluter-pays-principle cannot be applied, 2) contaminated with substances highly hazardous to humans and ecosystem, and 3) areas where human exposure is considered significant. In addition, land use maps were used to confirm the potential of pollution. Table A 3.1-1 shows the result of the confirmation of each criteria based on the findings at the beginning of the project activity. The obtained land use maps are shown in Table A 3.1-2.

Table A 3.1-1 Confirmation of the Selected Target Sites at the Time of Beginning of Project Activity

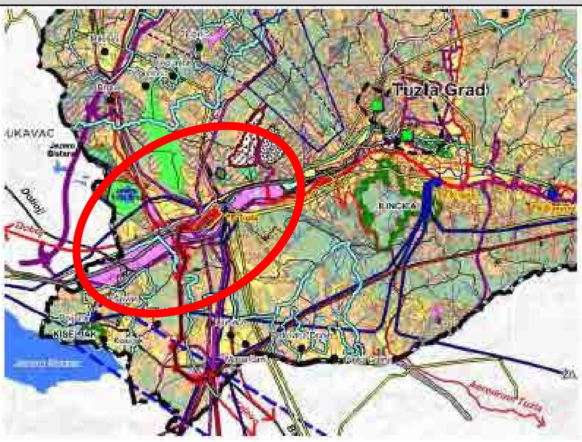
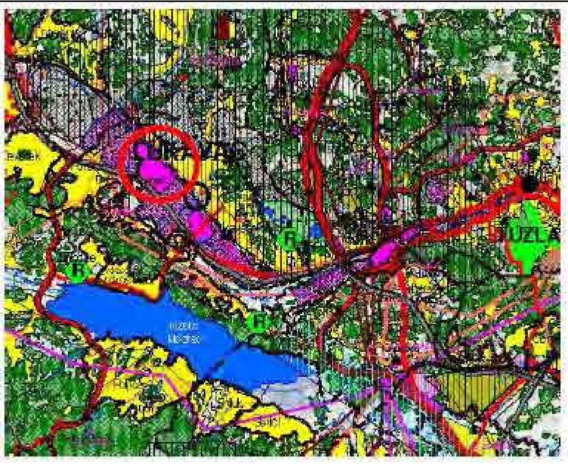
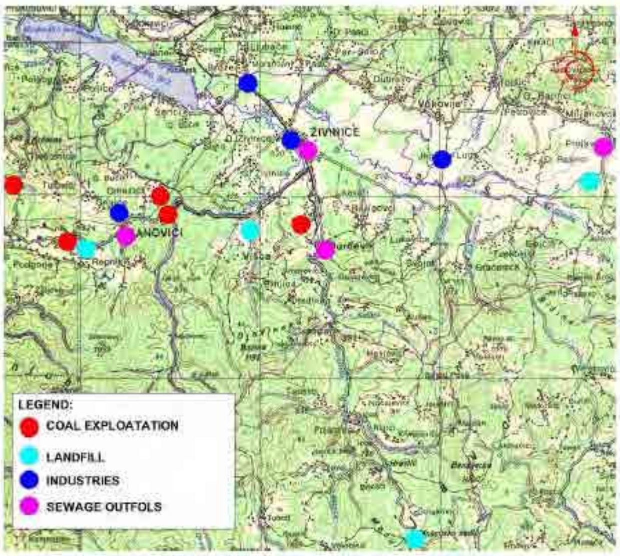
No.	Name of Site	Legacy pollution site or not	Contaminated with substances highly hazardous to humans and ecosystem or not	Human exposure is considered significant or not	Status of land use
1	Former chemical factory site	Apparently, the company that polluted the site does not exist anymore, and the site has been sold to the current owner through privatization process. It seems the current land owner company has the remediation liability for remediation. Since several companies have been involved in the ownership and use of the target site through privatization and bankruptcy processes, the responsibility for site remediation among these companies needs to be clarified.	Contamination with Hg and PCBs is suspected.	No one is living near the target site, because it is in the industrial zone. However, the health damage to the workers working adjacent to the site is one of concerns. The use of groundwater surrounding the site shall be investigated.	The site is located in one of the major industrial zones. Pollution by multiple polluters is seen as a strong possibility.

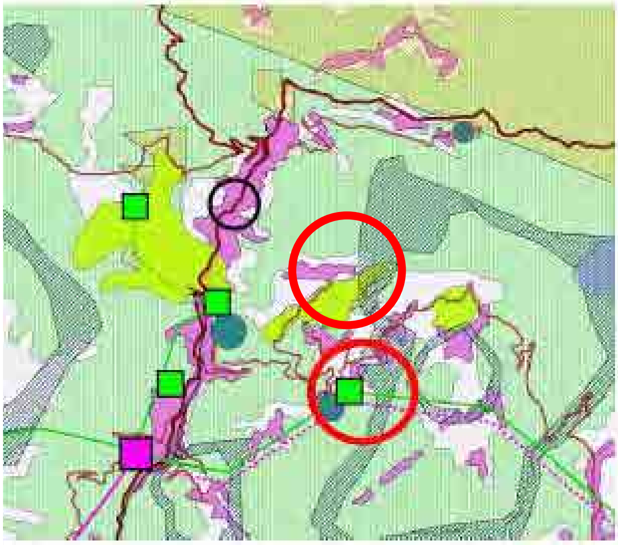
No.	Name of Site	Legacy pollution site or not	Contaminated with substances highly hazardous to humans and ecosystem or not	Human exposure is considered significant or not	Status of land use
2	Former soda factory site	Current owner of soda factory took over the deposit site. They plan to remediate the target site.	The waste deposited at the site seems to be alkaline but does not seem to contain elevated levels of heavy metals and other toxic substances. Though the toxicity of the waste to human beings seems not as high as those at other target sites, the local authority is concerned about the potential negative impact of the site to the irrigation water downstream of the site.	No one is living around the site. The impact to the downstream needs to be considered.	The existing factory is one of the major industries in Tuzla Canton and its impact to local environment is huge.
3	Lake Modrac	Tuzla Canton has a responsibility of water management of Lake Modrac.	The major issue of this site is the decreased volume of water storage due to the accumulation of sediment from upstream. If hazardous pollutants from the upstream areas are accumulated in the lake, it can be considered a high environmental risk.	The range of impact is quite huge because this site is drinking water source.	The site is the one of the big accumulation lake in FBiH. There are some mining sites and cities in the upstream basin area.
4	Abandoned mining sites	The ownership of the pond of the abandoned iron mine has not been resolved.. The site of the former processing factory of lead, zinc and barite mine is now owned by a private company after the bankruptcy of the company that had operated the factory. The tailing dam is managed by Vares Municipality.	Heavy metal which is one of the potential pollutants in processing factory is known as a high-risk hazardous material.	The health damage to people who visit the site for recreation is the main concern for the site of the abandoned mining pond. As for the former processing factory, there are some local residents living next to the site. The use of groundwater for drinking was not confirmed. The potential risk for the tailings dam is its potential collapse. The significant physical and health damage to the downstream might occur in case of such an accident.	The sites are major and representative mining sites in Vares.

Source: JET

Through the confirmation of the situations of the proposed target sites and the examination of the above criteria, it was found that the concept of “legacy pollution site for which polluter-pays-principle cannot be applied” is somewhat vague in actual cases in FBiH because under the current regulatory framework in FBiH, environmental liability generally lies with the current land owner while the liability of historical owners are not clearly defined. Also, it was difficult at the time of selection of targets site to clarify where the responsibility of pollution lies due to site histories with bankruptcy, privatization and changes in ownership. Regarding the criteria of contamination with hazardous substance and the risk of exposure, those sites where contamination with hazardous substance is suspected are considered to have high priority for site selection. At some sites, concentrations of hazardous substances seemed not particularly high, but they are environmentally-important sites which C/P and local people have a strong interest in. Eventually, the proposed four sites were selected as the targets site for the site survey based on discussions with C/P and JICA.

Table A 3.1-2 Confirmation of Land Use Map

Name of site	Land use map	Description
Former chemical factory	 Source: Tuzla Municipality, Spatial Planning of Tuzla Municipality 2006 – 2026, 2006	The target site is located inside an economic (i.e. industrial) zone (colored in pink on the map), which is planned for construction and operation of production plants and facilities.
Former soda factory site	 Tuzla Canton, Spatial Planning of area of Tuzla Canton 2005-2025, 2006	ditto
Lake Modrac	 Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014	Since environmental status of Modrac Lake is affected by the upstream pollution sources, the map shows the main pollution sources along the Spreca river, which is one of the main river inflowing to Modrac Lake. There are some coal mines, landfills and industries located along the river.

Name of site	Land use map	Description
Abandoned mining sites	 Source: Physical plan of ZDK. “Official Gazette of the ZDK”, Nos.04/09 and 06/09	The abandoned mining pond is located in the former zone for mineral extraction in the Municipality of Vares. The area has been legally zoned as a recultivation area (yellowish green area on the map), according to the Physical Plan of ZDK (2009). On the other hand, the abandoned processing plant is located in an economic (industrial) zone (Physical Plan of ZDK, 2009) in the period of the implementation of the plan (2009-2029). The area of the tailing pond does not have designation in the physical plan of ZDK (2009). Instead, the site is inside the forest land (light green area on the map).

Source (except for map): JET

A 3.2 Sampling and Analysis Method

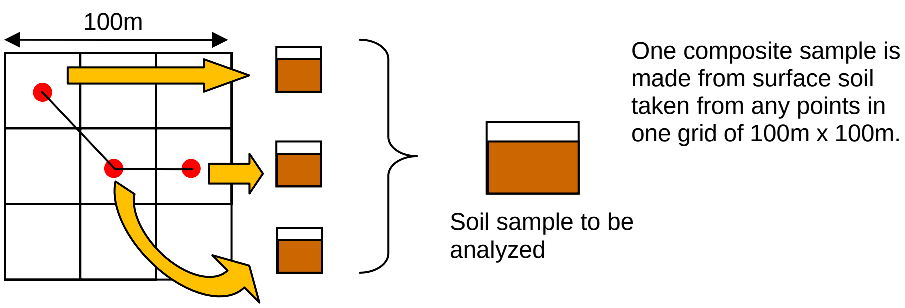
A 3.2.1 Sampling Method

All sampling activities were carried out taking into account the quality requirements under BAS EN ISO 5667 standard.

(1) Surface Soil/Sand

The soil collected in the range from 0 – 50 cm from the surface was provided as a surface soil sample. Since some of the sampling locations were in the area very close or inside the production buildings, the target soil/sand was often covered by layers of concrete or asphalt. Therefore, concrete auger and other concrete drilling devices were used to create holes wide enough to allow utilization of other sampling tools, such as hand auger and a small shovel.

On the other hand, as for sampling points in the suspected low contamination area in the former chemical factory site in Tuzla, a composite surface soil sample was prepared by mixing multiple soil samples collected from the same sampling grid. Since there is no technical guideline in FBiH which specifies the methodology of sampling, the sampling point in this site survey was selected considering the results of the surveys in the past, the result of the site reconnaissance and the objectives of the site survey.



Source: JET

Figure A 3.2-1 Sampling Method of Composite Surface Soil Using the Multi-Point Mixing Sample

(2) Boring core

In total three boring holes were created until the aquitard under the first aquifer: up to 5 m for B-1 and B-2 point and up to 7 m for P1 point, by dry boring method. The soil core samples were taken from 0-5 m, 1 m, 3 m, 5 m from the boring cores from B-1 and B2, and 0-5 m, 1 m, 3 m, 6 m from the boring core of the monitoring well P1.

(3) Sediment

The sampling methodologies of sediment differed depending on the location. A small shovel was used for the small channel in the former chemical factory in Tuzla and the abandoned mining pond in Vares. As for the pond of the abandoned tailings dam, the sample was taken at the point near the dam because the water depth in the middle of pond was too deep. Thus, the sediment was collected by a small shovel. Other sediment samples from the sedimentation tank, river, lake and the pond were taken by a sediment sampler.

(4) Sludge

The sludge samples of the former soda factory site were taken by the hand auger at the depth around 50 cm.

(5) Surface water/discharge water

All water samples were collected as grab samples with a water sampler or directly by using a bucket.

(6) Groundwater

Groundwater sample was collected by a groundwater sampler which can pass through the monitoring well, or directly from the collection basin or from the top connected to the groundwater under investigation.

A 3.2.2 Analysis Method

ORP for the soil, boring core and sediment and dissolved oxygen, pH, conductivity, salinity and turbidity for the water samples were measured on site. The other parameters were measured at the laboratory. The following table shows the analytical methods applied to this site survey.

Table A 3.2-1 Analysis Method in this Survey

No.	Parameter	Analysis method
1. Measurement at the sampling site		
1-1. Soil/Sediment/Sand/Waste		
(1)	ORP	ISO 11271
1-2. Surface Water/Groundwater		
(1)	DO	BAS EN 25814
(2)	pH	ISO 10523
(3)	EC	BAS EN 27888
(4)	Salinity	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition -2520 B. Electrical Conductivity Method
(5)	Turbidity	BAS EN ISO 7027
2. Analysis in the laboratory		
2-1. Soil/Sediment/Waste Analysis		
(1)	pH	BAS ISO 1390
(2)	EC	ISO 11265
(3)	ORP	ISO 11265; Methodes For the Examination of Water and Wastewater, 22 edition - 2520 B. Electrical Conductivity Method
(4)	Total organic carbon (TOC)	BAS ISO 14235:2003 - Tjurin method-K dichromate digestion
(5)	Oil/fat	Methodes For the Examination of Water and Wastewater, 22 edition -5520, Oil and Greas E Extraction Method for Sludge Samples
(6)	Water content	ISO 11465
(7)	Salinity	ISO 11265; Methodes For the Examination of Water and Wastewater, 22 edition - 2520 B. Electrical Conductivity Method
(8)	Cadmium (Cd)	ISO 11466 - Aqua Regia extraction;ISO 5961
(9)	Lead (Pb)	ISO 11466 - Aqua Regia extraction;Methodes For the Examination of Water and Wastewater, 22 edition - 3113 B Electrothermal Atomic Absorption Spectrometric Method
(10)	Total chromium (T-Cr)	ISO 11466 - Aqua Regia extraction;ISO 9174
(11)	Total mercury (T-Hg)	ISO 11466 - Aqua Regia extraction;ISO 5666
(12)	Copper (Cu)	ISO 11466 - Aqua Regia extraction;Methods For the Examination of Water and Wastewater, 22 edition -3111 B Electrothermal Atomic Absorption Spectrometric Method
(13)	Nickel (Ni)	ISO 11466; Methodes For the Examination of Water and Wastewater, 22 edition - 3111 B Electrothermal Atomic Absorption Spectrometric Method
(14)	Zinc (Zn)	ISO 11466 - Aqua Regia extraction;ISO 8288
(15)	Iron (Fe)	ISO 11466 - Aqua Regia extraction; ISO 6332 - Spectrometric method - phenanthroline
(16)	Manganese (Mn)	ISO 11466 - Aqua Regia extraction;Methodes For the Examination of Water and Wastewater, 22 edition - 3111 B Electrothermal Atomic Absorption Spectrometric Method
(17)	Arsenic (As)	ISO 11466 - Aqua Regia extraction; ISO 20280
(18)	Selenium(Se)	ISO 11466 - Aqua Regia extraction; ISO 20280
(19)	Cobalt (Co)	ISO 11466 - Aqua Regia extraction, ISO 8288
(20)	Calcium (Ca)	BAS ISO 14869-2:2004 – Alkaly fusion ; BAS ISO 6058 - EDTA titrimetric method
(21)	Sodium (Na)	ISO 11466 - Aqua Regia extraction; BAS 9964-3
(22)	Magnesium (Mg)	BAS ISO 14869-2:2004 - Alkalyfusion ; BAS ISO 6058 - EDTAtitrimetric method
(23)	Potasium (K)	ISO 11466 - Aqua Regia extraction; BAS ISO 9964-2
(24)	Aluminium (Al)	BAS ISO 14869-2:2004 – Alkaly fusion ; Methods For the Examination of Water and Wastewater, 22 edition 3500-Al B. Eriochrome Cyanine R Method
(25)	Sulfur (S)	ISO 11466 - Aqua Regia extraction; Methods For the Examination of Water and Wastewater, 22 edition 4500-SO42- C. Gravimetric Method with Ignition of Residue
(26)	Silica (Si)	BAS ISO 14869-2:2004 – Alkaly fusion ; Methodes For theExamination of Water and Wastewater, 22 edition 4500-SiO2 C. Molybdosilicate Method
(27)	Phosphorus (P)	ISO 11466 - Aqua Regia extraction; Methods For the Examination of Water and Wastewater, Stannous Chloride Method
(28)	Nitrogen (N)	ISO 11261 - Kjeldahl method
(29)	Ammonia nitrogen(N-NH4-)	ISO 11261 - Kjeldahl method

No.	Parameter	Analysis method
(30)	Fluoride (F)	Methods For the Examination ofWater and Wastewater, 4500-FD.SPADNS; analysis in waterextract
(31)	Chloride ion(Cl-)	BAS ISO 9297 - in water soluble substances (water extract 1:10), titrimetric method
(32)	Cyanide	ISO 11262
(33)	Polychlorinated Biphenyl (PCB)	Test method for PCB in Soil - Method 9078, Solvent extraction -EPA Method 3550B, Clean-up -EPA Method 3620C; Analyze by GC-MS EPA Method 8080A
(34)	Density	ISO/TS 17892-3:2004
(35)	Viscosity	Standard Test Method for Marsh Funnel Viscosity of Clay Construction Slurries Designation:D6910-04, ASTM International
(36)	Ignition loss	ASTM D7348 – 13
(37)	Particle size distribution	ISO 11277
2-2. Water Quality Analysis		
(1)	Total organic carbon (TOC)	BAS ISO 8245:2003
(2)	COD	BAS EN ISO 6060:1989
(3)	Alkalinity	ISO 9963-1
(4)	Total phosphorous (T-P)	ISO 6878
(5)	Total nitrogen (T-N)	ISO 25663, ISO 7890 - 3
(6)	Oil/fat	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 5520 Oil and Grease B Partition - gravimetric method
(7)	Chlorophyll a	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 10200 H Chlorophyll a
(8)	Coliform	ISO 9308-1:2000 Water quality -- Detection and enumeration of Escherichia coli and coliform bacteria -- Part 1: Membrane filtration method
(9)	SS	ISO 11923
(10)	Cadmium (Cd)	ISO 5961
(11)	Lead (Pb)	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 3113 B Electrothermal Atomic Absorption Spectrometric Method
(12)	Total chromium (T-Cr)	ISO 9174
(13)	Total mercury (T-Hg)	ISO 5666
(14)	Copper (Cu)	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition -3113 B Electrothermal Atomic Absorption Spectrometric Method
(15)	Zinc (Zn)	ISO 8288
(16)	Iron (Fe)	ISO 6332
(17)	Manganese (Mn)	ISO 6059
(18)	Arsenic (As)	ISO 11696
(19)	Nickel(Ni)	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 3113 B Electrothermal Atomic Absorption Spectrometric Method
(20)	Sulfate ion(SO42-)	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 4500 - SO4 E. Turbidimetric Method
(21)	Chloride ion(Cl-)	BAS ISO 9297
(22)	Fluoride (F)	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 4500- F - D -SPANDS method
(23)	Cyanide	ISO 6703 – 1
(24)	Polychlorinated Biphenyl (PCB)	APHA,AWWA,WEF, Standard Methods For the Examination of Water and Wastewater, 22 edition - 6440 C. Liquid - Liquid Extraction Gas Chromatographic/Mass Spectrometric Method
(25)	Polycyclic aromatic hydrocarbons (PAH) (total)	APHA,AWWA,WEF, StandardMethods For the Examination ofWater and Wastewater, 22 edition -6431 C. Liquid - Liquid ExtractionGas Chromatographic/MassSpectrometric Method

Note)
- PCBs in soil were first analyzed by screening method for PCB in soil (EPA, Method 9078).
- According to ISO 11464:2006, all soil quality parameters was analyzed in 2 mm fraction of the sample.
- Pretreatment was taken depending on the sample and analysis’s requirement for each parameter as needed.
- Heavy metals in water were analyzed as dissolved heavy metals because total concentration of heavy metals in water can vary and it depends on concentration of suspended solids caused by weather conditions or similar.

Source: HEIS, Work plan for “Sampling survey and analysis for the project for Master Plan for remediation of Hotspots in Bosnia and Herzegovina”, 2013

A 3.2.3 Reference Values in the Site Survey

A 3.2.3.1 Soil Quality

Because of the lack of regulations related to soil quality for contaminated site in FBiH, the standards used in some EU Member States and other countries were reviewed. Based on the analysis of those standards, reference values for soil were set for this survey **(**Table A 3.2-2**)**.

Among the presented standards for contaminated soil in different countries, the quality standards for soil applied in Austria generally have values that are in the mid-range of all analyzed standards. These standards served as a basis to define intervention threshold values for the purposes of this Study. Intervention thresholds values for Zn, Mn, Se, Co and Sn are adopted on the basis of standards from other countries. On the other hand, regarding PCBs, 5 mg/kg was selected as a reference value for this Study as a result of comparison of some references (Table A 3.2-3).

Table A 3.2-2 Threshold values for heavy metals in soil in different countries and reference values in this study (in mg/kg)

Source/Country	BiH	U.S. EPA	UK	Austria	Italy	Holland	Germ.	Poland	Lith.	Reference values for soil in this Survey
Year	2009	2013	2009	2000	2006	2000	1999	1995	2008	
Type	Limit	Scr.	Scr.	Interv.	Limit	Interv.	-	-	Limit	
Soil use	Agric.	Indust.	Comm.	No agri.	Indust.	-	Indust.	-	LU IV	
Notes	Hard soil	Risk based	Risk based	Human exp.	-	-		Depth 0-2m		
Cadmium (Cd)	1,5	80	230	10	15	12	60	15	3	10
Lead (Pb)	100	800	-	500	1,000	530	2,000	600	500	500
Total chromium (T-Cr)	100	56	-	250	800	380	1,000	500	600	250
Total mercury (T-Hg)	1,5	4.3	26	10	5	10	80	30	1	10
Copper (Cu)	80	4,100	-	600	600	190	-	-	200	600
Nickel (Ni)	50	2,000*	1,800	140	500	210	900	300	300	140
Zinc (Zn)	200	31,000	-	-	1500	720	-	-	1200	1,000
Manganese (Mn)	-	2,300	-	-	-	-	-	-	10,000	2,000
Arsenic (As)	20	2.4	640	50	50	55	-	-	80	50
Selenium (Se)	-	510	13,000	-	15	100	-	-	10	100
Cobalt (Co)	60	30	-	-	250	240	-	-	120	240
Tin (Sn)	-	61,000	-	-	350	900	-	-	40	500
Fluoride (F)	350	4,100	-	1,000	2,000	-	-	-	6,000	1,000
Cyanide	-	14	-	50	100	20	-	-	50	50
PCBs	0.2	-	-	1	-	-	40	-	-	5

Abbreviations: Germ. – Germany; Lith. – Lithuania; LU – Land Use; Scr. – Screening; Interv. – Intervention; Agric. – Agriculture; Indust. – Industrial; No agri. – No agriculture; MAC – Maximum Allowable Concentration

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.2-3 Threshold values for PCBs in soil in Different Countries

Criteria	Criteria Values (µg PCBs/g DW)	Jurisdiction	Published Year
Level considered to be contaminated	> 5.0	Quebec, Canada	1984
Recommended target level for cleanup	1.0	Quebec, Canada	1984
Target level for cleanup	< 5.0	Saskatchewan	1985
Guideline for further investigation of contamination	1.0	Holland	1983
Guideline for urgent remediation;	10.0	Holland	1983
Target level for cleanup of residential area	1.0 to 5.0	Holland	1985
Investigation level (level A) for residential, recreational, & agricultural land use	0.1	British Columbia	1989
Remediation level (level B) for residential, recreational, & agricultural land use	5.0		
Remediation level (level c) for commercial or industrial land use	50.0		
Guideline for further investigation	1.0	France	1985
Guideline for remediation	5.0		
Guideline for urgent remediation	10.0		
TSCA regulation for cleanup of spills <1 lb. PCBs	< 1.0	U.S. EPA	1987
TSCA regulation for cleanup of high-conc. spill or low-conc. spill of 1 lb. PCBs in outdoor electrical substation	25.0 or 50.0 + notice		
TSCA regulation for cleanup of high-conc. spill of 1 lb. PCBs in restricted access areas	25.0		
TSCA regulation for cleanup of high-conc. spill or spill of 1 lb. PCBs in non-restricted access areas	10.0 + excavation of top 25 cm; 1.0 for replacement soil		

Abbreviations: TSCA – Toxic substance control act
Source: "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014" and "Ministry of Environment, Lands and Parks, Province of British Columbia, Canada Water quality criteria for polychlorinated biphenyls (PCBs), Technical appendix , 1992"

A 3.2.3.2 Sediment Quality

Canadian sediment quality guideline was used for the reference values of sediment because of the lack of regulations related to sediment quality for contaminated site in FBiH. The Canadian guideline has defines the two values of ISQG (Interim Sediment Quality Guideline) and PEL (Probable Effect Level). Above the PEL, more than 50% adverse effects on aquatic life occur and fewer than 25% adverse effects occur below the ISQG.

Table A 3.2-4 List of Environmental Standard (Sediment)

Parameter	Units	Reference Value in this Survey	
		Freshwater (ISQG)	Freshwater (PEL)
Cadmium (Cd)	mg/kg	0.6	3.5
Lead (Pb)	mg/kg	35	91.3
Chromium (Cr)	mg/kg	37.3	90
Total mercury (T-Hg)	mg/kg	0.17	0.486
Zinc (Zn)	mg/kg	123	315
Arsenic (As)	mg/kg	5.9	17
Polychlorinated Biphenyls (PCBs)	mg/kg	0.0341	0.277

ISQG: Interim Sediment Quality Guidelines
PEL: Probable Effect Levels
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.2.3.3 Surface Water Quality

The water quality standard used for the site survey is shown in Table A 3.2-5. When the site survey was implemented, Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH (Official Gazette of SRBiH No.18/80) was still in force in FBiH. In January 2014, the new Rulebook on Characterization of Surface Waters and Froundwaters, Reference Conditions and Parameters for Assessing Water Status and on Water Monitoring was published (Official Gazette of FBiH, No. 1/14). It is expected that this new Decision will enable the classification based on ecological and chemical status of groundwaters and surface waters.

Table A 3.2-5 Environmental Standard (Surface Water)

Parameter	Units	Maximum concentration of certain harmful substances in surface waters	
		I-II	III-IV
PH	-	6.8-8.5(Class I) 5.8-8.5(Class II)	6.0-9.0
DO	mg/l	6-8	3-4
COD	mg/l	10-12	20-40
SS	mg/l	10-30	80-100
Cadmium (Cd)	mg/l	0.0005	0.005
Lead (Pb)	mg/l	0.002	0.08
Total chromium (T-Cr)	mg/l	0.001-0.006	0.006-0.002
Total mercury (T-Hg)	mg/l	0.00002	0.001
Copper (Cu)	mg/l	0.002-0.01	0.01- 0.02
Zinc (Zn)	mg/l	0.005-0.08	0.08-0.2
Iron (Fe)	mg/l	0.1	1
Manganese (Mn)	mg/l	0.05	1
Arsenic (As)	mg/l	0.05	0.05
Fluoride (F)	mg/l	0.0003	0.0015
Cyanide	mg/l	0.001	0.1
Polychlorinated Biphenyls (PCBs)	µg/l	0.02	0.2
Polycyclic aromatic hydrocarbons (PAH) (total)	ng/l	200	1000

Source: Decree on Hazardous and Noxious Substances in Water was adopted in 2007 (Official Gazette of FBiH, No. 43/07) and Decree on Classification of Waters and Coastal Waters of Yugoslavia Within the Borders of Socialist Republic of BiH (Official Gazette of SRBiH, No.18/80)

A 3.3 Former Chemical Factory Site in Tuzla

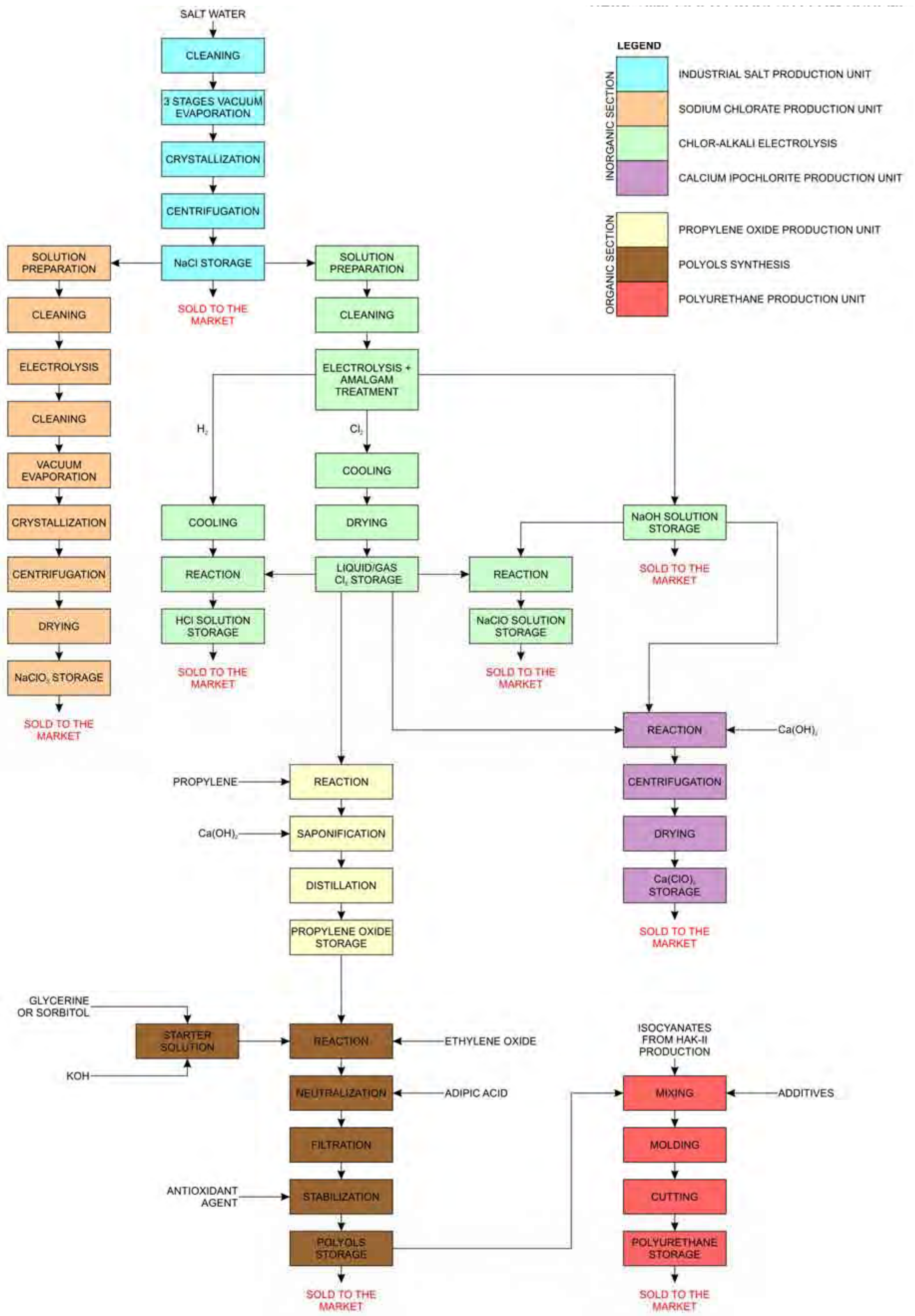
A 3.3.1 Supplementary Data of General Site Information and History of the Site

The production processes and product information are shown in the following tables and figure as additional data used to consider the possible contamination of the site.

Table A 3.3-1 Main Production Processes in the Former Chemical Factory

Building No.	Production	Chemicals used and process
Building 1	Industrial salt production	- Salt was produced by evaporation of salt water. - The majority of resulting salt (industrial quality salt) after centrifugation was sold to the market while a fraction was used as a raw material for the production of sodium chlorate and in the chlor-alkali electrolysis unit.
Building 3	Sodium chlorate(NaClO3) production	- Sodium chlorate was produced by the electrolysis of a hot sodium chloride solution with hydrogen gas using electrolytic cells each formed by titanium covered by a platinum-iridium anode and a carbon steel cathode.
Building 2	Chlor-alkali electrolysis and sodium hypochlorite (NaClO) production	- After the cleaning of salt solution, it was fed to the electrolytic cells composed by a mercury (Hg) cathode (about 50 tons of mercury) and a graphite anode. - At the anode was produced Chlorine gas. This chlorine was then used for the production Hydrochloric Acid, Calcium hypochlorite, Sodium hypochlorite and in the process of production of Propylene Oxide. - At the cathode there was the formation of an amalgam between mercury and sodium which was treated in a special reactor using water to produce Sodium hydroxide, Hydrogen and regenerated mercury to be returned to the electrolytic cells. The Sodium hydroxide solution was partially stored and sold on the market while a fraction was used for the production of Calcium hypochlorite and Sodium hypochlorite. - Produced Hydrogen after cooling was used only for the synthesis of Hydrochloric Acid by direct reaction with Chlorine gas. The final gas HCl product was then absorbed in water and stored. Small quantities of Hydrochloric Acid were used for internal needs while majority was sold on the market. - Excess Hydrogen was discharged to the atmosphere. Part of Sodium hydroxide solution underwent a reaction with chlorine gas to produce Sodium hypochlorite solution to be sold on the market.

Source: Prepared by JET based on Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina (HEIS, 2014)



Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.3-1 Process Flow of Inorganic Sector of Former Chemical Factory

Table A 3.3-2 Annual Volumes of Raw Materials, Products and By-products in the Former Chemical Factory

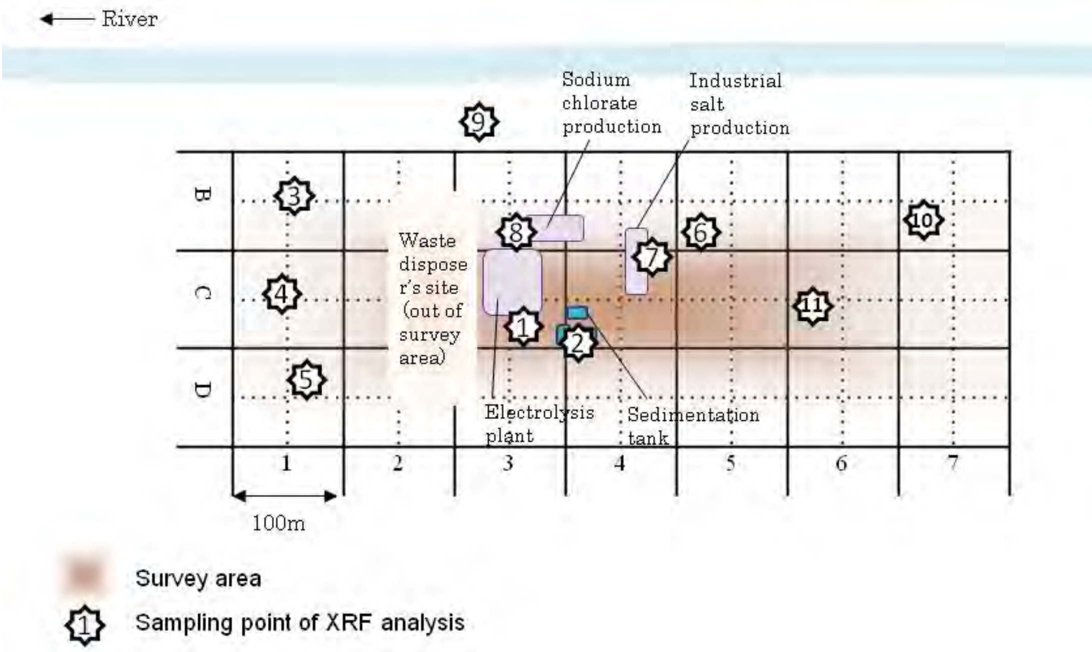
	Year	Design	1986	1984
	Source	EBS, 1987	EBS, 1987	EBS, 1985
	Workers	-	1096	1074
Raw materials and energy	Unit			
Salt water	t/year	285,000	349,961	337,640
Sodium carbonate	t/year	410	201	342
Urea	t/year	4.8	4.8	5.4
Sulphuric acid	t/year	540	393	523
Freon 22	t/year	-	8.8	11.7
Carbon tetrachloride	t/year	12	16	8.9
Diluted calcium hydroxide	t/year	2,061	780	577
Calcium hydroxide	t/year	24,300	29302	
Propylene	t/year	16,110	29,202	18,501
Chlorine (liquid)	t/year	30,540	21,317	27,981
Glycerine	t/year	406	648	611
Sorbitol (70%)	t/year	692	892	644
Mercury	t/year	4.3	7.0	4.2
Ethylene oxide	t/year	1430	1927	1686
Potassium hydroxide	t/year	54	79	50
Topanol (antioxidant agent)	t/year	27	36	31
Adipic acid	t/year	72	78	73
Filtercel (diatomaceous earth)	t/year	4.4	8.7	6.1
Other unspecified additives	t/year	1	0.4	0.4
Water	t/year	2,729,200	2,758,014	2,615,844
Steam	t/year	350,000	301,266	318,823
Electrical energy	MWh	202	109	93
Products and by-products				
Industrial salt	t/year	75,000	82,733	79,104
Sodium chloride	t/year	4,000	3,404	3,812
Chlorine (gas)	t/year	36,000	18,009	13,096
Chlorine (liquid)	t/year	28,800	14,110	8,579
Sodium hydroxide	t/year	40,500	20,311	14,772
Hydrochloric acid	t/year	6,000	3,975	5,053
Calcium hypochlorite	t/year	3,000	358	342
Sodium hypochlorite	t/year	15,000	17,893	19,448
Propylene oxide	t/year	18,000	22,352	19,488
Polyols	t/year	20,000	24,879	21,520
Polyurethane	t/year	5,000	4,477	3,112
Internal consumption				
Industrial salt	t/year	65,600	34,652	26,872
Sodium hydroxide	t/year	3,458	2,367	936
Hydrochloric acid	t/year	461	1,353	314
Sodium hypochlorite	t/year	0	300	138
Propylene oxide	t/year	14,304	22,484	19,530
Polyols	t/year	4,000	3,993	2,674

EBS: Report on determining EBS wastewater.
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.3.2 Site Investigation

(1) Simplified Measurement for Soil

The sampling points and the results of measurement with XRF Analyzer (X-ray fluorescence, Niton XL3t GOLDD+ Series Environmental Analyzer) are shown in the following figure and table. Detections of high concentration of Zn at the location No.4 and Hg at No.7 were not expected in the preliminary sampling plan. Hence, based on the results of the preliminary survey with XRF, the sampling and analysis of these parameters around these locations were added to the design of the site survey. Also, vapor gas of mercury, trichloroethylene, and toluene in soil were measured using gas sampling pump and gas detector tube on site. Though there was a difficulty with pumping of soil gas due to the clay-rich soil, those substances were not confirmed by these gas detectors.



Source: JET

Figure A 3.3-2 Sampling Point of XRF Analysis

Table A 3.3-3 Result of XRF Analysis (Soil)

Sample			Pb	As	Hg	Zn	Cu	Ni	Co	Fe	Mn	Cr
1	Electrolysis Plant 1	ppm	687.83	24.41	1135.09	3453.91	388.32	302.13	0	200312.48	1502.23	812.68
2	Electrolysis Plant 2	ppm	22.9	2.96	18.15	236.57	42.41	74.63	488.62	61483.08	1224.4	94.39
3	Waste Disposal 1	ppm	16.07	11.86	3.07	61.87	19.12	129.27	46.39	19937.54	347.98	281.18
4	Waste Disposal 2	ppm	1117.39	41.78	11.01	4412.07	112.3	73.98	352.83	108562.95	874.14	158.19
5	Waste Disposal 3	ppm	459.29	44.86	34.66	2112.9	330.93	178.08	0	116673.73	1085.66	361.36
6	Industrial Salt Production 1	ppm	383.84	40.7	8.73	1157.12	108.91	195.45	663.87	56429.28	1080.19	432.83
7	Industrial Salt Production 2	ppm	407.31	61.83	5336.69	598.77	519.81	107.57	125.77	39799.35	331.65	132.52
8	Sodium Chlorate Production 1	ppm	38.55	8.5	14.83	168.01	331.2	155.5	14.98	13565.54	261.35	270.71
9	Likely Low contaminated area 1	ppm	51.84	17.93	1.21	101.6	56.06	198.44	30.15	27591.23	608.27	398.69
10	Likely Low contaminated area 2	ppm	25.58	10.04	0.55	90.96	20.9	100.34	58.71	12265.47	363.01	292.3
11	Likely Low contaminated area 3	ppm	12.85	5.72	1.59	45.59	13.63	112.3	20.23	7876.88	224.78	536.54

Source: JET

(2) Sampling Locations

The sampling locations are shown in the following map. The exact sampling points are not indicated in the map as it is not the purpose of this report.

(3) Analysis Result

The analysis result is shown in the following tables.

Source: "HEIS, Completion Report of On –site Investigation and Sampling, 2013" and revised by JET

Figure A 3.3-3 Sampling Point of Former Chemical Factory Site

Table A 3.3-4 Site Investigation Result of Soil for Former Chemical Factory Site (1)

Parameter	Sample label / Type	CHE-BH-1 / 0.5	CHE-BH-1 / 1	CHE-BH-1 / 3	CHE-BH-1 / 5	CHE-BH-2 / 0.2	CHE-BH-2 / 1	CHE-BH-2 / 3	CHE-BH-2 / 5	CHE-P-1 / 0.5	CHE-P-1 / 1
		Soil at 0.5m	Soil at 1m	Soil at 3m	Soil at 5m	Soil at 0.2m	Soil at 1m	Soil at 3m	Soil at 5m	Soil at 0.5m	Soil at 1m
pH - Water	pH units	8.1	8.3	7.77	8.8	8.9	9.21	8.99	9.97	8.63	8.71
EC	uS/cm	3000	269	465	294	100	210	126	186	104	101
Oil/fat	g/kg	2.28	0.51	0.52	0.61	1.6	1.46	0.25	0.75	0.75	0.55
Water content	%	13.15	19.25	23.58	17.25	18.95	19.06	18.34	13.35	8.76	14.6
Cadmium (Cd)	mg/kg DW	11.97	2.18	2.87	4.07	15.54	3.29	1.56	3.37	2.99	1.72
Lead (Pb)	mg/kg DW	55.3	18.94	30.92	19.38	91.75	19.81	11.52	18.4	21.98	15.81
Total chromium (T-Cr)	mg/kg DW	25.34	23.9	115.18	245.69	60.6	98.2	54.74	38.32	19.88	21.18
Total mercury (T-Hg)	mg/kg DW	105.40	6.08	5.33	4.42	44.62	4.33	1.22	0.19	0.57	0.09
Zinc (Zn)	mg/kg DW	133.61	43.98	48.82	11.49	68.71	43.33	11.01	9.21	9.24	23.61
Arsenic (As)	mg/kg DW	6.92	7.11	13.7	6.02	7.25	7.83	4.71	10.85	5.77	4.53
Selenium(Se)	mg/kg DW	40.47	38.39	41.61	36.50	37.71	36.47	38.23	40.85	38.32	39.41
Cyanide	mg/kg DW	0.078	0.052	0.03	0.058	0.03	0.032	0.02	0.006	0.07	0.052
Polychlorinated Biphenyl (PCB)	mg/kg DW	0.18	<0.05	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Density	g/cm3	1.56	1.79	1.72	1.79	1.79	1.79	1.85	1.67	1.92	1.85
Ignition loss (550°C)	%	2.97	1.37	3.88	2.65	2.78	2.61	1.33	1.66	2.04	1.12

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-4 Site Investigation Result of Soil for Former Chemical Factory Site (2)

Parameter	Sample label / Type	CHE-P-1 / 3	CHE-P-1 / 6	CHE-B-3-3	CHE-B-4-4	CHE-B-5-3	CHE-C-4-2	CHE-B-3-4	CHE-B-4-3	CHE-C-3-1	CHE-C-3-2
		Soil at 3m	Soil at 6m	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil
pH - Water	pH units	8.24	10.17	8.71	8.98	9	9.65	8.86	9.81	9.52	10.51
EC	uS/cm	78	415	79	117	94.0	261	325	412	208	400
Oil/fat	g/kg	0.35	0.3	1.36	0.25	0.73	1.52	0.91	0.46	3.33	0.66
Water content	%	13.4	6.99	12.14	14.26	12.53	16.36	16.54	13.36	14.14	6.94
Cadmium (Cd)	mg/kg DW	1.89	3.11	0.22	0.22	0.30	<0.05	0.17	0.22	53.06	4.88
Lead (Pb)	mg/kg DW	11.42	16.66	19.83	23.87	56.87	70.91	26.9	47.26	87.57	45.44
Total chromium (T-Cr)	mg/kg DW	31.78	76.67	31.89	31.98	79.15	160.36	39.89	31.96	55.24	43.9
Total mercury (T-Hg)	mg/kg DW	0.55	0.26	0.19	0.17	0.39	0.09	0.07	1.70	12.68	5.03
Zinc (Zn)	mg/kg DW	16.34	12.05	55.4	1464,36	272.83	603.85	318.29	165.54	86.26	283.64
Arsenic (As)	mg/kg DW	4.3	11.13	6.24	7.44	5.64	8.37	7.54	10.35	6.01	7.49
Selenium(Se)	mg/kg DW	37.53	40.87	41.07	40.05	42.29	43.22	41.49	40.03	42.42	39.22
Cyanide	mg/kg DW	0.013	1.55	0.042	0.032	0.026	0.078	0.013	0.127	0.033	0.052
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Density	g/cm3	1.79	1.85	1.92	1.56	-	1.72	1.85	1.79	1.67	1.85
Ignition loss (550°C)	%	1.42	2.8	5.54	2.61	2.2	2.79	1.99	2.49	3.84	1.41

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-4 Site Investigation Result of Soil for Former Chemical Factory Site (3)

Parameter	Sample label	CHE-C-3-3	CHE-C-3-4	CHE-C-4-1	CHE-C-4-3	CHE-C-4-4	CHE-B-1 / COMP	CHE-B-2 / COMP	CHE-B-3 / COMP	CHE-B-5 / COMP	CHE-B-6 / COMP
	Type	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Composite of CHE-B-1-2 + CHE-B-1-3 + CHE-B-1-4	Composite of CHE-B-2-2 + CHE-B-2-3 + CHE-B-2-4	Composite of CHE-B-3-1 + CHE-B-3-2	Composite of CHE-B-5-2 + CHE-B-5-4	Composite of CHE-B-6-3 + CHE-B-6-4
pH - Water	pH units	8.7	10.39	9.23	9.79	9.96	8.72	8.21	8.56	8.46	8.7
EC	uS/cm	231	700	163	279	380	106	449	182	131	106
Oil/fat	g/kg	0.41	0.26	0.95	0.3	1.93	0.4	1.39	0.77	0.21	0.46
Water content	%	13.56	17.78	8.9	10.80	14.32	9.11	16.72	19.62	17.13	18.57
Cadmium (Cd)	mg/kg DW	8.69	<0.05	<0.05	0.46	1.90	0.15	11.19	0.39	0.21	0.23
Lead (Pb)	mg/kg DW	42.85	14.25	254.18	129.04	73.35	49.39	1123,76	109.61	33.21	32.74
Total chromium (T-Cr)	mg/kg DW	99.59	67.12	58.14	119.93	86.61	35.58	149.09	100.76	146.14	160.08
Total mercury (T-Hg)	mg/kg DW	<0.01	<0.01	1.37	0.52	0.06	0.49	1.36	0.67	<0.01	1.86
Zinc (Zn)	mg/kg DW	660.51	69.3	704.33	684.78	105.32	153.91	161.2	123.22	110.23	112.42
Arsenic (As)	mg/kg DW	8.74	6.09	6.63	15.67	8.64	5.77	7.18	8.46	12.49	9.53
Selenium(Se)	mg/kg DW	43.53	43.04	41.61	41.96	44.63	41.49	39.19	41.53	41.45	42.00
Cyanide	mg/kg DW	0.066	0.019	0.038	0.019	0.052	0.018	0.052	0.045	0.038	0.032
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0.05	<0.05	<0.05	<0.05	0.13	<0.05	<0.05	<0.05	0.11	<0.05
Density	g/cm3	1.79	1.79	1.92	1.79	1.72	-	-	-	-	-
Ignition loss (550°C)	%	3.86	0.68	1.66	1.53	1.74	1.25	5.7	5.43	6.97	2.66

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-4 Site Investigation Result of Soil for Former Chemical Factory Site (4)

Parameter	Sample label	CHE-B-7 / COMP	CHE-C-1 / COMP	CHE-C-2 / COMP	CHE-C-5 / COMP-A	CHE-C-5 / COMP-B	CHE-C-6 / COMP	CHE-C-7 / COMP	CHE-D-2 / COMP	CHE-D-3 / COMP	CHE-D-4 / COMP
	Type	Composite of CHE-B-7-1 + CHE-B-7-2 + CHE-B-7-3	Composite of CHE-C-1-1 + CHE-C-1-2 + CHE-C-1-4	Composite of CHE-C-2-1 + CHE-C-2-2 + CHE-C-2-3 + CHE-C-2-4	Composite of CHE-C-5-1 + CHE-C-5-3	Composite of CHE-C-5-2 + CHE-C-5-4	Composite of CHE-C-6-1 + CHE-C-6-3	Composite of CHE-C-7-1 + CHE-C-7-2 + CHE-C-7-3	Composite of CHE-D-2-1 + CHE-D-2-2	Composite of CHE-D-3-1 + CHE-D-3-2	Composite of CHE-D-4-1 + CHE-D-4-2
pH - Water	pH units	8.56	8.61	8.41	9.24	8.33	7.81	8.55	7.86	9.51	8.61
EC	uS/cm	121	138	159.0	237	257	4810	2220	2000	527	333
Oil/fat	g/kg	0.41	0.85	1.34	4.37	0.73	0.56	0.41	1.23	1.66	2.23
Water content	%	19.63	6.97	14.11	15.24	24.17	13.23	16.54	16.34	12.76	9.91
Cadmium (Cd)	mg/kg DW	0.28	0.23	4.31	1.31	1.03	1.76	0.08	1.41	4.52	10.81
Lead (Pb)	mg/kg DW	66.72	102.64	628.43	40.21	41.3	46.25	18.21	140.16	222.99	201.47
Total chromium (T-Cr)	mg/kg DW	160.93	46.29	48.73	23.98	45.16	67.05	37.49	34.99	46.14	106.81
Total mercury (T-Hg)	mg/kg DW	0.37	2.61	7.06	0.06	0.52	0.10	<0.01	0.24	0.42	0.04
Zinc (Zn)	mg/kg DW	514.31	1549,94	1370,61	1847,27	253.2	480.07	138.25	349.67	496.31	751.45
Arsenic (As)	mg/kg DW	10.76	7.47	8.91	7.13	10.89	11.29	8.14	11.08	6.88	9.5
Selenium(Se)	mg/kg DW	41.08	40.89	42.23	42.72	42.30	41.07	41.40	40.84	41.51	40.51
Cyanide	mg/kg DW	0.032	0.049	0.051	0.019	0.554	0.043	0.037	0.324	0.019	0.057
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0.05	0.42	<0.05	39.70	<0.05	<0.05	<0.05	0.59	0.32	<0.05
Density	g/cm3	-	-	-	-	-	-	-	-	-	-
Ignition loss (550°C)	%	4.08	2.97	4.28	2.61	4.66	2.61	3.29	4.44	3.34	3.27

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-4 Site Investigation Result of Soil for Former Chemical Factory Site (5)

Parameter	Sample label / Type	CHE-D-5 / COMP	CHE-D-6 / COMP	CHE-D-7 / COMP	Reference values
		Composite of CHE-D-5-1 + CHE-D-5-2	Composite of CHE-D-6-1 + CHE-D-6-2	Composite of CHE-D-7-1 + CHE-D-7-2	
pH - Water	pH units	8.69	8.70	8.63	-
EC	uS/cm	182	162	123	-
Oil/fat	g/kg	1.51	2.13	0.76	-
Water content	%	7.12	18.37	7.71	-
Cadmium (Cd)	mg/kg DW	<0.05	0.99	0.28	10
Lead (Pb)	mg/kg DW	288.94	30.45	33.04	500
Total chromium (T-Cr)	mg/kg DW	158.41	95.8	111.58	250
Total mercury (T-Hg)	mg/kg DW	0.72	0.68	<0.01	10
Zinc (Zn)	mg/kg DW	761.57	233.28	172.77	1,000
Arsenic (As)	mg/kg DW	7.79	7.71	6.81	50
Selenium(Se)	mg/kg DW	40.43	38.47	38.78	100
Cyanide	mg/kg DW	0.064	0.245	0.065	50
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0.05	<0.05	<0.05	5
Density	g/cm3	-	-	-	-
Ignition loss (550°C)	%	1.91	2.26	2.47	-

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-5 Site Investigation Result of Soil Background for Former Chemical Factory Site

Parameter	Sample label	CHE-BG-4	CHE-BG-5	CHE-BG-6	Referrence Values
	Type	Sub-surface soil	Sub-surface soil	Sub-surface soil	
pH - Water	pH units	7.36	7.98	7.23	-
EC	uS/cm	203	124	95	-
Oil/fat	g/kg	0.6	0.4	0.4	-
Water content	%	19.89	22.1	18.9	-
Cadmium (Cd)	mg/kg DW	0.28	0.13	<0,05	10
Lead (Pb)	mg/kg DW	32	18	14	500
Total chromium (T-Cr)	mg/kg DW	27	60	29	250
Total mercury (T-Hg)	mg/kg DW	<0,01	<0,01	<0,01	10
Zinc (Zn)	mg/kg DW	18	119	52	1000
Arsenic (As)	mg/kg DW	9	9	8	50
Selenium(Se)	mg/kg DW	43	43	43	100
Cyanide	mg/kg DW	0.03	0.02	0.03	50
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0,05	<0,05	<0,05	5
Density	g/cm3	-	-	-	-
Ignition loss (550°C)	%	7.1	4.45	7.1	-

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-6 Site Investigation Result of Sediment in the Sedimentation Tank of Former Chemical Factory Site

Parameter	Sample label / Type	CHE-ST-A / SED	CHE-ST-B / SED	CHE-ST-C / SED	CHE-SCH	Referrence Values
		Sediment	Sediment	Sediment	Sediment	
pH - Water	pH units	9.8	9.98	9.61	-	-
EC	uS/cm	10800	10400	121300	-	-
Oil/fat	g/kg	3.8	11.6	6.9	-	-
Water content	%	88.86	80.7	84.9	-	-
Cadmium (Cd)	mg/kg DW	26.28	31.7	17.85		10
Lead (Pb)	mg/kg DW	771	303	79	-	500
Total chromium (T-Cr)	mg/kg DW	41	68	32	-	250
Total mercury (T-Hg)	mg/kg DW	10	24	25	24	10
Zinc (Zn)	mg/kg DW	6851	2923	2792	-	1000
Arsenic (As)	mg/kg DW	3	5	4	-	50
Selenium(Se)	mg/kg DW	43	43	42		100
Cyanide	mg/kg DW	0	1	0	-	50
Polychlorinated Biphenyl (PCB)	mg/kg DW	0.47	<0,05	0.66	-	5
Density	g/cm3	-	-	-	-	-
Ignition loss (550°C)	%	13.7	18.71	7.12	-	-

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-7 Site Investigation Result of Sediment for Former Chemical Factory Site

Parameter	Sample label	CHE-RIVER-UP / SED	CHE-RIVER-DOWN / SED	Reference Values	
	Type	Sediment	Sediment	Freshwater (ISQG)	Freshwater (PEL)
pH - Water	pH units	8.81	8.78	-	-
EC	uS/cm	853	720	-	-
Oil/fat	g/kg	2.1	2.3	-	-
Water content	%	55.7	40.7	-	-
Cadmium (Cd)	mg/kg DW	0.43	0.54	0.6	3.5
Lead (Pb)	mg/kg DW	36	53	35	91.3
Total chromium (T-Cr)	mg/kg DW	21	45	37.3	90
Total mercury (T-Hg)	mg/kg DW	<0,01	<0,01	0.17	0.486
Zinc (Zn)	mg/kg DW	145	597	123	315
Arsenic (As)	mg/kg DW	4.1	5.1	5.9	17
Selenium(Se)	mg/kg DW	0.9	0.9	-	-
Cyanide	mg/kg DW	0.1	0.09	-	-
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0,05	<0,05	0.0341	0.277
Density	g/cm3	-	-	-	-
Ignition loss (550°C)	%	6.21	4.84	-	-

*) Canadian Sediment Quality Guidelines for Protection of Aquatic Life(http://ceqg-rcqe.ccme.ca/)

ISQG: Interim Sediment Quality Guidelines

PEL: Probable Effect Levels

:Freshwater (PEL) or more

:Freshwater (ISQG) or more, but less than PEL

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table 3.3-8 A Site Investigation Result of Waste for Former Chemical Factory Site

Parameter	Sample label / Type	CHE-WD / Waste*	Referrence Values
pH - Water	pH units	8.57	-
pH -KCl	pH units	8.49	-
EC	uS/cm	810	-
Oil/fat	g/kg	9.7	-
Water content	%	10.7	-
Cadmium (Cd)	mg/kg DW	14.26	10
Lead (Pb)	mg/kg DW	30	500
Total chromium (T-Cr)	mg/kg DW	40	250
Total mercury (T-Hg)	mg/kg DW	32	10
Zinc (Zn)	mg/kg DW	52	1000
Arsenic (As)	mg/kg DW	7.2	50
Selenium(Se)	mg/kg DW	45	100
Cyanide	mg/kg DW	0.07	50
Polychlorinated Biphenyl (PCB)	mg/kg DW	<0,05	5
Density	g/cm3	-	-
Ignition loss (550°C)	%	-	-

*Analyses of the sample were conducted after the manual removal of elementary mercury (liquid Hg) from the sample. Amount of the removed elementary mercury was 22% of the total mass of the waste.

: Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-9 Site Investigation Result of Water for Former Chemical Factory Site

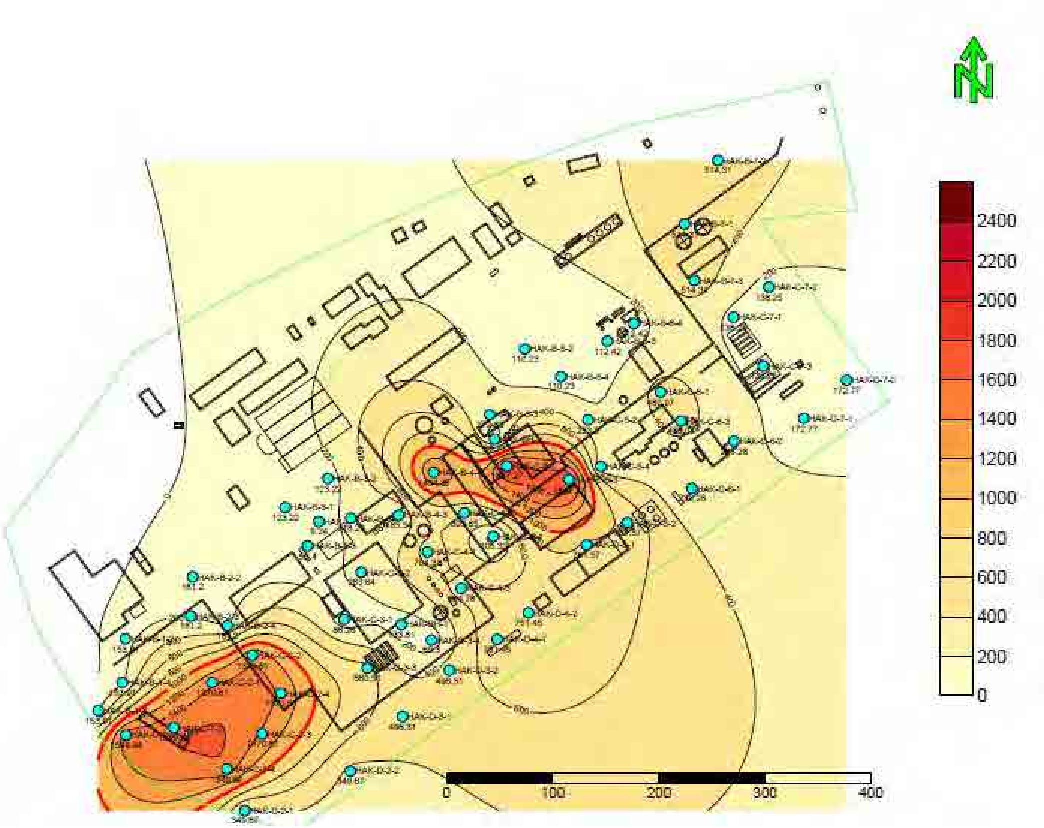
Parameter	Sample label	CHE-BG-1	CHE-BG-2	CHE-BG-3	CHE-BH-1 / W	CHE-RIVER-UP / W	CHE-RIVER-DOWN / W	CHE-P-1 / W	CHE-ST-A / W	CHE-ST-B / W	CHE-ST-C / W	Referrence Values	
	Type	Ground water	Ground water	Ground water	Water	Riverw ater	Riverw ater	Ground water	Surfacr water	Surfacr water	Surfacr water	Class I-II	Class III-IV
pH	-	6.6	7.94	7.17	7.10	10.94	10.67	7.08	9.88	9.35	9.39	6.8-8.5(Class I) 5.8-8.5(Class II)	6.0-9.0
EC	uS/cm	331	341	799	1494	2140	2200	3360	1713	454	35000		
DO	mg/l	5.6	1.3	3.5	-	6.2	5.3	2.4	6.69	6.03	6.55	6-8	3-4
Turbidity	NTU	< 0.01	< 0.01	< 0.01	-	350	150	110	10	0.15	3.2		
Salinity	PSU	0.1753	0.1808	0.4354	0.8366	1.2203	1.2563	1.9652	0.9657	0.2426	24.6658		
COD	mg/l	-	-	-	-	57	90	-	78	49	360	-	-
Total phosphorous (T-P)	mg/l	-	-	-	-	0.049	0.062	-	-	-	-	-	-
Total nitrogen (T-N)	mg/l	-	-	-	-	14.6	12.0	-	-	-	-	-	-
Oil/fat	mg/l	-	-	-	30	50	28	32	32	22	84	-	-
SS	mg/l	-	-	-	-	458	234	-	-	-	-	-	-
Cadmium (Cd)	mg/l	< 0,001	0.001	0.001	0.003	0.006	0.007	0.011	0.009	0.002	0.013	0.0005	0.005
Lead (Pb)	mg/l	0.010	0.008	0.011	0.025	0.066	0.060	0.052	0.020	0.013	1.520	0.002	0.08
Total chromium (T-Cr)	mg/l	0.011	0.004	0.004	0.003	0.110	0.054	0.014	0.008	0.005	0.006	0.001-0.006	0.006-0.002
Total mercury (T-Hg)	mg/l	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,001	< 0,001	0.006	0.008	0.005	0.00002	0.001
Copper (Cu)	mg/l	0.009	0.009	0.009	0.007	0.011	0.011	0.022	0.018	0.015	0.011	0.002-0.01	0.01- 0.02
Zinc (Zn)	mg/l	0.039	0.019	0.028	0.044	0.0220	0.054	0.147	0.022	0.023	0.036	0.005-0.08	0.08-0.2
Iron (Fe)	mg/l	0.06	0.08	0.05	-	0.15	0.12	0.54	0.28	0.16	0.14	0.1	1
Manganese (Mn)	mg/l	0.006	0.214	0.016	1.035	0.01	0.01	0.99	0.02	< 0.01	< 0.01	0.05	1
Arsenic (As)	mg/l	< 0,001	< 0,001	< 0,001	0.01	0.001	0.002	0.067	0.012	0.002	0.012	0.05	0.05
Nickel(Ni)	mg/l	0.009	0.011	0.014	0.009	-	-	0.0110	-	-	-	-	-
Cyanide	mg/l	< 0,001	< 0,001	< 0,001	0.002	0.009	0.009	0.005	0.008	0.001	0.003	0.001	0.1
Polychlorinated Biphenyl (PCB)	ug/l	<0,1	<0,1	<0,01	<0,1	<0.1	<0,1	4.65	0.24	0.26	0.26	0.02	0.2

:Reference values of class I-II or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.3.3 Hazardous Maps

The soil parameters whose results exceeded the reference values for soil at this site were Cd, Pb, Hg, Zn and PCBs. The hazardous map of Zn is shown as follows and the hazardous maps of other parameters are already shown in Chapter 4.



Pb (mg/kg D.W., soil concentration)

Note) In this hazardous map, the concentration of un-sampled area is estimated by interpolation. Generally, when the sampling number is limited, the accuracy of equal-concentration line is low. Extension of the polluted areas, especially when far from sampling points, should be considered only as indicative and it will require being checked during future investigation.

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.3-4 Hazardous Maps of Former Chemical Factory in Tuzla

A 3.3.4 Risk Analysis

(1) Methodology of HRS

The methodology used for the risk assessment in this Survey has been adopted from the U.S. EPA (U.S. EPA, 1992; U.S. EPA, 2006). This methodology relies on a numerically based scoring system named Hazard Ranking System (HRS). The main goal of this system is to assess the relative potential of sites to pose a threat to human health and/or the environment.

During the broad selection process of the most suitable methodology for the purposes of this Survey, HRS methodology used by the U.S. EPA certainly outweighed other possible options due to its sound scientific approach in measurement of relative risk from potential contamination and possibility to obtain reasonable quantitative results in due time.

Further benefits of the application of this methodology are given to the following parts of the risk assessment;

- Level of human exposure – extra emphasis is placed on those sites that result in actual human exposure, as opposed to potential exposure;
- Measurement of toxicity – entire spectrum of factors is used for toxicity assessment, which account not only acute toxicity, but also chronic, non-carcinogenic and carcinogenic effects of the same;
- Definition of targets – targets are classified and weighted depending on measured distance from the site and estimation of dilution factor which is likely to occur;
- Evaluation of environmental targets – aforesaid more accurate definition of targets resulted in more comprehensive approach to the evaluation of environmental targets.

According to the EPA website (http://www.epa.gov/superfund/programs/npl_hrs/hrsint.htm, confirmed on 24th February, 2014), the HRS is introduced by the following explanation.

"The HRS uses a structured analysis approach to scoring sites. This approach assigns numerical values to factors that relate to risk based on conditions at the site. The factors are grouped into three categories:

- likelihood that a site has released or has the potential to release hazardous substances into the environment;
- characteristics of the waste (e.g. toxicity and waste quantity); and
- people or sensitive environments (targets) affected by the release.

Four pathways can be scored under the HRS:

- ground water migration (drinking water);
- surface water migration (drinking water, human food chain, sensitive environments);
- soil exposure (resident population, nearby population, sensitive environments); and
- air migration (population, sensitive environments).

(2) Detail Data of Input and Output of Overall Risk Assessment

The overall risk assessment is a result of integrated overview, evaluation and application of scientific historical data (data on climatic, geological, hydrogeological, and hydrological conditions on this site), socio-demographic, topographic surveys, information on land and water use, together with data from sampling survey and chemical analysis conducted within this survey. Thus, the aim of this integrated approach applied in the overall risk assessment is the measurement of the possibility of potential or actual release of toxic substances, determination of threat to human health and environment, and quantification of risk for exposed organisms. The input values for HRS and the breakdown of the result for the former chemical factory site are shown in the following table.

Table A 3.3-10 Input Parameters and Values for the Risk Score Calculations of Former Chemical Factory Site

Summarized overview of input parameters for HAK sampling site														
Parameter	**Unit**	**Input values**												
		Months												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Σ**
Monthy Precipitation	mm/month	59	55	61	76	92	111	94	84	64	56	71	72	895
I-parameter		0	0.19528	1.2194	3.0307	5.1705	6.7794	7.7285	7.4873	5.4912	3.1194	1.1872	0.0746	41.483
α-parameter		1.151												
Mean monthly Evapotranspiration	mm/month	0	4.63419	23.697	51.973	88.661	110.53	123.19	110.78	75.452	44.307	17.931	2.0828	
Average Day Length of the month	hours	9.2	10.4	11.93	13.53	14.88	15.6	15.23	14.03	12.5	10.92	9.52	8.78	
Number of days in the month		31	28	31	30	31	30	31	31	30	31	30	31	
Mean monthly temperature	°C	-0.8	1.7	5.7	10.4	14.8	17.7	19.3	18.9	15.4	10.6	5.6	0.9	
Distance from the surface to the top of aquifer	(cm)	550												
Hydraulic Conductivity of the layer	(cm/sec.)	1x10^-4 - 1X10^-5												
Thickness of lowest hydraulic conductivity layer	(cm)	120												
Distance from the surface to the top of aquifer	(cm)	600												
Distance from the surface to the lowest known point of hazardous substances	(cm)	600												
Source type		Contaminated soil												
Contributing hazardous substances		Mercury, Lead, Zinc, Polychlorinated biphenils (PCBs)												
Overall constituent quantity of hazardous substances	lbs	342850.43												
Area of contaminated site	m^2	231089												
Distance of the nearest drinking water wells (max.distance 6.5 km)	m	4000-6500 (upstream)												
Number of people served by drinking water within distance of 0 to 0.4 km	/	0												
Number of people served by drinking water within distance of 0.4 to 0.8 km	/	0												
Number of people served by drinking water within distance of 0.8 to 1.6 km	/	0												
Number of people served by drinking water within distance of 1.6 to 3.2 km	/	0												
Number of people served by drinking water within distance of 3.2 to 4.8 km	/	10 wells (100 people)												
Number of people served by drinking water within distance of 4.8 to 6.5 km	/	11 wells (120 people)												
Presence of the Wellhead Protection Area within a distance of 6.5 km	YES/NO	YES												
Number of people who live/attend school within a distance of 60 m from the contaminated area	/	0												
Number of workers within a distance of 60 m from the contaminated area	/	125												
Presence of comercial agriculture/silviculture/livestock productuction and/or grazing on the contaminated area	YES/NO	NO												
Site-specific 2 Yearly 24 hours Rainfall for the site (statistics from atleast last 20 years)	mm	43												
Drainage area (see note)	(m^2)	5014672												
A-Coarse-textures soils with high infiltration rates (sands, loamy sands)	(%)	0												
B- Medium-textures soils with moderate infiltration rates (sandy loams, loams)	(%)	92771 (1.85)												
C-Moderately fine-textured soils with low infiltration rates (silty loams, silts, sandy clay loams)	(%)	1968259 (39.25)												
D-Fine-textured soils with very low infiltration rates (clays, sandy clays, silty clay loams, clay loams, silty clays	(%)	2953641 (58.9)												

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-11 Breakout of Risk Score of Former Chemical Factory Site

Factor Category		GWMP	Surface Water Migration Pathway						SEMP		AMP
			SW/OC			GWSWC					
			DWT	HFCT	ET	DWT	HFCT	ET	RPT	NPT	
1	Observed release	550	0	0	0	0	0	0	550	0	0
2	Potential to release (higher of 2a and 2b)	0	97	97	97	84	84	84	-	-	28
2a	Potential to release by overland flow	-	27	27	27	-	-	-	-	-	-
2b	Potential to release by flood	-	70	70	70	-	-	-	-	-	-
2c	Gas potential to release	-	-	-	-	-	-	-			28
2d	Particulate potential to release	-	-	-	-	-	-	-			22
2e	Attractiveness/Accessibility	-	-	-	-	-	-	-	-	10	-
2f	Areas of Contamination	-	-	-	-	-	-	-	-	100	-
3	Likelihood of Release (higher of lines 1 and 2)	550	97	97	97	84	84	84	-	-	28
3*	Likelihood of Exposure (higher of lines 1 and 2)	-	-	-	-	-	-	-	550	500	-
4	Toxicity	-	-	-	-	-	-	-	10000	10000	2000
4a	Toxicity/Mobility	100	-	-	-	-	-	-	-	-	-
4b	Toxicity/Mobility/Persistence	-	-	-	-	-	40	10	-	-	-
4c	Toxicity/Mobility/Persistence/ Bioaccumulation	-	-	-	-	-	$2x10^6$	-	-	-	-
4d	Toxicity/Persistence	-	10000	10000	-	100	-	$5x10^5$	-	-	-
4e	Toxicity/Persistence/Bioaccumulation	-	-	$5x10^8$	-	-	-	-	-	-	-
4f	Ecotoxicity/Persistence	-	-	-	10000	-	-	-	-	-	-
4g	Ecotoxicity/Persistence/Bioaccumulation	-	-	-	$5x10^8$	-	-	-	-	-	-
4h	Bioaccumulation	-	-	-	-	-	50000	-	-	-	-
4i	Ecosystem BAP value	-	-	-	50000	-	-	50000	-	-	-
5	Hazardous Waste Quantity	10^5	10^6	10^6	10^6	10^6	10^6	10^6	10^6	10^6	10^6
5a	Waste characteristics	-	100	1000	1000	100	1000	560	100	100	-
6	Waste characteristics factor category	100	100	100	100	-	-	-	100	100	-
7	Nearest well	18	-	-	-	-	-	-	-	-	-
8	Nearest intake	-	1	-	-	20	-	-	-	-	-
9	Nearest individual	-	-	-	-	-	-	-	-	-	20
9a	Nearest Food Chain Individual	-	-	2	-	-	2	-	-	-	-
9b	Level I	-	-	-	-	-	-	-	-	-	-
9c	Level II	-	-	-	-	-	-	-	-	-	-
9d	Potential Contamination	-	1	-	-	1.2	0.1	10	-	-	16.4
10	Total population	1	1	0.1	-	-	0.1	-	-	-	-
10a	Level I	0	-	0	-	-	0	-	-	-	-
10b	Level II	0	-	0	-	-	0	-	-	-	-
10c	Potential Contamination	1	1	0.1	-	-	0.1	-	-	-	-

Factor Category		GWMP	Surface Water Migration Pathway						SEMP		AMP
			SW/OC			GWSWC					
			DWT	HFCT	ET	DWT	HFCT	ET	RPT	NPT	
11	Workers	-	-	-	-	-	-	-	15	-	-
12	Resources	5	5	-	-	5	-	-	5	-	5
13	Wellhead Protection Area	20	-	-	-	-	-	-	-	-	-
14a	Actual Contamination	-	-	-	-	-	-	-	-	-	-
14b	Potential Contamination	-	-	-	1	-	-	1	-	-	2.3
14c	Sensitive Environments	-	-	-	0.1	-	-	1	30	-	-
15c	Nearby individual	-	-	-	-	-	-	-	-	1	-
16a	Population within a mile	-	-	-	-	-	-	-	-	20	-
16b	Targets factor category	44	26	2.1	0.1	26.2	2.1	1	95	21	43.7
17	Threat Score	-	3.06	2.14	0.12	2.67	2.14	0.57	522×10^5	105×10^4	-
18	Component Score	-	**5.65**			**5.38**			-	-	-
19	Pathway score	**29.34**	**5.38**						**76.06**		**1.48**
20	Overall site score	**40.87**									

Abbreviations: GWMP – Groundwater Migration Pathway, SW/OC – Surface Water/Overland Component, DWT – Drinking Water Threat, HFCT – Human Food Chain Threat, ET – Environmental Threat, GWSWC – Groundwater to Surface Water Component, SEMP – Soil Exposure Migration Pathway, RPT – Resident Population Threat, NPT – Nearby Population Threat, AMP – Air Migration Pathway

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.3.5 Supplemental Information of Proposed Remediation Plan

(1) Remediation Objectives

The overall remediation goal is to adequately decommission the existing facilities, properly dispose of the stored waste/chemicals including the waste originating from demolition activities and to eventually treat the contaminated soil to reduce contamination to a safe level for soil in industrial areas and minimize further spreading of the contaminants into the environment.

The results of soil, groundwater, water and sludge sampling indicated that the remediation plan has to consider contamination by heavy metals (mercury, lead, zinc, cadmium) and PCBs. There is also a chemical storage with about 20 t of chemicals, mainly organic chemicals, that has to be properly remediated. In addition, regarding the groundwater, the biggest concern is in fact contamination by PCBs.

In the following estimates regarding the volume and amount of the contaminated soil, depth of 0.5 m was taken as critical for the remediation purpose. Important data for the estimate of the volume of contaminated material are listed below:

- depth of contaminated soil: 0.5 m,
- specific weight of contaminated soil: 1,700 kg/m^3,
- moisture of contaminated soil: 18%,
- Volume of one sedimentation basin: 125 m^3,
- volume of sludge from one sedimentation basin: 25 m^3.

Input data for the preliminary estimate of the volume of pollution at the former chemical factory site is presented in the tables below.

Table A 3.3-12 Input data for the preliminary estimate of the volume of pollution

Conta-minant	Media	Estimated area (m^2)	Estimated volume (m^3)	Estimated mass (t)	Overlaping with the other contaminants	Concentration
Hg	Soil	10,553	5,277	10,585	Zn on the 2/3 of the surface, Cd on the half of the surface	Around 100 ppm of mercury
	Collected waste	-	10	10	Cd, 14.26 mg/kg	More then 20 % of mercury
	Sediment from the sedimentation basins	-	75	75	Cd around 20 mg/kg, Pb around 700 mg/kg in one of the basins, zinc 2000-6000 mg/kg	About 20 ppm of the mercury
Pb	soil	19,465	9,733	19,523	Zn on the 2/3 of the surface	
	sedimentation basin	-	25	25	Hg, Zn	
	groundwater	-	-	-	Cd, Zn, Fe, Mn, As, Cu in the concentration around and above IV class of water quality	0.052 mg/kg
Zn	soil	22,515	11,258	22,583		0.147 mg/kg
	sedimentation basin	-	75	75		
	groundwater	-	-	-	Cd, Zn, Fe, Mn, As, Cu in the concentration around and above IV class of water quality	
Cd	soil	14,022	7,011	14,064	Cd on the half of the surface	
	Collected waste	-	10	10	Hg	14.26 mg/kg
	Sedimentation basins	-	75	75	Hg, Zn	17-31 mg/kg
	groundwater	-	-	-	Cd, Zn, Fe, Mn, As, Cu in the concentration around and above IV class of water quality	0,011 mg/l
PCBs	soil	14,398	7,199	14,441	Hg	39.70 mg/kg
	groundwater	-	-	-	Cd, Zn, Fe, Mn, As, Cu in the concentration around and above IV class of water quality	4.65 mg/l

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.3-13 Summary of Input Data for the Estimate of the Volume of Pollution

Item	Estimated area (m^2)	Estimated volume (m^3)	Estimated mass (t)
Contaminated soil with Hg, Cd and Zn (Area 1)	15,100	7,550	15,100
Contaminated soil with Pb and Zn (Area 2)	15,900	7,950	15,900
Contaminated soil with Pb and Zn (Area 3)	8,800	4,400	8,800
Contaminated soil with Pb and Zn (Area 4)	5,500	2,750	5,500
Contaminated soil with Pb and Zn (Area 5)	800	400	800
Contaminated soil with Pb and Zn (Area 6)	3500	1750	3500
Contaminated soil with PCBs	9,800	4,900	9,800
Waste: soil with Hg (20%) and Cd			10
Chemicals mainly organic solvents/products which cannot be recycled			20
Sludge from the basins			70
Total contamination by the heavy metals	49,600	24,800	49,700
Total contamination by PCBs	9,800	4,900	9,800

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

(2) Proposed Remediation Plan

1) Development of Preliminary Remediation Plan

At this site the following issues were identified:

- There is a number of buildings and abandoned equipment sitting at the site, which have to be decommissioned because of the plans to use the site for other purposes. A part of the buildings and equipment is also polluted.
- There is a considerable amount of waste and sludge scattered around and stored at the site, which has to be properly disposed of.
- Soil is heavily polluted by heavy metals and PCBs, which requires remediation measures to bring the soil quality to acceptable level.

Since it has been estimated that the remediation of the soil will result in a gradual improvement of the groundwater quality, no specific measures regarding the groundwater remediation have been proposed here. The following describes possible remediation options for the contaminated soil.

2) Remediation Techniques for Hg, Cd and Zn Contamination

Among all heavy metals present at the site, mercury is the most important one because of the high toxicity and ability to evaporate. The following text presents techniques that are available for remediation of pollution caused by mercury and other heavy metals found at the site.

Mercury-containing wastes above a threshold concentration are classified “hazardous”. Hazardous and non-hazardous waste should be separated as much as possible and mixing of these should be avoided.

The most widely used full-scale remediation/containment technologies can be divided into 6 categories that are presented in table below.

Table A 3.3-14 Mercury treatment technologies screening for soil and waste

Technology	Residuals Produced	O&M or Capital Intensive	Factors Affecting the Applicability and Costs
Direct Disposal	Solid	O&M	Legislation limits; Public concerns; Volumes of soil and waste; availability and distance of adequate disposal site
Solidification/ Stabilization	Solid	Capital	pH of media; Presence of organic compounds; Particle size; Moisture content; Oxidation state of mercury
Soil Washing and Acid Extraction	Solid and liquid	Capital and O&M	Soil homogeneity; Presence of organic compounds; Particle size; pH of media; Moisture content
Thermal Treatment	Solid, liquid and vapor	Capital and O&M	Presence of organic compounds; Particle size; Moisture content
Vitrification	Solid, liquid and vapor	Capital and O&M	Lack of glass-forming materials; Particle size; Moisture content; Subsurface air pockets; Presence of organic compounds
Containment	–	Capital	-

O&M: Operation & Maintenance
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

3) Remediation Techniques for PCB Contamination

According to the experiences in Europe and USA[1], the most frequent remediation solutions adopted are "dig and dump" and "dig and incinerate". On the other hand, there are currently new methods that could be more sustainable alternatives. Several techniques for PCB contamination of soil were considered for the selection of the final proposal measures, and it is listed below:

- Land filling – Disposal of the contaminated soil on specially created landfills for the disposal of chemical waste.
- Thermal treatment (ex situ). High temperatures, 870 to 1.200°C, are used to volatilize and combust (in the presence of oxygen) halogenated and other refractory organics in hazardous wastes. The destruction and removal efficiency (DRE) for properly operated incinerators exceeds the 99.99% requirement for hazardous waste and can be operated to meet the 99.9999% requirement for PCBs and dioxins. Commercial incinerator designs are

[1] Federal Remediation Technologies Roundtable, The Remediation Technologies Screening Matrix and Reference Guide, Version 4.0 (available at: www.frtr.gov/matrix2/., confirmed on 24th Match 2014)

rotary kilns, equipped with an afterburner, a quench, and an air pollution control system. Incinerator off-gas requires treatment by an air pollution-control system to remove particulates and neutralize and remove acid gases (HCl, NOx, and SOx). Baghouses, venturi scrubbers, and wet electrostatic precipitators remove particulates; packed-bed scrubbers and spray driers remove acid gases. Limestone or caustic solution added to the combustor loop removes acid gases. Incineration of the chlorinated organic compounds have to be specially secured regarding the off gas treatment, because of formation of dioxin that is highly toxic and harmful gas. Therefore, incineration is very expensive, costing up to $2,300 per ton for a fixed PCB incinerator.

- Biodegradation (in situ)
- Chemical Oxidation of Contaminated Soil and Groundwater (In Situ)
- Dehalogenation (ex situ).
- Solvent extraction (Ex situ)

4) Groundwater Contamination

Once the highly contaminated soil is remediated, the source of groundwater pollution will be removed. However, although this aquifer is not used for drink water purpose, it is of paramount importance to assess, depending on aquifer characteristics, if pollution can eventually reach the river near the site in a significant amount. This last scenario presents the highest risk for the downstream environment and consequently relatively costly containment and pump and treat remediation techniques will need to be proposed and adopted.

5) Assessment of Applicability and Cost estimate of the Proposed Remediation Technique

At the moment there is no company in BiH that own the technology to deal with majority of the above-presented remediation measures. Taking into consideration a large area and the volume of the contaminated soil, the remediation of this target site should probably be commissioned at an international tender. For the purpose of the assessment of applicability and the cost estimate, data from FRTR (2007)[1] were taken as a reliable input.

Cost estimate of possible remediation options for heavy metals is presented below.

Table A 3.3-15 Preliminary Cost Estimate for the Soil and Waste Remediation Options for Heavy Metals

Technology	Unit Cost (BAM)*		Estimated cost range (BAM)		Max Cost Ranking
	min	max	From	To	
Direct disposal	391/t	665/t	19,394,000	32,984,000	5
Solidification/Stabilization	65/t	180/t	3,224,000	8,928,000	4
Soil washing and acid extraction	31/m^3	49/m^3	769,000	1,215,000	1
	-	98/m^3	-	2,430,000	
Thermal treatment	1,320/m^3	2,020/m^3	32,736,000	50,096,000	6
Vitrification	313/m^3	358/m^3	7,762,000	8,878,000	3
Containment	59/m^2	78/m^2	2,926,000	3,869,000	2

*Source: Federal Remediation Technologies Roundtable, The Remediation Technologies Screening Matrix and Reference Giuide, Version 4.0 (available at: www.frtr.gov/matrix2/., confirmed on 24th Match 2014)

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Soil washing and acid extraction is the recommended technique for the remediation of this target site. The technique is capital and O&M intensive; however, it is by far the cheapest remediation

[1] Federal Remediation Technologies Roundtable, The Remediation Technologies Screening Matrix and Reference Giuide, Version 4.0 (available at: www.frtr.gov/matrix2/., confirmed on 24th Match 2014)

option. Transport and direct disposal of the soil polluted by heavy metals is not recommended because of large quantities and high costs associated.

Table A 3.3-16 Assessment of the Soil and Waste Remediation Options for Heavy Metals

Technology	Residuals produced	O&M or capital intensive	Factors affecting the applicability
Direct disposal	Solid	O&M	Legislation limits; Public concerns; Volumes of soil and waste; availability and distance of adequate disposal site
Solidification/ Stabilization	Solid	Capital	pH of media; Presence of organic compounds; Particle size; Moisture content; Oxidation state of mercury
Soil washing and acid extraction	Solid and liquid	Capital and O&M	Soil homogeneity; Presence of organic compounds; Particle size; pH of media; Moisture content
Thermal treatment	Solid, liquid and vapor	Capital and O&M	Presence of organic compounds; Particle size; Moisture content
Vitrification	Solid, liquid and vapor	Capital and O&M	Lack of glass-forming materials; Particle size; Moisture content; Subsurface air pockets; Presence of organic compounds
Containment	–	Capital	

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

The preferred option for the treatment of the soil polluted by PCBs is oxidation. This is not the cheapest option; however, cheaper bioremediation has a major disadvantage that it needs a long time for full remediation effects.

Table A 3.3-17 Preliminary Cost Estimate for the Soil and Waste Remediation Options for PCB

Technology	Unit cost (BAM)*		Estimated cost range(BAM)		Max cost ranking
	min	max	From	To	
Direct disposal	391/t	665/t	3.832.000	6.517.000	3
Oxidation process	47/m^3	106/m^3	230.000	519.000	2
Dehalogenation	391/t	9,787/t	3.832.000	95.913.000	6
Solvent washing	3,090/m^3	3,358/m^3	15.141.000	16.454.000	5
Thermal treatment	-	3,129/m^3	-	15.332.000	4
Bioremediation	43/m^3	78/m^3	211.000	382.000	1

*Source: Federal Remediation Technologies Roundtable, The Remediation Technologies Screening Matrix and Reference Giuide, Version 4.0 (available at: www.frtr.gov/matrix2/., confirmed on 24th Match 2014)

Source: "HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014" and "Federal Remediation Technologies Roundtable, The Remediation Technologies Screening Matrix and Reference Giuide, Version 4.0"

Table A 3.3-18 Assessment of the Soil and Waste Remediation Options for PCBs

Technology	Residuals produced	O&M or capital intensive	Factors affecting the applicability
Direct Disposal/ landfilling	Solid	O&M	Legislation limits; Public concerns; Volumes of soil and waste; availability and distance of adequate disposal site
Dehalogenation	Solid, liquid and vapor	-	High clay and moisture content will increase treatment costs; Concentrations of chlorinated organics greater than 5% require large volumes of reagent. With the BCD process, capture and treatment of residuals (volatilized contaminants captured, dust, and other condensates) may be difficult, especially when the soil contains high levels of fines and moisture.
Solvent washing	liquid and vapor	-	Complex waste mixtures (e.g., metals with organics) make formulating washing fluid difficult; High humic content in soil may require pretreatment; The aqueous stream will require treatment at demobilization. Additional treatment steps may be required to address hazardous levels of washing solvent remaining in the treated residuals. It may be difficult to remove organics adsorbed onto clay-size particles.
Chemical oxidation of contaminated soil and groundwater	liquid and vapor	Capital	pH of media, possible dissolution of heavy metals; Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation.
Thermal treatment	Solid, vapor	-	Only one off-site incinerator is permitted to burn PCBs and dioxins. There are specific feed size and materials handling requirements that can impact applicability or cost at specific sites. Metals can react with other elements in the feed stream, such as chlorine or sulfur, forming more volatile and toxic compounds than the original species. Such compounds are likely to be short-lived reaction intermediates that can be destroyed in a caustic quench. Sodium and potassium form low melting point ashes that can attack the brick lining and form a sticky particulate that fouls gas ducts.
Bioremediation	-	-	Cleanup goals may not be attained if the soil matrix prohibits contaminant-microorganism contact. The circulation of water-based solutions through the soil may increase contaminant mobility and necessitate treatment of underlying ground water. Preferential colonization by microbes may occur causing clogging of nutrient and water injection wells. Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones. The system should not be used for clay, highly layered, or heterogeneous subsurface environments because of oxygen (or other electron acceptor) transfer limitations. High concentrations of heavy metals, highly chlorinated organics, long chain hydrocarbons, or inorganic salts are likely to be toxic to microorganisms. Bioremediation slows at low temperatures. The length of time required for treatment can range from 6 months to 5 years and is dependent on many site-specific factors.

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

6) Final Disposal of Waste from the Site

It is estimated that around 100 t of hazardous waste exist at the site and have to be collected and appropriately prepared for the transport. There is no other solution for the removing the subjected waste but transport and disposal out of the country by the companies authorized for that activity. Two technologies are possible for treatment of this kind of the waste: incineration or land disposal.

On the other hand, because of the high content of the mercury (22%), possible solution is the recovery of the mercury inside of the regular production process, so this possibility have to be considered more before final decision. In that case removal of the waste with extremely high content of the mercury (22%) in amount of 10 t could be solved in most cost effective way, since mercury has still very favorable price on the market.

(3) Temporary measures to reduce the risk

Depending on the capacity to obtain the required funding for the implementation of the remediation plan and consequently the reduction of the risk posed by storage of hazardous chemicals and waste, soil pollution by heavy metals and PCBs, the whole process may require several years.

The following low investment actions could be envisaged in order to temporary reduce the risk until the final remediation will be completed:

- Creation of an adequate temporary storage space for chemicals and waste – A location such as the one where majority of chemicals are already nowadays stored could be improved by providing an impermeable layer on the floor to prevent eventually spilled liquids to reach soil and underground water, rims should be provided on the perimeter to prevent spilled material to exit from the storage paved area and general maintenance of the roof and site should be provided to prevent infiltration of rain. The perimeter of the storage area should be closed by fences. All chemicals, metal barrels with old production residual (more important is the one currently not protected from the rain), plastic barrels with polluted waste should be stored in this location until a proper disposal will be available. This temporary site should be visually monitored regularly to check for potential spill of hazardous material.
- Covering high polluted areas with plastic layers – Theoretically, high polluted surfaces could be temporary isolated from rain using low cost plastic foils. However, most of low cost plastic foils do not last long under climate condition such as sun, freezing and strong wind. Therefore, this action should be carefully planned in order to avoid easy breaking of the coverage due to strong wind and snow. In addition due to the presence of large quantity of demolition waste and objects, the area should be leveled before this action is taken requiring relatively high investment in order to be properly done. Covering a surface without this leveling and cleaning step maybe lead to physical damage and breakage of the plastic foil or to the formation of leaky pockets during rain events. If large surfaces are covered in this way, also a stormwater drainage system should be provided. Due to these issues this option may not be recommended for this target site except, if clearly identified by further analyses, for a very small surface (maybe up to about $100m^2$) where the spill of PCBs had occurred or where visible drops of Hg are visible on the soil surface.

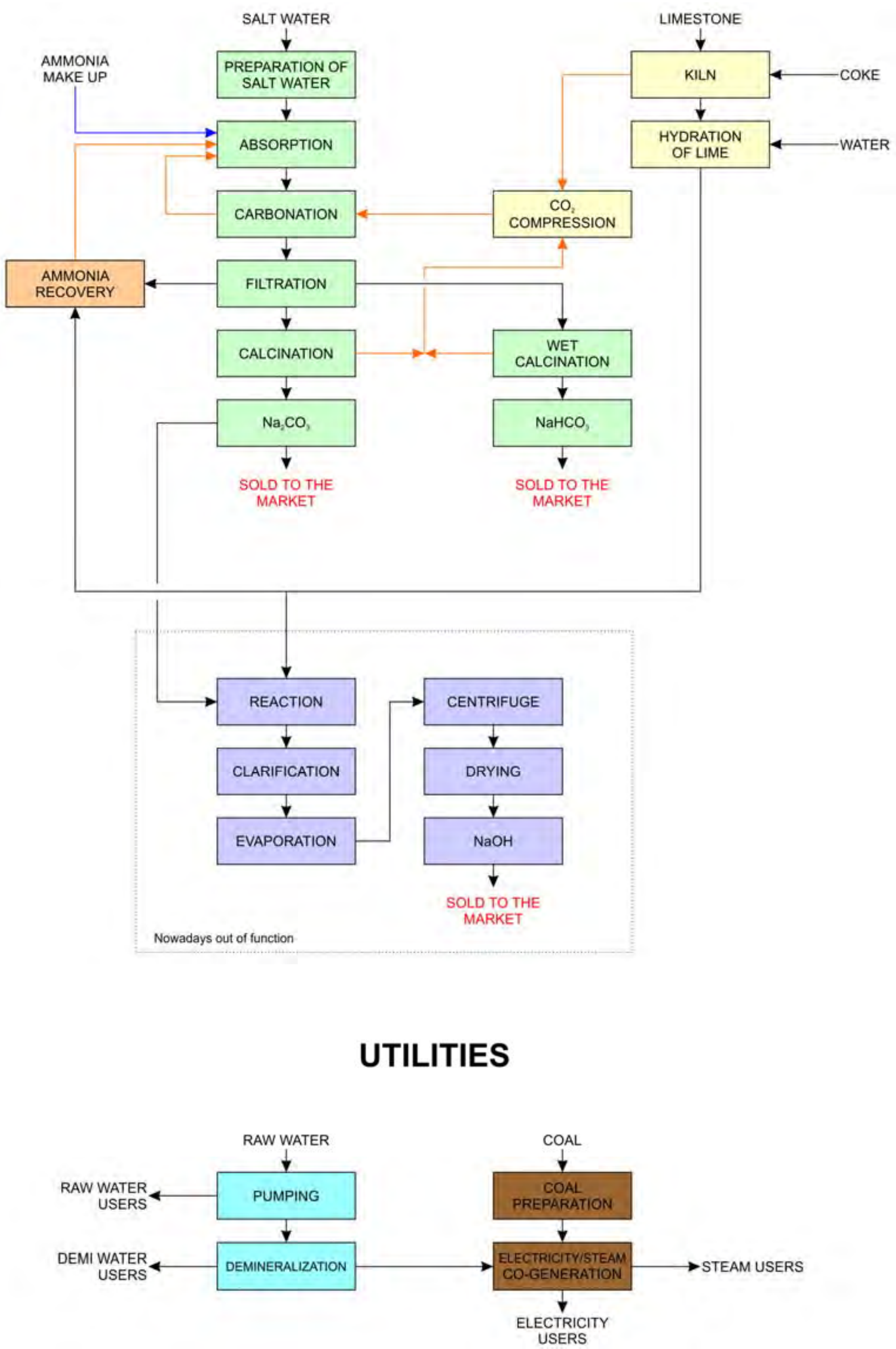
(4) Post Remediation Activities

Monitoring of the soil around the contaminated area has to be conducted immediately after the remediation activities. Monitoring of the groundwater has to be conducted at least three times during the year after the remediation activities are completed.

A 3.4 Former Soda Factory Site in Tuzla

A 3.4.1 Supplementary Data of General Site Information and History of the Site

The production processes and product information are shown in the following tables and figure as an additional data used to consider the possible contamination of the site.



Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.4-1 Process Flow at Inorganic Sector of Former Soda Factory

The production of sodium carbonate anhydrous (soda ash) was the Solvay process, starting from salt water, limestone and coke as raw materials and using ammonia as a sort of catalyst.

Technological process description have been provided based on available information. The Sodium chloride rich water is pretreated in order to remove impurities such as calcium, magnesium and metal ions. The obtained solution is pumped at the top of an absorption column where it reacts with a stream of ammonia introduced from the lower section.

The brine solution saturated with ammonia is then fed to the carbonation column where come into contact with a countercurrent stream of carbon dioxide. As result of this step, there is the production of Sodium bicarbonate which, due to the low solubility, precipitates. The overall reaction can be summarized as:

$$2NaCl + 2NH_4OH + 2CO_2 \rightarrow 2NaHCO_3 + 2NH_4Cl$$

The crystalline suspension collected on the bottom of the column, in addition of crystals of sodium bicarbonate, will contain ammonium bicarbonate, ammonium chloride, residual un-reacted sodium chloride and a small quantity of soluble sodium bicarbonate. The gas extracted on the top of the column contains residual amount of carbon dioxide and ammonia and maybe sent to the absorption column in order to improve the recovery of these compounds. The suspension is filtered under vacuum conditions in order to separate the crystals which are then calcinated in order to produce the low density soda ash product:

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Part of this compound is nowadays used in order to produce also high density granulated soda ash. The crystalline suspension can also be wet calcinated in order to produce sodium bicarbonate as product. The filtrate solution is sent to the ammonia recovery step where it reacts with hydrated lime to form a wastewater stream constituted mainly by calcium chloride (together with a residual of reagents and products) while the ammonia is freed, recovered and used again in the process:

$$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3 + 2H_2O$$

Therefore, the overall net consumption of ammonia is relatively low. Carbon dioxide needed in the process of carbonation is partially coming from the recovery of CO_2 in the products calcinations steps while majority is produced by decomposition of limestone at high temperature (800-1000°C) using coke as combustible (combustion also produce the carbon dioxide). In addition to the production of carbon dioxide, this step produces also the lime necessary after hydration with water for the recovery of the ammonia.

$$CaCO_3 \rightarrow CaO + CO_2$$

$$CaO + H_2O \rightarrow Ca(OH)_2$$

A fraction of calcium oxide was used for the production of caustic soda. Caustic soda is obtained by direct reaction of soda ash with lime:

$$Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$$

The calcium carbonate is precipitated and separated and the clarified solution is concentrated and crystallized in order to obtained precipitation of sodium hydroxide. The product was then dried and packed to be sold on the market. This process is no longer performed at the soda factory due to the high costs and consequently low profitability. It was however in function during the period when the old section of the target site was active.

In addition to units directly involved in the production process, the facilities includes also systems for the production of utilities such as technological water, de-mineralized water and a coal cogeneration plant (about 900 tons/d of coal in 4 boilers for a total of 200 MW installed capacity) to produce electricity (about 5 MW) and steam (about 160 tons/d) for the functioning of the whole process.

Table A 3.4-1 Annual Volumes of Raw Materials, Products and By-products in the Former Soda Factory

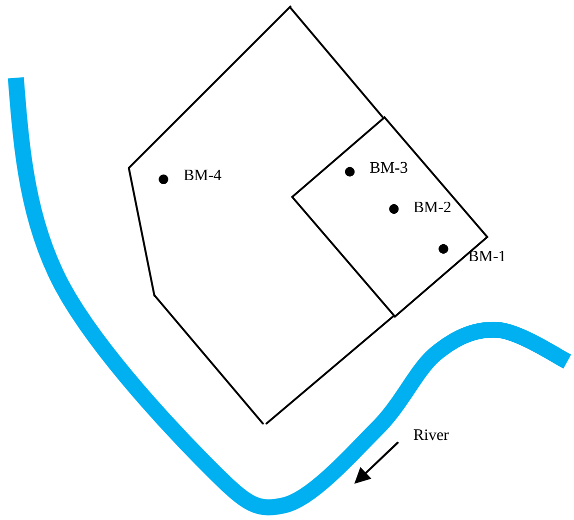
Item	Year	Design	Design	1985
	Source	WW study 1976	EBS 1986	EBS 1986
	Workers	-	-	1788
Raw materials	Unit			
Salt water	t/year	-	1,519,400	1,544,761
Limestone	t/year	-	408,800	451,410
Ammonia	t/year	-	2,732	2,123
Coal	t/year	-	365,000	350,049
Water	t/year	-	-	24,390,951
Steam	Nm^3/year	-	1,500,000	1,357,696
Electrical energy	MWh	-	202	109
Products and by-products				
Soda ash	t/year	146,000	208,000	149,275
Caustic soda	t/year	45,625	44,000	38,857
Sodium bicarbonate	t/year	14,600	15,000	10,063
Powder for fire extinguishers	t/year	-	3,000	2,511

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.4.2 Site Investigation

(1) Sampling Location

The sampling locations of the sludge waste are shown in the following map.



Source: JET

Figure A 3.4-2 Sampling Point of Former Soda Factory Site

(2) Analysis Result

The analytical results are shown in the following tables.

Table A 3.4-2 Site Investigation Result of Former Soda Factory Site (1)

Parameter	Sample labe	BM-1	BM-2	BM-3	BM-4	Referrence Values
	Type	Waste	Waste	Waste	Waste	
pH - Water	pH units	12.10	12.01	12.10	11.54	-
pH -KCl	pH units	11.43	11.11	11.34	10.78	-
EC	uS/cm	6850	5680	13300	32100	-
ORP	mV	72	68	41	18	-
Total organic carbon (TOC)	mg/l	0.54	0.34	0.32	<0,1	-
Oil/fat	g/kg	17.5	0.5	0.5	0.6	-
Water content	%	43.7	45.2	47.1	59.3	-
Salinity	PSU	4	3	9	22	-
Cadmium (Cd)	mg/kg DW	5.87	4.03	3.89	4.75	10
Lead (Pb)	mg/kg DW	35	35	25	32	500
Total chromium (T-Cr)	mg/kg DW	209	96	39	150	250
Total mercury (T-Hg)	mg/kg DW	<0.01	<0.01	<0.01	<0.01	10
Copper (Cu)	mg/kg DW	14	9	7	15	600
Nickel (Ni)	mg/kg DW	61	50	39	66	140
Zinc (Zn)	mg/kg DW	34	29	14	41	1000
Arsenic (As)	mg/kg DW	26	46	56	94	50
Selenium(Se)	mg/kg DW	<10	<10	<10	<10	100
Cobalt (Co)	mg/kg DW	19	15	12	33	-
Calcium (Ca)	g/kg DW	364.7	356.7	358.7	326.6	-
Sodium (Na)	g/kg DW	1.5	1.5	3.5	15.6	-
Magnesium (Mg)	g/kg DW	7.3	15.8	15.8	24.3	-
Potasium (K)	mg/kg	182	259	461	2493	-
Aluminium (Al)	g/kg DW	4.9	4.5	2.9	3.5	-
Sulfur (S)	g/kg DW	14.8	17.2	10.8	11.2	-
Silica (Si)	g/kg DW	12.5	13.1	4.8	4.5	-
Phosphorus (P)	g/kg DW	0.45	0.30	0.29	0.12	-
Nitrogen (N)	g/kg DW	0.19	0.35	0.23	0.52	-
Ammonia nitrogen(N-NH4-)	g/kg DW	0.024	0.026	0.028	0.03	-
Fluoride (F)	g/kg DW	1.22	0.71	0.20	0.37	1
Chloride ion(Cl-)	g/kg DW	0.7	0.5	16.5	71.4	-
Density	g/cm3	1.45	1.52	1.52	1.49	-
Ignition loss (550°C)	%	5.53	4.79	4.75	6.45	-

:Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.4-2 Site Investigation Result of Former Soda Factory Site (2)

Parameter	Sample label / Type	BM-SPR-3 / Water	BM-SPR-2 / Water	BM-SPR-1 / Water	Referrence Values
pH	-	10.69	11.00	7.77	5.8-8.5
EC	uS/cm	1409	1618	9900	-
DO	mg/l	8.1	7.9	6.0	6-8
Turbidity	NTU	1300	780	240	-
Salinity	PSU	0.7868	0.9095	6.2311	-
COD	mg/l	45.0	52.0	83.0	10-12
Alkalinity	mg/l	76	96	100	-
Total phosphorous (T-P)	mg/l	0.049	0.026	0.028	-
Total nitrogen (T-N)	mg/l	5.6	5.9	12.3	-
Oil/fat	mg/l	11.0	14.0	10.0	-
SS	mg/l	611	520	148	-
Cadmium (Cd)	mg/l	0.0034	0.0049	0.0201	0.0005
Lead (Pb)	mg/l	0.0515	0.0526	0.0946	0.002
Total chromium (T-Cr)	mg/l	<0.001	0.0393	0.0302	0.001-0.006
Total mercury (T-Hg)	mg/l	<0.0005	<0.0005	<0.0005	0.00002
Arsenic (As)	mg/l	0.001	< 0,001	< 0,001	0.05
Sulfate ion(SO42-)	mg/l	227.5	246.5	203.5	-
Chloride ion(Cl-)	mg/l	276.5	318.9	3244.0	-
Fluoride (F)	mg/l	0.54	0.58	0.79	0.0003

:Reference values or more

Prescribed watercourses class for the measurement site; city - upstream of the industrial zone : Class II

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.4.3 Detail Data of Input and Output of Risk Assessment

The input values for HRS and the breakout of the result for this site are shown in the following tables.

Table A 3.4-3 Input Parameters and Values for the Risk Score Calculations for the Former Soda Factory Site

Summarized overview of input parameters for White Sea sampling site

Parameter	Unit	Input values												
		Months												
		1	2	3	4	5	6	7	8	9	10	11	12	Σ
Monthy Precipitation	mm/month	75	67	45	79	111	116	121	66	84	58	55	72	949
I-parameter		0	0.3292	1.522	3.075	5.118	6.896	8.405	7.789	5.984	3.576	1.453	0.003	44.15
α-parameter		1.191												
Mean monthly Evapotranspiration	mm/month	0	6.2608	26.54	50.64	85.93	110.2	130	112.8	79.01	47.56	19.76	0.133	
Average Day Length of the month	hours	9.2	10.4	11.93	13.53	14.88	15.6	15.23	14.03	12.5	10.92	9.52	8.78	
Number of days in the month		31	28	31	30	31	30	31	31	30	31	30	31	
Mean monthly temperature	°C	-0.3	2.4	6.6	10.5	14.7	17.9	20.4	19.4	16.3	11.6	6.4	0.1	
Distance from the surface to the top of aquifer	(cm)	/												
Hydraulic Conductivity of the layer	(cm/sec.)	1x10^-6												
Thickness of lowest hydraulic conductivity layer	(cm)													
Distance from the surface to the top of aquifer	(cm)	/												
Distance from the surface to the lowest known point of hazardous substances	(cm)	/												
Source type		Surface water												
Contributing hazardous substances		Lead, Cadmium, Chromium, Arsenic (Chlorides, Fluorides*)												
Overall constituent quantity of hazardous substances	lbs	28777.051												
Area of contaminated site	m²	99456												
Distance of the nearest drinking water wells (max.distance 6.5 km)	m	160 (upstream)												
Number of people served by drinking water within distance of 0 to 0.4 km	/	2300												
Number of people served by drinking water within distance of 0.4 to 0.8 km	/	1470												
Number of people served by drinking water within distance of 0.8 to 1.6 km	/	230												
Number of people served by drinking water within distance of 1.6 to 3.2 km	/	0												
Number of people served by drinking water within distance of 3.2 to 4.8 km	/	0												
Number of people served by drinking water within distance of 4.8 to 6.5 km	/	0												
Presence of the Wellhead Protection Area within a distance of 6.5 km	YES/NO	YES												
Number of people who live/attend school within a distance of 60 m from the contaminated area	/	4												
Number of workers within a distance of 60 m from the contaminated area	/	0												
Presence of comercial agriculture/silviculture/livestock produtuction and/or grazing on the contaminated area	YES/NO	NO												
Site-specific 2 Yearly 24 hours Rainfall for the site (statistics from atleast last 20 years)	mm	43												
Drainage area (see note)	(m²)	559506												
A-Coarse-textures soils with high infiltration rates (sands, loamy sands)	(%)													
B- Medium-textures soils with moderate infiltration rates (sandy loams, loams)	(%)	141331 (25,26)												
C-Moderately fine-textured soils with low infiltration rates (silty loams, silts, sandy clay loams)	(%)	101886 (18,21)												
D-Fine-textured soils with very low infiltration rates (clays, sandy clays, silty clay loams, clay loams, silty clays	(%)	316288 (56,53)												

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.4-4 Breakout of Risk Score of Former Soda Factory Site

Factor Category		GWMP	Surface Water Migration Pathway						SEMP		AMP
			SW/OC			GWSWC					
			DWT	HFCT	ET	DWT	HFCT	ET	RPT	NPT	
1	Observed release	0	550	550	550	0	0	0	550	550	0
2	Potential to release (higher of 2a and 2b)	230	0	0	0	144	144	144	-	-	27
2a	Potential to release by overland flow	-	0	0	0	-	-	-	-	-	-
2b	Potential to release by flood	-	0	0	0	-	-	-	-	-	-
2c	Gas potential to release	-	-	-	-	-	-	-	-	-	2
2d	Particulate potential to release	-	-	-	-	-	-	-	-	-	27
2e	Attractiveness/Accessibility	-	-	-	-	-	-	-	-	10	-
2f	Areas of Contamination	-	-	-	-	-	-	-	-	20	-
3	Likelihood of Release (higher of lines 1 and 2)	230	550	550	550	144	144	144	0	-	27
3*	Likelihood of Exposure (higher of lines 1 and 2)	-	-	-	-	-	-	-	550	550	-
4	Toxicity	-	-	-	-	-	-	-	$1x10^4$	$1x10^4$	
4a	Toxicity/Mobility	$1x10^3$	-	-	-	-	-	-	-	-	200
4b	Toxicity/Mobility/Persistence	-	-	-	-	100	100	100	-	-	-
4c	Toxicity/Mobility/Persistence/Bioaccumulation	-	-	-	-	-	$5x10^5$	-	-	-	-
4d	Toxicity/Persistence	-	$1x10^4$	$1x10^4$	-	100	-	-	-	-	-
4e	Toxicity/Persistence/Bioaccumulation	-	-	$5x10^7$	-	-	-	-	-	-	-
4f	Ecotoxicity/Persistence	-	-	-	$1x10^4$	-	-	-	-	-	-
4g	Ecotoxicity/Persistence/Bioaccumulation	-	-	-	$5x10^8$	-	-	$5x10^6$	-	-	-
4h	Bioaccumulation	-	-	-	-	-	$5 x10^3$	-	-	-	-
4i	Ecosystem BAP value	-	-	-	$5 x10^4$	-	-	$5 x10^4$	-	-	-
5	Hazardous Waste Quantity	$1x10^4$	$1x10^4$	$1x10^3$	$1x10^4$	$1x10^4$	$1x10^4$	$1 x10^4$	$1x10^4$	$1x10^4$	$1x10^4$
5a	Waste characteristics		100	560	$1x10^3$	32	180	320	100	100	32
6	Waste characteristics factor category	100	100	560	$1x10^3$	-	-	-	100	100	-
7	Nearest well	20	-	-	-	-	-	-	-	-	-
8	Nearest intake	-	2	-	-	2.0	-	-	-	-	-
9	Nearest individual	-	-	-	-	-	-	-	-	-	45
9a	Nearest Food Chain Individual	-	-	2	-	-	2	-	-	-	-
9b	Level I	-	-	-	-	-	-	-	-	-	-
9c	Level II	-	-	-	-	-	-	-	-	-	-
9d	Potential Contamination	-	-	-	-	34.7	-	4.6	-	-	-
10	Total population	0	-	-	-	-	-	-	-	-	-
10a	Level I	0	-	0	-	-	0	-	-	-	-
10b	Level II	0	-	0	-	-	0	-	-	-	-
10c	Potential Contamination	23.1	5.2	-	-	-	2.3	-		-	-
11	Workers	-	-	-	-	-	-	-	0	-	-
12	Resources	0	0	-	-	-	-	-	0	-	0
13	Wellhead Protection Area	5	-	-	-	-	-	-	-	-	-
14a	Actual Contamination	-	-	-	-	-	-	-	-	-	-
14b	Potential Contamination	-	-	-	1.2	-	-	4.6	-	-	-
14c	Sensitive Environments	-	-	-	0.1	-	-	-	-	-	-
15c	Nearby individual	-	-	-	-	-	-	-	45	-	-
16a	Population within a mile	-	-	-	-	-	-	-	-	5	-
16b	Sensitive environments	-	-	-	1.2	-	-	-	-	-	-
16c	Targets factor category	48.1	7.2	2	1.2	36.7	4.3	4.6	45	5	50
17	Threat Score	-	4.8	7.47	8	2.05	1.35	2.57	$2.48x10^6$	$2.5x10^3$	-
18	Component Score	-	20.27			5.97			-	-	-
19	Pathway score	**13.41**	**20.27**						**30.03**		**0.52**
20	Overall site score	**19.32**									

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.4.4 Preliminary Remediation Plan

(1) Remediation Objectives

The investigated site is a 10 ha large settling pond used about 30 years ago (and abandoned today) to settle suspended solids in the wastewater stream from the local soda ash factory. Nowadays, there are other two of such inactive ponds around the site plus another pond that is currently in function. The settled material is composed mainly by calcium carbonate with a relatively high pH due to a small percentage of residual active calcium oxide/hydroxide. Significant quantities of calcium, magnesium, sodium and potassium chlorides are also present.

This site, due to mostly inert characteristics of the stored waste, does not represent a significant risk to human health and the only concern is to stabilize the present situation and reduce the impact of this site on the surrounding environment including the nearby river. This impact is mainly related to the infiltration of precipitation through the alkaline bulk material which eventually reaches the nearby flowing river. This primary objective may partially overlap with a long-term plan from the company to free the basin from currently settled material (if a proper technical/economical re-use path can be identified) so that ultimately, after proper adaptation, the site can be again reactivated in future as a settling basin. Although this long-term strategy associated with the exploitation of the material may have a positive feedback to the environment (for example the reuse of the site instead of the construction of new ponds in the future) there are currently large technical and economic issues to be solved and uncertainties on the time schedule for the practical implementation that suggest to leave it as a future option after proper remediation and closure of the site.

The proposed measures, which consist of technical reculvation with gravel and soil and biological recultivation, are explained in Chapter 4.

(2) Potential Alternative Waste Management options

In order to add the supplement information to the proposed remediation plan in Chapter 4, the potential alternative waste management options to reuse the waste sludge are introduced in this Section.

The soda ash industry, since the Solvay process was introduced in the early 20th century, faced the problem of large quantity of suspended solids in the effluent and consequently the challenge to find a possible re-use of this material. There are several attempts described in the scientific literature striving to assess the suitability of this waste in other sectors such as construction material (block production or filling material), cement manufacture or in agriculture for the correction of soil acidity. However, generally speaking, as reported in the relevant BREF document (CEFIC[1], 2004): "*attempts have failed to provide a long-term viable alternative, the major restrictions being the chloride content of the material and its physical properties. Moreover, the variability of its composition does not guarantee constant quality of a material, which limits its use in low value applications for which other more readily processed materials already exist in abundance*".

Removal of the residual salt in the waste could be accomplished by several washing steps. However, large quantities of water are necessary. Drying can be performed in a rotary kiln, yet it requires a large amount of energy. The costs associated with conditioning (chlorine removal and drying) for improve the re-use of the waste are high and in most cases, they are prohibitive for full scale implementation.

For these reasons all these potential waste exploitation methods have not been considered at a sufficient development stage to be reasonably applied to the remediation of the site in a short-medium term. This however, does not prevent the current soda factory in the future, if any of these options becomes technically and economically feasible, if already closed, to re-open the site (using all adequate pollution prevention measures) and proceed with an excavation front while the remaining part of the pond may be kept still protected by the measures. Hereafter, the following summarizes the

[1] The European Soda Ash Producers Association , IPPC BAT reference document, Large volume solid inorganic chemicals family, Process BREF for soda ash. European Chemical Industry Council, Brussels., 2004

potential re-use option that maybe further investigated in the future with highlighted the potential related issues that may pose a problem to the full scale development.

a) Re-use as acid soil modifier

The current soda factory started in 2013 a long-term project (5-years) aimed to investigate the use of this material to meliorate acid soil characteristics. No results are yet available at this stage. This option appears to have a good potential of success due to the presence of acid soil in the Tuzla region and the waste core composition made of inert calcium carbonate (with a pH-water of around 12). However, from a chemical composition stand point there are two main issues to be considered carefully: the chloride concentration (which, together with sodium, accumulating in agricultural terrain may produce adverse effects on soil productivity) and heavy metals buildup (with potential effects on human health). It should be emphasized that the heavy metal content in the settled material is below the limit values for industrial sites; however, it exceeds limits for agricultural land in FBiH (FBiH, 2009) for As, Ni, Cr, and Cd. Although the water content in the settled material is low enough to allow handling with machinery and truck transport, it maybe be necessary to provide this material drier in form of granulate to allow a much easier spread on the field and increase the applicability and appeal of this material among users in the region.

b) Re-use as construction/filling material

The current soda factory implemented the study to assess the feasibility to use a blend of wastes from this sludge disposal site and the other ash settling pond as filling material (mainly as the material for road construction). The study result showed that these two wastes, after combination, can undergo a pozzolanic reaction increasing their mechanical characteristics to a level that maybe acceptable in few construction application. On the other hand, the final mixture showed little resistance to water so that the use of this material is limited to application without direct contact with water. Among the final study remarks, is stated that in order to produce the final material the waste from this sludge waste as to be dried.

c) Re-use in the cement factor

Theoretically, this carbonate rich waste maybe use as alternative co-source of raw material for clinker production in the cement factory industry. This option is even more appealing considering that the cement factory is located just one kilometer from the target site. Large quantity of alkali (Na and K) are usually unwanted in the a Portland cement due to potential expansion reactions which produce cracks in the concrete and significantly reduce its durability. Sodium content in this sludge waste maybe therefore an issue. On the other hand calcium chloride (also present in the waste) is often used to reduce the alkali concentration during production of the clinker in the kiln due to partial volatilization. Large chlorides quantities in the kiln could also accelerate corrosion reactions due to formation of HCl in the gasses. Despite these contradictory factors, a potential acceptable blend of this waste in the cement production factory could be eventually found. However, the most important issue is related to the high water quantity in this waste which will largely increase the fuel consumption (and therefore operational costs) making the use of this wet product economically unfeasible for the cement factory.

d) Disposal in abandoned quarries/mines

Practical implementation of this option requires careful selection of potential disposal sites, study of the impact and risk of this material on the surrounding environment at the new location. The site will require being properly isolated, monitored and managed in order to avoid that this solution will represent only the transport of the issues and risk currently related to this target site to another location. Using the unit price estimation given for the Lake Modrac the only cost of transport and excavation (about 7 BAM/m^3 and 4.5 BAM/m^3 respectively) of about 40000m^3 of settled material (estimated quantity for the settling pond 1) would cost about 460,000 BAM.

(3) Post Remediation Activities

Once covering of the site is concluded, considering the inert characteristics of the material, no special provision is required for prohibiting access to the sites. Similarly, it is not expected a specific monitoring plan for this site except some basic analysis to show the recipient quality changes from upstream to downstream the target site which can be easily integrated in the regular monitoring required by legislation for the current discharge of wastewater in the final recipient. A certain degree of physical monitoring and maintenance will be required only in order to maintain the greening and landscaping.

A 3.5 Lake Modrac

A 3.5.1 Supplementary Data of General Site Information and History of the Site

(1) Sediment Problem

The following table elaborates the sediment problems which is one of the main concerns in Lake Modrac. Already in 2002 Lake Modrac lost all of its original dead volume, so the further sedimentation has been significantly affecting the storage capacity of the lake. In this period the average depth decreased from 5.7 to 5.2 meters, making the lake aphotic zone smaller and the lake more susceptible to eutrophication.

Table A 3.5-1 Morphometric Characteristics of Lake Modrac in Different Time Periods

Period	Lake surface F (km²)	Volume (m^3)		Depth (m)		Max. length (km)	Max. width (km)	Shore length (km)
		Total	Effective	Max.	Average			
1964	17.10	$98x10^6$	$86x10^6$	18	5.7	10.7	1.6	33.25
1985	16.75	$88x10^6$	$76x10^6$	18	5.2	10.4	1.58	31.7
2002	–	$85x10^6$	$64x10^6$	–	–	–	–	–

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

(2) Recent/Ongoing Pollution Control Activities

Quality of water from Lake Modrac is regularly monitored each month by the authorized laboratory from the public enterprise Spreca, since the management and maintenance of the lake is under their jurisdiction. According to the monitoring plan, samples are taken at the same monitoring points that have been selected in this study.

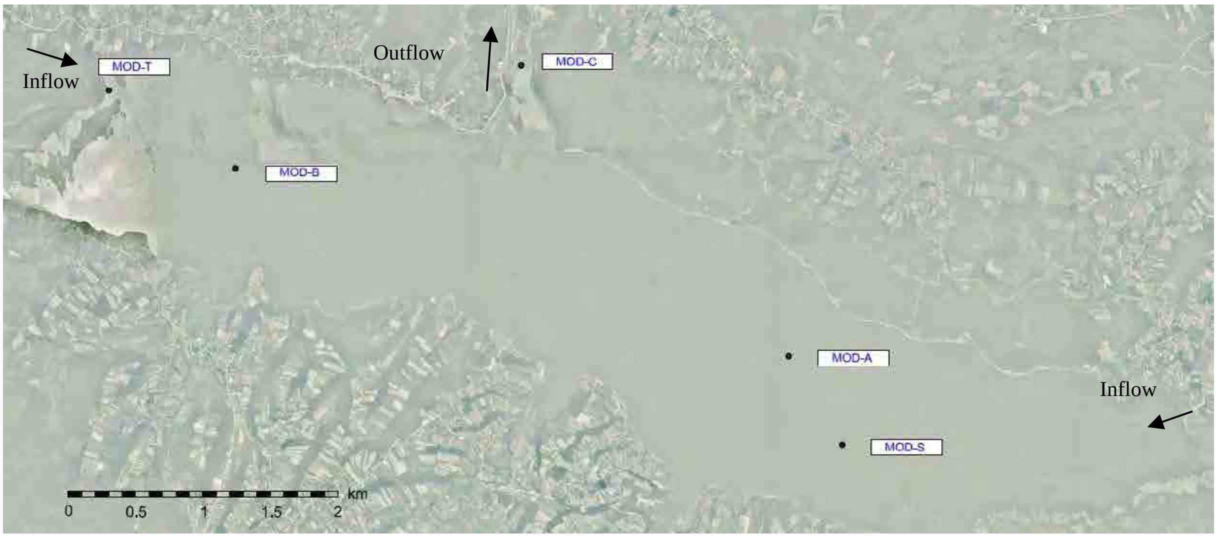
In addition, Lake Modrac is one of regular monitoring sites for the Water Agency for the Sava River Basin District Sarajevo. Only two points have been selected for the monitoring, one close to the Spreca confluence, and the other close to the water intake.

Monitoring of the sediments or aquatic organisms from the lake is not carried out on a regular basis at the moment.

A 3.5.2 Site Investigation

(1) Sampling Location

The sampling locations are shown in the following maps.



Source: HEIS, Completion Report of On –site Investigation and Sampling, 2013

Figure A 3.5-1 Sampling Point of Lake Modrac

(2) Analysis Result

The analysis result is shown in the following tables.

Table A 3.5-2 Site Investigation Result of Sediment in Lake Modrac

Parameter	Sample label / Type	MOD-A / SED	MOD-B / SED	MOD-S / SED	MOD-T / SED	Reference Values	
		Sediment	Sediment	Sediment	Sediment	Freshwater (ISQG)	Freshwater (PEL)
pH - Water	pH units	7.70	7.90	8.00	8.03	-	-
pH -KCl	pH units	7.35	7.46	7.48	7.50	-	-
EC	uS/cm	392	318.0	352	384	-	-
ORP	mV	33	-45.0	-154.0	0	-	-
Total organic carbon (TOC)		11	6.40	19.44	5	-	-
Oil/fat	g/kg DW	2.4	2.0	2.5	1.3	-	-
Water content	%	73.3	78.5	64.8	67.5	-	-
Cadmium (Cd)	mg/kg DW	1.71	2.17	0.98	0.41	0.6	3.5
Lead (Pb)	mg/kg DW	30	33	19	27	35	91.3
Total chromium (T-Cr)	mg/kg DW	204	190	81	265	37.3	90
Total mercury (T-Hg)	mg/kg DW	1.82	1.89	0.22	0.35	0.17	0.486
Copper (Cu)	mg/kg DW	35	40	28	41	-	-
Nickel (Ni)	mg/kg DW	151	305	229	319	-	-
Zinc (Zn)	mg/kg DW	97	153	64	156	123	315
Manganese (Mn)	mg/kg DW	671	1042	537	989	-	-
Arsenic (As)	mg/kg DW	12.1	9.8	11.4	10.2	5.9	17
Selenium(Se)	mg/kg DW	<10	<10	<10	<10	-	-
Phosphorus (P)	g/kg DW	0.39	0.15	0.25	0.15	-	-
Nitrogen (N)	g/kg DW	2.4	1.3	1.9	1.7	-	-
Cyanide	mg/kg DW	0.04	0.13	0.07	0.08	-	-
Polychlorinated Biphenyl (PCB)	mg/kg DW	0.1	<0,05	<0,05	0.12	0.0341	0.277
Density	g/cm3	1.56	1.61	1.25	1.61	-	-
Viscosity (Marsh funel)	s	80	480	37.84	31.53	-	-
Ignition loss (550°C)	%	17.4	17.7	31.1	8.39	-	-

Note) MOD-A / SED, MOD-B / SED – mixture of 700 ml original sediment sample and 300 ml water

:PEL or more

:ISQG or more, but less than PEL

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.5-3 Site Investigation Result of Water in Lake Modrac

Parameter	Sample label	MOD-A / W LOW	MOD-A / W UP	MOD-B / W LOW	MOD-B / W UP	MOD-S / W	MOD-T / W	MOD-C	Reference Values*	
	Type	Water lower layer	Water upper layer	Water lower layer	Water upper layer	Water	Water	Water	I-II	III-IV
pH	-	8.58	9.28	8.04	8.32	9.50	8.66	7.97	6.8-8.5(Class I) 5.8-8.5(Class II)	6.0-9.0
EC	uS/cm	448	431	463	455	416	454	455	-	-
DO	mg/l	9.0	18.2	4.4	9.6	21.1	10.8	6.9	6-8	3-4
Turbidity	NTU	17	8.4	11	15	95	7	40	-	-
Salinity	PSU	0.2393	0.2300	0.2476	0.2432	0.2217	0.2426	0.2432	-	-
TOC (See attached for more information)	mg/l	7.03	5.08	5.00	4.36	5.62	4.43	4.53	-	-
COD	mg/l	70	13	35	9	61	22	13	10-12	20-40
Total phosphorous (T-P)	mg/l	0.07	0.05	0.05	0.06	0.05	0.05	0.06	-	-
Total nitrogen (T-N)	mg/l	4.2	4.5	3.9	4.2	5.0	3.9	2.5	-	-
Oil/fat	mg/l	60	12	4	7	45	5	10	-	-
Chlorophyll a	ug/l	20	134	2	14	649	15	10	-	-
SS	mg/l	32	6	13	15	73	6	19	10-30	80-100
Cadmium (Cd)	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0005	0.005
Lead (Pb)	mg/l	0.0115	0.0163	0.0126	0.0124	0.0057	0.0111	0.0156	0.002	0.08
Total chromium (T-Cr)	mg/l	0.0008	< 0,001	0.0021	0.0022	0.0010	0.0031	0.0108	0.001-0.006	0.006-0.002
Total mercury (T-Hg)	mg/l	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,001	< 0,001	< 0,001	0.00002	0.001
Copper (Cu)	mg/l	0.0036	0.0032	0.0056	0.0032	0.0019	0.0034	0.0074	0.002-0.01	0.01- 0.02
Zinc (Zn)	mg/l	0.0400	0.0290	0.0680	0.0420	0.0500	0.0280	0.0840	0.005-0.08	0.08-0.2
Iron (Fe)	mg/l	0.0800	0.0600	0.0600	0.0700	0.0900	0.0500	0.1300	0.1	1
Manganese (Mn)	mg/l	0.0052	0.0033	0.0027	0.0027	0.0014	0.0010	0.0063	0.05	1
Arsenic (As)	mg/l	0.0070	0.0050	0.0050	0.0030	0.0040	0.0030	0.0120	0.05	0.05
Cyanide	mg/l	0.0010	0.0010	0.0030	< 0,001	0.0010	< 0,001	0.0020	0.001	0.1
Polycyclic aromatic hydrocarbons (PAH) (total)	ng/l	0.676	0.560	4.214	0.412	0.328	0.791	0.362	200	1000

*) Prescribed watercourses class is Class II

:Reference values of class I-II or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.5.3 Detail Data of Input and Output of Overall Risk Assessment

The input values for HRS and the breakout of the result are shown in the following table.

Table A 3.5-4 Input Parameters and Values for the Risk Score Calculations of Lake Modrac

Summarized overview of input parameters for Modrac sampling site														
Parameter	Unit	Input values												
		Months												
		1	2	3	4	5	6	7	8	9	10	11	12	Σ
Monthy Precipitation	mm/month	75	67	45	79	111	116	121	66	84	58	55	72	949
I-parameter		0	0.3292	1.522	3.075	5.118	6.896	8.405	7.789	5.984	3.576	1.453	0.003	44.15
α-parameter		1.191												
Mean monthly Evapotranspiration	mm/month	0	6.2608	26.54	50.64	85.93	110.2	130	112.8	79.01	47.56	19.76	0.133	
Average Day Length of the month	hours	9.2	10.4	11.93	13.53	14.88	15.6	15.23	14.03	12.5	10.92	9.52	8.78	
Number of days in the month		31	28	31	30	31	30	31	31	30	31	30	31	
Mean monthly temperature	°C	-0.3	2.4	6.6	10.5	14.7	17.9	20.4	19.4	16.3	11.6	6.4	0.1	
Distance from the surface to the top of aquifer	(cm)	/												
Hydraulic Conductivity of the layer	(cm/sec.)	1x10^-6												
Thickness of lowest hydraulic conductivity layer	(cm)													
Distance from the surface to the top of aquifer	(cm)	/												
Distance from the surface to the lowest known point of hazardous substances	(cm)													
Source type		Surface water and water sediment												
Contributing hazardous substances		Mercury, Lead,Chrome, Nickel, Polyaromated hydrocarbons (PAHs)												
Overall constituent quantity of hazardous substances	lbs	472450.035												
Area of contaminated site	m²	12601463												
Distance of the nearest drinking water wells (max.distance 6.5 km)	m	390 (downstream)												
Number of people served by drinking water within distance of 0 to 0.4 km	/	20												
Number of people served by drinking water within distance of 0.4 to 0.8 km	/	0												
Number of people served by drinking water within distance of 0.8 to 1.6 km	/	1150												
Number of people served by drinking water within distance of 1.6 to 3.2 km	/	2850												
Number of people served by drinking water within distance of 3.2 to 4.8 km	/	0												
Number of people served by drinking water within distance of 4.8 to 6.5 km	/	0												
Presence of the Wellhead Protection Area within a distance of 6.5 km	YES/NO	YES												
Number of people who live/attend school within a distance of 60 m from the contaminated area	/	400												
Number of workers within a distance of 60 m from the contaminated area	/	10												
Presence of comercial agriculture/silviculture/livestock produtuction and/or grazing on the contaminated area	YES/NO	NO												
Site-specific 2 Yearly 24 hours Rainfall for the site (statistics from atleast last 20 years)	mm	43												
Drainage area (see note)	(m²)	1006070128												
A-Coarse-textures soils with high infiltration rates (sands, loamy sands)	(%)													
B- Medium-textures soils with moderate infiltration rates (sandy loams, loams)	(%)	171736170 (17,07)												
C-Moderately fine-textured soils with low infiltration rates (silty loams, silts, sandy clay loams)	(%)	327878254 (32,59)												
D-Fine-textured soils with very low infiltration rates (clays, sandy clays, silty clay loams, clay loams, silty clays	(%)	506455702 (50,34)												

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.5-5 Breakout of Risk Score of Lake Modrac

Factor Category		GWMP	Surface Water Migration Pathway						SEMP		AMP
			SW/OC			GWSWC					
			DWT	HFCT	ET	DWT	HFCT	ET	RPT	NPT	
1	Observed release	0	0	0	0	0	0	0	0	0	0
2	Potential to release (higher of 2a and 2b)	100	310	310	310	130	130	130	310	-	80
2a	Potential to release by overland flow	-	310	310	310	-	-	-	310	-	-
2b	Potential to release by flood	-	250	250	250	-	-	-	250	-	-
2c	Gas potential to release	-	-	-	-	-	-	-	-	-	12
2d	Particulate potential to release	-	-	-	-	-	-	-	-	-	80
2e	Attractiveness/Accessibility	-	-	-	-	-	-	-	-	50	-
2f	Areas of Contamination	-	-	-	-	-	-	-	-	20	-
3	Likelihood of Release (higher of lines 1 and 2)	100	500	500	500	130	130	130	0	-	28
3*	Likelihood of Exposure (higher of lines 1 and 2)	-	-	-	-	-	-	-	-	125	-
4	Toxicity	-	-	-	-	-	-	-	1×10^{4}	1×10^{4}	
4a	Toxicity/Mobility	100	-	-	-	-	-	-	-	-	2 x10
4b	Toxicity/Mobility/Persistence	-	-	-	-	100	100	100	-	-	-
4c	Toxicity/Mobility/Persistence/Bioaccumulation	-	-	-	-	-	5×10^{6}	-	-	-	-
4d	Toxicity/Persistence	-	1×10^{4}	1×10^{4}	-	100	-	5×10^{5}	-	-	-
4e	Toxicity/Persistence/Bioaccumulation	-	-	5×10^{8}	-	-	-	-	-	-	-
4f	Ecotoxicity/Persistence	-	-	-	1×10^{4}	-	-	-	-	-	-
4g	Ecotoxicity/Persistence/Bioaccumulation	-	-	-	5×10^{7}	-	-	-	-	-	-
4h	Bioaccumulation	-	-	-	-	-	5×10^{4}	-	-	-	-
4i	Ecosystem BAP value	-	-	-	50000	-	-	5×10^{4}	-	-	-
5	Hazardous Waste Quantity	1×10^{4}	1×10^{3}	1×10^{6}	1×10^{6}	1×10^{3}	1×10^{4}	1×10^{6}	1×10^{4}	1×10^{4}	1×10^{3}
5a	Waste characteristics	-	100	1×10^{3}	1×10^{3}	32	1×10^{3}	180	100	100	56
6	Waste characteristics factor category	100	100	1×10^{3}	560	-	-	-	100	100	-
7	Nearest well	45	-	-	-	-	-	-	-	-	-
8	Nearest intake	-	1	-	-	20	-	-	-	-	-
9	Nearest individual	-	-	-	-	-	-	-	-	-	7
9a	Nearest Food Chain Individual	-	-	2	-	-	2	-	-	-	-
9b	Level I	-	-	-	-	-	-	-	-	-	-
9c	Level II	-	-	-	-	-	-	-	-	-	-
9d	Potential Contamination	-	-	-	-	23.1	-	1.3	-	-	35
10	Total population	1	-	1	-	-	-	-	-	-	-
10a	Level I	0	-	0	-	-	0	-	-	-	-
10b	Level II	0	-	0	-	-	0	-	-	-	-
10c	Potential Contamination	1.2	164	1	-	-	-	-	-	-	-
11	Workers	-	-	-	-	-	-	-	5	-	-
12	Resources	5	5	-	-	5	-	-	5	-	5
13	Wellhead Protection Area	20	-	-	-	-	-	-	-	-	-
14a	Actual Contamination	-	-	-	-	-	-	-	-	-	-
14b	Potential Contamination	-	-	-	2	-	-	1.3	-	-	2.3
14c	Sensitive Environments	-	-	-	0.1	-	-	1	45	-	-
15c	Nearby individual	-	-	-	-	-	-	-	-	1	-
16a	Population within a mile	-	-	-	-	-	-	-	-	50	-
16b	Sensitive environments	-	-	-	7.5	-	-	1.3	-	25	35
16c	Targets factor category	70	41.4	3	7.5	78.1	2	1.3	80	51	135
17	Threat Score	-	50.06	18.18	25.45	3.94	1.01	0.37	1.65×10^{6}	1.27×10^{5}	-
18	Component Score	-	68.72			5.32			-	-	-
19	Pathway score	2.77	68.72						21.55		7.33
20	Overall site score	39.67									

Abbreviations: GWMP – Groundwater Migration Pathway, SW/OC – Surface Water/Overland Component, DWT – Drinking Water Threat, HFCT – Human Food Chain Threat, ET – Environmental Threat, GWSWC – Groundwater to Surface Water Component, SEMP – Soil Exposure Migration Pathway, RPT – Resident Population Threat, NPT – Nearby Population Threat, AMP – Air Migration Pathway

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.5.4 Supplemental Information of Proposed Remediation Plan

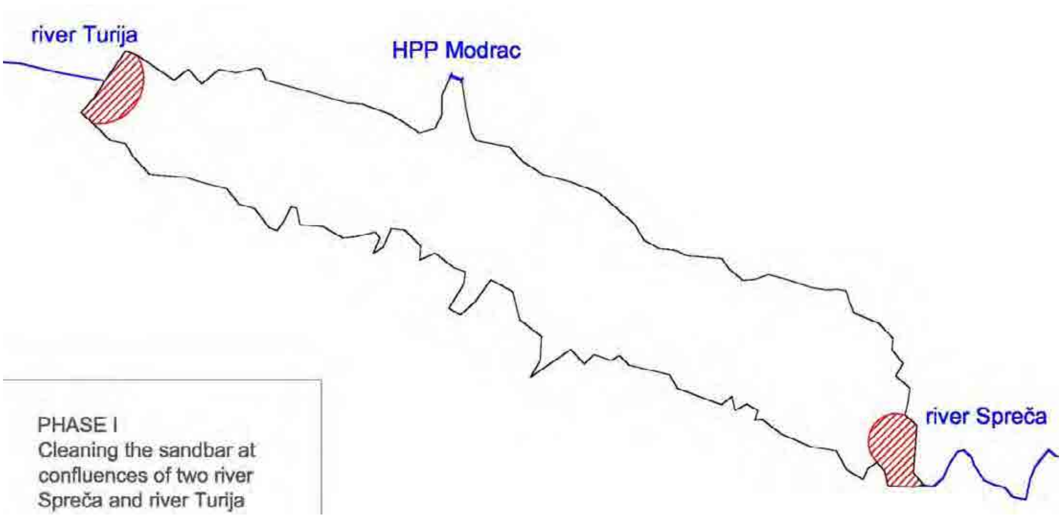
(1) Proposed Remediation Plan

1) Cleaning of the lake sediments

Before the start of the sediments removal from the lake, it is necessary to carry out a morphometric survey of Lake Modrac. The survey will provide up-to-date information regarding the volume of the sediments in the lake. It will enable a more precise programming of the implementation plan, as well as a more reliable cost estimate. During the whole dredging process, the quality of sediment has to be monitored (for example analyzing one sample every 10,000 m^3). Based on results of this monitoring the final disposal site can be assessed. Specific disposal route should be identified if a batch of dredged material has concentration of pollutants above established limits. Cost of these analyses has not been included because negligible compared with the overall cost of the remediation process.

a) Phase I

The scope of work proposed within phase I includes the removal of two large shoals formed near the mouths of the Spreca and Turija Rivers as shown in the figure below. In addition to the suspended load, these two rivers bring a significant volume of the bottom load into the lake, as well as large quantities of waste material. After the water currents slow down in the lake, the bottom load settles in the area nearby the river mouth, forming a distinctive fluvial landform composed of sand and gravel.



HPP: Hydropower plant
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.5-2 Cleaning of the sediments from Lake Modrac in Phase I

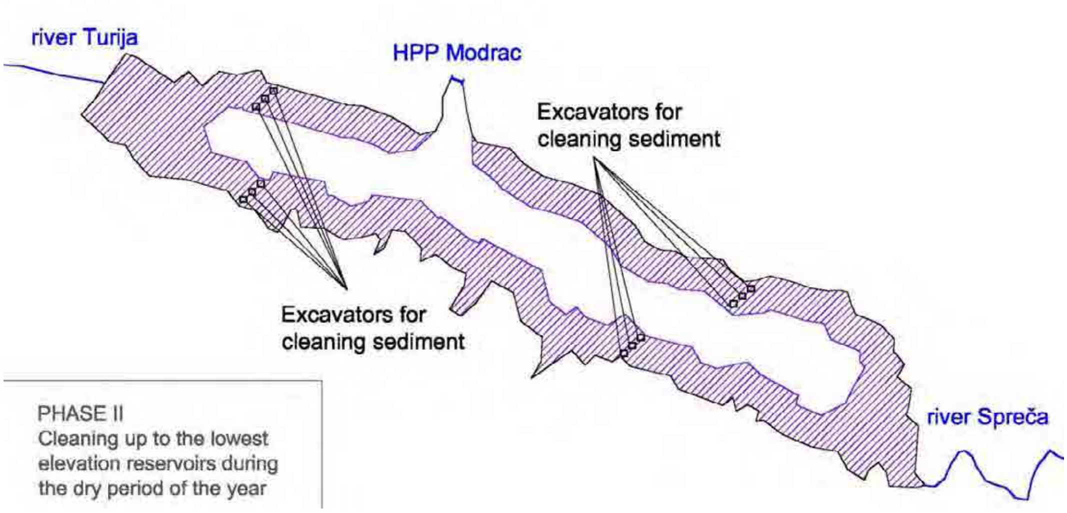
There is no data on the volume of the shoal sediment at these two locations. However, an assessment was made based on available data from other rivers in BiH. Studies show that the bottom load makes around 10-15% of the total granular material carried by the river. Based on this assumption and the total volume of sediment in Lake Modrac (16.4×10^6 m^3) it can be estimated that the quantity of sediments that has to be removed in phase I is around 2,000,000 m^3.

This is a considerable quantity of material composed predominantly of sand and gravel, and some percentage of various waste material, plastic, wood, rubber and other types of solid waste, both organic and inorganic.

Because the locations are fairly easily accessible, the excavation can be carried out with ordinary construction machinery. The material can be transported by trucks to a disposal site. It is very important to select a suitable disposal site because of the large quantity of the material and high transportation costs. A realistic option for the disposal of the material may be one or more abandoned mining sites in the Tuzla region. Currently there are a large number of such sites which have not been remediated, and which can serve this purpose.

b) Phase II

Phase II should include littoral part of the lake which gets dry during the summer period due to lowering of the water level in the lake. The excavation of the sediments in this phase is also done using ordinary construction machinery (excavators, loaders) and outside the water (minimum water level in the lake is more than 4 meters below the normal level). The excavated material is transported by trucks-dumpers to the landfill used in phase I, or another disposal location which has to be selected.



HPP: Hydropower plant
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.5-3 Cleaning of the sediments from Lake Modrac in Phase II

If a new disposal location is to be found, it is important to take into account the volume of the sediments and possible environmental impacts of disposal. In any case, future impacts of the disposal site on Lake Modrac should be avoided. An important aspect in the selection of the disposal site is the distance from the lake and the corresponding transportation costs.

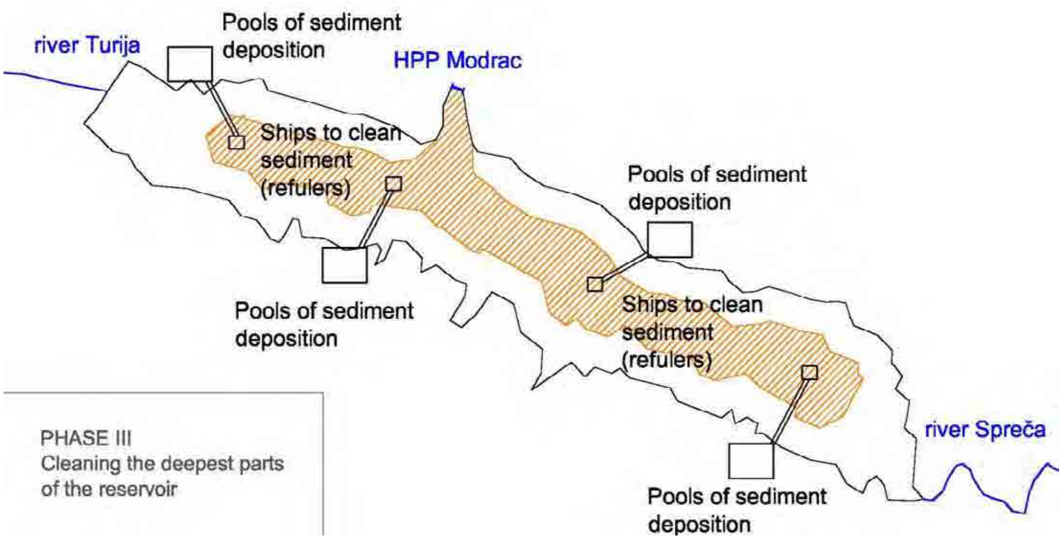
During phase II, it is vital to clean as much sediments as possible from the littoral area using the construction machinery and to execute the works under dry conditions, i.e. outside the water. This way, very high costs that are associated with the removal of sediments in phase III, which will require a much more complex technology, will be avoided.

c) Phase III

Phase III will be carried out in the limnetic zone of the lake, i.e. in the central part of the lake that is under water virtually throughout the entire year. This is the deepest part of the lake which for sure holds the largest volume of the lake sediments.

The sediment removal methods from phases I and II are not applicable in this part of the lake, because the sediments here are always in the water. The use of ordinary construction machinery in this case is possible only in shallow waters when water level in the lake is very low during dry periods of the year. In deep waters dredgers have to be used for the sediment removal. A dredger is typically mounted on a barge that moves around the lake and removes the sediments.

Different types of dredgers are used for the removal of material from the bottom of lakes. In this case, it is important to select a technology that prevents the spread of contaminants to other areas of the lake, in particular the area near the water intake. This type of dredging is termed environmental dredging. For this reason, mechanical dredgers (e.g. dipper-backhoe dredges or clamshell-bucket dredges) are not foreseen in this Study, since they have difficulty retaining loose, fine materials in buckets, and may need added and expensive controls to handle contaminated sediments



HPP: Hydropower plant
Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.5-4 Cleaning of the sediments from Lake Modrac in Phase III

Another option is to employ hydraulic dredging to remove the sediments. Most widely used techniques are with cutterhead pipeline dredgers, which are used to remove compact sediments, and with suction dredgers used for loose sediments. In both techniques sediments are typically pumped directly from the barge to the lake shore by a floating or a submerged pipeline. Hydraulic dredging is faster than mechanical dredging, creates less turbidity, and is typically the most cost-effective method for large dredging projects such as the one for Lake Modrac.

The material removed from the lake hydraulic dredgers is a slurry mixture that has to be dewatered before the sediment is transported to the disposal site. For this reason, in this phase it will be necessary to build settling ponds on lake shores, in which the slurry will be treated by sedimentation and coagulation (if needed). The water from the settling ponds overflows back to the lake and the sediment is moved to the disposal site.

The proposed plan for the cleaning of Lake Modrac was developed on the basis of very scarce input parameters, which are considered estimates rather than measured data. The only data considered reliable is the volume of sediments in the lake, which is assessed based on morphometric surveys carried out in the years 1984 and 2002.

(2) Required further investigations

Before the start of the sediments removal from the lake, it is necessary to carry out a morphometric survey of Lake Modrac. Although this Study provided an important step forward in the comprehension of the water and sediment characteristics in the Modrac Lake, more analyses especially of sediments would be welcome before the ultimate remediation plan can be finalized. Analyses of sediments performed in this Study refer only to the upper sediment layer. Further investigation may also provide insight into the characteristics and composition of deeper and older layer of sediments. Monitoring of sediment quality should also be performed during the entire dredging process. Monitoring of bio-accumulation of heavy metals other pollutants in the fishes of Modrac Lake and downstream river would be of paramount importance to better define the risk of fishery for the human health.

(3) Post Remediation Activities

Active and passive protection measures in the catchment area are certainly a very important long-term goal, but they will make little difference for the existing situation. Since the remediation is a very expensive and lengthy operation, all efforts should be made to minimize the sediment flux from the catchment area in the future. Obvious priorities for intervention are municipal wastewaters, and the coal mines in the catchment; however, all other point and diffuse sources of pollution should be considered and prioritized. In this regard, a detailed study is necessary in order to focus the efforts on priority issues and maximize cost-effectiveness of the watershed protection measures.

Monitoring of chemical and ecological status of the lake is an important tool for proper lake management decisions. The current water monitoring should be extended to include sediment and biota which are two major components that indicate the status of the lake.

A 3.6 Abandoned Mining Sites in Vares

A 3.6.1 Abandoned Open-pit Pond Site

A 3.6.1.1 Supplementary Data of General Site Information and History of the Site

(1) Technological Process

The site was a large iron mine where the excavation of raw ferrous ore took place. The treatment of ferrous ore included application of three major types of mining equipment: mining processing machines (shaking table, spiral separator), crushing machines (jaw crusher and fine crusher), and grinding machines (ball mill).

(2) Raw Materials, Products and By-products

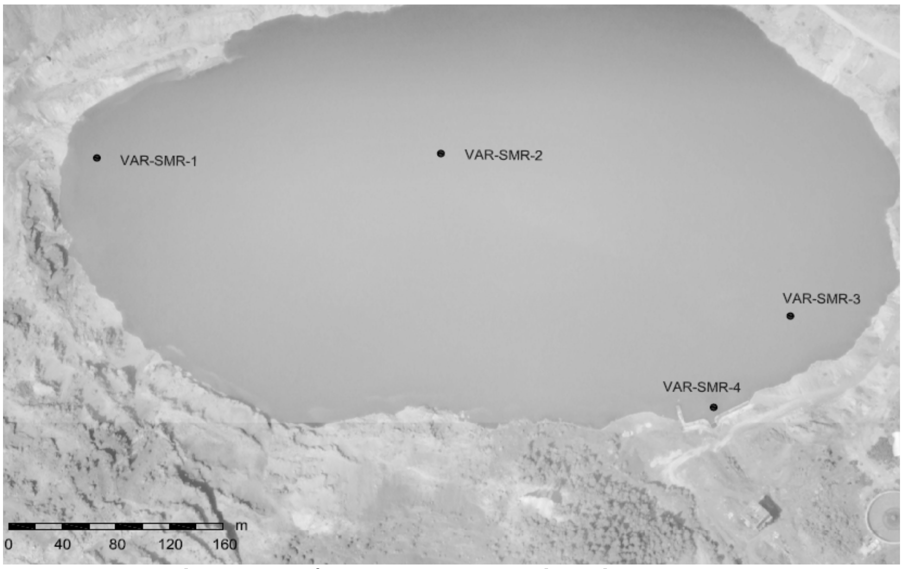
The technological process within iron ore pit included only crushing of the ore. The ore was further upon processed in respective iron smelting plants in either Zenica, BiH or Smederevo, Serbia. Therefore, only iron in the form of iron oxide (Fe_2O_3) together with our trace elements (Zn, Mn, Pb, Al, Ni, Si, As) present in the hematite minerals has been used as raw material.

The main product from the technological process was the concentrate of siderite, where the iron content amounted to 36%. On the other hand, by-products from the technological process were present in remaining tailings. The tailings most probably had elevated content of other trace metals which usually accompany ferrous ores.

A 3.6.1.2 Site Investigation

(1) Sampling Location

The sampling locations are shown in the following maps.



Source: HEIS, Completion Report of On –site Investigation and Sampling, 2013

Figure A 3.6-1 Sampling Point of Abandoned Open-pit Pond Site

(2) Analysis Result

The analysis result is shown in the following tables.

Table A 3.6-1 Site Investigation Result of Sediment of Abandoned Open-pit Pond Site

Parameter	Sample label / Type	VAR-SMR-1 / SED / Sediment	Reference Values: Freshwater (ISQG)	Reference Values: Freshwater (PEL)
pH - Water	pH units	8.29	-	-
pH -KCl	pH units	8.09	-	-
EC	uS/cm	748	-	-
ORP	mV	235	-	-
Total organic carbon (TOC)	%	1.05	-	-
Oil/fat	g/kg DW	0.6	-	-
Water content	%	15.35	-	-
Cadmium (Cd)	mg/kg DW	1.34	0.6	3.5
Lead (Pb)	mg/kg DW	176	35	91.3
Total chromium (T-Cr)	mg/kg DW	36	37.3	90
Total mercury (T-Hg)	mg/kg DW	1.83	0.17	0.486
Copper (Cu)	mg/kg DW	81	-	-
Nickel (Ni)	mg/kg DW	49	-	-
Zinc (Zn)	mg/kg DW	1115	123	315
Iron (Fe)	mg/kg DW	2149	-	-
Manganese (Mn)	mg/kg DW	4751	-	-
Arsenic (As)	mg/kg DW	71	5.9	17
Selenium(Se)	mg/kg DW	19.83	-	-
Sulfur (S)	g/kg DW	1.1	-	-
Cyanide	mg/kg DW	-	-	-
Density	g/cm3	1.92	-	-
Ignition loss (550°C)	%	2.2	-	-

:PEL or more (orange)

:ISQG or more, but less than PEL (blue)

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.6-2 Site Investigation Result of Water of Abandoned Open-pit Pond Site

		Open-pit Pond				Back Ground in Vares			Referrence Values	
	Sample label	VAR-SMR-1 / W	VAR-SMR-2	VAR-SMR-3	VAR-SMR-4	VAR-BG-4	VAR-BG-5	VAR-BG-6		
Parameter	Type	Water	Water	Water	Water	Water	Water	Water	Class I-II	Class III-IV
pH	-	8.17	-	8.15	8.14	8.05	8.08	7.44	6.8-8.5(Class I) 5.8-8.5(Class II)	6.0-9.0
EC	uS/cm	1045	-	1046	1045	491	1026	385	-	-
DO	mg/l	8.8	-	9.1	8.7	9.0	9.44	7.77	6-8	3-4
Turbidity	NTU	2.9	-	1.4	2.6	5.8	< 0.01	< 0.01	-	-
Salinity	PSU	0.5758	-	0.5763	0.5758	0.2630	0.5648	0.2048	-	-
Cadmium (Cd)	mg/l	0.0015	0.0013	0.0013	0.0008	0.0019	0.0018	<0,001	0.0005	0.005
Lead (Pb)	mg/l	0.014	0.013	0.016	0.013	0.032	0.018	0.013	0.002	0.08
Total chromium (T-Cr)	mg/l	<0,001	0.007	0.007	<0,001	<0,001	<0,001	<0,001	0.001-0.006	0.006-0.02
Total mercury (T-Hg)	mg/l	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,0005	0.0007	< 0,0005	0.00002	0.001
Copper (Cu)	mg/l	<0,001	<0,001	<0,001	<0,001	0.016	0.012	0.014	0.002-0.01	0.01- 0.02
Zinc (Zn)	mg/l	<0,1	<0,1	<0,1	<0,1	<0,1	0.356	<0,1	0.005-0.08	0.08-0.2
Iron (Fe)	mg/l	0.04	0.01	0.05	0.05	0.10	0.09	0.10	0.1	1
Manganese (Mn)	mg/l	0.053	0.049	0.058	0.057	0.003	0.010	0.009	0.05	1
Arsenic (As)	mg/l	< 0,001	< 0,001	< 0,001	0.001	0.003	0.001	< 0,001	0.05	0.05
Sulfate ion(SO42-)	mg/l	537.6	596.9	614.9	505.6	16.6	460.8	33.9	-	-
Chloride ion(Cl-)	mg/l	2.8	2.8	2.8	3.6	7.1	3.6	2.8	-	-
Fluoride (F)	mg/l	-	-	-	-	< 0,01	0.34	0.07	0.0003	0.0015
Cyanide	mg/l	0.001	< 0,001	0.002	< 0,001	< 0,001	< 0,001	< 0,001	0.001	0.1

(blue) : Reference values of Class I-II or more, but less than reference values of class III-IV

(orange) : Reference values of Class III-IV or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.6.1.3 Detail Data of Input and Output of Overall Risk Assessment

The input values for HRS and the breakout of the result are shown in the following tables.

Table A 3.6-3 Input Parameters and Values for the Risk Score Calculations of Abandoned Open-pit Pond Site

Summarized overview of input parameters for Smreka sampling site														
Parameter	Unit	Input values												
		Months												
		1	2	3	4	5	6	7	8	9	10	11	12	Σ
Monthy Precipitation	mm/month	79	74	77	81	90	100	88	78	77	85	103	94	1026
I-parameter		0	0.0306	0.74	2.193	4.298	5.763	6.896	6.664	4.805	2.559	0.796	0.003	34.75
α-parameter		1.050												
Mean monthly Evapotranspiration	mm/month	0	1.6893	19.56	45.59	82.63	102.7	117.4	105.6	72.57	42.31	15.88	0.291	
Average Day Length of the month	hours	9.2	10.4	11.93	13.53	14.88	15.6	15.23	14.03	12.5	10.92	9.52	8.78	
Number of days in the month		31	28	31	30	31	30	31	31	30	31	30	31	
Mean monthly temperature	°C	-1.9	0.5	4.1	8.4	13.1	15.9	17.9	17.5	14.1	9.3	4.3	0.1	
Distance from the surface to the top of aquifer	(cm)	/												
Hydraulic Conductivity of the layer	(cm/sec.)	1x10^-9												
Thickness of lowest hydraulic conductivity layer	(cm)													
Distance from the surface to the top of aquifer	(cm)	/												
Distance from the surface to the lowest known point of hazardous substances	(cm)	/												
Source type		Surface water and Sediment												
Contributing hazardous substances		Zinc, Iron, Manganese												
Overall constituent quantity of hazardous substances	lbs	32640.04												
Area of contaminated site	m²	170202												
Distance of the nearest drinking water wells (max.distance 6.5 km)	m	4800 (upstream)												
Number of people served by drinking water within distance of 0 to 0.4 km	/	0												
Number of people served by drinking water within distance of 0.4 to 0.8 km	/	0												
Number of people served by drinking water within distance of 0.8 to 1.6 km	/	0												
Number of people served by drinking water within distance of 1.6 to 3.2 km	/	0												
Number of people served by drinking water within distance of 3.2 to 4.8 km	/	0												
Number of people served by drinking water within distance of 4.8 to 6.5 km	/	0												
Presence of the Wellhead Protection Area within a distance of 6.5 km	YES/NO	YES												
Number of people who live/attend school within a distance of 60 m from the contaminated area	/	0												
Number of workers within a distance of 60 m from the contaminated area	/	0												
Presence of comercial agriculture/silviculture/livestock produtuction and/or grazing on the contaminated area	YES/NO	NO												
Site-specific 2 Yearly 24 hours Rainfall for the site (statistics from atleast last 20 years)	mm	47												
Drainage area (see note)	(m²)	664667												
A-Coarse-textures soils with high infiltration rates (sands, loamy sands)	(%)													
B- Medium-textures soils with moderate infiltration rates (sandy loams, loams)	(%)	223593 (33,64)												
C-Moderately fine-textured soils with low infiltration rates (silty loams, silts, sandy clay loams)	(%)	121168 (18,23)												
D-Fine-textured soils with very low infiltration rates (clays, sandy clays, silty clay loams, clay loams, silty clays	(%)	319904 (48,13)												

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.6-4 Breakout of Risk Score of Abandoned Open-pit Pond Site

Factor Category		GWMP	Surface Water Migration Pathway						SEMP		AMP
			SW/OC			GWSWC					
			DWT	HFCT	ET	DWT	HFCT	ET	RPT	NPT	
1	Observed release	0	0	0	0	0	0	0	550	550	0
2	Potential to release	40	170	170	170	50	50	50	-	-	12
2a	Potential to release by overland flow	-	100	100	100	-	-	-	-	-	-
2b	Potential to release by flood	-	70	70	70	-	-	-	-	-	-
2c	Gas potential to release	-	-	-	-	-	-	-			2
2d	Particulate potential to release	-	-	-	-	-	-	-			12
2e	Attractiveness/Accessibility	-	-	-	-	-	-	-	-	25	-
2f	Areas of Contamination	-	-	-	-	-	-	-	-	20	-
3	Likelihood of Release (higher of lines 1 and 2)	40	170	170	170	50	50	50	0	0	12
3*	Likelihood of Exposure (higher of lines 1 and 2)	-	-	-	-	-	-	-	550	550	-
4	Toxicity	-	-	-					$1x10^4$	$1x10^4$	2
4a	Toxicity/Mobility	100	-	-					-	-	
4b	Toxicity/Mobility/Persistence					100	100				
4c	Toxicity/Mobility/Persistence/Bioaccumulation						$5x10^6$				
4d	Toxicity/Persistence	-	$1x10^4$	$1x10^4$				$5x10^5$	-	-	-
4e	Toxicity/Persistence/Bioaccumulation	-	-	$5x10^8$					-	-	-
4f	Ecotoxicity/Persistence				$1x10^3$				-	-	-
4g	Ecotoxicity/Persistence/Bioaccumulation	-	-	-	$5x10^7$				-	-	-
4h	Bioaccumulation						$5 x10^4$				
4i	Ecosystem BAP value				$5 x10^4$			$5 x10^4$	-	-	-
5	Hazardous Waste Quantity	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$	$1x10^4$
5a	Waste characteristics	-	100	$1x10^3$	560	32	320	180	100	100	10
6	Waste characteristics factor category	100	100	$1x10^3$	560				100	100	-
7	Nearest well	5	-	-	-				-	-	-
8	Nearest intake		10	-	-	20			-	-	-
9	Nearest individual	-	-	-	-				-	-	1
9a	Nearest Food Chain Individual	-	-	2	-		2		-	-	-
9b	Level I	-	-	-	-				-	-	-
9c	Level II	-	-	-	-				-	-	-
9d	Potential Contamination	-	-	-	-	0.42	4.3	-	-	-	44.1
10	Total population	1	-	-	-		-		-	-	-
10a	Level I	0	-	0	-		0		-	-	-
10b	Level II	0	-	0	-		0		-	-	-
10c	Potential Contamination	1.6	2.4	-	-		-			-	-
11	Workers								0	-	-
12	Resources	5	5	-	-	5			5	-	5
13	Wellhead Protection Area	5	-	-	-					-	-
14a	Actual Contamination	-	-	-	-					-	-
14b	Potential Contamination	-	-	-	2.3			24.3		-	0.12
14c	Sensitive Environments	-	-	-	2.3			24.3		-	-
15c	Resident/Nearby individual								45	1	-
16a	Population within a mile									27.5	-
16b	Sensitive environments				2.3			-			0.12
16c	Targets factor category	16.60	15.24	4.12	2.3	25.42	6.3	24.3	50	28.5	50.22
17	Threat Score		3.14	4.12	2.65	0.49	1.22	2.65	$2.75 x10^6$	$1.43 x10^4$	
18	Component Score		9.91			4.36			-	-	-
19	Pathway score	0.26	9.91						33.51		0.07
20	Overall site score	17.47									

Abbreviations: GWMP – Groundwater Migration Pathway, SW/OC – Surface Water/Overland Component, DWT – Drinking Water Threat, HFCT – Human Food Chain Threat, ET – Environmental Threat, GWSWC – Groundwater to Surface Water Component, SEMP – Soil Exposure Migration Pathway, RPT – Resident Population Threat, NPT – Nearby Population Threat, AMP – Air Migration Pathway

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.6.1.4 Supplemental Information of Proposed Remediation Plan

Remediation measures at the target site should include biological recultivation (reclamation) of the slopes around the pond which lost the soil and vegetation during the mining operations. The area of disturbed land that should undergo biological recultivation is estimated at 105 ha.

Revegetation of abandoned surface mines is often difficult due to their chemical and physical traits – the absence of topsoil, scarcity of nitrogen and other essential macro and micro nutrients, the absence of soil organic matter provided by decay of dead plant material, lack of soil micro flora necessary for the decay of plant material, low infiltration rates and water retention capacity of the stony land, etc.

The main challenge with the development of a permanent vegetation cover at the site is to establish a plant community that will maintain itself indefinitely without attention or artificial aid, and support native fauna. To achieve better results, some ecological variables must be considered while selecting species for plantation. These are, *inter alia*, their capacity to stabilize soil, increase soil organic matter and available soil nutrients, and facilitate under storey development. In the initial stages of revegetation quick growing grasses with short life cycle, legumes and forage crops are recommended. They will improve the nutrient and organic matter content in soil. Plantation of mixed species of economic importance should be done after 2-3 years of growing grasses.

Specific remediation measures should be proposed in a detailed design of the biological recultivation, which should be developed beforehand. These measures can be implemented over a period of several years, according to available financial resources of the local community.

A 3.6.2 Processing plant facility/ Tailings pond and dam Site

A 3.6.2.1 Supplementary Data of General Site Information and History of the Site

(1) History of the Site

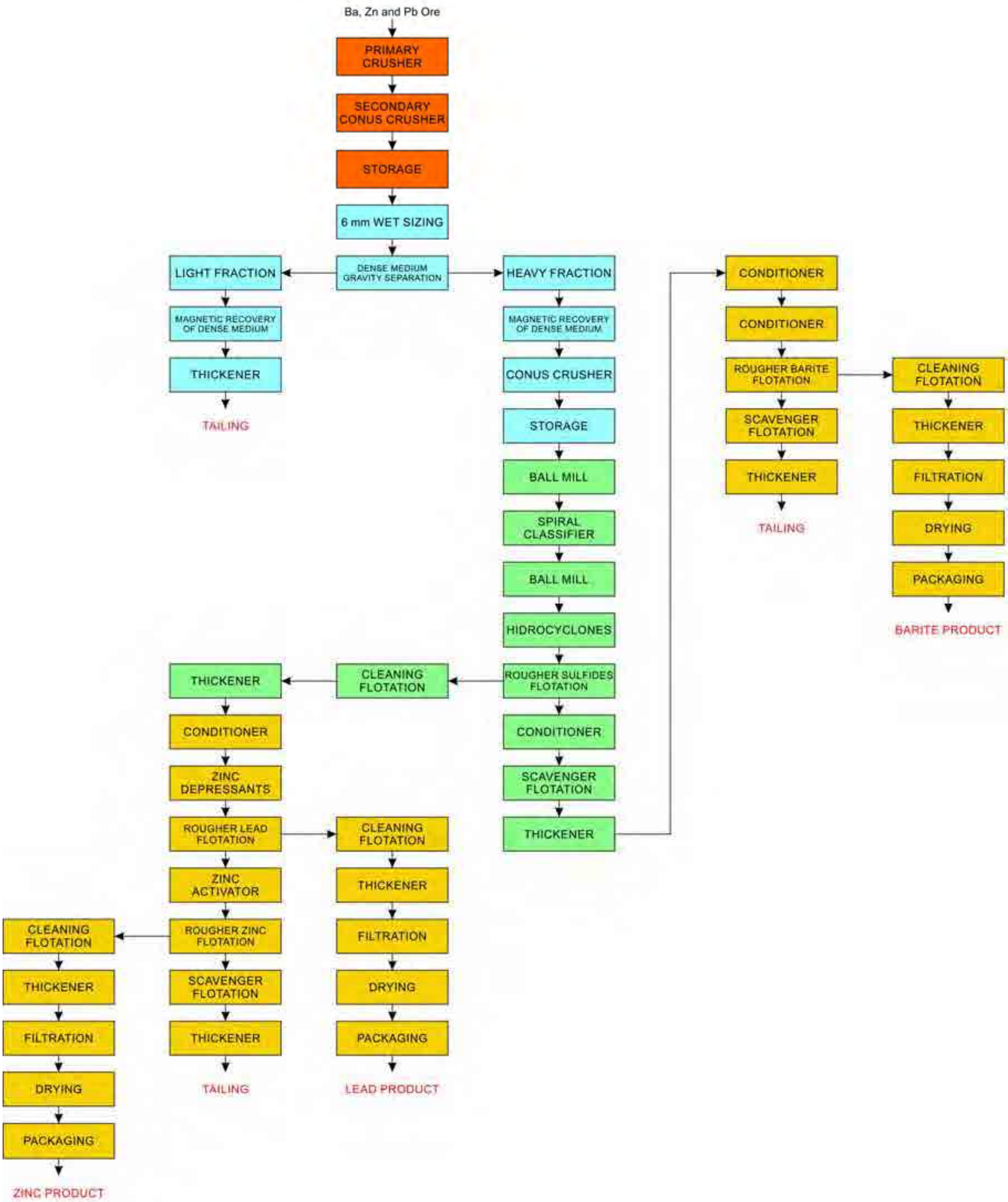
The enrichment of the ore at the processing plant was accomplished through 6 main process steps (Ćorić, 1985[1]):

1) Crushing and storing of raw ore
2) PT(Pliva-Tone) Separation unit
3) Wet grinding
4) Collective flotation unit
5) Barite separation unit
6) Lead and Zinc separation unit

During the operation of the former processing plant of the lead, zinc and barite mine, the residues from the production process were transported by gravity as slurry – wet pulp (1:3 ratio of solids and water) from the plant to the tailing site by a slurry pipeline. It was foreseen that the settleable solids from the slurry (sand mostly) are removed by a hydrocyclone[2] and the remaining supernatant is transported to the tailing site for sedimentation. After the sedimentation, water was clarified and used in recirculation in the flotation process at the former processing plant. The water was recirculated by a floating pump installed at the tailing pond.

[1] Mining, Geology and Petroleum Engineering, Zagreb , Analysis of the technological process of processing of barite in the separation of previously rendered, Graduate work, 1981 (Analiza tehnološkog procesa oplemenjivanja barita u separaciji Tisovci, Diplomski rad. Rudarsko geološko naftni fakultet Zagreb.)

[2]. Mining Institute in Belgrade, Design of the auscultation of the tailing dam; Construction of tailing dam - Flotation of "Vares" mines, (Projekat oskultacije brane jalovišta; Izgradnja jalovišta – flotacija rudnika „Vareš“, Rudarski institut Beograd, Zemun.), 1981



Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Figure A 3.6-2 Process Flow of Former Processing Factory

(2) Raw Materials and Waste Management

Regarding chemicals used in the process, detailed information are available for the barite flotation process only (Ćorić, 1985), while for the lead and zinc separation only standard chemicals used typically for this process can be listed.

Table A 3.6-5 Raw Materials used for Barite Flotation Processes

Type	Name of Reagent	Quantity
Gravity separation medium	Sodium silicate	0.13 kg/t ore
Gravity separation medium	Magnetite	0.08 kg/t ore
pH controller	Hydrated lime	Not reported
Depressant	Sodium cyanide*	-
Depressant	Sodium silicate	5.2 kg/t ore
Depressant	Tannin	1.7 kg/t ore
Collector	Nadar 776 or BC-50 (Xanthates?)	2.4 kg/t ore or 0.7 kg/t ore
Activator	Copper Sulfate *	-
Fuel for the barite dryer	Fuel oil	15 kg/t barite
Electricity	Electricity	51500 MWh/year

*) The values were assumed from standard Pb/Zn flotation processes

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

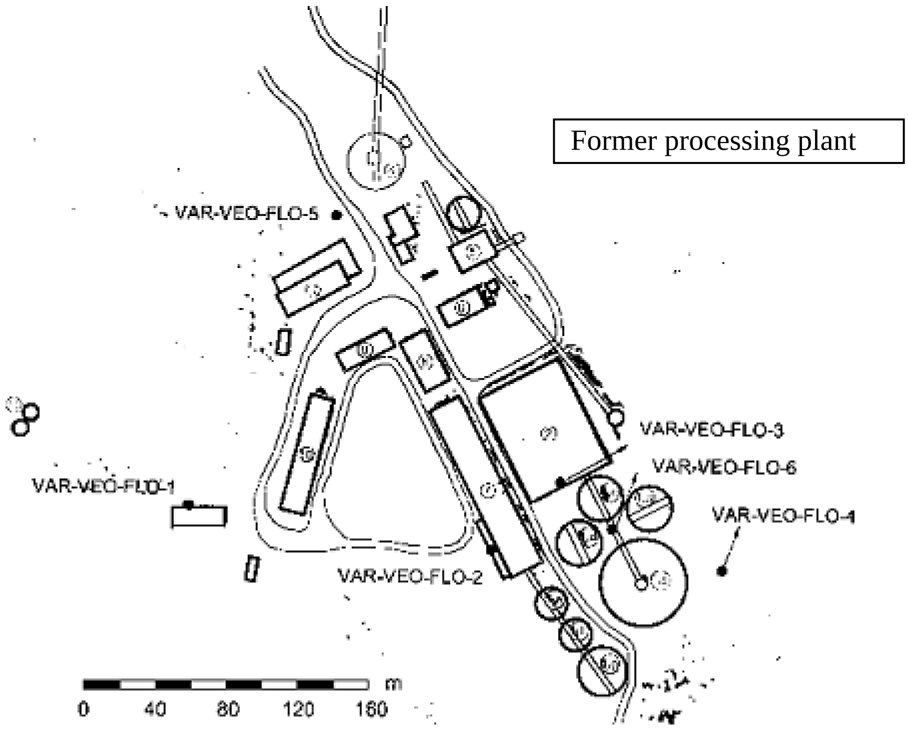
Tailing residual represents the only significant type of waste generated at the flotation plant. The tailing is composed by the original silicate/carbonate matrix from where the barite and sulfides mineral have been extracted. However, high residual concentrations of lead, zinc and barite are still present (for example 10-20% of barite) and at least for barite caused a not-optimal function of the plant (a 60% barite recovery was achieved against an 80% expected). The tailing waste (about 87% of the raw ore) collected from the thickener is produced into two particle size classes:

- The fines are transported as slurry to a tailing pond constructed on the bottom of the valley, where settling occurred. Clarified water from this accumulation is pumped back to the flotation plant to be used as technological water.
- The rougher fraction was temporary stored nearby the PT separation building and then transported by truck to the nearby tailing dump site located less than 1 km southwest of the flotation plant and downstream of the tailing pond. It should be noticed that also in the case of the tailing dump site, a water accumulation was formed upstream and the creek flowing in the valley was tunneled under the pond and dump site in similar way how the tailing pond is constructed.

A 3.6.2.2 Site Investigation

(1) Sampling Location

The sampling locations are shown in the following maps.



Source: HEIS, Completion Report of On –site Investigation and Sampling, 2013 and modified by JET

Figure A 3.6-3 Sampling Point of Abandoned Mining Sites

(2) Analysis Result

The analysis result is shown in the following tables.

As a reference, the vapor gas of cyanide, trichloroethylene, and toluene were measured using a gas sampling pump and a detector on site. Those substances were not confirmed around the waste storage and disposal areas by these gas detectors.

Table A 3.6-6 Site Investigation Result of Former Processing Plant Site

Parameter	Sample label / Type	VAR-VEO-FLO-4	VAR-VEO-FLO-1	VAR-VEO-FLO-2	VAR-VEO-FLO-3	VAR-VEO-FLO-5	VAR-VEO-FLO-6	Reference Values
		Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	Sub-surface soil	
pH - Water	pH units	7.50	8.05	9.61	8.11	8.17	7.66	-
pH -KCl	pH units	5.81	7.40	9.47	7.81	7.81	8.2	-
EC	uS/cm	124	127	229	1960	498	271	-
ORP	mV	118	137	-31	155	93	103	-
Total organic carbon (TOC)	%	3.94	2.87	0.70	2.51	2.38	2.25	-
Oil/fat	g/kg DW	0.3	0.2	0.2	0.3	0.1	0.2	-
Water content	%	16.6	11.3	4.7	13.0	8.8	13.7	-
Cadmium (Cd)	mg/kg DW	3.70	3.54	2,00	36.36	4.79	16.43	10
Lead (Pb)	mg/kg DW	58	726	540	400	913	3005	500
Total chromium (T-Cr)	mg/kg DW	108	228	45	534	40	136	250
Total mercury (T-Hg)	mg/kg DW	0.59	0.65	0.35	0.85	0.55	3.36	10
Copper (Cu)	mg/kg DW	46	85	17	338	81	227	600
Nickel (Ni)	mg/kg DW	253	195	36	929	109	162	140
Zinc (Zn)	mg/kg DW	174	5192	327	2728	1107	2245	1000
Iron (Fe)	mg/kg DW	2487	2840	2909	2443	2485	2212	-
Manganese (Mn)	mg/kg DW	1337	1497	431	14847	10942	1638	2000
Arsenic (As)	mg/kg DW	49	49	12	30	147	91	50
Selenium(Se)	mg/kg DW	21.73	19.78	<10	<10	<10	<10	100
Sulfur (S)	g/kg DW	1.0	1.8	2.8	12.9	3.3	2.1	-
Cyanide	mg/kg DW	2.20	1.44	<0,01	2.11	2.21	0.27	50
Density	g/cm3	1.79	2.00	2.28	1.72	2.17	1.79	-
Ignition loss (550°C)	%	5.0	4.4	1.9	3.5	4.8	2.7	-

:Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.6-7 Site Investigation Result of Tailing Dam Site

Parameter	Sample label / Type	VAR-VEO-POND-3 / SED	VAR-VEO-POND-DAM	Reference Values
		Sediment	Sub-surface soil	
pH - Water	pH units	7.80	9.01	-
pH -KCl	pH units	7.63	7.89	-
EC	uS/cm	313	335	-
ORP	mV	132	235	-
Total organic carbon (TOC)	%	0.36	0.39	-
Oil/fat	g/kg DW	0.2	0.3	-
Water content	%	24.0	8.6	-
Cadmium (Cd)	mg/kg DW	7.78	7.21	10
Lead (Pb)	mg/kg DW	1887	2981	500
Total chromium (T-Cr)	mg/kg DW	26	17	250
Total mercury (T-Hg)	mg/kg DW	4.07	3.18	10
Copper (Cu)	mg/kg DW	150	149	600
Nickel (Ni)	mg/kg DW	25	18	140
Zinc (Zn)	mg/kg DW	1061	1360	1000
Iron (Fe)	mg/kg DW	2422	2234	-
Manganese (Mn)	mg/kg DW	1712	1394	2000
Arsenic (As)	mg/kg DW	140	140	50
Selenium(Se)	mg/kg DW	20.71	20.53	100
Sulfur (S)	g/kg DW	1.4	2.8	-
Cyanide	mg/kg DW	1.80	2.06	50
Density	g/cm3	1.79	2.27	-
Ignition loss (550°C)	%	2.2	1.6	-

:Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.6-8 Site Investigation Result of Background Soil in Vares

Parameter	Sample label / Type	VAR-BG-1	VAR-BG-2	VAR-BG-3	Reference Values
	Type	Sub-surface soil	Sub-surface soil	Sub-surface soil	
pH - Water	pH units	6.42	8.00	8.11	-
pH -KCl	pH units	4.73	7.17	7.32	-
EC	uS/cm	97	129	140	-
ORP	mV	150	101	132	-
Total organic carbon (TOC)	%	3.12	5.42	6.75	-
Oil/fat	g/kg DW	0.15	0.21	0.6	-
Water content	%	20.56	25.2	27.3	-
Cadmium (Cd)	mg/kg DW	2.95	2.84	6.93	10
Lead (Pb)	mg/kg DW	269	254	208	500
Total chromium (T-Cr)	mg/kg DW	41	106	154	250
Total mercury (T-Hg)	mg/kg DW	0.20	0.56	0.24	10
Copper (Cu)	mg/kg DW	38	27	69	600
Nickel (Ni)	mg/kg DW	33	32	155	140
Zinc (Zn)	mg/kg DW	253	415	379	1000
Iron (Fe)	mg/kg DW	2413	2821	2848	-
Manganese (Mn)	mg/kg DW	1480	1708	1867	2000
Arsenic (As)	mg/kg DW	53	12	11	50
Selenium(Se)	mg/kg DW	<10	<10	<10	100
Sulfur (S)	g/kg DW	0.5	0.5	0.4	-
Cyanide	mg/kg DW	1.64	0.02	0.05	50
Density	g/cm3	-	-	-	-
Ignition loss (550°C)	%	5.3	8.7	8.8	-

:Reference values or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.6-9 Site Investigation Result of Water of Tailing Dam Site

Parameter	Type	Tailing Pond and Dam						Back Ground in Vares			Referrence Values	
	Sample label	VAR-VEO-POND-1	VAR-VEO-POND-2	VAR-VEO-POND-3 / W	VAR-VEO-POND-DISCH-TOT	VAR-VEO-POND-SPRING	VAR-VEO-POND-DS	VAR-BG-4	VAR-BG-5	VAR-BG-6	Class I-II	Class III-IV
	Type	Water	Water	Water	Water	Water	Water	Water	Water	Water		
pH	-	8.37	8.29	8.33	8.19	7.64	8.28	8.05	8.08	7.44	6.8-8.5(Class I) 5.8-8.5(Class II)	6.0-9.0
EC	uS/cm	510	340	340	879	1127	851	491	1026	385	-	-
DO	mg/l	8.5	9.9	9.6	9.4	9.14	9.9	9.0	9.44	7.77	6-8	3-4
Turbidity	NTU	3.8	8.2	4.0	< 0.01	6.5	50	5.8	< 0.01	< 0.01	-	-
Salinity	PSU	0.2735	0.1802	0.1802	0.4808	0.6230	0.4649	0.2630	0.5648	0.2048	-	-
Cadmium (Cd)	mg/l	<0,001	<0,001	<0,001	0.0016	0.0034	0.0020	0.0019	0.0018	<0,001	0.0005	0.005
Lead (Pb)	mg/l	0.012	0.008	0.011	0.013	0.023	0.013	0.032	0.018	0.013	0.002	0.08
Total chromium (T-Cr)	mg/l	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0.001-0.006	0.006-0.02
Total mercury (T-Hg)	mg/l	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,0005	< 0,0005	0.0007	< 0,0005	0.00002	0.001
Copper (Cu)	mg/l	<0,001	<0,001	<0,001	<0,001	0.022	<0,001	0.016	0.012	0.014	0.002-0.01	0.01- 0.02
Zinc (Zn)	mg/l	<0,1	<0,1	<0,1	0.174	0.386	0.100	<0,1	0.356	<0,1	0.005-0.08	0.08-0.2
Iron (Fe)	mg/l	0.08	0.03	0.03	0.03	0.11	0.14	0.10	0.09	0.10	0.1	1
Manganese (Mn)	mg/l	0.004	0.003	0.002	0.227	0.034	0.018	0.003	0.010	0.009	0.05	1
Arsenic (As)	mg/l	0.007	0.008	0.007	0.001	< 0,001	0.002	0.003	0.001	< 0,001	0.05	0.05
Sulfate ion(SO42-)	mg/l	60.4	51.5	50.2	413.9	623.1	364.5	16.6	460.8	33.9	-	-
Chloride ion(Cl-)	mg/l	3.6	2.1	1.4	2.1	3.6	2.8	7.1	3.6	2.8	-	-
Fluoride (F)	mg/l	-	-	-	-	0.18	-	< 0,01	0.34	0.07	0.0003	0.0015
Cyanide	mg/l	0.001	0.002	< 0,001	0.0070	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	0.001	0.1

: Reference values of class I-II or more, but less than reference values of class III-IV

: Reference values of class III-IV or more

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.6.2.3 Detail Data of Input and Output of Overall Risk Assessment

The input values for HRS and the breakout of the result for this site are shown in the following table.

Table A 3.6-10 Input Parameters and Values for the Risk Score Calculations for the Former Processing Site/Tailing Dam

Summarized overview of input parameters for Veovača sampling site														
Parameter	Unit	Input values												
		Months												
		1	2	3	4	5	6	7	8	9	10	11	12	Σ
Monthy Precipitation	mm/month	79	74	77	81	90	100	88	78	77	85	103	94	1026
I-parameter		0	0.0306	0.74	2.193	4.298	5.763	6.896	6.664	4.805	2.559	0.796	0.003	34.75
α-parameter		1.050												
Mean monthly Evapotranspiration	mm/month	0	1.6893	19.56	45.59	82.63	102.7	117.4	105.6	72.57	42.31	15.88	0.291	
Average Day Length of the month	hours	9.2	10.4	11.93	13.53	14.88	15.6	15.23	14.03	12.5	10.92	9.52	8.78	
Number of days in the month		31	28	31	30	31	30	31	31	30	31	30	31	
Mean monthly temperature	°C	-1.9	0.5	4.1	8.4	13.1	15.9	17.9	17.5	14.1	9.3	4.3	0.1	
Distance from the surface to the top of aquifer	(cm)	/												
Hydraulic Conductivity of the layer	(cm/sec.)	1x10^-7 - 1x10^-9												
Thickness of lowest hydraulic conductivity layer	(cm)													
Distance from the surface to the top of aquifer	(cm)	Flotation - about 60 m												
Distance from the surface to the lowest known point of hazardous substances	(cm)	/												
Source type		Contaminated soil and Sediment												
Contributing hazardous substances		Mercury, Lead, Zinc, Iron, Manganese, Arsenic												
Overall constituent quantity of hazardous substances	lbs	235742.56												
Area of contaminated site	m²	125886												
Distance of the nearest drinking water wells (max.distance 6.5 km)	m	1500 (upstream)												
Number of people served by drinking water within distance of 0 to 0.4 km	/	0												
Number of people served by drinking water within distance of 0.4 to 0.8 km	/	0												
Number of people served by drinking water within distance of 0.8 to 1.6 km	/	5000												
Number of people served by drinking water within distance of 1.6 to 3.2 km	/	0												
Number of people served by drinking water within distance of 3.2 to 4.8 km	/	0												
Number of people served by drinking water within distance of 4.8 to 6.5 km	/	0												
Presence of the Wellhead Protection Area within a distance of 6.5 km	YES/NO	YES												
Number of people who live/attend school within a distance of 60 m from the contaminated area	/	50												
Number of workers within a distance of 60 m from the contaminated area	/	0												
Presence of comercial agriculture/silviculture/livestock produtuction and/or grazing on the contaminated area	YES/NO	YES												
Site-specific 2 Yearly 24 hours Rainfall for the site (statistics from atleast last 20 years)	mm	47												
Drainage area (see note)	(m²)	2877140												
A-Coarse-textures soils with high infiltration rates (sands, loamy sands)	(%)													
B- Medium-textures soils with moderate infiltration rates (sandy loams, loams)	(%)	721586 (25,08)												
C-Moderately fine-textured soils with low infiltration rates (silty loams, silts, sandy clay loams)	(%)	876089 (30,45)												
D-Fine-textured soils with very low infiltration rates (clays, sandy clays, silty clay loams, clay loams, silty clays	(%)	1279464 (44,47)												

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

Table A 3.6-11 Breakout of Risk Score the Former Processing Site/Tailing Dam

Factor Category		GWMP	Surface Water Migration Pathway						SEMP		AMP
			SW/OC			GWSWC					
			DWT	HFCT	ET	DWT	HFCT	ET	RPT	NPT	
1	Observed release	550	550	550	550	-	-	-	550	550	0
2	Potential to release	-	-	-	-	120	120	120	-	-	162
2a	Potential to release by overland flow	-	-	-	-	-	-	-	-	-	-
2b	Potential to release by flood	-	-	-	-	-	-	-	-	-	-
2c	Gas potential to release	-	-	-	-	-	-	-	-	-	12
2d	Particulate potential to release	-	-	-	-	-	-	-	-	-	162
2e	Attractiveness/Accessibility	-	-	-	-	-	-	-	-	50	-
2f	Areas of Contamination	-	-	-	-	-	-	-	-	5	-
3	Likelihood of Release (higher of lines 1 and 2)	550	550	550	550	120	120	120	550	550	162
3*	Likelihood of Exposure (higher of lines 1 and 2)	-	-	-	-	-	-	-	550	550	-
4	Toxicity	-	-	-	-	-	-	-	$1x10^{4}$	$1x10^{4}$	2000
4a	Toxicity/Mobility	100	-	-	-	-	-	-	-	-	-
4b	Toxicity/Mobility/Persistence	-	-	-	-	100	100	10	-	-	-
4c	Toxicity/Mobility/Persistence/Bioaccumulation	-	-	-	-	-	$5x10^{6}$	$5x10^{5}$	-	-	-
4d	Toxicity/Persistence	-	$1x10^{4}$	$1x10^{4}$	-	-	-	-	-	-	-
4e	Toxicity/Persistence/Bioaccumulation	-	-	$5x10^{8}$	-	-	-	-	-	-	-
4f	Ecotoxicity/Persistence	-	-	-	$1x10^{3}$	-	-	-	-	-	-
4g	Ecotoxicity/Persistence/Bioaccumulation	-	-	-	$5x10^{7}$	-	-	-	-	-	-
4h	Bioaccumulation	-	-	-	-	-	$5 x10^{4}$	-	-	-	-
4i	Ecosystem BAP value	-	-	-	$5 x10^{4}$	-	-	$5 x10^{4}$	-	-	-
5	Hazardous Waste Quantity	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$	$1x10^{4}$
5a	Waste characteristics	-	100	$1x10^{3}$	560	32	320	180	100	100	56
6	Waste characteristics factor category	100	100	$1x10^{3}$	560	32	320	180	100	100	56
7	Nearest well	9	-	-	-	-	-	-	-	-	-
8	Nearest intake	-	2	-	-	2	-	-	-	-	-
9	Nearest individual	-	-	-	-	-	-	-	-	-	50
9a	Nearest Food Chain Individual	-	-	2	-	-	2	-	-	-	-
9b	Level I	-	-	-	-	-	-	-	-	-	-
9c	Level II	-	-	-	-	-	-	-	-	-	-
9d	Potential Contamination	-	3.3	0.2	8.1	23.1	-	9.4	-	-	25.4
10	Total population	1	-	-	-	-	-	-	-	-	67.3
10a	Level I	0	-	0	-	-	0	-	-	-	-
10b	Level II	0	-	0	-	-	0	-	-	-	-
10c	Potential Contamination	0.7	2.4	-	-	-	-	-	-	-	67.3
11	Workers	-	-	-	-	-	-	-	0	-	-
12	Resources	0	5	-	-	-	-	-	0	-	0
13	Wellhead Protection Area	5	-	-	-	-	-	-	-	-	-
14a	Actual Contamination	-	-	-	-	-	-	-	-	-	-
14b	Potential Contamination	-	-	-	2.3	-	-	-	-	-	25.4
14c	Sensitive Environments	-	-	-	2.3	-	-	9.4	-	-	-
15c	Resident/Nearby individual	-	-	-	-	-	-	-	50	1	-
16a	Population within a mile	-	-	-	-	-	-	-	-	5	-
16b	Sensitive environments	-	-	-	2.3	-	-	9.4	-	-	25.4
16c	Targets factor category	14.7	15.24	4.12	2.3	25.42	6.3	9.4	50	3	142.7
17	Threat Score	-	2.2	1.4	30.24	1.17	0.93	2.46	$2.75 x10^{6}$	1500	-
18	Component Score	-	33.84			4.56			-	-	-
19	Pathway score	3.14	33.84						33.51		15.69
20	Overall site score	25.52									

Abbreviations: GWMP – Groundwater Migration Pathway, SW/OC – Surface Water/Overland Component, DWT – Drinking Water Threat, HFCT – Human Food Chain Threat, ET – Environmental Threat, GWSWC – Groundwater to Surface Water Component, SEMP – Soil Exposure Migration Pathway, RPT – Resident Population Threat, NPT – Nearby Population Threat, AMP – Air Migration Pathway

Source: HEIS, Final Report of Sampling Survey and Analysis for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina, 2014

A 3.6.2.4 Supplemental Information of Proposed Remediation Plan

(1) Remediation Objectives

The soil inside the Former processing plant is heavily polluted by heavy metals, so proper remediation measures should be applied in order to improve the current environmental conditions.

Around 4.5 ha, or around 2/3 of the total area, needs remediation to reduce the concentrations of heavy metals to the levels close to the background level. Most of the soil samples, which were taken at a depth of 0.5 m, are very contaminated by Pb, Mn and Zn. It is estimated that only small part of the area – approximately 10,000 m^2, particularly around circular basins, is contaminated also with Cd, Cr, and Ni. The total quantity of the soil that should be remediated in that case is estimated at 22,500 m^3 or 44,000 t.

Long-term stability of the tailing dam is a major concern at the tailing, as the possible failure of the dam represents a risk to downstream aquatic and semi-aquatic ecosystems and human population. Therefore, the primary remediation objective is to ensure high safety of the dam and minimize the risk of the dam failure. Other issues, e.g. the pollution of water in the pond and the toxicity of the tailing material, are not of primary concern, as the pollution is confined in the immediate area of the tailings dam. However, the remediation plan provides general guidelines with regard to possible further steps aimed at the full cleanup of the site. It has to be emphasized that the future land use of this site is not defined in this moment, so this is another reason why this plan cannot address this issue in more detail. Regardless of the remediation measures at the tailing and pond, a priority objective is to minimize the inflow of surface water from the catchment to the pond, in order not to increase the volume of water already existing in the pond.

(2) Proposed Remediation Plan

1) Development of Preliminary Remediation Plan

At this site the following issues have been identified:

- The existing buildings and equipment have to be decommissioned because of the plans to use the site for other purposes.
- Soil is heavily polluted by heavy metals, which requires remediation measures to bring the soil quality to acceptable level.

The following sections describe possible remediation options for the above listed issues.

2) Soil Contamination

The same options that are available for the former chemical factory site in Tuzla can be used for the remediation of soils at the former processing plant. A significant difference between the two sites comes from the fact that soils at the former processing plant in Vares are not contaminated with Hg and PCBs, which are two very hazardous pollutants. Because of this it is possible to consider much simpler and cheaper remediation techniques at this site, while all other available techniques presented in Section should be applied only if the proposed measures fail for any reason.

3) Tailing dam

The priority remediation measure at the tailing dam is the rehabilitation of the tailing dam. The rehabilitation measures have to be based on detailed topographic survey and geotechnical investigations to be carried out at the dam. Based on those results, a detailed design is needed to develop technical measures for the rehabilitation. In Chapter 4, the following two measures were proposed: (i) rehabilitation of the dam, and (ii) vegetation of the downstream slope of the dam.

The detailed design of the dam rehabilitation will provide technical solutions regarding the new geometry of the dam. In any case, the stability and impermeability of the dam as well as the resistance to erosion of the downstream slope are the major issues to consider in the design. The design should be based on detailed geotechnical investigations, which should define geotechnical parameters for the existing dam material.

In this plan it was foreseen that the dam keeps the existing sloping profile– with a berm at 985.0 m.a.s.l.(metres above sea level) and a toe berm. However, depending on the results of the geotechnical investigations, any other profile of the dam can be proposed.

The dam should be rehabilitated using the same or similar materials that were used for the construction of the original dam. It is preferred that the locally borrowed material is used for the remediation; however, this has to be decided and explained in more detail in the detailed design.

It is foreseen that the downstream slope should be protected from erosion by planting grass vegetation and/or other vegetation with a very shallow root system. Trees and bushes are not permitted on the embankments, as deep root systems provide seepage paths for water, especially after roots decay. Trees that fall over or are blown down can leave large holes in the embankment surface, weakening the embankment and possibly leading to increased erosion or even immediate failure.

The existing piezometers are currently in a bad shape, so it is foreseen that the piezometers should be examined during the preparation of the detailed design, and eventually replaced in case they are broken or blocked. In any case, the piezometers have to be fully operational so that a regular monitoring can be carried out in the future.

In order to ensure a proper monitoring of the status of the dam, a survey benchmark should be installed at or very nearby the dam crest.

In order to reduce the inflow of the surface runoff into the pond, it is foreseen that two interception ditches are constructed in a general direction NE(northeast)-SW(southwest) parallel to the pond. The ditches will collect surface water from the pond’s catchment, and discharge it into the nearby river just downstream from the outflow structure of the pipe culvert.

(3) Post Remediation Activities

Monitoring of the soil should be done immediately after the implementation of the remediation measures, aiming to assess the effects of the remediation techniques. Taking into consideration plans for the restart of the plant operations, appropriate protection of the remediated soil have to be considered, as a first activity before re-building the plant.

The safety of the tailing dam is a primary concern after the proposed remediation measures are implemented. It is therefore necessary to introduce and carry out regular inspections of the dam in order to ensure that the dam is always in a good condition. The inspections should include the following:

- Visual inspections of the dam, and the auxiliary structures (piezometers, inlet and outlet structure of the pipe culvert, the downstream open channel) on a monthly basis. Should any damages or problems be observed, the rehabilitation measures have to be implemented immediately.
- Observation of the water level in piezometers on a monthly basis. The data collected have to be analyzed in order to check the impermeability of the dam.
- Topographic survey of the benchmark on a monthly basis. The data collected have to be analyzed in order to check the stability of the dam.

The inspections and monitoring at the dam have to be carried out by a specialized institution, experienced with the observation of high dams. The results of the inspections and monitoring should be presented in annual reports, which should summarize the findings of the inspections and monitoring, and propose immediate and long-term measures at the dam.

Annex 4

CHECKLIST FOR REMEDIATION OF ENVIRONMENTAL HOTSPOTS

Annex 4 CHECKLIST FOR REMEDIATION OF ENVIRONMENTAL HOTSPOTS

A 4.1 Introduction

This section provides a checklist on conducting and reporting site investigations, risk assessments, development and implementation of remediations, and monitoring and follow-up of contaminated sites. This checklist provides some important elements on each stage for the environmental consultants and others who conduct investigations and remediation activities, as well as for reviewers of such works.

Although the checklist addresses many pertinent issues, it is not a complete listing of all potential concerns. It should be considered that there are site-specific factors and information provided during investigations. In this regard, JET proposes some examples of checklists, tentatively considering acceptability for BiH under limited conditions.

A 4.2 Checklist

A 4.2.1 Site Identification

Checklist: Site Identification	
A) Objectives	Y/N
- To identify potentially contaminated site.	
- To register and manage the potentially contaminated site.	
B) Collection of Information	
1. General site identification	
☐ Site name and address ☐ Registered number ☐ Map ☐ Geographic coordinates ☐ Owner/operator ☐ Legend of owner/operator ☐ Layout map	
2. Description of site	
☐ Facility type ☐ Active/inactive ☐ Years of operation ☐ Physical characteristics and settings ☐ Involvement of regulatory agencies on control of contamination ☐ Site history	
3. Environmental setting	
☐ Groundwater or aquifer in use ☐ Surface water and river ☐ Important sources and environment on or near the site ☐ Population (residents, students, workers, and others) ☐ Groundwater/surface water use and characteristics ☐ Fisheries and agriculture in and around the site	
4. Identification of potential contaminants and source area	
☐ Hazardous substances used in the site of each stage (history) ☐ Probable source types ☐ Size and amount of hazardous substances ☐ Waste types	
5. Summary of existing samples and analytical data	
6. Emergency or removal actions	
7. Human health and/or environmental damage observed	
8. Complaints from residents	
9. Map	

A 4.2.2 Preliminary Investigation

Checklist: Preliminary Investigation	
A) Objectives	Y/N
- To conduct preliminary investigation of potentially contaminated land.	
- To differentiate sites that have potential threat to human health and environment.	
B) Collection of Information	
1. General site information (see A.2.2.1)	
2. Geology and hydrogeology	
☐ Deposits and solid geology ☐ Flood potential ☐ Groundwater depth and flow	

Checklist: Preliminary Investigation

3. Site history

- ☐ Zoning
- ☐ Review of aerial photographs
- ☐ Records of relevant development and building approvals
- ☐ Details of building and related permits, licenses, approvals, and trade waste agreements
- ☐ Inventory of chemicals and wastes
- ☐ Site layout plans showing industrial process
- ☐ Sewer and service plans
- ☐ Product spill and loss history
- ☐ Discharges to land, water, and air
- ☐ Disposal location
- ☐ Land use (previous, present, and proposed)
- ☐ Chronological list of site users
- ☐ Possible source of contaminants
- ☐ Potential off-site effects
- ☐ Description of manufacturing process
- ☐ Details and locations of current and former underground and above ground storage tanks
- ☐ Filling history
- ☐ Relevant complaint history
- ☐ Local literature about the site, including newspaper articles
- ☐ Historical use of adjacent land
- ☐ Local site knowledge of residents and staff, both present and former

4. Site conditions and surrounding environment by visual inspection

- ☐ Site boundary such as type of fencing, soil stability, and erosion
- ☐ Visible signs of plant stress
- ☐ Presence of drums, wastes, and fill material
- ☐ Condition of buildings and roads
- ☐ Quality of surface water
- ☐ Transparency
- ☐ pH (pH paper or mobile pH/EC meter)
- ☐ EC (pH/EC meter)
- ☐ Topography
- ☐ Visible signs of contamination such as discoloration or staining of soil and bare soil patches
- ☐ Odor
- ☐ Any relevant sensitive environment, e.g., rivers, creeks, wetlands, local habitat areas, and endangered flora and fauna

- ☐ Identification of potential receptors
  - ・Population and ecosystem
  - ・Number of people who approach the site and frequency of visit
  - ・Existence of public buildings such as hospitals and schools
- ☐ Identification of possible pathways
  - ・Local use of ground/surface water and location of bores/pumps
  - ・Presence of rivers or streams for recreational purposes
  - ・Presence of fish for human consumption
  - ・Land use for agricultural or residential purposes

5. Inspection of current or former installations

- ☐ Site layout plans indicating storage areas, storage tank locations, production buildings, wastewater treatment plants, drainage systems, and monitoring wells
- ☐ Inventory of materials handled, stored, and used in production processes
- ☐ Monitoring data on wastewater discharge
- ☐ Waste water control
- ☐ Written procedure for inspection and maintenance of the on-site drainage system
  - ・Pipelines
  - ・Liquid effluent discharge/outfall points
  - ・Intermediate holding facilities
- ☐ Inventory of wastes produced, stored, and disposed from all processes and operations
  - ・Waste types and status
  - ・Treatment method/disposal (on- and off-site), e.g., recycling
  - ・Written procedures for environmental control and monitoring of waste handling
- ☐ On-site waste disposal areas
  - ・Age of facility
  - ・Total surface and volume
  - ・Type and conditions of base and cover protection
  - ・Type of waste disposed
  - ・Presence of drainage system
  - ・Bottom sealed material
- ☐ Presence of on-site ponds/reservoirs for storing contaminated liquid waste

6. Sampling and analysis

Rationale for selection of:

- ☐ Sampling pattern
- ☐ Sampling density including an estimated size of these residual hotspots that may remain undetected
- ☐ Sampling locations to check both source and pathways
- ☐ Sampling depths
- ☐ QA/QC samples
- ☐ Background samples
- ☐ Analytical methods

Detailed description of sampling methods including:

- ☐ Sample containers and type of seal used
- ☐ Sampling devices and equipment, e.g., auger type
- ☐ Equipment contamination procedures
- ☐ Sampling handling procedures
- ☐ Sample preservation methods and recognized protocols
- ☐ Detailed description of field screening protocols

7. Field quality assurance and quality control

Checklist: Preliminary Investigation	
☐ Decontamination procedures ☐ Sample splitting techniques ☐ Field blank sample ☐ Background sample ☐ Field instrument calibrations ☐ Logs for each sample collected ・ID ・Date and time ・Location ・Duplicate locations and type ・Chemical analysis to be performed ・Weather condition	
8. Laboratory quality assurance and quality control	
☐ Signed chain of custody forms ☐ Record of holding times and a comparison with method specifications ☐ Analytical method used ☐ Laboratory accreditation for analytical method ☐ Laboratory performance in inter-laboratory trail ☐ Description of surrogates and spikes ☐ Percent recoveries of surrogates and spikes ☐ Instrument detection limits ☐ Matrix of practical quantification limits ☐ Standard solution results ☐ Reference sample results ☐ Reference check sample results ☐ Daily check sample results ☐ Laboratory duplicate results ☐ Laboratory blank results ☐ Laboratory standard charts	
9. Data evaluation, quality assurance, and quality control	
C) Required Materials	
10. Personal protective equipment (PPE): shoes, gloves, face masks, helmets, reflecting vests, etc.	
11. Maps, documents, questionnaires, etc.	
12. Other materials: compass/GPS, photo camera with extra battery, notebook, pen, etc.	
D) Health and Safety Measures	
13. Site-specific characteristics and potential types of contamination must be known beforehand	
14. Use appropriate PPEs	
15. Wash hands, equipment, shoes, cloths, and tires of vehicles in case of contact with contamination	
16. If there would be continuous site visits, then planned area/media-specific protocols must be followed	
E) Results	
17. Review and summary of previous reports	
18. Summary of all results in the table that: ☐ Show all essential details such as sample numbers and sampling depth, ☐ Show assessment criteria and standard values, and ☐ Highlight all results exceeding the assessment criteria.	

A 4.2.3 Preliminary Evaluation

Checklist: Preliminary Risk Assessment	
A) Objectives	Y/N
- To evaluate which site has potential threat to human health using screening methods.	
- To determine the next steps for sites with potentially unacceptable risks.	
B) Evaluation and Results of Preliminary Site Investigation	
1. General site information (see A2.2.1)	
2. Description of site and surroundings (see A2.2.2)	
3. Past and current activities at the site (see A2.2.2)	
4. Details of intended future use of the site	
5. Summary of sampling and analysis	
☐ Parameters ☐ Background samples ☐ Sampling location and media ☐ Sampling methods ☐ QA/QC methods during site investigation and analysis ☐ Evaluation of analytical methods ☐ Tentatively identified contaminants ☐ Chemical concentrations ☐ Comparison of data with background ☐ Uncertainties, limitations, and gaps in the quality of collection or analysis	
6. Site-specific data evaluation	
☐ Screening values ☐ Screening procedure ☐ Comparison of samples with screening value	
C) Preliminary Risk Assessment	
7. Identification of sources, pathways, and receptors (pollution linkage)	
☐ Sources and receiving media ☐ Fate and transport in releasing media ☐ Exposure points and exposure routes ☐ Integration of sources, releases, fate of transport mechanisms, exposure points, and exposure routes into complete exposure pathways	
8. Identification of potentially unacceptable risk	

D) Description and Justification of Next Steps Proposed at the Site, e.g., Carrying Out Detailed Site Investigation and Quantitative Risk Assessment	

A 4.2.4 Detailed Investigation

Checklist: Detailed Investigation	
A) Objectives	Y/N
- To test hypotheses regarding suspected contamination and targets exposed to actual contamination.	
- To demonstrate targets exposed to hazardous substances and determine levels of exposure.	
- To collect information for further action and development of remediation plan.	
B) Information Review (see A2.2.2)	
1. Site description	
2. Site history	
3. Operation history and waste characteristics	
4. Conceptual site model to describe hazard exposure scenario from source to receptor	
5. Review and summary of previous reports	
C) Sampling Activities	
6. Sampling plan	
☐ Number of source and pathway samples ☐ Number of QA/QC samples ☐ Number of background samples ☐ Application of previous samples ☐ Rationale for selection of sampling pattern, density, locations, and depth ☐ Sampling methods ☐ Analytical methods	
7. Source sampling	

Types of sample
☐ Solid
  ☐ Soil from industrial field
  ☐ Garbage from waste deposit (dumpsite)
  ☐ Soil from mine site (tailings dam sample)
☐ Liquid
  ☐ Surface water
  ☐ Groundwater
  ☐ Leachate/seepage
☐ Gas
  ☐ Gas from solid waste dumpsite
  ☐ Industrial emission gases
  ☐ Mobile emission gas
Types of waste sources
☐ Constituent
☐ Waste stream
☐ Landfill
☐ Drums
☐ Contaminated soil
☐ Land treatment
☐ Tanks
☐ Pile
☐ Surface impoundment
☐ Others
Types of wastes
☐ Organic chemicals
  ☐ VOCs
  ☐ PCB
  ☐ Hydrocarbons
  ☐ Organic mercury
☐ Inorganic chemicals
  ☐ Heavy metals
  ☐ Freon and boron
  ☐ Asbestos
☐ Radionuclides
☐ Others	

8. Soil sampling	
Samples ☐ Source ☐ Nearby source ☐ Residential soil ☐ Background soil Description ☐ Soil type ☐ Color ☐ Grain size ☐ Texture ☐ Moisture ☐ Odor Sampling activities ☐ Containers ☐ Labelling ☐ Storage at low temperature ☐ Sending to laboratory within 24-48 hours ☐ Photographs	
9. Drilling of soil borings	
☐ Location and depth of borings ☐ Boring core sampling ☐ Refilling of grout into ground surface after completion of boring ☐ Photographs of samples and sample locations ☐ Description of stratigraphy ☐ Note containment of artificial materials ☐ Information during drilling works ・Name or identification number of soil boring ・Start and end date/time of work ・Observed lithology ・Soil appearance, color, and odor ・Soil moisture ・Water levels and presence of non-aqueous phase liquid (NAPL)	
10. Groundwater sampling	
Samples ☐ Municipal well ☐ Domestic well ☐ Background ☐ Source Well information ☐ Drinking use and population ☐ Distance from source ☐ Stratigraphy, geology, thickness of formation, and hydraulic conductivity ☐ Depth to top of aquifer; elevation	

11. Well installation	
☐ Drilling works (see 'Drilling of soil borings') ☐ Preventive measures against expansion of contamination, i.e., wash drill pipe, sampler, and other equipment during drilling works ☐ Casing design; depth of slotted pipe ☐ Multiple aquifers isolated to prevent mixing ☐ Well development and purging ☐ Recording of data related to well installation ☐ Supervision of well installation by specialists ☐ Strainer depth and length ☐ Measurement of parameters ・Static water level ・Groundwater presence and level ・Water color ・Turbidity ・Odor ・pH ・Temperature ・Specific conductance ・Presence of non-aqueous phase liquid (NAPL)	
12. Surface water sampling	
Samples: ☐ River ☐ Lake ☐ Overland runoff ☐ Leachate Description: ☐ Distance from source ☐ Size of drainage area ☐ Drinking water intake ☐ Fisheries ☐ Sensitivities in environment ☐ On-site measurement Sampling activities: ☐ Containers ☐ Labelling ☐ Storage at low temperature ☐ Sending to laboratory within 24-48 hours ☐ Photographs	
13. Air sampling	
14. Quality assurance and quality control (See A2.2.2)	
☐ Field QA/QC ☐ Laboratory QA/QC	
15. Data evaluation of quality assurance and quality control (See A2.2.2)	
D) Required Materials for Field Activities	
16. Personal protective equipment (PPE): chemical protective clothing, safety shoes, gloves, helmets, reflective vests, face masks, full face mask respirators, mask filters against organic vapors and toxic particles, hearing protection, etc.	
17. Collective protective equipment: first aid kit, eye wash/cleaning water, detection devices, etc.	
E) Health and Safety Measures	
18. Site-specific characteristics and potential types of contamination must be known before going to site	
19. Use appropriate PPEs	
20. Wash hands, equipment, shoes , cloths, and tires of vehicles in case of contact with contamination	
21. If there are continuous site visits, then planned area/media-specific protocol must be followed	
F) Machine and Equipment for Sampling and Testing	
22. Drilling machine: drill pipes, drill crowns, PVC pipes, slotted pipes, pipe caps, gravel, cement, bentonite, and covers	
23. Equipment for:	
☐ Soil sampling ☐ Soil gas sampling ☐ Hydraulic conductivity ☐ Geophysical surveying	
G) Results	
24. Summary of all results in the table that: ・ Show all essential details such as sample numbers and sampling depth, ・ Show assessment criteria and standard values, and ・ Highlight all results exceeding the assessment criteria.	

A 4.2.5 Risk Assessment

Checklist: Risk Assessment	
A) Objectives	Y/N
- To screen the site with a site-specific evaluation and set remediation priorities.	
- To design a remediation plan if risk assessment demonstrates unacceptable risks.	
B) Evaluation and Results of Preliminary Site Investigation	
1. General site information (see A2.2.1)	
2. Description of site and surroundings (see A2.2.2)	
3. Past and current activities at the site (see A2.2.2)	
4. Details on intended future use of the site	
5. Summary of investigations	
☐ Site investigation strategy ・Methods used for soil and soil gas sampling ・Methods used for boreholes, trial pits, etc. ・Methods used for collecting, preserving, and transporting samples to the analytical ☐ QA/QC methods during site investigation and analysis ☐ Details of in-situ tests and geotechnical tests on groundwater regime and surface water features ☐ Cross sections showing site strata of shallow and	

laboratory ・Monitoring program for groundwater location, depth, and frequencies □ Analytical strategy ・Rationale for selection of analytical parameters ・Description of chemical analysis deep groundwater level □ Summary table of chemical analysis, site monitoring, and geotechnical test results □ Description of type, nature, and spatial distribution of contamination	
C) Risk Assessment (items shall be decided according to the proposed methodology)	
6. Risk assessment objectives	
7. Rationale for the chosen risk assessment approach and explanation for its validity for this site	
8. Discussion of relevant exposure scenarios introduced by the conceptual site model	
9. Assessment criteria selected for this site	
10. Description of mode	
□ Input parameters □ Safety factors □ Assumptions □ Any sensitivity analysis undertaken	
11. Exposure assessment	
□ Physical setting ・Climate ・Vegetation ・Soil type ・Surface hydrology ・Groundwater hydrology □ Potentially exposed populations ・Relative locations of populations with respect to site ・Current land use ・Potential alternate future land uses ・Subpopulations of potential concern □ Identification of exposure pathways □ Quantification of exposure ・Exposure concentrations ・Estimation of chemical intake for each pathway □ Identification of uncertainties ・Current and future land use ・Environmental sampling and analysis ・Exposure pathway evaluation ・Fate of transport modeling ・Parameter values	
12. Toxicity assessment	
□ Toxicity information for non-carcinogenic effects □ Toxicity information for carcinogenic effects □ Chemicals for which toxicity values are available □ Uncertainties related to toxicity information	
13. Characterization of risks	
□ Summary discussion and tabulation of the risk characterization ・Key site related contaminants and key exposure pathways identified ・Types of health risks concerned ・Level of confidence in quantitative information used to estimate risk ・Presentation of quantitative information on toxicity ・Confidence in the key exposure estimates of the key exposure pathways ・Magnitude of the carcinogenic and noncarcinogenic risk estimates ・Major factor driving risks ・Major factors contributing to uncertainty ・Exposure population characteristics ・Comparison with site-specific health studies	

A 4.2.6 Development of Remediation Plan

Checklist: Development of Remediation Plan	
A) Objectives	Y/N
- To identify a feasible remediation plan.	
- To evaluate and develop a remediation strategy.	
B) Identification of Feasible Remediation Options	
1. Statement and explanation of remediation objectives	
2. Remediation criteria against which compliance with remediation objectives for each relevant pollutant linkage (pathway) can be measured	
3. Overall site remediation criteria	
4. Summary of feasible remediation options identified for each pathway, including general characteristics of those options and methods used for collecting information on them	
5. General technique applicability	
□ Contaminant type ・Organic ・Inorganic □ Soil type ・Coarse sand soil ・Heterogeneous soil ・Clay and silt soil □ Safety □ Depth of contamination □ Contaminant concentration levels □ Minimum achievable concentration □ Decontaminated matrix quality	

	6. Shortlist of feasible remediation options to be taken	
	☐ Assessment of suitability for use at the site ☐ Reasons for selecting and rejecting options	
	7. Justification for selection of the preferred remediation strategy	
C)	Detailed Remediation Action Plan	
	8. Remediation goal	
	9. Discussion of the extent of remediation work required	
	10. Discussion of possible remediation options and how risk can be reduced	
	11. Rationale for the selection of recommended remedial option	
	12. Technical and scientific basis of the strategy	
	13. Proposed testing to validate the site after remediation	
	14. Contingency plan if the selected remedial strategy fails	
	15. Site preparation plan	
	16. Action plan in operation phase	
	☐ Site flood control plan ☐ Soil management plan ☐ Noise control plan ☐ Dust control plan, including wheel wash ☐ Odor control plan ☐ Occupational health and safety plan	
	17. Remediation schedule; hours of operation	
	18. Timescales required for remediation	
	19. Preventive measure for secondary contamination	
	20. Identification of regulatory compliance requirements such as licenses and approvals	
	21. Names and phone numbers of appropriate personnel to contact during remediation	
	22. Community relations plans and where it is applicable	
	23. Staged progress reporting	
	24. Long-term site management plan	

A 4.2.7 Implementation of Remediation Plan

Checklist: Implementation of Remediation Plan		
A)	Objectives	Y/N
	- To prepare an implementation plan.	
	- To design, implement, and verify remediation.	
B)	Preparation of Implementation Plan	
	1. Remediation objectives and strategy (see A2.2.6)	
	2. Site location map and site layout plans	
	3. Discussion on permitting requirements and proposals for obtaining the appropriate permits	
	☐ Environmental permit ☐ Decision and clear permission of management entity ☐ Discharge consent ☐ Treatment license ☐ Groundwater regulations ☐ Flood defense consent ☐ Other permits	
	4. Identify management responsibilities	
	5. Consult with relevant parties (regulators, landowners, etc.)	
	6. Construction details of proposed monitoring boreholes, if needed	
C)	Verification Plan	
	7. Rationale and justification for validation strategy including clean-up criteria and statistically based decision making methodology	
	8. Data gathering requirements to demonstrate that site remediation criteria are achieved	
	☐ Record of on- and off-site observations ☐ Explanation and schedule of chemical analysis ☐ Laboratory QA/QC requirements	
	9. Sampling and monitoring strategy	
	☐ Validation testing of excavations to remove contaminated materials ☐ Validation testing of materials excavated, treated, and deposited at the site ☐ Validation testing of materials imported as 'clean fill' ☐ Post-completion verification testing of the remediated area ☐ Background water quality testing of groundwater and nearby surface waters ☐ Water quality testing of treated water ☐ Site sampling, monitoring methods, and frequency ☐ Plans of sampling monitoring points	
	10. Performance testing required, e.g., for contaminant barriers and capping layers	
	11. Verification of compliance with regulatory requirements	
D)	Other Activities	
	12. Pilot trials	
	13. Procurement of contractors	

A 4.2.8 Monitoring and Follow Up

Checklist: Preliminary Risk Assessment		
A)	Objectives	Y/N
	- To monitor effectiveness of remediation work.	
	- To take action if analysis results indicate a need.	
B)	Monitoring and Follow-up Plan	
	1. Scope and explanation of site monitoring and/or follow-up work	
	2. Statement and justification of end-point for the site monitoring program	
	3. Proposed monitoring assessment criteria and reasons for their selection	
	4. Measures for ensuring that the required monitoring and/or follow-up is undertaken	
	5. Schedule of monitoring and follow-up activities	
	6. Construction details of monitoring boreholes or other types of monitoring installation	
	7. Method of collecting, preserving, and transporting samples to the analytical laboratory	
	8. Type and suitability of monitoring equipment to be used	
	9. Plans showing proposed monitoring point locations	
	10. Description of chemical analysis required	
	11. Results of monitoring analysis including all relevant QA/QC reporting requirements	
	12. Details of party(ies) responsible for monitoring and/or follow-up program	
	13. Confirmation of post-completion monitoring and/or follow-up requirements	

A 4.2.9 Reference for Checklist

1) UK Environment Agency, “GPLC1-Guiding principles for land contamination”, 2010
2) UK Environment Agency, “GPLC3-Reporting checklists”, 2010
3) UNIDO, “Checklist I, Preliminary Site Investigation”
4) UNIDO, “Checklist II, Detailed Site Investigation”
5) US Environmental Protection Agency (EPA), “Guidance for Performing Preliminary Assessments Under CERCLA”, 1991
6) US EPA, “Guidance for Performing Site Inspection Under CERCLA”, 1992
7) US EPA, “Risk Assessment Guidance for Superfund Volume I Human Health Evaluation”, 1989

Annex 5

REFERENCES ON REMEDIATION TECHNOLOGIES

Annex 5 REFERENCES ON REMEDIATION TECHNOLOGIES

A 5.1 Introduction

Applicability of remediation technology depends on the pollution substance, pollution type, pollution origin (sectors), pollutant migration pathway and also pollution mechanism.

Pollution substances are organic chemicals such as polychlorobiphenyls (PCBs), dioxins, and volatile organic compounds (VOCs); inorganic substances such as heavy metals, fluorine, boron, asbestos, acids, and caustic soda; and of which aspects are various such as solid, liquid, and gas.

Pollution type is categorized as water contamination, air pollution, and soil and underground contamination.

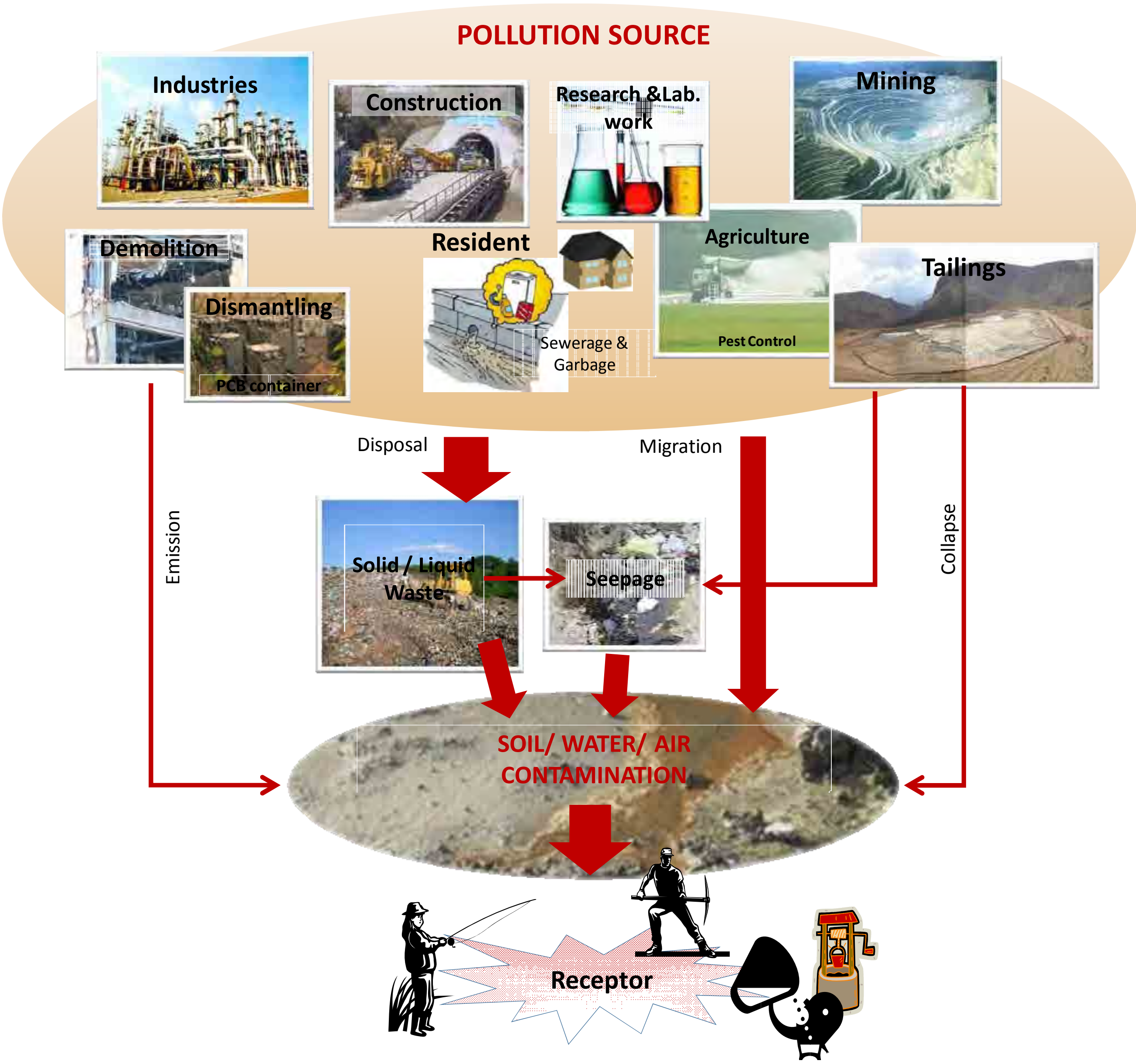
Pollution origins are classified as sectors of industry including mining and smelting, agriculture, stock farming, fishery, medical activity, transportation, civil works, etc. Sewage produced from livelihood activities is also a pollution origin.

The migration pathway of pollutants is very complex and difficult to identify clearly. Nevertheless, it is very important to understand the exposure route. Some pollutants change their characteristics during migration as they undergo chemical reactions. For example, inorganic mercury changes to organic mercury therefore increasing its toxicity that drastically affects the organs of natural fauna and flora. Another example is that sulfide minerals (solid) generate sulfuric acid by reacting with water and oxygen (i.e., rainfall), dissolve heavy metals through ionization enabling heavy metals to migrate mainly through underground.

Figure A 5.1-1 shows an example of a simplified pollution mechanism from various sources.

Table A 5.1-1 provides a summarized list of pollution sources, exposure routes, and pollution mechanisms. The contaminants are normally classified into two groups, namely, organic contaminants and inorganic contaminants. Several categories of contaminants are shown in Table A 5.1-2.

Figure A 5.1-2 describes the typical soil and groundwater contamination mechanism of VOCs and heavy metals. It is important to understand that the behavior of each contaminant in the environment depends on the chemical and physical properties of the contaminant.



Source: JET

Figure A 5.1-1 Various Types of Pollution Sources

Table A 5.1-1 List of Types of Sites, Potential Contaminants and Pollution Mechanisms

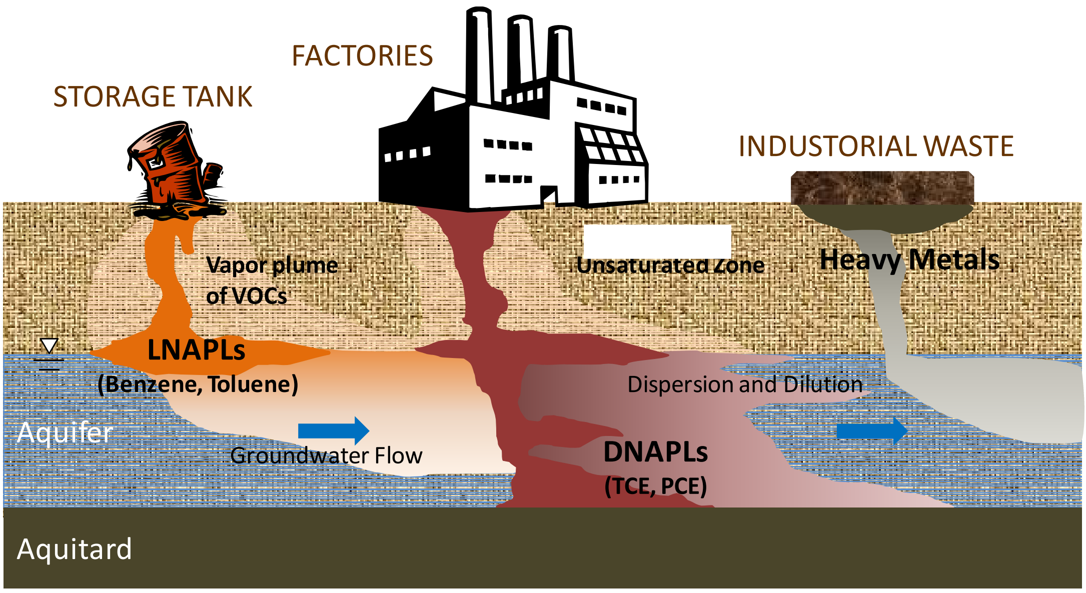
Type of Site			Potential Contaminants			Pollution Mechanism	
No.	Sector	Category	Organic	Inorganic: Heavy Metals	Inorganic: Others	Phase of contaminants	Exposure Route
1	Industrial						
	1-1	Mining	+	++	++	Liquid and Solid	Soil, Goundwater, Surface Water, and Air
	1-2	Smelting	-	++	++	Liquid, Solid, and Gas	Soil, Goundwater, Surface Water, and Air
	1-3	Refining	-	++	++	Liquid	Soil, Goundwater, Surface Water, and Air
	1-4	Chemical Industries	++	-	+	Liquid and Gas	Soil, Goundwater, Surface Water, and Air
	1-5	Electric and Electrolitic (IT) Industries	++	-	-	Liquid and Gas	Groundwater and Air
	1-6	Dismantling of Used Equipment Works	++	+	-	Liquid and Gas	Groundwater and Air
	1-7	Other Industrial Activities	++	++	++	Liquid, Solid, and Gas	Soil, Goundwater, Surface Water, and Air
2	Research Works and Laboratory Activities						
	2-1	Chemicals in Liquid from Laboratory	++	+	++	Liquid	Soil and Leachate
	2-2	Heavy Metals in Liquid and/or Solid from Laboratory	-	++	-	Liquid and Solid	Soil and Leachate
	2-3	Gas Emmission by Incineration from Laboratory	-	-	++	Gas	Emmission Gas and Dust
	2-4	Lubricants and Chemicals used in Boring Works	-	-	++	Liquid	Soil and Groundwater
	2-5	Turbidity and Suspended Solid(SS) Contamination from Boring Works	++	-	++	Solid	Soil and Groundwater
3	Civil, Construction and Demolition Works						
	3-1	Civil Works	+	++	++	Solid and Dust	Soil, Goundwater, Surface Water, and Air
	3-2	Construction Works	+	+	++	Liquid and Solid	Soil, Groundwater
	3-3	Demolition Works	++	-	++	Solid and Dust	Soil, Goundwater, and Surface Water
4	Agriculture and Livestock						
	4-1	Insecticide	++	-	-	Liquid	Soil, Goundwater, Surface Water, and Atomizing
	4-2	Disinfectant	++	-	-	Liquid	
	4-3	Pest Control	++	-	-	Liquid	
	4-4	Fertilizers	++	-	-	Solid and Liquid	
5	Dismantling of Used Equipment Works						
	5-1	Electrical Appliances and Transformers	++	-	-	Liquid and Gas	Soil, Goundwater, and Surface Water
	5-2	Used Cars and Batteries	++	++	++	Liquid and Gas	
	5-3	Electronic Equipment Components	-	++	-	Solid	
6	Solid Waste Piles and/or Deposit						
	6-1	Leachate	++	+	++	Liquid	Soil, Goundwater, and Surface Water
	6-2	Generation of Anaerobic Gas	++	-	-	Gas	Air

++ : High, + : Medium, - : Low
Source: JET

Table A 5.1-2 Group and Category of Contaminants

Group and Category	Typical Compounds / Product Name
Organic Contaminants	
1. Nonhalogenated Volatile Organic Compounds (VOCs)	
a. Light Hydrocarbons	Ethane, Cresole, Propane, and Cyclohexanone
b. BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
c. Oxygenated Hydrocarbons	Aldehydes, Alcohols, Ketones, and Organic Acids
d. Other Compounds	
2. Halogenated Volatile Organic Compounds (X-VOCs)	
a. Chrorinated Hydrocarbons	Trichloroethylene (TCE), Cis-1,2-dichloroethylene, and Tetrachloroethylene (Perchloroethylene or PCE)
b. Other Compounds	
3. Nonhalogenated Semi-Volatile Organic Compounds (SVOCs)	
a. Heavy Hydrocarbons	Heavy hydrocarbons (C9-23) found in petroleum distillates and products such as kerothane, fuel oil, jet oil, and diesel fuel
b. Nonhalogenated Pesticides	Dimethylphosphate (DMP) Aldicarb, Mehomyl, and Permethrin
c. Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene, Benzo(a)pyrene, Napthalene, and Pyrene
d. Nitro Aromatics and Amines	2,4,6-Trinitrotoluene(TNT), DNT, RDX and HMX Mthylamine, and Aniline
e. Nonhalogenated Phenols	Phenol, Cresol, Nitrophenol 2,4-dimethylphenol
4. Halogenated Semi-Volatile Organic Compounds (X-SVOCs)	
a. Polychlorinated Byphenyls (PCB)	Arochlor, Chlophen, Kaneclor, and Solvol
b. Halogenated Pesticides	BHC-alpha/beta/gamma, 4,4´-DDD, Endosulfan I/II Endrin, Methylparathion, and Toxaphene
c. Other Halogenated Compounds	1,2,4-Trichlorobenzene, Bis(2-chloroethoxy) ether Hexachlorobenzene, and Tetrachlorophenol
4. Dioxins and Furanes	Dibenzo-p-dioxins (PCDD) and Dibenzofurans (PCDFs)
Inorganic Contaminants	
1. Heavy Metals	
a. Volatile Heavy Metals and Compounds	Mercury (Hg) and Non-metallic Arsenic (As)
b. Non-Volatile Heavy Metals and Compounds	Antimony (Sb), Cadmium (Cd), Chromium (Cr), Iron (Fe), Lead (Pb), Nickel (Ni), Tin (Ti), and Zinc (Zn)
2. Radionuclides	Cesium-137, Plutonium, Radon, Tririum, and Uranium
3. Other Inorganic Elements and Compounds	Asbestos, Fluorine, and Cyanide

Source: JET based on UNIDO “Survey of Soil Remediation Technology” and FRTR, 2007



Source: JET

Figure A 5.1-2 Cross-sectional View of Soil and Groundwater Contamination by VOCs and Heavy Metals

A 5.2 Classification of Remediation Technologies

Remediation technologies are mainly categorized applying the following three pollution states according to target aspect:

i) Soil: Soil, sediment, bedrock and sludge

ii) Water: Groundwater, surface water and leachate

iii) Air: Air

There are two groups of contaminants in water and soil, namely, organic substances such as VOCs, and inorganic substances such as heavy metals. On the other hand, as for air, the main pollutants are inorganic and organic chemicals besides suspended particle material (SPM).

Remediation technologies can be defined in accordance with the type of treatment process taking place, such as the following:

i) Biological treatment

ii) Chemical/physical treatment

iii) Thermal treatment

Remediation solutions are also referring to where the action is taking place:

i) On-site: In situ or ex situ

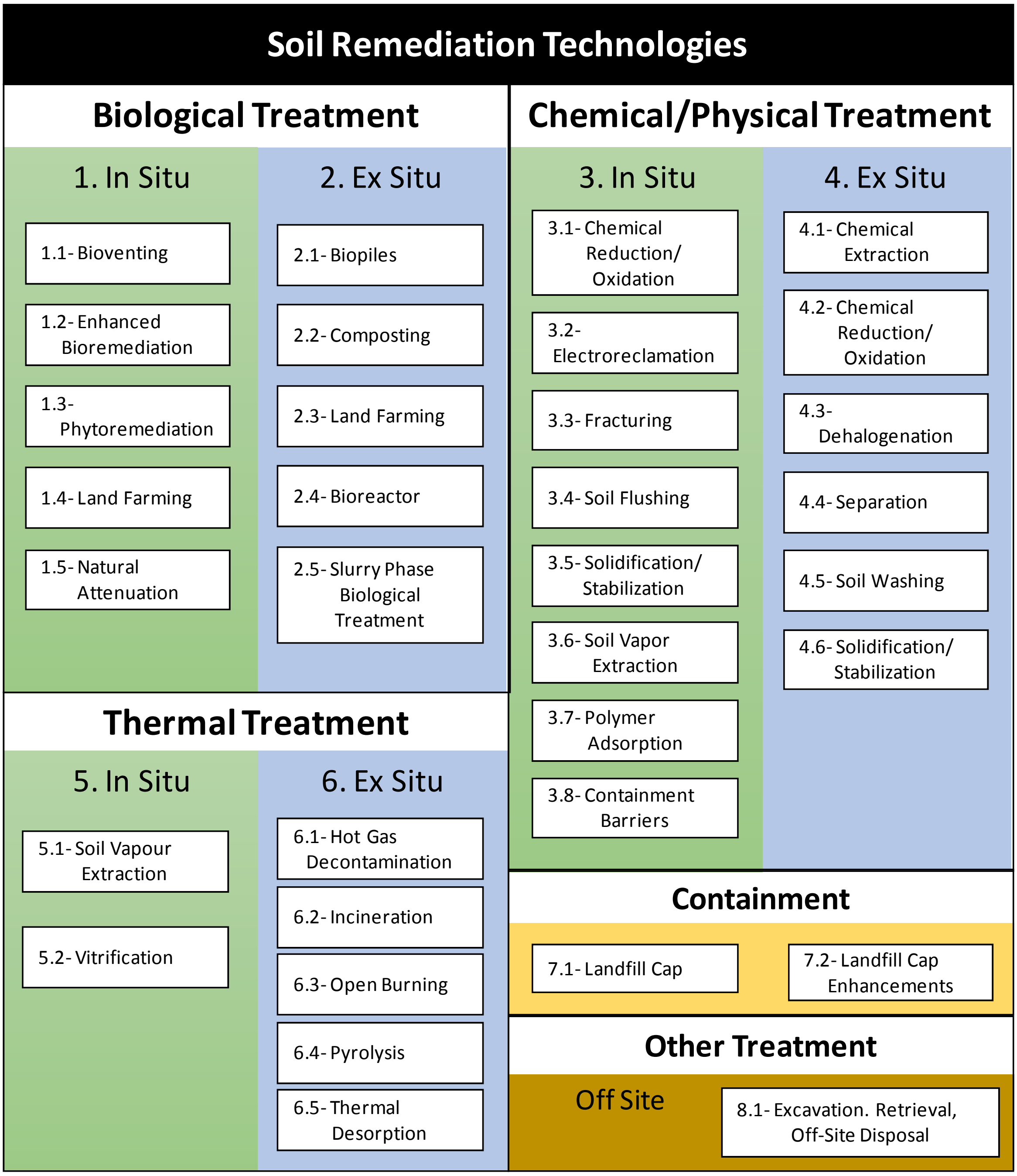
ii) Off-site: Ex situ

There are various approaches to classification of remediation technologies. Furthermore, it is important to take into consideration emergency countermeasures and permanent remediation. The former requires temporary and urgent methods to stop harmful effects to human health, while the latter should consider efficiency, cost, and operation period. It is recommended to prepare guidelines for both emergency countermeasures and remediation measures for a sustainable environment.

A 5.2.1 Soil Remediation Technologies

Typical remediation technologies for soil contamination are shown in Figure A 5.2-1.

- In situ and ex situ bioremediation method
- In situ and ex situ chemical reduction method
- In situ soil flushing method
- Ex situ soil washing method
- Ex situ incineration
- Excavation, removal, and off-site disposal



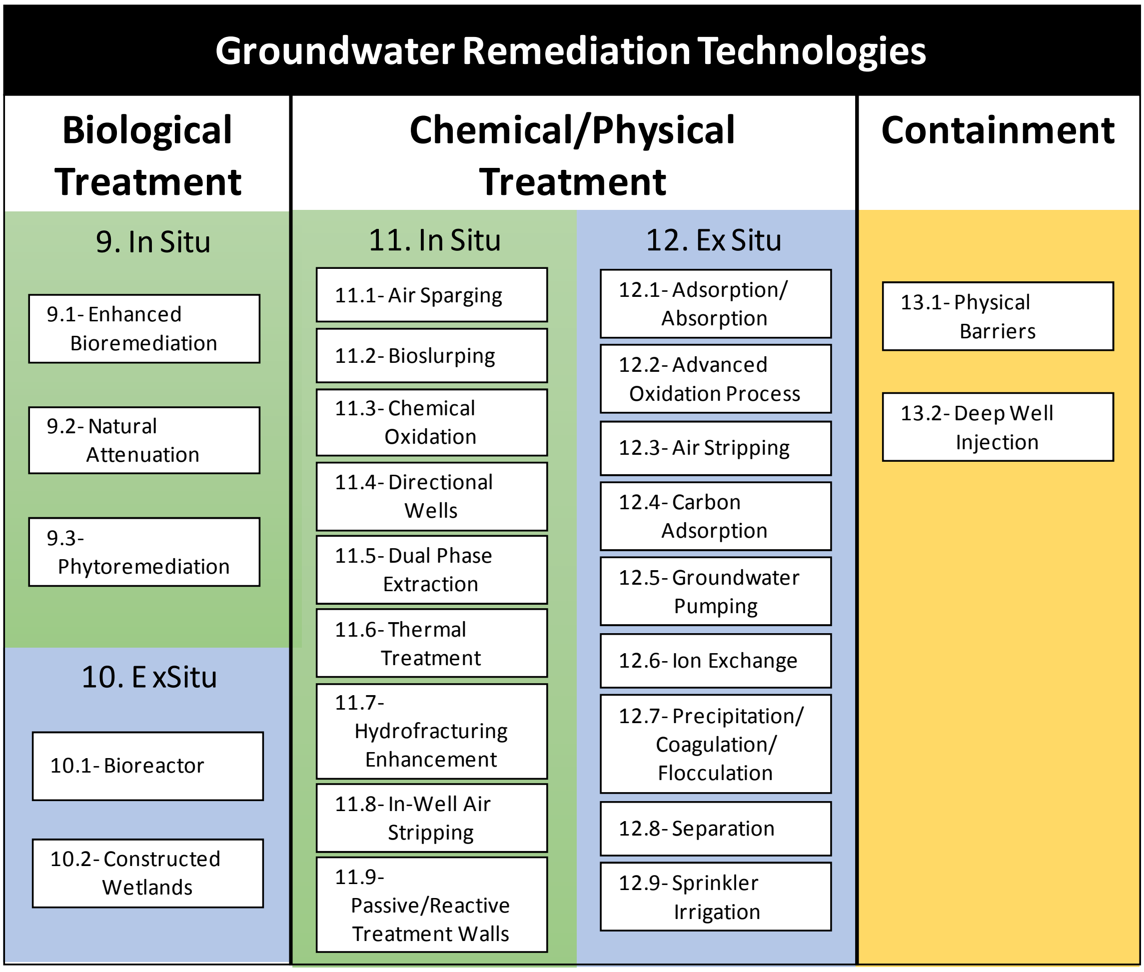
Source: JET

Figure A 5.2-1 Soil Remediation Technologies

A 5.2.2 Water Remediation Technologies

Typical remediation technologies for groundwater contamination are shown in Figure A 5.2-2.

- In situ and ex situ bioremediation method
- In situ and ex situ chemical oxidation method
- In situ air sparging
- In situ treatment walls
- Physical barriers



Source: JET

Figure A 5.2-2 Groundwater Remediation Technologies

A 5.2.3 Air Remediation Technologies

Typical remediation technologies for air contamination are shown in Figure A 5.2-2.

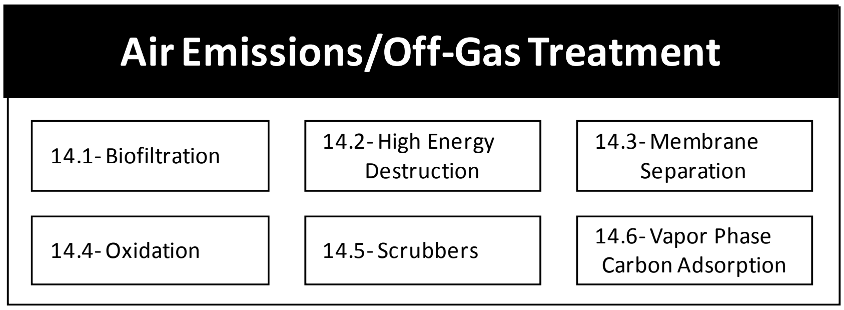
Air pollution is mainly caused by emission gases of ongoing activities such as industrial operation and operation of transportation vehicles.

On the other hand, solid waste dumpsites tend to generate methane gas caused by acceleration of anaerobic reaction thereat and thus influences unusual weather. This is a sensitive issue on distinguishing ongoing pollution or legacy pollution.

Also, there are fine particles (solid) which are emitted by thermal power plants (TPPs) that are using coal, and suspended particle materials (SPMs) which are spread by strong winds, in particular, from the tailings dam site. The tailings dam may also cause SPMs through strong winds in the dry season.

- Membrane separation
- Oxidation

Figure A 5.2-3 shows remediation technologies for air contamination.



Source: JET

Figure A 5.2-3 Air Remediation Technologies

A 5.3 Remediation Technologies

This section introduces some of the remediation technologies, as mentioned in the figures above, which are widely conducted in many countries. The main references for each technology in the following table are FRTR (2007) and UNIDO (2007).

The contents of remediation technologies introduced are as follows:

Soil Remediation	Groundwater/Air Remediation
1.2- Enhanced Bioremediation	9.2- Natural Attenuation
2.1- Biopiles	11.1- Air Sparging
3.4- Soil Flushing	11.9- Passive/Reactive Treatment Walls
4.1- Chemical Extraction	12.2- Advanced Oxidation Process
4.5- Soil Washing	12.7- Precipitation/ Coagulation/ Flocculation
5.1- Soil Vapor Extraction	13.1- Physical Barriers
6.2- Incineration	14.4- Oxidation (Air)
7.1- Landfill Cap	
8.1- Excavation, Retrieval, and Off-Site Disposal	

1.2- Biological-In Situ

Enhanced Bioremediation

Contaminant Type	**Petroleum hydrocarbons, VOCs, SVOCs, SVOCs, X-SVOCs, Pesticides, and Dioxins and Furans**

Description

Enhanced bioremediation, also known as biostimulation or bioaugmentation, involves the addition of microorganisms (e.g., fungi, bacteria, and other microbes) or nutrients (e.g., oxygen and nitrates) to the subsurface environment in order to accelerate the natural biodegradation process of petroleum hydrocarbons and some fuel oxygenates such as methyl tertiary-butyl-ether (MTBE). These technologies work by providing a supplemental supply of oxygen to the subsurface, which becomes available to aerobic hydrocarbon-degrading bacteria. There are four major types of enhancements involved, namely, gaseous nutrient injection, hydrogen peroxide circulation, nitrate enhancement, and bioaugmentation.

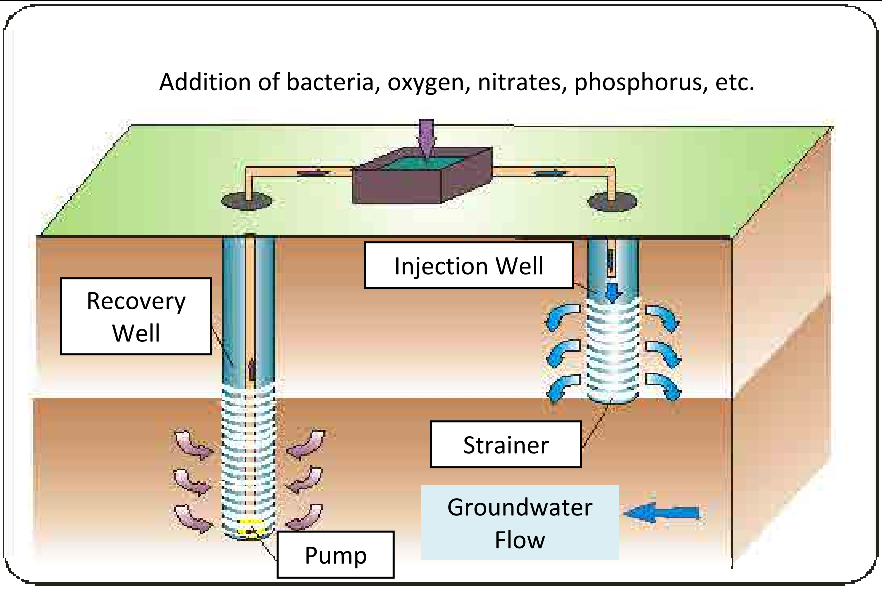
[Biostimulation]

(1) Gaseous nutrient injection: nutrients are injected into contaminated soil via wells to encourage and feed naturally occurring microorganisms. The most commonly added gas is air.
(2) Hydrogen peroxide circulation: a dilute solution of hydrogen peroxide is injected into the soil to enhance the rate of aerobic biodegradation.
(3) Nitrate enhancement: a solution of nitrate is added to the contaminated soil to enhance anaerobic biodegradation.

[Bioaugmentation]

Biological activity is increased by the addition of acclimated microorganisms.

Figure



Source: JET adopted from OIWA, 2013

Applicability

It is especially effective to remediate soils contaminated with petroleum hydrocarbons, VOCs, SVOCs and pesticides, and low-level residual contamination in conjunction with source removal. Anaerobic microbial degradation of nitrotoluenes in contaminated soils has been effectively demonstrated.

Advantages

- ❖ Minimal disturbance to site operations and producing no significant waste.
- ❖ Abiotic oxidation of contaminants contacting reagents.
- ❖ Remediates contamination in unsaturated soils.
- ❖ Considered a safe and cost-competitive technique.
- ❖ Simple operation and monitoring requirements.

❖ Low energy approach. ❖ May reduce petroleum contamination at leaking underground storage tank sites.
Limitations
❖ Very high contaminant concentrations may be toxic to microorganisms. ❖ Under anaerobic conditions, contaminants may be degraded to products that are more hazardous than the original contaminants. ❖ May increase contaminant mobility and necessitate treatment of groundwater. ❖ Safety precautions must be used when handling hydrogen peroxide. ❖ Low permeability soils are difficult to treat. ❖ Biotic and abiotic sinks for oxygen can increase costs and duration of operation and maintenance. ❖ Use of amended oxygen can increase biological growth near injection wells reducing the diffusion of oxygen in contaminated sites and the input of nutrients. ❖ Requires long-term monitoring of residual contamination in soil and groundwater. ❖ Concentrations of hydrogen peroxide greater than 100 ppm to 200 ppm in groundwater inhibit the activity of microorganisms. ❖ Heavy petroleum products may take longer to biodegrade. ❖ Difficult to decide the target level before planning stage.
Cost
Typical costs for enhanced bioremediation range from USD 30/yd^3 to USD 100/m^3 (USD 20/yd^3 to USD 80/yd^3) of soil. Factors that affect cost include soil type and chemistry, type and quantity of amendments used, and type and extent of contamination.

2.1-Biological- Ex Situ

Biopiles

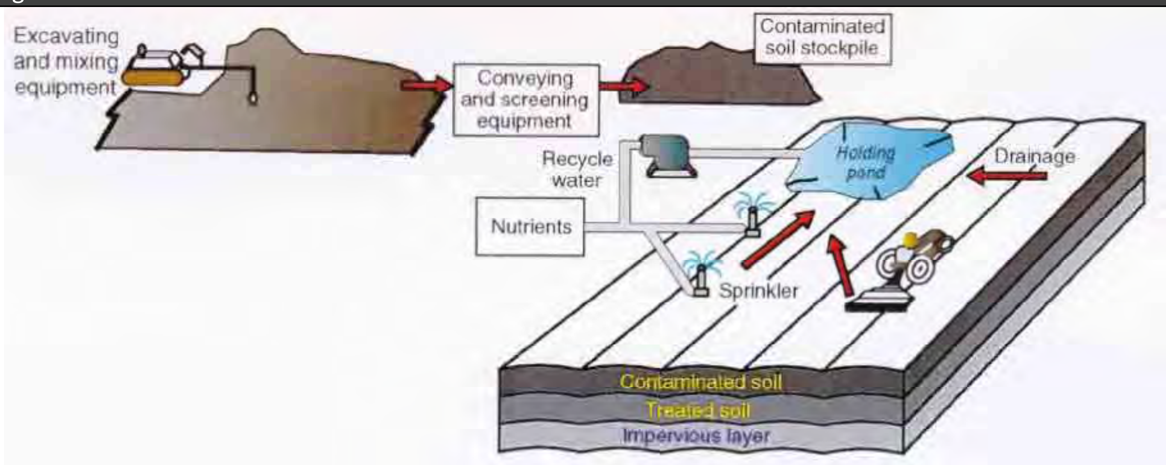
Contaminant Type	**VOCs, SVOCs, X- SVOCs, X-VOCs, Dioxins and Furans, Other Inorganics, and Pesticides**

Description

Biopiles, also known as biocells or biomounds, are engineered systems in which excavated soils are submitted to aeration and combined with soil amendments and bulking materials in order to stimulate naturally occurring aerobic microbial activities. Biodegradation by enhanced microbial activity is effective in reducing residues from petroleum refinery to carbon dioxide and water.

These systems are performed on a treatment area, formed into compost piles, and enclosed for treatment. They are commonly provided with an air distribution system such as blowers and vacuum pumps. Treatment area is generally covered or contained with an impermeable liner to control runoff, evaporation and volatilization, to promote solar heating, and to minimize the risk of contaminants leaching into uncontaminated soil. The leachate must be collected and treated to prevent contaminants into the underlying groundwater. Several properties of these processes are dependent on soil characteristics and climate conditions, such as nutrients, oxygen, moisture, pH and heat, which can be controlled in order to enhance the remediation procedure. Biopiles may be comparable with landfarming, even though landfarming is aerated by tilling or plowing.

Figure



Source: FRTR, 2007

Applicability

This as been applied in the treatment of halogenated and nonhalogenated VOCs, fuel hydrocarbons, SVOCs, and pesticides.

Advantages

- ❖ Very simple and cost-competitive technology to design and implement.
- ❖ Can be designed to be a closed system.
- ❖ Short-time treatment.
- ❖ Can be engineered to be potentially effective for any combination of site conditions and petroleum products.
- ❖ Requires less land area than landfarming.

Limitations

- ❖ Concentration reductions greather than 95% and constituent concentrations less than 0.1 ppm are very difficult to achieve.
- ❖ Presence of significant heavy metal concentrations may inhibit microbial growth.
- ❖ Vapor generation during aeration may require treatment prior to discharge.
- ❖ Contaminated soils must be excavated and dust and noise must be controlled.
- ❖ For smaller areas of contamination, off-site disposal may be more economical.
- ❖ Static treatment processes may result in less uniform treatment than processes that involve periodic mixing.
- ❖ Treatability testing may be performed to identify the biodegradability of pollutants and appropriate

oxygenation and nutrient rates. ❖ May not be effective for contaminants with high concentrations of hydrocarbons.
Cost
Costs are dependent on the contaminant, procedure to be used, need for additional pre- and post-treatment, and need for air emission control equipment. Biopiles are relatively simple and require few personnel for operation and maintenance. Typical costs with a prepared bed and liner are USD 130 m^3 to USD 260/m^3 (USD 30/yd^3 to USD 60/yd^3).

3.4- Chemical/Physical-In Situ

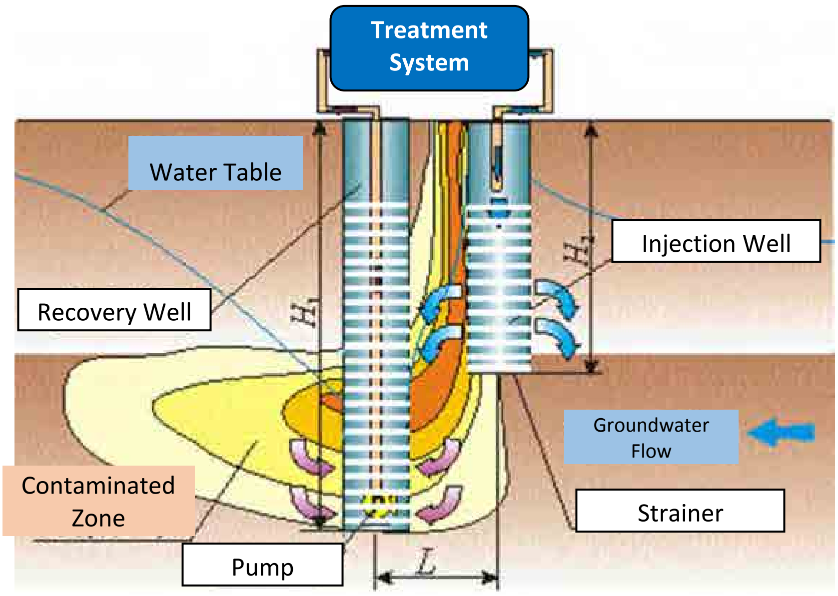
Soil Flushing

Contaminant Type	Heavy Metals, including radioactive contaminants and VOCs, SVOCs, XVOCs, X-SVOCs, Dioxins and Furans, Fuels and Pesticides

Description

Soil flushing, also known as injection/recirculation, is a technology used for extracting contaminants from the soil by the use of water or water solutions. Water is used to treat contaminants that dissolve easily in it. Additives such as acids are used to remove metals and organic contaminants; bases are used to treat phenols and some metals; and surfactants are effective at removing oily contaminants. This technique is accomplished by passing the extraction fluid through in-place soils using an injection or infiltration process. The effectiveness of this process is dependent on hydrogeologic variables (e.g. type of soil, and soil moisture) and type of contaminant. Contaminants that are dissolved in the flushing solution are leached into the groundwater, which is then extracted and treated.
In some cases, the flushing solution is injected directly into the groundwater. One variation of this technology is co-solvent enhancement, which involves injecting a solvent mixture to extract organic contaminants. Recovered groundwater and flushing fluids with the desorbed contaminants may need treatment to meet appropriate discharge standards prior to recycle or release to wastewater treatment facilities or receiving streams.

Figure



Source: JET adopted from OIWA, 2013

Applicability

Soil flushing technology removes metals, including radioactive contaminants and VOCs, SVOCs, fuels, and pesticides from soil. It is usually less cost-effective for organic materials. Environmentally compatible surfactants may be used to increase the effective solubility of some organic compounds.

Advantages

- Applicable to a wide range of contaminants.
- Can perform a rapid and adequate cleanup of newly deposited contaminants, such as those from accidental spills.
- The resulting matrix (water) is easy to treat.
- Preparation of soil is not required.
- Effective technique for VOCs.

Limitations

- The additives for flushing could remain in low amounts in the soil and need to be monitored.
- Only useful when the solution can be contained and recaptured.
- Contamination toxicity is not reduced.

- Low permeability or heterogeneous soils are difficult to treat.
- Aboveground separation and treatment costs for recovered fluids can drive the economics of the process.
- Flushing fluid chosen is difficult when different contaminants are present in the soil.
- Be careful for secondary pollution.

Cost

The key cost driver information and cost analysis were developed using the 2006 version of the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers:

Soil Permeability

- The primary cost driver is soil permeability. Soils with lower permeability are more recalcitrant to soil flushing, thus remediation time can be significantly prolonged which increases costs.

Depth to Groundwater

- Depth to groundwater is the secondary cost driver where a deeper water table will cause higher cost to complete.

Cost Analysis:

The following table represents the estimated costs (by common unit of measure) in applying soil flushing technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		**Large Site**	
	Easy	**Difficult**	**Easy**	**Difficult**
Cost per 1,000 yd^3	USD 32,320	USD 48,729	USD 18,420	USD 26.853

4.1- Chemical/Physical- Ex Situ

Chemical Extraction

Contaminant Type	**SVOCs, VOCs, X-VOCs, X-SVOCs, Fuels, Pesticides, and Heavy Metals**

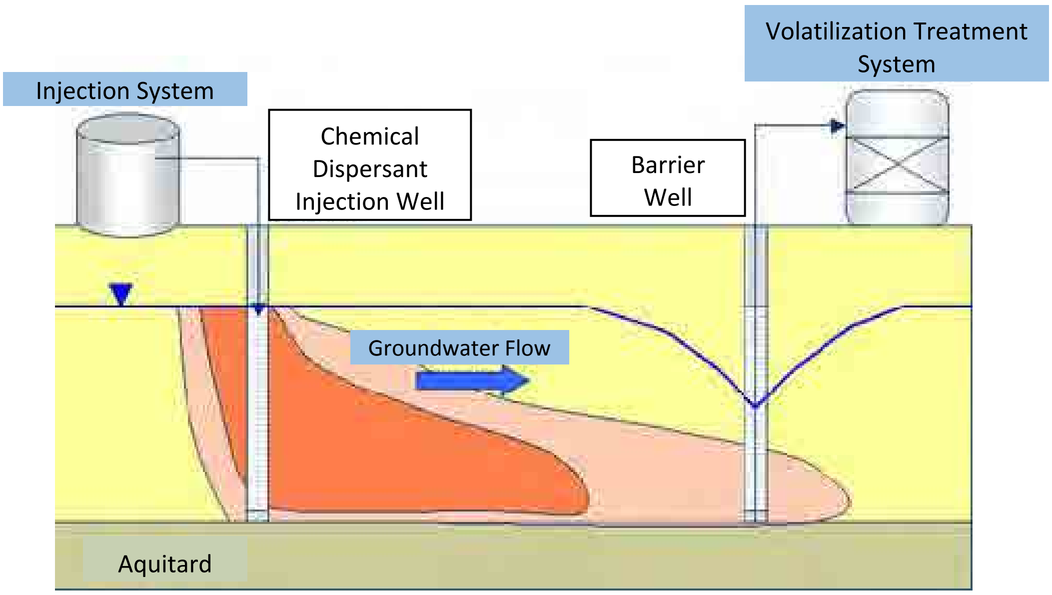
Description

Chemical extraction is a remediation process that introduces a solvent into soil to promote the dissolution of contaminants for subsequent separation by temperature and pressure changes. It does not destroy but separates hazardous contaminants from soils, sludge and sediments, thereby reducing the volume of the contaminant that must be treated. The two major chemical extraction processes, which are based on the type of contaminant present in the soil, are the following:

(1) Acid extraction, which uses acids to extract contaminants from soils. Heavy metals are potentially suitable for recovery. Clean soils are dewatered and mixed with lime and fertilizer to neutralize any residual acid.
(2) Solvent extraction, which uses solvents to remove metals and mixtures of metal and organic compounds. Soil is removed and treated.

Physical separation is generally used before chemical extraction, on the assumption that the major part of the contamination is on the smaller particles. Physical separation can also enhance the kinetics of extraction by separating out particulate heavy metals, if these are present in the soil. Chemical extraction may be also used combined with other remediation technologies depending on site-specific conditions.

Figure



Source: JET adopted from OIWA, 2013

Applicability

Chemical extraction is used to treat soils containing organic contaminants such as SVOCs, VOCs, fuels, and pesticides, as well as heavy metals.

Advantages

- ❖ Can be used to extract a wide range of target contaminants.
- ❖ High concentrations of pollutants can be treated.

Limitations

- ❖ Less effective on high molecular weight organics or on hydrophilic substances.
- ❖ Certain solvents will be ineffective in some soil types or if excessive moisture is present.
- ❖ Solvent treatment and disposal can be significant factors.
- ❖ After acid extraction, any residual acid in the treated soil must be neutralized.
- ❖ The toxicity of the solvent is an important consideration as traces may remain in the treated soil.

Cost

The key cost driver information and cost analysis were developed in 2006 using the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers

- Economy of Scale
  - Quantity of material treated has a large impact
- Moisture Content in Waste
  - Slight increase in costs between soil and sludge

Cost Analysis

The following table represents the estimated costs (by a common unit of measure) in applying chemical extraction technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		Large Site	
	Easy	Difficult	Easy	Difficult
Cost per yd^3	USD 1,202	USD 1,305	USD 272	USD 275

4.5- Chemical/Physical-In Situ

Soil Washing

Contaminant Type	**SVOCs, VOCs, X-VOCs, X-SVOCs, Fuels, and Heavy Metals**

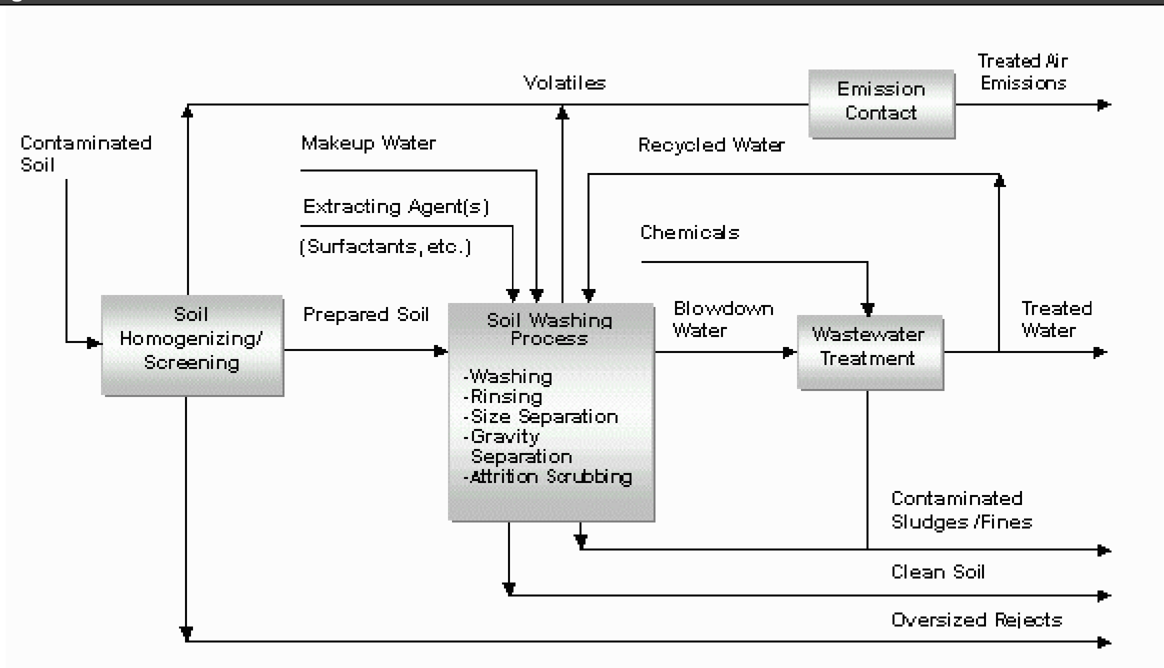
Description

Soil washing is a technique in which contaminants absorbed into fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. This remediation technique can minimize the need for landfill disposal and transportation of contaminated soil by removing contaminants from the soil in one of the following two ways:

(1) By dissolving or suspending them in the wash solution.
(2) By concentrating them into smaller volumes of soil through particle size separation, gravity separation, and attrition scrubbing.

The concept of reducing soil contamination through the use of particle size separation is based on the finding that most organic and inorganic contaminants tend to bind, either chemically or physically, to clay, silt and organic soil particles. Most silt and clay are stuck in larger particles like sand and gravel. Washing separates the small particles from the large ones by breaking the adhesive bonds. Granular material, once treated, may be eventually reused on site. The resulted concentrated soil is smaller in volume and must be disposed of carefully.

Figure



Source: UNIDO, 2007

Applicability

Contaminants treated are SVOCs, fuels, and heavy metals. The technology can be used on selected VOCs and pesticides. It offers the ability to recover metals and can clean a wide range of organic and inorganic contaminants from coarse-grained soils.

Advantages

- It is a well-established and versatile technique.
- It provides a cost-effective and environmentally proactive alternative to stabilization and landfilling.

Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Is not always effective on all soil types and works better on coarse-particle and sandy soils.
- High levels of organic matter inhibit desorption.
- The aqueous stream will require treatment at demobilization.

- Complex mixtures of pollutants may be difficult to remediate with a single wash regime.

Cost

The key cost driver information and cost analysis was developed in 2006 using the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers

- Economy of Scale
  - Quantity of material treated has a large impact
- Processor Speed
  - Also depends on the amount of waste being processed

Cost Analysis

The following table represents the estimated costs (by a common unit of measure) in applying soil washing technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B
	Small Site	**Large Site**
Cost per yd^3	USD 142	USD 53

5.1- Thermal-In Situ

Soil Vapor Extraction Thermally Enhanced

Contaminant Type	**SVOCs, VOCs, X-VOCs, X-SVOCs, Some Pesticides, and Fuels**

Description

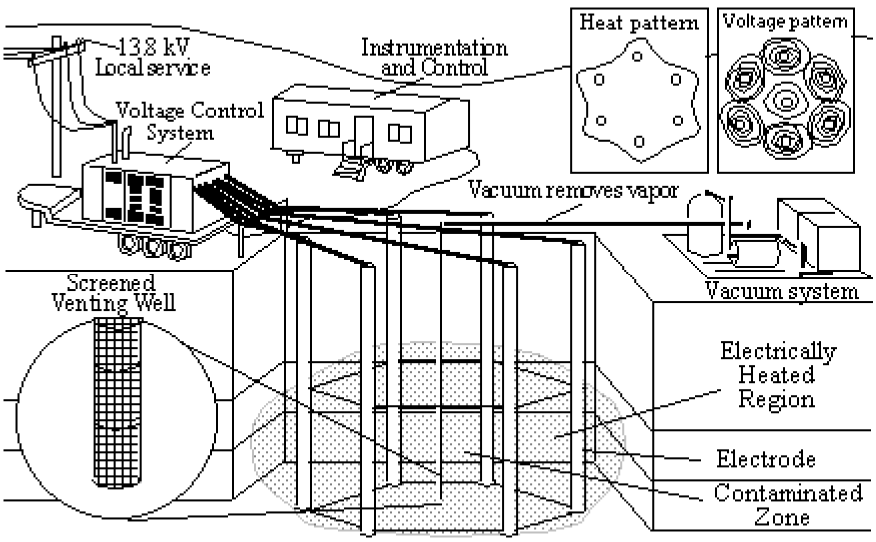
Thermally enhanced soil vapor extraction (SVE) is a full-scale technology that uses hot air/steam injection or mixing lime to increase the volatilization rate of semi-volatiles and to facilitate extraction. The process is otherwise similar to standard SVE, but requires heat-resistant extraction wells. Thermally enhanced SVE is normally short- to medium-term technology.

Hot Air/Steam Injection: Hot air or steam is injected below the contaminated zone to heat up contaminated soil. Heating enhances the release of contaminants from the soil matrix. Some VOCs and SVOCs are stripped from the contaminated zone and brought to the surface through soil vapor extraction.

Radio Frequency/Electromagnetic Heating: Radio frequency heating (RFH) is an in situ process that uses electromagnetic energy to heat soil and enhance soil vapor extraction (SVE). RFH is used to heat the soil to over 300 °C, increasing the volatility and mobility of the contaminant and the soil permeability.

Advanced technologies, such as electrical resistance heating and radio frequency/electromagnetic heating, are under development. These technologies are at the testing stage on site.

Figure



Source: UNIDO, 2007

Applicability

High moisture content is a limitation of standard SVE that thermal enhancement may help overcome. Heating, especially through radio frequency heating and electrical resistance heating, can improve air flow in high moisture soils by evaporating water. The system is designed to treat SVOCs but will consequently treat VOCs. Thermally enhanced SVE technologies also are effective in treating some pesticides and fuels, depending on the temperatures achieved by the system. After application of this process, subsurface conditions are excellent for biodegradation of residual contaminants.

Advantages

- Primitive technology is used with simple method.
- Easy application with low cost.
- Applicable for low vaporizing temperature substances such as VOCs.

Limitations

The following factors may limit the applicability and effectiveness of the process:

- Debris or other large objects buried in the media can cause operational difficulties.
- Performance in extracting certain contaminants varies depending on the maximum temperature

achieved in the selected process.

- Soil that is tight or has high moisture content has a reduced permeability to air. This hinders the operation of thermally enhanced SVE and requires more energy input to increase vacuum and temperature.
- Soil with highly variable permeability may result in an uneven delivery of gas flow to the contaminated regions.
- Soil that has high organic content has a high sorption capacity of VOCs, which results in reduced removal rates.
- Air emissions may need to be regulated in order to eliminate possible harm to the public and the environment. Air treatment and permitting will increase project costs.
- Thermally enhanced SVE is not effective in saturated zones; however, lowering the aquifer can expose more media to SVE (this may address concerns regarding LNAPLs).
- Hot air injection has limitations due to the low heat capacity of air.

Cost

The key cost driver information and cost analysis were developed using the 2006 version of the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers

- Type of Soil
  - The primary cost driver is type of soil, which determines soil permeability. For thermal treatment, soils with lower permeability (silts/silty-clays) are less expensive to remediate as they require less gas flow.
- Depth to Top/Thickness of Contaminated Area
  - The secondary cost drivers are depth to the top and thickness of the contaminated zone. A deeper and thicker region of contaminated soils has higher remedial costs.

Cost Analysis

The following table represents the estimated costs (by common unit of measure) in applying thermal treatment technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		Large Site	
	Easy	Difficult	Easy	Difficult
Cost per 1,000 yd^3	USD 50,947	USD 61,502	USD 29,174	USD 37,634

6.2- Thermal- Ex Situ

.Incineration

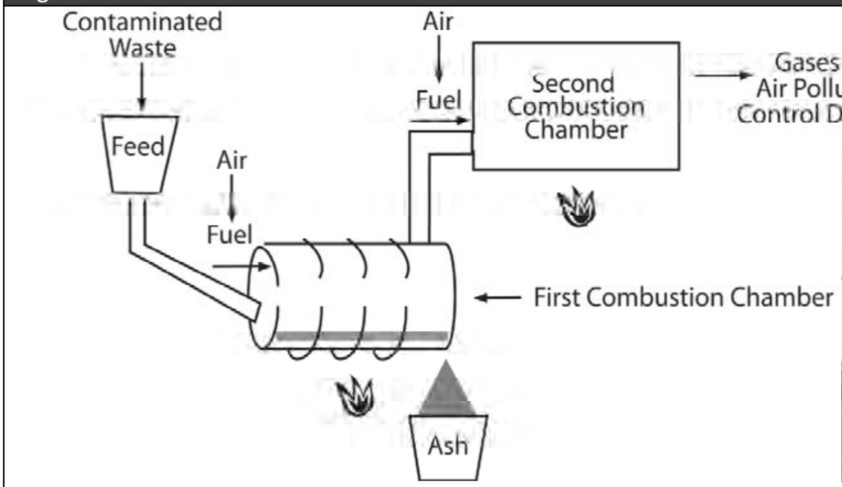
Contaminant Type	**VOCs, SVOCs, X-VOCs, X-SVOCs, and Fuels**

Description

Incineration technology uses a burner that ignites supplied fuel at high temperatures, i.e., 850-1,200 °C, to volatize and combust different kinds of hazardous contaminants. Proper design of incinerator and efficiency of operation (temperature, residence time, and turbulent mixing of the waste material) are essential to ensuring adequate destruction of undesirable combustion gases. A properly operated incinerator can meet the stringent requirements for all gaseous emissions. Air pollution control systems are employed to remove particulates, and to neutralize and remove acids.

Incineration is different from other thermal technologies in that it oxidizes bulk quantities of contaminants that may be in liquid or solid phase. Four common incinerator types are rotary kiln, liquid injection, fluidized bed, and infrared kiln.

Figure



Source: US EPA

Applicability

Used in remediating soils contaminated with hazardous substances, particularly halogenated and organic compounds, fuels and explosives.

Advantages

- It is one of the most mature and well-known treatment technologies.
- At high temperatures, it is fast and very effective (99%).
- Highly effective for a wide range of contaminants in high concentrations.

Limitations

Factors that may limit the applicability and effectiveness of the process include:

- It is a costly technique.
- Pretreatment to remove heavy metals may be required because they remain in the solid residue or may possibly leave with the flue gases.
- May release toxic chemicals from their stacks.
- When chlorinated hydrocarbons are incinerated, products of incomplete combustion can be formed; these may include dioxins and furans.
- Wastes with heavy metals can produce bottom ash of high concentrations.

Cost

The key cost driver information and cost analysis were developed in 2006 using the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers

- Type of waste
  - Debris < Soil < Sludge < Sediment
- Quantity
  - There is only a USD 300-400 gap in cost for quantities ranging from 5,000 to 100,000.

Cost Analysis

The following table represents the estimated costs (by common unit of measure) in applying incineration technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		**Large Site**	
	Easy	**Difficult**	**Easy**	**Difficult**
Cost per yd^3	USD 796	USD 1,171	USD 695	USD 1,063

7.1- Containment

Landfill Cap

Contaminant Type	VOCs, SVOCs, X-VOCs, X-SVOCs, and Fuels

Description

Landfill caps can be used to:

- Minimize exposure on the surface of the waste facility.
- Prevent vertical infiltration of water into wastes that would create contaminated leachate.
- Contain waste while treatment is being applied.
- Control gas emissions from underlying waste.
- Create a land surface that can support vegetation and/or be used for other purposes.

The design of landfill caps is site-specific and depends on the intended functions of the system. Landfill caps can range from a one-layer system of vegetated soil to a complex multilayer system of soils and geosynthetics. In general, less complex systems are required in dry climates while more complex systems are required in wet climates. The materials used in the construction of landfill caps include low permeability and high permeability soils and low permeability geosynthetic products. The low permeability materials divert water and prevent its passage into the waste. The high permeability materials carry water away that percolates into the cap. Other materials may be used to increase slope stability.

The most critical components of a landfill cap are the barrier layer and the drainage layer. The barrier layer can be low permeability soil (clay) and/or geosynthetic clay liners (GCLs). A flexible geomembrane liner is placed on top of the barrier layer. Geomembranes are usually supplied in large rolls and are available in several thicknesses (20-140 mm), widths (15-100 ft), and lengths (180-840 ft). The candidate list of polymers commonly used is lengthy, which includes polyvinyl chloride (PVC), polyethylenes of various densities, reinforced chlorosulfonated polyethylene (CSPE-R), polypropylene, ethylene interpolymer alloy (EIA), and many newcomers. Soils generally used as barrier materials are clays that are compacted to a hydraulic conductivity no greater than 1×10^{-6} cm/s. Compacted soil barriers are generally installed in minimum lifts of 6 in to achieve a thickness of 2 ft or more. A composite barrier uses both soil and a geomembrane, taking advantage of the properties of each. The geomembrane is essentially impermeable; but, if it develops a leak, the soil component prevents significant leakage into the underlying waste.

For facilities on top of putrescible wastes, the collection and control of methane and carbon dioxide, which are among the potent greenhouse gases, must be part of facility design and operation.

Asphalt/Concrete Cap

The most effective single-layer caps are composed of concrete or bituminous asphalt. It is used to form a surface barrier between landfill and the environment. An asphalt concrete cap would reduce leaching through the landfill into an adjacent aquifer.

RCRA Subtitle C Cap

The RCRA Subtitle C multilayered landfill cap is a baseline design that is suggested for use in RCRA hazardous waste applications. These caps generally consist of an upper vegetative (topsoil) layer, a drainage layer, and a low permeability layer which consists of a synthetic liner over 2 ft of compacted clay. The compacted clay liners are effective if they retain a certain moisture content but are susceptible to cracking if the clay material is desiccated. As a result, alternate cap designs are usually considered for arid environments.

RCRA Subtitle D Cap

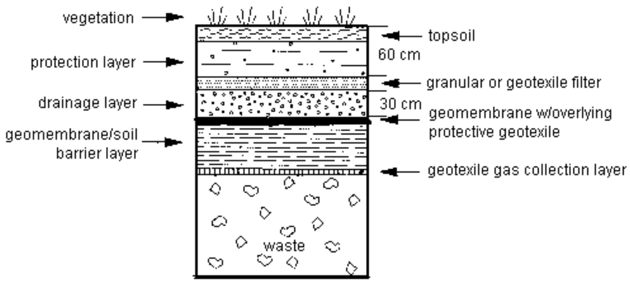
RCRA Subtitle D requirements are for non-hazardous waste landfills. The design of a landfill cover for an RCRA Subtitle D facility is generally a function of the bottom liner system or natural subsoils present. The cover must meet the following specifications:

- The material must have permeability no greater than 1×10^{-5} cm/s, or equivalent permeability of any bottom liner or natural subsoils present, whichever is less.
- The infiltration layer must contain at least 45 cm of earthen material.
- The erosion control layer must be at least 15 cm of earthen material capable of sustaining native

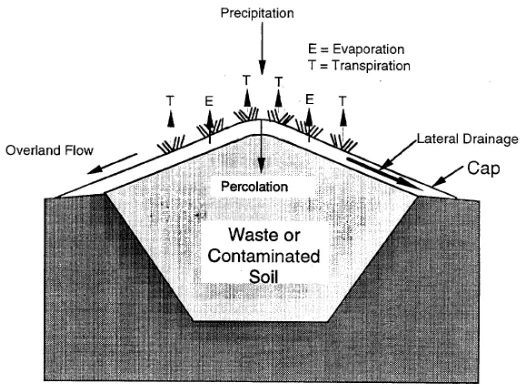
plant growth.

Alternative design can be considered, but must be of equivalent performance as the specifications outlined above. All covers should be designed to prevent a "bathtub effect". A bathtub effect occurs when a more permeable cover is placed over a less permeable bottom liner or natural subsoil. The landfill then fills up like a bathtub.

Figure



Source: FRTR, 2007



Source: UNIDO, 2007

Applicability

Landfill caps may be temporary or final. Temporary caps can be installed before final closure to minimize generation of leachate until a better remedy has been selected. They are usually used to minimize infiltration when the underlying waste mass is undergoing settling. A more stable base will thus be provided for the final cover, reducing the cost of post-closure maintenance. Landfill caps also may be applied to waste masses that are so large that other treatments are considered impractical. For example, at mining sites, caps can be used to minimize the infiltration of water to contaminated tailings piles and to provide a suitable base for the establishment of vegetation. In conjunction with water diversion and detention structures, landfill caps may be designed to route surface water away from the waste area while minimizing erosion.

Advantages

- Most appropriate method for mine tailings dam.
- Applicable for two ways of temporary and final.
- No required special technology to protect seepage generation by surface water and/or precipitation.
- Surface is usable for other objectives such as greenfield, park, and playground after stable condition has been confirmed.
- No requirement for treatment of contaminated soil.

Limitations

Landfilling does not lessen toxicity, mobility, or volume of hazardous wastes, but does mitigate migration. Landfill caps are most effective where most of the underlying waste is above the water table. A cap, by itself, cannot prevent the horizontal flow of groundwater through the waste, but only the vertical entry of water into the waste. In many cases, landfill caps are used in conjunction with vertical walls to minimize horizontal flow and migration. The effective life of landfill components (including cap) can be extended by long-term inspection and maintenance. Vegetation, which has a tendency for deep root penetration, must be eliminated from the cap area. In addition, precautions must be taken to assume that the integrity of the cap is not compromised by land use activities.

Cost

Landfill caps are generally the least expensive way for managing human health and ecological risks effectively. Rough industry costs are USD 175,000/acre for RCRA Subtitle D, and USD 225,000/acre for RCRA Subtitle C. Additional cost information can be found in the Hazardous, Toxic, and Radioactive Wastes (HTRW) Historical Cost Analysis System (HCAS) developed by the Environmental Historical Cost Committee of the Interagency Cost Estimation Group.

8.1- Other

Excavation, Retrieval, Off-Site Disposal

Contaminant Type	No particular target group

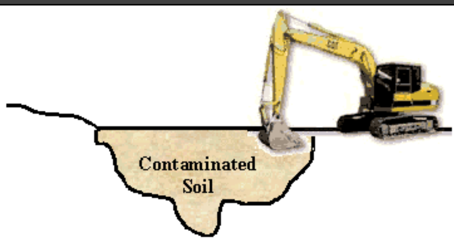
Description

Contaminated material is removed and transported to permitted off-site treatment and/or disposal facilities. Some pretreatment of the contaminated media is usually required in order to meet land disposal restrictions.

Confined disposal facilities (CDFs) are engineered structure enclosed by dikes and designed to retain dredged materials. A CDF may have a large cell for material disposal, and adjoining cells for retention and decantation of turbid and supernatant water. A variety of linings have been used to prevent seepage through the dike walls. The most effective are clay or bentonite-cement slurries; however, sand, soil, and sediment linings are also being used.

Location and design are two important considerations for CDFs. Terms to consider for the location of a CDF are the physical aspects (size and proximity to a navigable waterway), design/construction (geology/hydrology), and environment (current use of the area, environmental value, and environmental effects). The primary goal of CDF design is to minimize contaminant loss. Caps are the most effective way to minimize contaminant loss from CDFs, but selection of proper lining material is also an important control for CDFs. Finally, CDFs require continuous monitoring to ensure their structural integrity. Operation and maintenance duration lasts as long as the service life of the facility.

Figure



Source: FRTR, 2007

Applicability

Excavation and off-site disposal are applicable to the complete range of contaminant groups with no particular target group. Excavation and off-site by relocating the waste to a different (and presumably safer) site.

Advantages

- ❖ It is the most simple method.
- ❖ It is possible to treat complex contaminations such as heavy metals, VOCs and fuels.

Limitations

Factors that may limit the applicability and effectiveness of the process include:

- ❖ Generation of fugitive emissions may be a problem during operations.
- ❖ Distance from the contaminated site to the nearest disposal facility with the required permit(s) will affect cost.
- ❖ Depth and composition of the media requiring excavation must be considered.

- Transportation of the soil through populated areas may affect community acceptability.
- Disposal options for certain waste (e.g., mixed or transuranic waste) may be limited. There is currently only one licensed disposal facility for radioactive and mixed waste in the United States.
- Contaminants can potentially migrate from CDF from several pathways, including effluent discharge to surface water, rainfall surface runoff, leachate into groundwater, volatilization to the atmosphere, and dike uptake.
- CDFs can develop odor problems as well as mosquito and insect problems without proper design and maintenance.
- Confirmation investigation should be required at both remediated site and disposal site.

Cost

Cost estimates for excavation and disposal range from USD 300 to USD 510/ metric t (USD 270 to USD 460/ton) depending on the nature of hazardous materials and methods of excavation. These estimates include excavation/removal, transportation, and disposal at an RCRA permitted facility. Additional cost for treatment at disposal facility may also be required. Excavation and off-site disposal are relatively simple processes with proven procedures. These are labor-intensive practices with little potential for further automation. Additional costs may include soil characterization and treatment to meet land ban requirements.

Additional cost information can be found in the Hazardous, Toxic, and Radioactive Wastes (HTRW) Historical Cost Analysis System (HCAS) developed by the Environmental Historical Cost Committee of the Interagency Cost Estimation Group.

9.2- Biological-In Situ

Monitored Natural Attenuation

Contaminant Type	VOCs, SVOCs, X-VOCs, X-SVOCs, and Fuel Hydrocarbons

Description

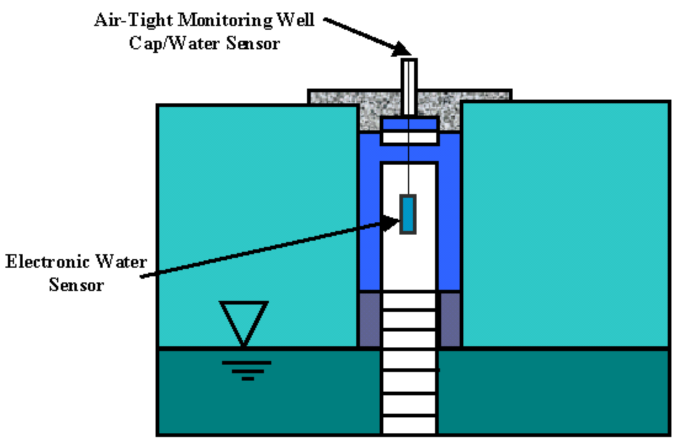
Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminant concentrations to acceptable levels. Natural attenuation is not a technology, and there is significant debate among technical experts about its use at hazardous waste sites. Consideration of this option usually requires modeling and evaluation of contaminant degradation rates and pathways and predicting contaminant concentration at downgradient receptor points, especially when plume is still expanding/migrating. The primary objective of site modeling is to demonstrate that natural processes of contaminant degradation will reduce contaminant concentrations below regulatory standards or risk-based levels before potential exposure pathways are completed. In addition, long-term monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives.

Natural attenuation is not the same as "no action," although it often is perceived as such. CERCLA (The Comprehensive Environmental Response, Compensation, and Liability Act (US), December 11, 1980) requires evaluation of a "no action" alternative but does not require evaluation of natural attenuation. Natural attenuation is considered in the Superfund program on a case-by-case basis, and guidance on its use is still evolving.

Compared with other remediation technologies, natural attenuation has the following advantages:

- Less generation or transfer of remediation wastes;
- Less intrusion as few surface structures are required;
- May be applied to all or part of a given site, depending on site conditions and cleanup objectives;
- Natural attenuation may be used in conjunction with or as a follow-up to other (active) remedial measures; and
- Overall cost will likely be lower than active remediation.

Figure



Source: FRTR, 2007

Applicability

Target contaminants for natural attenuation are VOCs, SVOCs, and fuel hydrocarbons. Fuel and halogenated VOCs are commonly evaluated for natural attenuation. Pesticides also can be allowed to naturally attenuate, but the process may be less effective and may be applicable to only some compounds within the group. Additionally, natural attenuation may be appropriate for some metals when natural attenuation processes result in a change in the valence state of the metal that results in immobilization (e.g., chromium) and free cyanide ion.

Advantages
❖ Remediation cost is cheap. ❖ No need to use chemicals. No need to disturb the environment.
Limitations
Factors that may limit applicability and effectiveness include: ❖ Data used as input parameters for modeling must be collected. ❖ Intermediate degradation products may be more mobile and more toxic than the original contaminant. ❖ Natural attenuation is not appropriate where imminent site risks are present. ❖ Contaminants may migrate before they are degraded. ❖ Institutional controls may be required, and the site may not be available for reuse until contaminant levels are reduced. ❖ If free product exists, it may have to be removed. ❖ Some inorganics, such as mercury, can be immobilized but they will not be degraded. ❖ Long-term monitoring and associated costs. ❖ Longer time frames may be required to achieve remediation objectives, compared to active remediation. ❖ The hydrologic and geochemical conditions amenable to natural attenuation are likely to change over time and could result in renewed mobility of previously stabilized contaminants and may adversely impact remedial effectiveness. ❖ More extensive outreach efforts may be required in order to gain public acceptance of natural attenuation.
Cost
There are costs for modeling and monitoring. Modeling determines whether natural attenuation is a feasible remedial alternative. The most significant costs associated with natural attenuation are most often due to monitoring requirements, which include two major parts, i.e., site characterization and performance monitoring. Site characterization determines the extent of contamination and contaminant degradation rates. Performance monitoring tracks down contaminants migration and degradation and cleanup status.

11.1- Chemical/Physical-In Situ

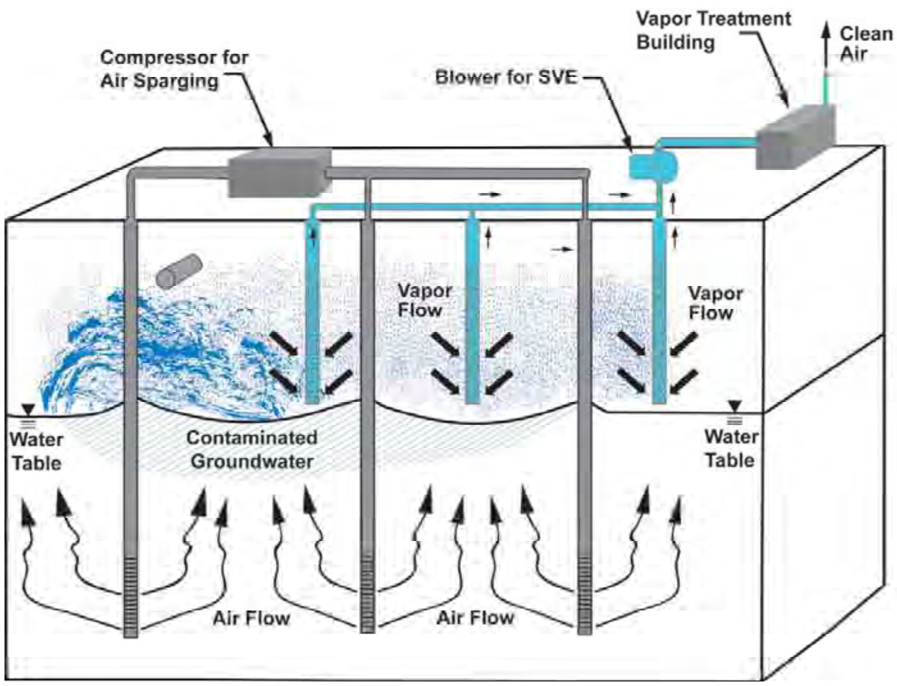
Air Sparging

Contaminant Type	**VOCs, SVOCs, X-VOCs, X-SVOCs, and Fuels**

Description

Air sparging is an in situ technology in which air is injected through a contaminated aquifer. Injected air traverses horizontally and vertically in channels through the soil column, creating an underground stripper that removes contaminants by volatilization. This injected air helps flush (bubble) the contaminants up into the unsaturated zone where a vapor extraction system is usually implemented in conjunction with air sparging to remove the generated vapor phase contamination. This technology is designed to operate at high flow rates in order to maintain increased contact between groundwater and soil and strip more groundwater by sparging.
Oxygen added to contaminated groundwater and vadose zone soils can also enhance biodegradation of contaminants below and above the water table.
Air sparging has a medium to long duration which may last, generally, up to a few years.
Air sparging is most often used together with soil vapor extraction (SVE), but it can also be used with other remedial technologies.

Figure



Source: US EPA

Applicability

The target contaminant groups for air sparging are VOCs and fuels. Only limited information is available on the process. Methane can be used as an amendment to the sparged air to enhance cometabolism of chlorinated organics.

Advantages

- Easy way with simple system.
- Boring holes, which were used for soil contamination investigation, are used effectively.
- Assist other remediation technologies more effectively.

Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Air flow through the saturated zone may not be uniform, which implies that there can be uncontrolled movement of potentially dangerous vapors.

- Depth of contaminants and site-specific geology must be considered.
- Air injection wells must be designed for site-specific conditions.
- Soil heterogeneity may cause some zones to be relatively unaffected.
- Air sparging should **NOT** be used if the following site conditions exist:
  - Free product is present. Air sparging can create groundwater mounding which could potentially cause free product to migrate and contamination to spread.
  - Nearby basements, sewers, or other subsurface confined spaces are present at the site. Potentially dangerous constituent concentrations could accumulate in basements unless a vapor extraction system is used to control vapor migration.
  - Contaminated groundwater is located in a confined aquifer system. Air sparging cannot be used to treat groundwater in a confined aquifer because the injected air would be trapped by the saturated confining layer and could not escape to the unsaturated zone.

Cost

The key cost driver information and cost analysis were developed in 2006 using the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers

- Surface Area (Contaminant Orientation)
  - Surface area of contamination is the primary cost driver, and directly affects the quantity of air sparge points.
- Depth to Contamination
  - Depth is the secondary cost driver. Cost increases with depth as it affects the drilling costs.

Cost Analysis

The following table represents estimated costs (by common unit of measure) to apply air sparging technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		Large Site	
	Easy	Difficult	Easy	Difficult
Cost per yd^3	USD 64	USD 28	USD 18	USD 20

11.9- Chemical/Physical-In Situ

Passive/Reactive Treatment Walls

Contaminant Type	**VOCs, SVOCs, X-VOCs, X-SVOCs and Inorganics**

Description

A permeable reaction wall is installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall. These barriers allow the passage of water while prohibiting the movement of contaminants by employing agents such as zero-valent metals, chelators (ligands selected for their specificity for a given metal), sorbents, and microbes. The contaminants will either be degraded or retained in a concentrated form by the barrier material. The wall could provide permanent containment for relatively benign residues or provide a decreased volume of more toxic contaminants for subsequent treatment.

Funnel and Gate: Modifications to the basic passive treatment walls may involve a funnel-and-gate system or an iron treatment wall. The funnel-and-gate system for in situ treatment of contaminated plumes consists of low hydraulic conductivity (e.g., 1E-6 cm/s) cutoff walls (the funnel) with a gate that contains in situ reaction zones. Groundwater primarily flows through high conductivity gaps (the gates). The type of cutoff walls most likely to be used in the current practice is slurry walls or sheet piles. Innovative methods such as deep soil mixing and jet grouting are also being considered for funnel walls.

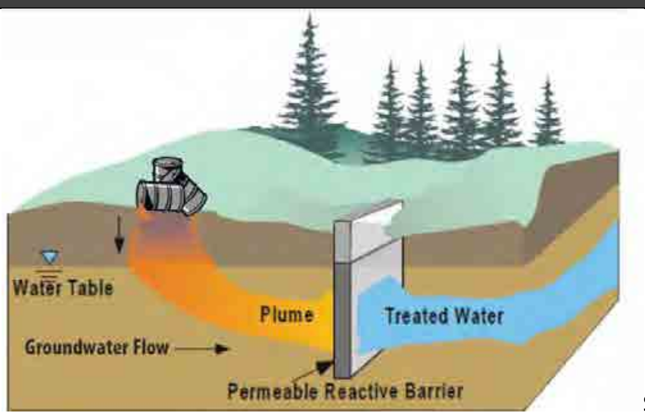
Iron Treatment Wall: An iron treatment wall consists of iron granules or other iron bearing minerals for the treatment of chlorinated contaminants such as TCE and PCE. As the iron is oxidized, a chlorine atom is removed from the compound by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron. The iron granules are dissolved by the process, but the metal disappears so slowly that the remediation barriers can be expected to remain effective for many years, possibly even decades.

Barrier and post-closure monitoring tests are being conducted by the US Air Force, US Navy, and Department of Energy in field-scale demonstration plots and are being designed for actual contaminated sites. The range of materials available for augmenting existing barrier practice is broad. Two types of barriers have been the focus of initial efforts of this program, i.e., permeable reactive barriers and in-place bioreactors.

Special Concrete Plug: Special concrete plug consists of cement concrete with water glass (Na_2SiO_3) for the treatment of acid mine drainage (AMD). Special concrete has alkalinity and neutralizes AMD protecting leakage path. Special concrete plug is dissolved by the neutralizing reaction process, but solidificated alkalinity elements as cement and water glass disappear so slowly that the remediation barriers can be expected to remain effective for the long term.

Passive treatment walls are generally intended for long-term operation to control migration of contaminants in groundwater.

Figure



Source: US EPA

Applicability

Target contaminant groups for passive treatment walls are VOCs, SVOCs, and inorganics. The technology can be used but may be less effective in treating some fuel hydrocarbons.

Advantages

- Lasts in the long term.
- Highly effective for narrow water path.
- Usable for a wide scope of remediation as VOCs to AMD selecting method (iron or special concrete).

Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Passive treatment walls may lose their reactive capacity, requiring replacement of the reactive medium.
- Passive treatment wall permeability may decrease due to precipitation of metal salts.
- Depth and width of barrier.
- Limited to a subsurface lithology that has a continuous aquitard at a depth that is within the vertical limits of trenching equipment.
- Volume cost of treatment medium.
- Biological activity or chemical precipitation may limit the permeability of the passive treatment wall.

Cost

The key cost driver information and cost analysis were developed in 2006 using the Remedial Action Cost Engineering and Requirements (RACER) software.

Key Cost Drivers

- Economy of Scale
  - Quantity of material treated has a large impact
  - Width of the plume to be treated
- Choice of supplemental amendments
- Additional monitoring required by regulators

Cost Analysis

The following table represents the estimated costs (by common unit of measure) in applying passive/reactive treatment wall technology at sites of varying size and complexity.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		**Large Site**	
	Easy	**Difficult**	**Easy**	**Difficult**
Cost per yd^3 (of treatment wall)	USD 963	USD 1,277	USD 1,142	USD 1.961
Cost per yd^3 (of groundwater treated)	USD 0.16	USD 0.21	USD 0.08	USD 0.13

12.2- Chemical/Physical- Ex Situ

Advanced Oxidation Processes

Contaminant Type	**VOCs, SVOCs, X-VOCs, and X-SVOCs**

Description

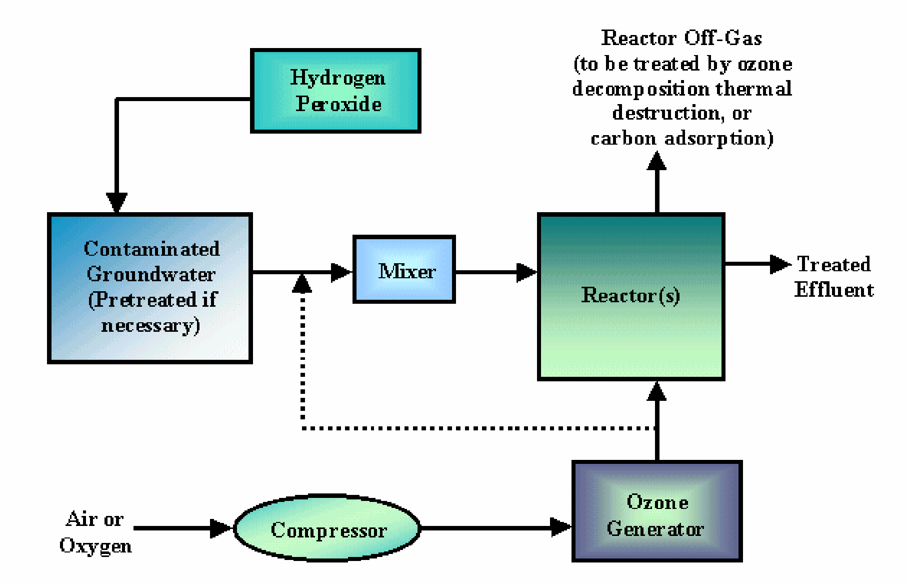
Ultraviolet (UV) oxidation is a destruction process that oxidizes organic and explosive constituents in wastewater by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with the oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone (O_3) and/or hydrogen peroxide (H_2O_2). If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts. The main advantage of UV oxidation is that it is a destruction process, as opposed to air stripping or carbon adsorption, for which contaminants are extracted and concentrated in a separate phase. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput under consideration.

The UV oxidation process is general done with low pressure lamps operating at 65 W of electricity for ozone systems and lamps operating at 15 kW to 60 kW for hydrogen peroxide systems.

UV Photolysis: UV photolysis is a process by which chemical bonds of the contaminants are broken under the influence of UV light. Products of photodegradation vary according to the matrix in which the process occurs, but the complete conversion of an organic contaminant to CO_2, H_2O, etc. is not probable.

The duration of operation and maintenance of UV oxidation depends on influent water turbidity, contaminant and metal concentrations, existence of free radical scavengers, and the required maintenance intervals on UV reactors and quartz sleeves.

Figure



Source: FRTR, 2007

Applicability

Practically, any organic contaminant that is reactive with the hydroxyl radical can potentially be treated. A wide variety of organic and explosive contaminants are susceptible to destruction by UV oxidation, including petroleum hydrocarbons, chlorinated hydrocarbons used as industrial solvents and cleaners, and ordnance compounds such as TNT, RDX, and HMX. In many cases, chlorinated hydrocarbons that are resistant to biodegradation may be effectively treated by UV oxidation. Typically, easily oxidized organic compounds, such as those with double bonds (e.g., TCE, PCE, and vinyl chloride), as well as simple aromatic compounds (e.g., toluene, benzene, xylene, and phenol), are rapidly destroyed in UV oxidation processes.

Advantage
❖ UV oxidation is also effective for remediation of bacteria.
Limitations
Limitations of UV oxidation include: ❖ The aqueous stream being treated must provide for good transmission of UV light (high turbidity causes interference). This factor can be more critical for UV/H_2O_2 than UV/O_3 (turbidity does not affect direct chemical oxidation of the contaminant by H_2O_2 or O_3). ❖ Free radical scavengers can inhibit contaminant destruction efficiency. Excessive dosages of chemical oxidizers may act as a scavenger. ❖ The aqueous stream to be treated by UV/oxidation should be relatively free of heavy metal ions (less than 10 mg/L) and insoluble oil or grease to minimize the potential for fouling of the quartz sleeves. ❖ When UV/O_3 is used on volatile organics such as TCA, the contaminants may be volatilized (e.g., "stripped") rather than destroyed. They would then have to be removed from the off-gas by activated carbon adsorption or catalytic oxidation. ❖ Costs may be higher than competing technologies because of energy requirements. ❖ Pretreatment of the aqueous stream may be required to minimize ongoing cleaning and maintenance of UV reactor and quartz sleeves. ❖ Handling and storage of oxidizers require special safety precautions.
Cost
Costs generally are between USD 0.03 to USD 3.00 per 1,000 L (USD 0.10 to USD 10.00 per 1,000 gal). Factors that influence the cost to implementing UV/oxidation include: ❖ Types and concentration of contaminants (as they affect oxidizer selection, oxidizer dosage, UV light intensity, and treatment time). ❖ Degree of contaminant destruction required. ❖ Desired water flow rates. ❖ Requirements for pretreatment and/or posttreatment.

12.7- Chemical/Physical- Ex Situ

Precipitation/Coagulation/Flocculation

Contaminant Type	**Dissolved Heavy Metals and Radionuclides**

Description

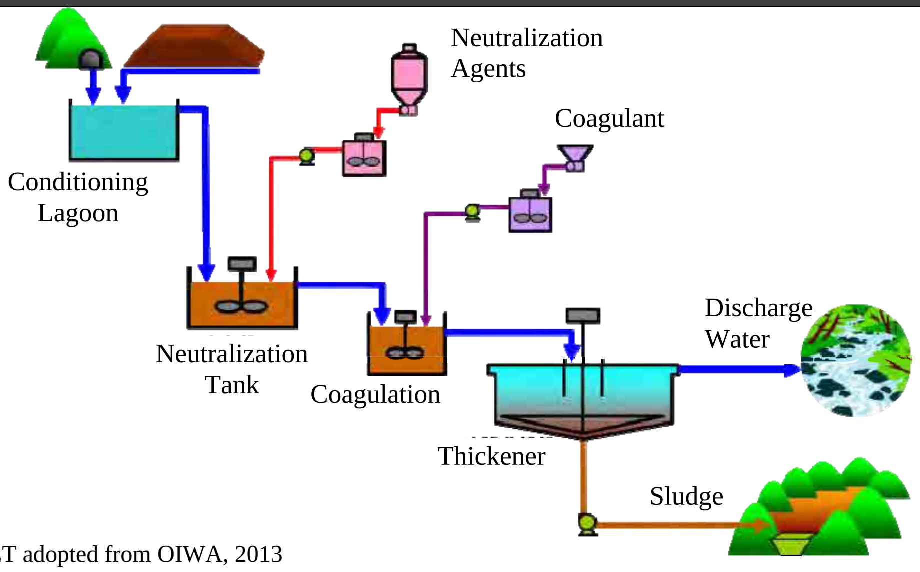
Precipitation of metals has long been the primary method of treating metal-laden industrial wastewaters and AMD. As a result of the success of metals precipitation in such applications, the technology is being considered and selected for use in remediating groundwater containing heavy metal ions, including their radioactive isotopes.

Metal ion precipitation from contaminated water involves the conversion of soluble heavy metal salts to insoluble salts that will precipitate. The precipitations can then be removed from the treated water by physical methods such as clarification (settling) and/or filtration. The process usually uses pH adjustment, addition of a chemical precipitant, and flocculation. Typically, metals precipitate from the solution as hydroxides, sulfides, or carbonates. The solubilities of the specific metal contaminants and the required cleanup standards will dictate the process used. In some cases, process design will allow for the generation of sludge that can be sent to recyclers for metal recovery.

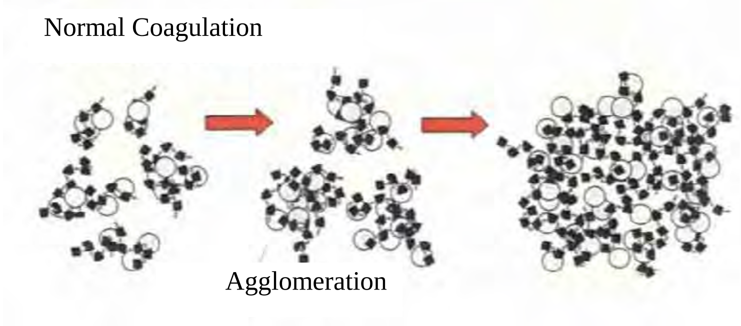
Coagulants and Flocculation: In the precipitation process, chemical precipitants, coagulants, and flocculation are used to increase particle size through aggregation. The precipitation process can generate very fine particles that are held in suspension by electrostatic surface charges. These charges cause clouds of counter-ions to form around the particles, giving rise to repulsive forces that prevent aggregation and reduce the effectiveness of subsequent solid-liquid separation processes. Therefore, chemical coagulants are often added to overcome the repulsive forces of the particles. The three main types of coagulants are inorganic electrolytes (such as alum, lime, ferric chloride, and ferrous sulfate), organic polymers, and synthetic polyelectrolytes with anionic or cationic functional groups.

Flocculant settling refers to a rather dilute suspension of particles that coalesce or flocculate during the sedimentation operation. As coalescence or flocculation occurs, the particles increase in mass and settle at a faster rate. The amount of flocculation that occurs depends on the opportunity for contact, which varies with the overflow rate, the depth of the basin, the velocity gradients in the system, the concentration of particles, and the range of particle sizes. The effects of these variables can only be accomplished by sedimentation tests.

Figure



Source: JET adopted from OIWA, 2013



Sedimentation Test

Applicability

Precipitation is used mainly to convert dissolved ionic species into solid-phase particulates that can be removed from the aqueous phase by coagulation and filtration. Remedial application of this technology usually involves removal of dissolved toxic metals and radionuclides. Depending on the process design, sludge may be amenable to metal recovery.

Advantages

- ❖ The most basic treatment method for heavy metal ions.
- ❖ Equipment or apparatus are simple and easy to operation.

Limitations

- ❖ As with any pump and treatment process, if the source of contamination is not removed (as in metals absorbed to soil), treatment of the groundwater may be superfluous.
- ❖ The presence of multiple metal species may lead to removal difficulties as a result of amphoteric natures of different compounds (i.e., optimization on one metal species may prevent removal of another).
- ❖ As discharge standards become more stringent, further treatment may be required.
- ❖ Soluble hexavalent chrome requires extra treatment prior to coagulation and flocculation.
- ❖ Reagent addition must be carefully controlled to preclude unacceptable concentrations in treatment effluent.
- ❖ Efficacy of the system relies on adequate solids separation techniques (e.g., clarification, flocculation, and/or filtration).
- ❖ Process may generate toxic sludge requiring proper disposal.
- ❖ Process can be costly, depending on reagents used, required system controls, and required operator involvement in system operation.
- ❖ Dissolved salts are added to the treated water as a result of pH adjustment.
- ❖ Polymer may need to be added to the water to achieve adequate settling of solids.
- ❖ Treated water will often require pH adjustment.
- ❖ Metals held in solution by complexing agents (e.g., cyanide or EDTA) are difficult to precipitate.
- ❖ Arsenic and hexavalent chrome ions require special technology for removal.

Cost

Cost Analysis

RACER Parameters	Scenarios A and B	Scenarios C and D
	Small Site	**Large Site**
	No Cost Sensitivity Possible	**No Cost Sensitivity Possible**
Cost per 1,000 gal per year	USD 41	USD 17

13.1- Containment

Physical Barriers

Contaminant Type	No particular target group of contaminants

Description

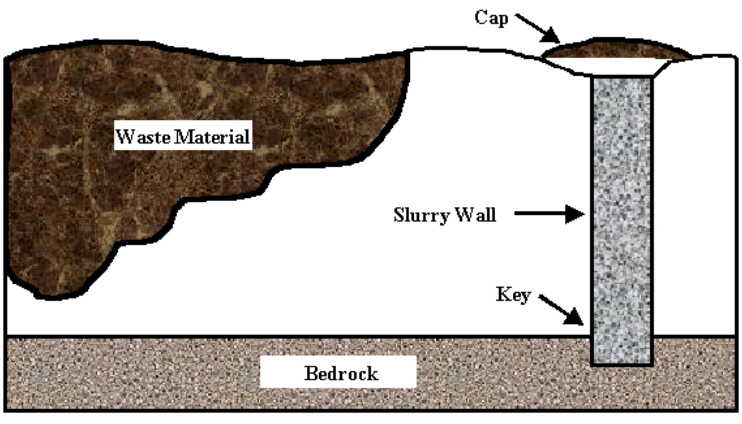
Physical barriers (or slurry walls) are used to contain contaminated groundwater, divert contaminated groundwater from the drinking water intake, divert uncontaminated groundwater flow, and/or provide a barrier for the groundwater treatment system.
These subsurface barriers consist of a vertically excavated trench that is filled with slurry. The slurry hydraulically shores the trench to prevent collapse and forms a filter cake to reduce groundwater flow. Slurry walls are often used where the waste mass is too large for treatment and where soluble and mobile constituents pose an imminent threat to a source of drinking water.

Slurry walls are a full-scale technology and have been used for decades as long-term solutions for controlling seepage. They are often used in conjunction with capping. The technology has demonstrated its effectiveness in containing greater than 95% of the uncontaminated groundwater. However, in contaminated ground water applications, specific contaminant types may degrade the slurry wall components and reduce its long-term effectiveness.

Most slurry walls are constructed of clayey ore as a soil, bentonite, and water mixture. The bentonite slurry is used primarily for wall stabilization during trench excavation. A soil-bentonite backfill material is then placed into the trench (displacing the slurry) to create the cutoff wall. Walls of this composition provide a barrier with low permeability and chemical resistance at low cost. Other wall compositions, such as cement/bentonite, pozzolan/bentonite, attapulgite, organically modified bentonite, or slurry/geomembrane composite, may be used if greater structural strength is required or if chemical incompatibilities between bentonite and site contaminants exist. Tailings mixed with cement are used for constructing walls to prevent leakage of seepage at mine site.

Slurry walls are typically placed at depths up to 30 m (100 ft) and are generally 0.6 to 1.2 m (2 to 4 ft) thick. Installation depths of over 30 m (100 ft) are implementable using clamshell bucket excavation, but the cost per unit area of wall increases by about a factor of three. The most effective application of the slurry wall for site remediation or pollution control is to base (or key) the slurry wall 0.6 to 0.9 m (2 to 3 ft) into a low permeability layer such as clay or bedrock, as shown in the preceding figure. This "keying-in" provides for an effective foundation with minimum leakage potential. An alternate configuration for slurry wall installation is a "hanging" wall in which the wall projects into the groundwater table to block the movement of lower density or floating contaminants such as oil, fuel, and gas. Hanging walls are used less frequently than keyed-in walls.

Figure



Source: FRTR, 2007

Applicability

Slurry walls contain the groundwater itself, thus treating no particular target group of contaminants. They are used to contain contaminated groundwater, divert contaminated groundwater from drinking water intake, divert uncontaminated groundwater flow, and/or provide a barrier for the groundwater treatment system.

Advantage

- Same as passive/reactive treatment walls.

Limitations

Factors that may limit the applicability and effectiveness of the process include:

- Most of the approaches involve a large amount of heavy construction.
- The technology only contains contaminants within a specific area.
- Soil-bentonite backfills are not able to withstand attack by strong acids, bases, salt solutions, and some organic chemicals. Other slurry mixtures can be developed to resist specific chemicals.
- There is a potential for slurry walls to degrade or deteriorate over time.
- Use of this technology does not guarantee that further remediation in the future may not be necessary.

Cost

Costs likely to be incurred in the design and installation of a standard soil-bentonite wall in soft to medium soil range from USD 540/m^2 to USD 750/m^2 (USD 5/ft^2 to USD 7/ft^2) (1991). These costs do not include variable costs required for chemical analysis, feasibility, or compatibility testing. Testing costs depend heavily on site-specific factors.
Factors that have the most significant impact on the final cost of soil-bentonite slurry wall installation include:

- Type, activity, and distribution of contaminants;
- Depth, length, and width of wall;
- Geological and hydrological characteristics;
- Distance from source of materials and equipment;
- Requirements for wall protection and maintenance;
- Type of slurry and backfill used;
- Other site-specific requirements as identified in the initial site assessment (e.g., presence of contaminants or debris); and
- Planning, permitting, regulatory interaction, and site restoration.

14.1- Air Emission/Off-Gas	
Oxidation	
Contaminant Type	**Nonhalogenated VOCs and SVOCs, and Fuel Hydrocarbons**
Description	

Oxidation equipment (thermal or catalytic) are used for destroying and decomposing contaminants in the exhaust gas from air strippers and SVE systems. Thermal oxidation units are typically single chamber and refractory-lined oxidizers equipped with a propane or natural gas burner and a stack. Lightweight ceramic blanket refractory is used because many of these units are mounted on skids or trailers. If gasoline is the contaminant, heat exchanger efficiencies are limited to 25% to 35%, and preheat temperatures are maintained below 180 °C (530 °F) in order to minimize the possibility of ignition occurring in the heat exchanger. Flame arrestors are always installed between the vapor source and the thermal oxidizer. Burner capacities in the combustion chamber range from 0.5 to 2 million BTU/h. Operating temperatures range from 760 °C to 870 °C (1,400 °F to 1,600 °F), and gas residence times are typically 1 s or less.

Catalytic oxidation is a relatively recently applied alternative for the treatment of VOCs in air streams resulting from remedial operations. The addition of a catalyst accelerates the rate of oxidation by adsorbing the oxygen and the contaminant on the catalyst surface where they react to form carbon dioxide, water, and hydrochloric gas. The catalyst enables the oxidation reaction to occur at much lower temperatures than required by a conventional thermal oxidation. VOCs are thermally destroyed at temperatures typically ranging from 320 °C to 540 °C (600 °F to 1,000 °F) by using a solid catalyst. First, the contaminated air is directly preheated (electrically or, more frequently, using natural gas or propane) to reach a temperature necessary to initiate the catalytic oxidation at 310 °C to 370 °C (600 °F to 700 °F) of the VOCs. Then the preheated VOC-laden air is passed through a bed of solid catalysts where the VOCs are rapidly oxidized. Thermal oxidizers can often be converted to catalytic units after initially high influent contaminant concentrations decrease to less than 1,000 ppmv to 5,000 ppmv.

Catalytic Oxidation: Catalyst systems used to oxidize VOCs typically use metal oxides such as nickel oxide, copper oxide, manganese dioxide, or chromium oxide. Noble metals such as platinum and palladium may also be used. Most commercially available catalysts are proprietary.

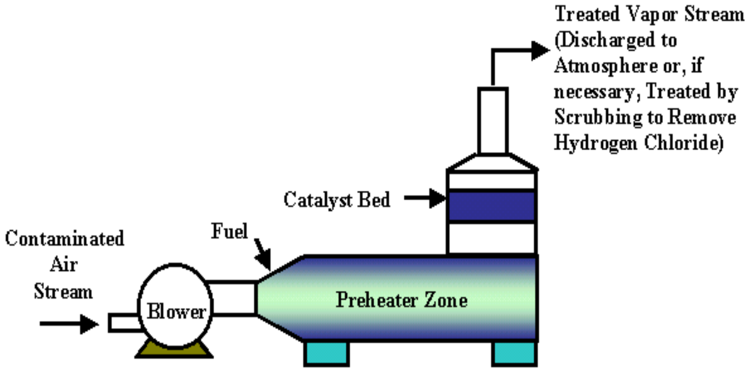
Internal Combustion Engine Oxidation: Organic contaminants in air can be used as fuel and burned in an internal combustion engine. When the concentration of organics is too low, auxiliary fuel is added to enhance the oxidation process.

Thermal Oxidation: In most cases, the thermal or catalytic oxidation process can be enhanced to reduce auxiliary fuel costs by using an air-to-air heat exchanger to transfer heat from the exhaust gases to the incoming contaminated air. Typically, about 50% of the heat of the exhaust gases is recovered.

UV Oxidation: Oxidation of organic contaminants in air can also be achieved by UV oxidation. As described in UV oxidation of wastewater, UV oxidation is the process by which chemical bonds of the contaminants are broken under the influence of UV light. Products of photodegradation vary according to the matrix in which the process occurs, but the complete conversion of an organic contaminant to CO_2, H_2O, etc. is not probable.

Natural aeration: Natural aeration is oxidation using oxygen in the air, agitating and recirculating polluted water to surface, and oxidizing biological oxygen demand materials such as BOD.

Figure



Source: FRTR, 2007

Applicability

The target contaminant groups for oxidation are nonhalogenated VOCs and SVOCs, and fuel hydrocarbons. Both precious and base metal catalysts have been developed and have been reportedly capable of effectively destroying halogenated (including chlorinated) hydrocarbons. Specific chlorinated hydrocarbons that have been treated include TCE, TCA, methylene chloride, and 1,1-DCA.

Limitations

The following factors may limit applicability and effectiveness:

- If sulfur or halogenated compounds or high particulate loadings are in the emissions stream, the catalyst can be poisoned/deactivated that would require replacement.
- Destruction of halogenated compounds requires special catalysts, special materials or construction, and the addition of a flue gas scrubber to reduce acid gas emissions.
- Influent gas concentrations must be less than 25% of the lower explosive limit for catalytic and thermal oxidation.
- The presence of chlorinated hydrocarbons (see comment above) and some heavy metals (e.g., lead) may poison a particular catalyst.

Cost

The primary factors that will affect the overall cost include quantity, concentration, and type of contaminant; required destruction efficiencies; management of residuals; and utility and fuel costs.

Key Cost Drivers

- Catalytic oxidation is more expensive than thermal oxidation at low flow rates, and vice versa for high flow rates. Additionally, thermal oxidation is more economical at very high VOC concentrations and catalytic oxidation is more economical at moderate VOC concentrations. Commonly at the start of a project, VOC concentrations are high for a limited time and the leasing option for a thermal unit should be evaluated for this limited duration. No other sensitivity analysis is feasible.

RACER Parameters	Scenario A	Scenario B	Scenario C	Scenario D
	Small Site		Large Site	
	Easy	Difficult	Easy	Difficult
Cost per 1,000 SCFM*	USD 0.72	USD 0.83	USD 0.17	USD 0.24

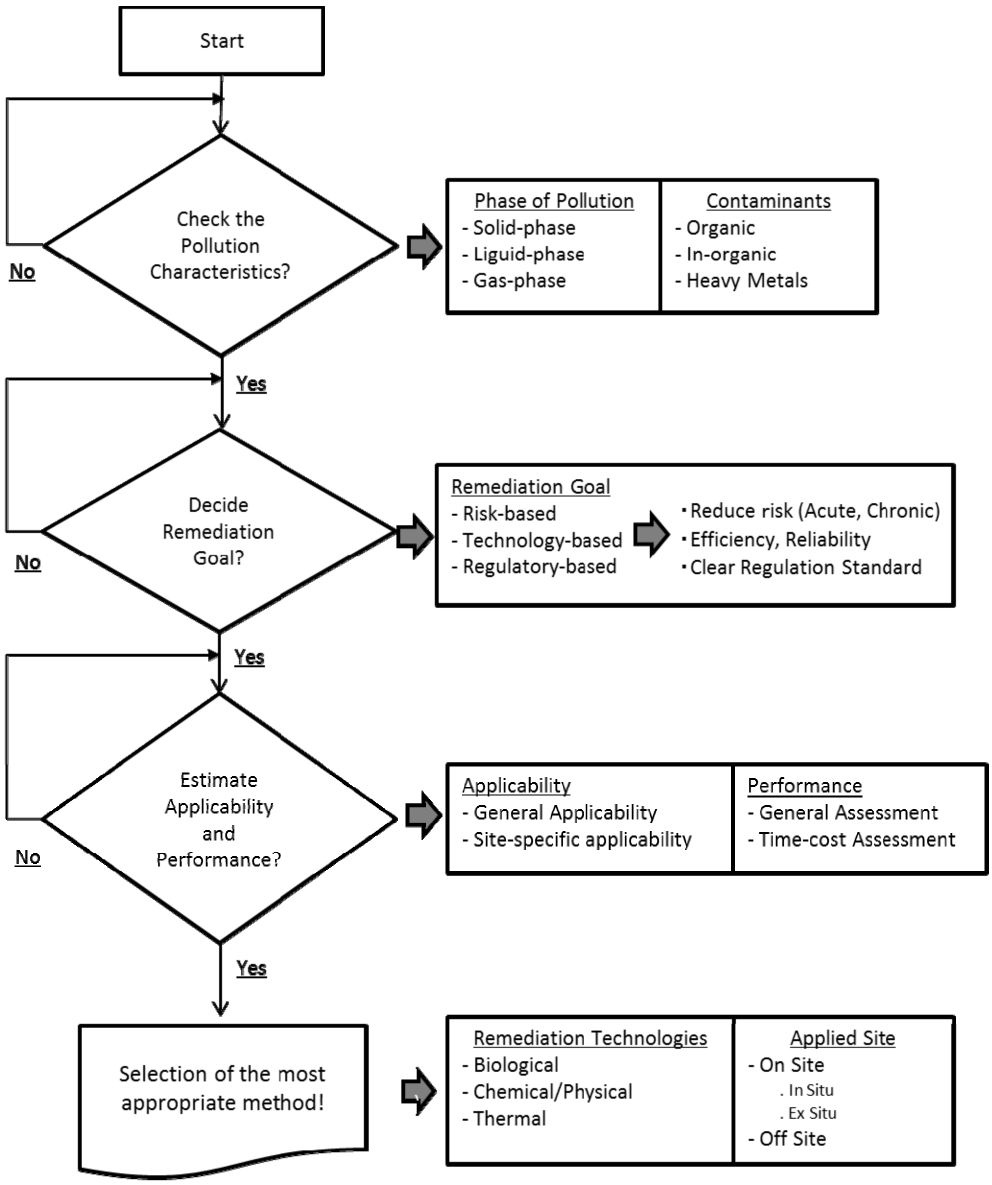
*SCFM = Standard Cubic Feet per Minute

A 5.4 Methods of Selection

A 5.4.1 Methods

There are many applicable remediation technologies for contaminated sites. It is necessary to consider reliability and maintainability of the technology in its selection. However, the effectiveness of these technologies is dependent on contaminant and site characteristics, regulatory requirements, remediation goal, and time-cost limitations. As remediation technologies are being developed and improved constantly, it is recommended to follow the latest information of remediation technologies at any time.

Figure A 5.4-1shows the process of selection of remediation technology. The criteria for applicability and performance of remediation technology are listed in Table A 5.4-1.



Source: JST based on UK Environment Agency, "Model Procedures for the Management of Land Contamination", 2004

Figure A 5.4-1 Process of Selecting Remediation Technology

Table A 5.4-1 Criteria for Applicability and Performance of Remediation Technology

Criteria	Criteria	Issues
Applicability	General Applicability	Contaminant type Soil type Depth of contamination
	Site-specific Applicability	Contamination concentration levels Minimum achievable concentration Decontaminated matrix quality Safety
Performance Assessment	General Assessment	Development status Reliability and maintenance Residuals produced Stand-alone character Public acceptability
	Time-cost Assessment	Clean-up time required Overall cost

Source: UNIDO, 2007

A 5.4.2 Decision Supporting Tool

(1) UNIDO

The International Centre for Science and High Technology, which is an institution within the legal framework of the United Nations Industrial Development Organization (UNIDO), has introduced the Decision Aid for Remediation Technology Selection (DARTS) as the software-based decision support tool with complete and comprehensive reporting basis on remediation methods. DARTS supports the user to compare different remediation scenarios and choose the most suitable in situ and ex situ remediation technologies for environmental remediation.

The key criteria used in DARTS for assessment of applicability of remediation technologies and their performance are shown in Table A 5.4-1. The evaluation of criteria through an integrated system of phases allows the improvement of analysis of benefits and risks associated to an optimal approach to remediation.

(2) FRTR

The US Federal Remediation Technologies Roundtable (FRTR) provides the Remediation Technologies Screening Matrix on its website. It is a user-friendly tool for screening potentially applicable technologies for a remediation project. The matrix allows to screen 64 in situ and ex situ technologies for either soil or groundwater remediation. Variables used in screening include contaminants, development status, overall cost, and cleanup time. In-depth information on each technology are also available, including direct links to the database of cost and performance reports written by the FRTR members.

The decision support matrix and the environmental cost estimating tools are also provided on their website (http://www.frtr.gov/default.htm).

A 5.4.3 Remediation Technologies Screening Matrix

This section introduces an example of the screening matrix of remediation technologies for soil and groundwater contamination. Table A 5.4-3 to Table A 5.4-6 show the screening matrices for soil and groundwater remediation technologies. These matrices have been prepared by JET based on FRTR (2007) and are supported by UNIDO (2007).

Table A 5.4-2 Definition of Symbols Used in Remediation Technologies Screening Matrix

Factors		++ Above Average	+ Average	- Below Average
Development Status Scale status of an available technology		Implemented as part of the final remedy at multiple sites, well documented, understood, etc.	Has been implemented as full-scale but still needs improvements, testing, etc.	Not been fully implemented but has been tested (pilot, bench, and lab scale) and is promising.
Treatment Train Is the technology only effective as part of the treatment train?		Stand-alone technology (not complex in terms of number of media/ treatment technologies, maybe one "routine" technology in addition)	Relatively simple (two-car train or so), well understood, widely applied, etc.	Complex (more technologies, media to be treated, generates excessive waste, etc.)
Relative overall cost and performance	**O&M** Operation and Maintenance Intensive	Low degree of O&M intensity	Average degree of O&M intensity	High degree of O&M intensity
	Capital Capital Intensive	Low degree of capital investment	Average degree of capital investment	High degree of capital investment
	System Realiability/ Maintainability The expected range of demonstrated reliability and maintenance relative to other effective technologies	High reliability and low maintenance	Average reliability and average maintenance	Low reliability and high maintenance
	Relative Cost Design,construction,and operations and maintance (O&M) cost of the core process that defines each and pretreatment and posttreatment	Low degree of general costs relative to other options	Average degree of general costs relative to other options	High degree of general costs relative to other options
	Time Time required for in situ soil	Less than 1 year	1-3 years	More than 3 years for in situ soil
	Cleanup a "standard" site (ex situ soil)	Less than 0.5 years	0.5-1 years	More than 1 year for water
	Using the technology for groundwater	Less than 3 years	3-10 years	More than 10 years for water
Availability Number of vendors that can design, construct, and maintain technology in the US		More than 4 vendors	2-4 vendors	Fewer than 2 vendors

Source: FRTR, 2007

Table A 5.4-3 Soil Remediation Technologies Screening Matrix for Contaminants

Soil, Sediment, Bedrock and Sludge		Organics				Inorganics
Rating Codes ++: Above Average +: Average −: Below Avelage N/A: Not applicable I/D: Insufficient Data ●: Level of Effectiveness highly depend upon specific contaminant and its application		VOCs	X-VOCs	SVOCs	X-SVOCs	
1. In Situ Biological Treatment						
1.1	Bioventing	++	●	++	−	−
1.2	Enhanced Bioremediation	++	++	++	●	●
1.3	Phytoremediation	+	+	+	●	+
1.4	Land Farming	++	++	+	+	−
1.5	Natural Attenuation	++	−	+	−	−
2. Ex Situ Biological Treatment(assuing excavation)						
2.1	Biopiles	++	++	+	●	●
2.2	Composting	+	+	+	●	−
2.3	Landfarming	+	+	++	+	−
2.4	Bioreactor	+	+	++	++	−
2.5	Slury Phase Biological Treatment	+	++	++	●	●
3. In Situ physical / Chemical Treatment						
3.1	Chemical Oxidation	+	+	−	+	●
3.2	Electrocinetic Separation	+	+	+	+	++
3.3	Fracturing	+	+	+	+	−
3.4	Soil Flushing	++	++	+	+	++
3.5	Solidification / Stabilization	−	−	+	+	++
3.6	Soil Vapor Extraction	++	++	+	+	−
3.7	Polymer Adsorption	+	−	−	−	++
3.8	Containment Barriers	++	++	++	++	++
4. Ex Situ Physical / Chemical Treatment (assuming excavation)						
4.1	Chemical Extraction	+	+	++	++	++
4.2	Chemical Reduction −Oxidation	+	+	+	+	++
4.3	Dehalogenation	−	++	−	++	−
4.4	Separation	+	+	+	+	+
4.5	Soil Washing	+	+	+	+	+
4.6	Solidification / Stabilization	−	−	+	+	++
5. In Situ Thermal Treatment						
5.1	Soil Vapour Extraction Thermally Enhanced	++	++	++	++	−
5.2	Vitrification	++	++	++	++	++
6. Ex Situ Thermal Treatment (assuming excavation)						
6.1	Hot Gas Decontamination	−	−	−	−	−
6.2	Incineration	++	++	++	++	−
6.3	Open Burn / Open Detonation	−	−	−	−	−
6.4	Pyrolysis	+	+	++	++	−
6.5	Thermal Desorption	++	++	++	++	−
7. Containment						
7.1	Landfill Cap	+	+	+	+	+
7.2	Landfill Cap Enhancements / Alternatives	+	+	+	+	+
8. Other Treatment						
8.1	Excavation, Retrieval, Off- Site Disposal	+	+	+	+	+

Source: JET based on FRTR, 2007 and UNIDO, 2007

Table A 5.4-4 Applicability of Soil Remediation Technologies

Soil, Sediment, Bedrock and Sludge		Development Status	Treatment Train	Relative Overall Cost and Performance					Availability
Rating Codes ++: Above Average +: Average −: Below Avelage N/A: Not applicable I/D: Insufficient Data ●: Level of Effectiveness highly depend upon specific contaminant and its application				O&M	Capital	System reliability & Maintainability	Relative costs	Time	
1. In Situ Biological Treatment									
1.1	Bioventing	++	++	++	++	++	++	+	++
1.2	Enhanced Bioremediation	++	++	−	+	+	++	+	++
1.3	Phytoremediation	++	++	++	++	−	++	−	+
1.4	Land Farming	++	++	−	+	++	++	−	++
1.5	Natural Attenuation	++	++	−	+	+	++	●	++
2. Ex Situ Biological Treatment(assuing excavation)									
2.1	Biopiles	++	++	++	++	++	++	+	++
2.2	Composting	++	++	++	++	++	++	+	++
2.3	Landfarming	++	++	++	++	++	++	+	++
2.4	Bioreactor	++	++	+	+	++	+	+	+
2.5	Slury Phase Biological Treatment	++	−	−	−	+	+	+	++
3. In Situ physical / Chemical Treatment									
3.1	Chemical Oxidation	++	++	−	+	+	+	++	++
3.2	Electrocinetic Separation	++	−	−	+	+	−	+	+
3.3	Fracturing	++	+	+	−	+	+	+	++
3.4	Soil Flushing	++	++	−	+	+	+	+	++
3.5	Solidification / Stabilization	++	++	+	−	++	++	++	++
3.6	Soil Vapor Extraction	++	−	+	+	+	+	−	++
3.7	Polymer Adsorption	−	−	+	+	+	+	+	+
3.8	Containment Barriers	++	−	+	−	++	++	−	++
4. Ex Situ Physical / Chemical Treatment (assuming excavation)									
4.1	Chemical Extraction	++	−	−	−	+	+	+	++
4.2	Chemical Reduction -Oxidation	++	+	+	−	++	+	++	++
4.3	Dehalogenation	++	+	−	+	+	−	+	+
4.4	Separation	++	+	−	+	++	+	++	++
4.5	Soil Washing	++	−	−	−	++	+	++	++
4.6	Solidification / Stabilization	++	++	+	−	++	++	++	++
5. In Situ Thermal Treatment									
5.1	Soil Vapour Extraction Thermally Enhanced	++	−	−	−	++	+	++	++
5.2	Vitrification	+	++	−	−	++	+	−	+
6. Ex Situ Thermal Treatment (assuming excavation)									
6.1	Hot Gas Decontamination	−	++	−	−	++	++	++	+
6.2	Incineration	++	++	−	−	+	−	++	++
6.3	Open Burn / Open Detonation	++	++	−	−	++	++	++	++
6.4	Pyrolysis	++	++	−	−	−	−	++	++
6.5	Thermal Desorption	++	++	−	−	+	+	++	++
7. Containment									
7.1	Landfill Cap	++	++	+	−	++	++	−	++
7.2	Landfill Cap Enhancements / Alternatives	++	++	+	−	++	++	−	++
8. Other Treatment									
8.1	Excavation, Retrieval, Off- Site Disposal	++	++	++	++	++	●	++	++

Source: JET based on FRTR, 2007 and UNIDO, 2007

Table A 5.4-5 Groundwater Remediation Technologies Screening Matrix for Contaminants

Ground Water, Surface Water and Leachate		Organics				Inorganics
Rating Codes ++: Above Average +: Average −: Below Avelage N/A: Not applicable I/D: Insufficient Data ●: Level of Effectiveness highly depend upon specific contaminant and its application		VOCs	X-VOCs	SVOCs	X-SVOCs	Inorganics
9. In Situ Biological Treatment						
9.1	Enhanced Bioremediation	++	●	++	●	●
9.2	Monitored Natural Attenuation	++	+	+	+	−
9.3	Phytoremediation	+	+	+	+	●
10. Ex Situ Biological Treatment						
10.1	Bioreactors	++	++	++	●	−
10.2	Constructed Wetlands	+	+	+	●	++
11. In Situ Physical / Chemical Treatment						
11.1	Air Sparging	++	+	+	+	−
11.2	Bioslurping	+	+	++	++	+
11.3	Chemical Oxidation	+	+	−	+	●
11.4	Directional Wells (enhancement)	+	+	+	+	+
11.5	Dual Phase Extraction	++	++	++	++	−
11.6	Thermal Treatment	+	++	++	++	−
11.7	Hydrofracturing Enhancements	+	+	+	+	+
11.8	In-Well Air Stripping	+	+	+	−	−
11.9	Passive /Reactive Treatment Walls	++	++	++	++	●
12. Ex Situ Physical/ Chemical Treatment (assuming pumping)						
12.1	Adsorption / Absorption	+	+	+	+	++
12.2	Advanced Oxidation Processes	++	++	++	++	●
12.3	Air Stripping	++	++	−	−	−
12.4	Granulated Activated Carbon / Liquid Phase Carbon Adsorption	++	++	++	++	●
12.5	Groundwater Pumping /Pump & Treat	+	+	+	●	+
12.6	Ion Exchange	−	−	−	−	++
12.7	Precipitation / Coagulation / Flocculation	−	−	−	−	++
12.8	Separation	++	++	++	++	●
12.9	Sprinkler Irrigation	++	++	−	−	−
13. Containment						
13.1	Physical Barriers	++	++	++	++	++
13.2	Deep Well Injection	+	+	+	+	+
14. Air Emissions / Off- Gas Treatment						
14.1	Biofiltration	++	●	●	●	−
14.2	High Energy Destruction	++	++	++	++	+
14.3	Membrane Seaparation	++	++	+	+	−
14.4	Oxidation	++	++	++	++	−
14.5	Scrubbers	−	−	−	−	++
14.6	Vapor Phase Carbon Adsorption	++	++	++	++	+

Source: JET based on FRTR, 2007 and UNIDO, 2007

Table A 5.4-6 Applicability of Groundwater Remediation Technologies

Ground Water, Surface Water and Leachate

Rating Codes
++: Above Average
+: Average
–: Below Avelage
N/A: Not applicable
I/D: Insufficient Data
●: Level of Effectiveness highly depend upon specific contaminant and its application

No.	Technology	Development Status	Treatment Train	Relative Overall Cost and Performance: O&M	Capital	System reliability & Maintainability	Relative costs	Time	Availability
9. In Situ Biological Treatment									
9.1	Enhanced Bioremediation	++	++	–	+	+	++	●	++
9.2	Monitored Natural Attenuation	++	++	–	+	+	++	●	++
9.3	Phytoremediation	++	++	++	++	–	++	–	+
10. Ex Situ Biological Treatment									
10.1	Bioreactors	++	++	+	–	++	++	+	++
10.2	Constructed Wetlands	++	++	+	–	●	+	●	–
11. In Situ Physical / Chemical Treatment									
11.1	Air Sparging	++	++	++	++	++	++	++	++
11.2	Bioslurping	++	+	++	++	+	++	+	++
11.3	Chemical Oxidation	++	++	–	+	+	+	++	++
11.4	Directional Wells (enhancement)	++	++	+	–	+	+	+	+
11.5	Dual Phase Extraction	++	–	–	–	+	+	+	++
11.6	Thermal Treatment	++	–	–	–	+	+	++	++
11.7	Hydrofracturing Enhancements	++	+	++	++	++	+	+	++
11.8	In-Well Air Stripping	++	+	+	–	+	+	–	++
11.9	Passive /Reactive Treatment Walls	++	++	+	–	++	+	–	++
12. Ex Situ Physical/ Chemical Treatment (assuming pumping)									
12.1	Adsorption / Absorption	++	+	–	+	+	–	–	++
12.2	Advanced Oxidation Processes	++	+	–	–	+	+	–	++
12.3	Air Stripping	++	+	–	+	++	++	–	++
12.4	Granulated Activated Carbon / Liquid Phase Carbon Adsorption	++	+	–	+	++	+	–	++
12.5	Groundwater Pumping /Pump & Treat	++	+	–	–	++	–	–	++
12.6	Ion Exchange	++	+	–	–	++	+	–	++
12.7	Precipitation / Coagulation / Flocculation	++	+	+	–	++	+	–	++
12.8	Separation	++	+	–	–	++	–	++	++
12.9	Sprinkler Irrigation	++	++	++	++	++	–	–	++
13. Containment									
13.1	Physical Barriers	++	++	+	–	++	++	–	++
13.2	Deep Well Injection	++	++	++	++	+	++	–	++
14. Air Emissions / Off- Gas Treatment									
14.1	Biofiltration	++	N/A	++	++		++	++	–
14.2	High Energy Destruction	–	N/A	I/D	I/D	–	+	I/D	+
14.3	Membrane Seaparation	–	N/A	I/D	I/D	–	+	I/D	+
14.4	Oxidation	++	N/A	++	++	++	++	I/D	++
14.5	Scrubbers	++	N/A	+	–	++	++	I/D	++
14.6	Vapor Phase Carbon Adsorption	++	N/A	++	++	++	++	I/D	++

Source: JET based on FRTR, 2007 and UNIDO, 2007

A 5.5 Reference of Remediation Cost

(1) Indicative Costs of Remediation, UK Experience (Nathanail, 2000)

Remediation Technology	Indicative Unit Price
Engineering capping	GBP 15-30/m^2
Excavation and disposal to landfill	GBP 50/m^3
Encapsulation (shallow cut-off wall)	GBP 40-60/m^2
Encapsulation (deep cut-off wall)	GBP 70-120/m^2
'Typical' landfill gas control system	GBP 200,000 per site
'Typical' grout curtain/vent trench	GBP 220,000 per site
Bioremediation	GBP 35-45/t
Vitrification	GBP 40/t
In situ vitrification (5 t/hr)	GBP 150-215/t
Incineration (special wastes)	GBP 750-1,000/t
Dechlorination	GBP 100-300/t
Soil vapor extraction	GBP 40-60/m^3 vadose zone
Soil washing	GBP 30-35/t
Enhanced thermal conduction	GBP 35-45/m^3
Six-phase heating	GBP 20-30/m^3
In situ chemical oxidation	GBP 40-80/m^3
Pump and treat	GBP 20-30/m^3
Free product recovery	GBP 10-20/m^3 vadose zone
Air sparging	GBP 45-55/m^3 groundwater
Oxidation of cyanide	GBP 400/t
Solvent extraction and incineration	GBP 400/t
Thermal desorption (including excavation and pretreatment)	GBP 35-150/t

(2) European Data Ranked by Average Cost (Mike Sammergill, 2006)

Technique	Ranked by Cost (All costs in EUR/m^3)		
	Minimum	Maximum	Average
Off-Site Incineration	148	2850	885
In Situ Vitrification	518	814	666
On-site Thermal Treatment	26	935	238
Off-site Landfilling	10	979	231
Off-site Thermal Treatment	15	600	229
Off-site Soil Washing	30	608	226
Ex Situ Vitrification	44	380	220
In Situ Steam Injection	50	300	175
Off-site Biological Treatment	20	665	167
On-site Biopiling	10	570	142
On-site Immobilization	15	400	139
In Situ Immobilization	25	270	128
In Situ Electro-reclamation	44	207	126
On-site Phytoremediation	22	222	122
On-site Bioslurry Reactor	89	222	122
On-site Soil Washing	15	456	116
Off-site Immobilization	50	270	112
Encapsulation (m^2)	30	178	104
In Situ Biolsurping	20	162	92
In Situ Air Sparging	11	360	91
On-site Biological Treatment	11	222	76
In Situ Remediation	15	200	73
Pump and Treat	10	228	71
Chemical Oxidation	30	126	68
On-site Landfarming	15	114	62
Reactive Walls	40	70	55
In Situ Soil Venting	10	152	54
Containment Walls	40	60	50
Hydrogeological Containment	10	80	49
Dual Vapor Extraction (DVE)	40	70	45
Confinement	20	40	34
Free Product Recovery	10	70	30
On-site Windrows	7	44	26
In Situ Natural Attenuation	15	25	20

Reference

1) US FRTR, “Remediation Technologies Screening Matrix and Reference Guide, Version 4.0”, 2007
2) UNIDO, “Survey of Soil Remediation Technology”, 2007
3) UNIDO, “Survey of Sediment Remediation Technologies”, 2007
4) UK Environment Agency, “Model Procedures for the Management of Land Contamination”, 2004
5) Toshio OIWA, “Examination collection for soil pollution investigation technology manager”, 2013

EPA: Remediation technology

http://www.epa.gov/superfund/remedytech/remed.htm

EPA: A Citizen's Guide to Cleanup Technologies

http://cluin.org/products/citguide/

FRTR

http://www.frtr.gov/matrix2/section1/toc.html

Annex 6

ENVIRONMENTAL AND SOCIAL CONSIDERATIONS IN DEVELOPMENT OF DRAFT MASTER PLAN

Note)

Annex 6 is the supplementary part of Chapter 11 (Environmental and Social Consideration). SEA (Strategic Environmental Assessment) study of the draft master plan was subcontracted to the local consulting firm, Enova d.o.o. Sarajevo. Annex 6 is composed largely of the extracted part of Final Report of “Survey for Strategic Environmental Assessment (SEA) for the Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina” (April, 2014) prepared by Enova d.o.o. Sarajevo.

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List of Abbreviations

BD	Brcko District of Bosnia and Herzegovina
BiH	Bosnia and Herzegovina
EIA	Environmental Impact Assessment
EP	Environmental Permit
EU	European Union
FBiH	Federation of Bosnia and Herzegovina
FMoET	Federal Ministry of Environment and Tourism
IUCN	International Union for Conservation of Nature
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
MoFTER	Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina
PWC	Preliminary Water Consent
RS	Republika Srpska
SEA	Strategic Environmental Assessment
SFRY	Socialist Federal Republic of Yugoslavia

Annex 6 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS IN DEVELOPMENT OF DRAFT MASTER PLAN

A 6.1 Introduction

This annex summarizes the results of the study entitled “Survey for Strategic Environmental Assessment (SEA)” (hereinafter referred to as: SEA Survey), which was implemented in order to minimize possible environmental and social impacts of the draft master plan for management of environmental hotspots (see Chapters 5-10) developed within the framework of “The Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina” (the Project). To carry out the activities of the SEA Survey, JICA Expert Team has selected an environmental consultancy company Enova d.o.o. Sarajevo, BiH (hereinafter as: the Consultant).

The objectives of the SEA Survey are the following:

- To summarize the baseline information and legal procedures related to environmental and social considerations, and their responsible organizations in FBiH and BiH;
- To identify the stakeholders and impacts which are expected if the activities proposed in the master plan were implemented;
- To support and organize a stakeholder meeting.

The SEA Survey was implemented in the process of the Draft Master Plan development by the JET and organizations that are involved in the Project[1].

A 6.1.1 A Need for Strategic Environmental Assessment (SEA)

In the process of development of the Draft Master Plan, environmental and social issues need to be assessed which could significantly affect those involved in hotspots remediation activities, such as disputes over liability, conflicts among the site owner and the environmental authorities, spreading of contamination during remediation activities, incomplete or inappropriate remediation, lack of support for victims, and limited participation of stakeholders in various decision making processes. In order to identify such issues and to incorporate necessary safeguarding measures into the Draft Master Plan, the Project has adopted the approach of Strategic Environmental Assessment (SEA).

SEA is a systematic process of assessment of likely significant environmental impacts that may arise from implementation of policies, plans, programs and strategies.

The SEA process includes:

- Identification and evaluation of significant environmental impacts and preparation of environmental report of the state of the environment;
- Implementation of the public consultation process which includes consulting environmental and other relevant authorities, stakeholders and the public;
- Decision-making process, which takes into account of the findings of the report and the results of consultations to decide whether to adopt or modify the draft policy, plan, programme or strategy;
- Public disclosure of decisions on adoption of the policy, plan, programme or strategy.

Carrying out SEA will ensure that potential environmental impacts are appropriately addressed at the earliest stage of decision-making process taking into account economic and social considerations.

In accordance with JICA Guideline for Environmental and Social Consideration (April, 2004), the SEA Survey identified potential environmental and social issues that might arise from implementation of the Draft Master Plan, and it suggested the safeguard measures to be built into the Draft Master

1Organizations involved in the Project are shown in Chapter 1 of this report.

Plan based on the concept of SEA. This SEA is primarily prepared based on the above mentioned JICA guideline, considering at the same time the requirements of relevant BiH and FBiH legislation.

The target Draft Master Plan, as a document prior to policy making, was prepared in accordance with the JICA guideline. Nevertheless, in order to formally adopt and implement the activities proposed in the Draft Master Plan, requirements of BiH and FBiH legislation relating to requirements of SEA, information disclosure and public participation system, should be followed in the appropriate stages of their implementation in the future.

A 6.1.2 Target of the SEA

The SEA was prepared for the draft document of the Draft Master Plan developed by JET. The target area for the SEA is the whole territory of FBiH.

A 6.1.3 Objectives of the SEA

The SEA has concentrated on three objectives:

1. Encourage environmental and sustainability integration of biophysical, social, institutional and economic aspects;
2. Add-value to decision-making, discussing opportunities and risks of development options;
3. Help decision makers and all relevant stakeholders to create a culture of decision-making, promoting institutional cooperation and dialogues, avoiding conflicts.

The SEA in this Project will be implemented in order to integrate and promote environmental and social considerations in the process of the Draft Master Plan development.

A 6.1.4 Methodology of SEA

The methodology for the preparation of this SEA is described in Figure A 6.1-1 below.

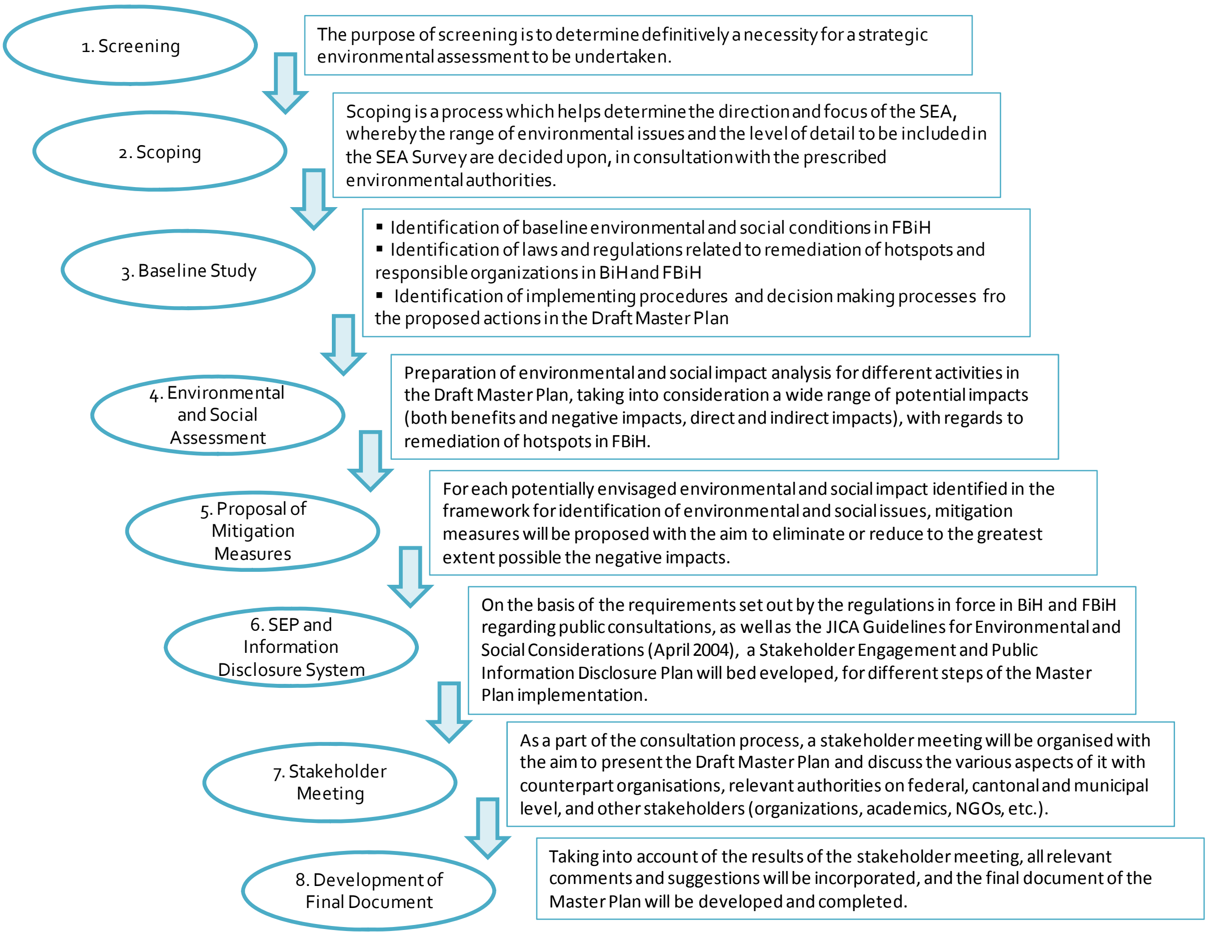

Figure A 6.1-1 Methodology of SEA

A 6.2 Environmental and Social Baseline

A 6.2.1 General Information

In accordance with the General Peace Agreement for BiH, signed in Dayton on 21 November 1995, Bosnia and Herzegovina (BiH) consists of two entities: Federation of BiH (hereinafter referred to as FBiH), Republika Srpska (hereinafter referred to as RS). On the basis of an arbitral award passed on 5th March 1999, the Brčko District of BiH (hereinafter referred to as BD) was formed as the third separate administrative unit under exclusive sovereignty of the State.

According to the Law on Federal Units (Official Gazette of FBiH, No. 9/96), FBiH consists of ten cantons and each has its own government and adopts its own laws - which are in accordance with legislation of FBiH). Names and seats of cantons have been defined by the Constitution of Cantons. FBiH is divided into 79 municipalities.

General information on FBiH is presented in Table A 6.2-1.

Table A 6.2-1 General Information on FBiH

Item	Summary
Official name:	Federation of Bosnia and Herzegovina (most commonly abbreviated as FBiH)
Capital city:	Sarajevo (population 311.000)
Other major cities:	Bihać, Mostar, Tuzla, Zenica
Geographic location:	BiH is located on the Balkan Peninsula, bordering with the Republic of Croatia (931 km) in the north, north-west and south, the Republic of Serbia (375 km) and the Republic of Montenegro (249 km) in the east. In the north, BiH has access to the Sava River and further via Danube to the Black Sea, whereas in the south, in Neum, it has access to the Adriatic Sea. As one of two entities in BiH, FBiH occupies central and south-western part of BiH. Geographical coordinates of extreme points of FBiH are: ▪ North (45°13' 52,61'' φ and 15° 55' 26,40'' λ ▪ South (42°36' 09,65'' φ and 18° 14' 56,63'' λ ▪ East (44°34' 59,35''φ and 19° 03' 18,06'' λ ▪ West (44° 49' 31,75'' φ and 15° 44' 00,42'' λ
Area:	26.085,8733 km^2 (land area 26.072,0833 km^2, sea area 13,97 km^2)
Landforms:	Most of the territory of FBiH, is represented by mountain-valley area, with the inter-mountain, inside-mountain and pre-mountain relief, which extends from Peripannonian Bosnia in the north to the switching zone between the outer and inner Dinarides, consisting of Dinaric mountains: Grmeč, Srnetica, Vranica, Bitovinja, Bjelašnica, Treskavica i Zelengora. Lower inter-mountain area is intersected by river valleys that are commonly polyphase, polygenetic, polymorphic, often composite and canyon-like, and in general are manifested as antecedent and epigenetic form.
Climate:	The geographical location and terrain of FBiH generate the complexity of the climate represented by three major separate climatic areas: ▪ Moderate continental (Central European climate) in the north of FBiH; ▪ Continental mountain (Alpine) in the central FBiH; ▪ Mediterranean (maritime) in the south of FBiH.
Government Structure:	Legislative power: the Parliament of FBiH Executive power: the President of FBiH and the Government of FBiH Judiciary power: the Constitutional Court, the Supreme Court FBiH is further decentralized into 10 Cantons with their own governments, parliaments and courts. Cantons are further divided into municipalities and cities - local self-government units.
Administrative organization:	Cantons : 10 Towns: 61 Municipalities: 79 Settlements: 3.343
Population:	2.371.603
Religions:	Muslim, Orthodox Christian, Roman Catholic and others
Ethnic groups:	Bosniaks, Croats, Serbs and others
Languages:	Bosnian, Croatian – official languages in FBiH
Vulnerable groups:	▪ Women ▪ Returnees and displaced persons (within BiH) ▪ National minorities ▪ People with disabilities

Item	Summary
	▪ Pensioners ▪ The population of young people in BiH (15 – 24) ▪ Children
GDP:	16.554.140 .000 KM/ 8.464.127.000 EUR
GDP per capita:	5.775 KM/2.953 EUR
Currency:	Bosnia and Herzegovina convertible mark (BAM-official code; KM-sign, common use in BiH)
Exchange rate:	1 EUR = 1,95 BAM (fixed exchange rate)
Main industries	Manufacturing (68,12 % of total industrial production) Electricity and gas supply (20,96%) Mining and quarrying (10,92%)

A 6.2.2 Environmental Baseline

A 6.2.2.1 Air Quality

According to the State of the Environment Report for BiH (2012), the average annual values obtained by analysing 24 hour data from 1975 to 1991 in Sarajevo show a significantly lower pollution level compared to the last 17 years. The reason for this appears to be because of reduced level of production in the industrial sector and change from using a coal as a fuel to gas as a fuel in Sarajevo thermal plants. Also, using gas was expensive which has caused people to change back to coal. In the period from 1995 to 2011, there was a gradual increase in concentrations of SO_2 and smoke.

Data from meteorological station Bjelave located in Sarajevo show that concentration of SO_2, NO, NO_2, NO_x, CO and O_3 in the period 2002-2010 were lower than limiting values defined in the Rulebook for Limit Values of Air Quality Parameters in FBiH (Official Gazette of FBiH, No. 12/05) (State of the Environmental Report of BiH, 2012). However, in comparison to the limited values of SO_2 by WHO Air Quality guidelines (20 $\mu g/m^3$ 24-hour mean), concentrations of SO_2 were higher in Sarajevo in 2011 (27 $\mu g/m^3$ 24-hour mean) and 2012 (22 $\mu g/m^3$ 24-hour mean).

In Tuzla, monitoring of SO_2 and smoke concentrations after the war was performed during the first decade and was started again in 2002. Comparing the measuring results of 24-hour samples in the period 2002-2011 with the measurements from the period 1990-1991, it is evident that the concentration of SO_2 is lower, while the concentration of smoke exceeds the limit of permissible level of concentration (State of the Environmental Report of BiH, 2012).

In comparison to the limited values of SO_2 by WHO Air Quality guidelines (20 $\mu g/m^3$ 24-hour mean) and Sarajevo (in 2011 was 27 $\mu g/m^3$ 24-hour mean; in 2012 was 22 $\mu g/m^3$ 24-hour mean), concentration of SO_2 is even higher in Tuzla (in 2011 was 33 $\mu g/m^3$ 24-hour mean; in 2012 was 31 $\mu g/m^3$ 24-hour mean). Much higher concentration of SO_2 (above 30 $\mu g/m^3$ 24-hour mean) in Tuzla is indicated in the period from 1990 to 2010 compared to 2011 and 2012.

A 6.2.2.2 Water Quality

In December 2013, the Government of the Federation of Bosnia and Herzegovina adopted the Decision on characterization of surface and groundwater, reference conditions and parameters for assessing water status and on water monitoring (Official Gazette of FBiH, No. 1/14)[2] which has created preconditions for implementation of provisions of the FBiH Law on Waters[3]. The Decision, however, did not repeal regulations relevant to characterization of the quality of water bodies of both surface waters and ground waters in FBiH, dating from the 1960-ies and 1980-ies,which are still in

[2]Decision prescribes:
Methodology for determining the types of surface water bodies and characterization of surface water and groundwater bodies;
Reference conditions for classification of ecological status and limit values of chemical quality parameters for classification of chemical status of a surface water body;
Quantitative and chemical quality parameters for classification of state of groundwater bodies;
Monitoring and the content of water monitoring program.
[3]Official Gazette of FBiH, No. 70/06

force (Decree on Categorization of Watercourses[4] and Decree on Classification of Waters and Coastal Waters of the Limits of Socialist Republic of BiH[5]). In line with these regulations, all watercourses, ground waters, natural lakes and coastal waters within the boundaries of FBiH are divided into 4 categories depending on purpose and pollution degree.

Controls and analyses of surface water quality in BiH were systematically carried out from 1965 to 1991 at 58 gauging stations of river basins and sub-basins of the rivers: Una, Vrbas, Ukrina, Bosna, Drina, Neretva and Trebišnjica. After the war, organized control of surface water quality in FBiH was resumed in 1995, or 2005, and is under the responsibility of Sava River Basin District Agency, Sarajevo and the Adriatic Sea River Basin District Agency, Mostar.

According to Water Management Strategy of FBiH 2010-2022, surface water quality measurements were undertaken in the period October 2005 - May 2007 on 36 river profiles, in 6 series on rivers of the Sava River watershed in FBiH, by the Federal Public Health Institute and the Faculty of Natural Sciences and Mathematics of University of Sarajevo which have concluded that the most polluted rivers are those belonging to the Bosna River sub-basin, and the most significant sources of pollution are untreated industrial wastewaters (from Zenica and Maglaj) and untreated municipal wastewaters. River waters belonging to the Adriatic Sea watershed meet the standards prescribed by the Decree on Categorization of Watercourses (Official Gazette of SR BiH, No. 42/67).

Regular monitoring of lake water quality has been established on Jablanicko lake, and according to State of the Environment Report of BiH 2012, based on the results of monitoring of surface waters carried out by the Adriatic Sea River Basin District Agency – Mostar, total phosphorus content (mgP/l) in Jablanicko lake has been on the decrease, from almost 0.1 mgP/l in 2004 to just over 0.03 mgP/l in 2009.

Since 2001, the Adriatic Sea River Basin District Agency has been conducting analysis of the quality of coastal bathing water at the Adriatic Sea during the summer tourist season at the beach in Neum for Total Coliforms – TC, Faecal Coliforms – FC and Faecal Streptococci – FS. The rate of compliance with guide values for FS (100 FS/100 ml) varied from 8.3% in 2004 to 83.3% in 2002, while compliance with mandatory values for Faecal coliforms was 100% (2000 FC/100 ml), except for 2001, when the compliance rate was 75%.

According to the State of the Environment Report of BiH 2012, systematic monitoring of groundwater quality is not performed. However, water source quality used for public water supply is monitored e.g., raw water quality is controlled in accordance with the Rulebook on Sanitary Quality of Drinking Water (Official Gazette of BiH, Nos. 40/10, 43/10, 30/12).

A 6.2.2.3 Soil Quality

Institutions in charge of soil resources in FBiH are the Federal Institute of Agriculture in Sarajevo, the Federal Institute for Agropedology in Sarajevo and the Federal Agro-Mediterranean Institute of Mostar.

According to the State of the Environment Report of BiH 2012, except for agricultural land, there are no laws which refer to measuring and monitoring of soil quality and its protection in BiH, nor FBiH. The main problems which are not dealt with by legislation are lack of:

- systematic soil monitoring,
- Soil/Land Information System - SIS,
- detailed information on soil/land contamination (to ensure healthy food production),
- an adequate system of land assessment (land capability classification),
- a unified land inventory (a separate registry and excerpt from the land registry books), etc.

According to the scientific article “Contents of some inorganic and organic pollutants in soils of FBiH”, authors reported concentration values of heavy metals (Pb, Zn, Cd, Cu, Ni, Cr, Co and Mn)

[4]Offcial Gazette of SR BiH No. 42/67
[5]Offcial Gazette of SR BiH No. 19/80

and organic pollutants (TPH, PAHs). In FBiH, risk areas are identified which are mostly contaminated with presence of lead, cadmium, nickel, chromium, cobalt and manganese as well as with PAHs.

A 6.2.3 Socio-economic Baseline

A 6.2.3.1 Social Data

According to the last official census in BiH, conducted in October 2013, the number of people living in FBiH was 2,371,603. In 2012 the estimates show there were around 2,338,000 people living in FBiH. In 1991, when the previous official census was conducted, 2,720,074 people were living in FBiH. In 2008, according to Revised Strategy of BiH for the Implementation of Annex VII of the Dayton Peace Agreement, it was estimated that 400,000 people due to the conflicts in 1992-1995 refuged from FBiH and were living abroad.

The total employment rate in FBiH from 2010 – 2012 has decreased from 438,949 persons in 2010 to 437,331 in 2012. The most people were employed in public administration and defense and compulsory social security, where the number of employees has increased from 46,841 in 2010 to 47,936 in 2012. Among the sectors that employed the least people are the activities of households from 2010 to 2012 and the real estate activity with 2.083 in 2010 and 1.510 in 2012.

Agency for Statistics of BiH estimated that in 2011, 17.1% of the population in FBiH was living in relative poverty. Every sixth household was considered poor. The relative poverty line was 416.40 KM a month per equivalent adult. The percentage of poor households has decreased from 2004 (18.3%) to 2011 (16.0%).
According to the document "Socially Excluded in BiH", social exclusion in BiH is largely associated with the consequences of war and the transition process, as well as exposure of the population to new types of various risks, such as recession, rising unemployment and budget problems. The Social Inclusion Strategy and the document Socially Excluded in BiH have identified the following vulnerable groups in BiH: women; returnees and displaced persons (within BiH); national minorities; people with disabilities; pensioners; the population of young people in BiH (15 – 24) and children.

Before the war, in 1991, 38% of the total population in BiH was connected to the public sewage system. According to estimates from strategic documents of FBiH, this percentage is lower today and it amounts to 33%.There are in total 7 plants for municipal wastewater treatment built and operated in FBiH and they are located in Gradacac, Zepa, Srebrenik, Trnovo, Ljubuski, Citluk and Grude. Two municipal wastewater treatment which were in operation before the war are not operational now (Sarajevo and Siroki Brijeg), while one is in the final stage of construction are not currently in operation (Bosnasko Grahovo).

In FBiH, according to available data obtained by public utility companies in 2009, waste generation ranged from 211 kg/capita/year in West Herzegovina Canton to 386 kg/capita/year in the Sarajevo Canton. Municipal waste collection systems in FBiH in urban and partly in rural areas are based on weekly house-to-house collection of household waste. In general, there is no waste separation on the level of households. According to data from Federal Institute for Statistics, the total amount of collected solid waste in 2012 in FBiH was 689,135 t. Of the total amount of collected waste, the largest was the amount of municipal waste, 567,910 t, while the least was the amount of packaging waste, 13,337 t. Waste collection in FBiH is executed by 67 utility companies. Total of 614,296 t of waste was disposed on landfills in 2012.

There is no operating waste incineration or MBT[6] plant in FBiH. Recyclables separated from the mixed municipal waste amount to less than 5% of the total municipal waste mass, while at least 95% of the collected mixed municipal waste is disposed of mostly at non-sanitary municipal landfills. The main option for disposal of municipal waste is still landfilling, which is inadequate in most cases. At the majority of municipal waste landfills there is no protection system for soil, water and air preservation and no control of leachate and gases. Waste is occasionally covered with inert materials using excavators.

[6] Mechanical and Biological Treatment of Waste

A 6.2.3.2 Local Governments

The Constitution of BiH, an annex to the General Framework Agreement for Peace in Bosnia and Herzegovina (the Dayton Agreement) adopted in 1995, defines BiH as a sovereign state with a decentralized political and administrative structure. In BiH and FBiH there are several levels of political governance:

- Government at the level of the state of Bosnia and Herzegovina
    - Legislative power: the Parliamentary Assembly of BiH
    - Executive power: the Presidency of BiH and the Council of Ministers of BiH
    - Judiciary power: the Constitutional Court of BiH and the Court of BiH);
- Federation of Bosnia and Herzegovina
    - Legislative power: the Parliament of FBiH
    - Executive power: the President of FBiH and the Government of FBiH
    - Judiciary power: the Constitutional Court, the Supreme Court);

The Federation of BiH is further decentralized into 10 cantons with their own governments, parliaments and courts. Cantons are further divided into municipalities and cities - local self-government units.

A 6.2.3.3 Agriculture and Industry Sector

Agriculture in the economy of BiH is still one of the most important economic sectors providing food security for a significant part of rural population. According to statistical data of Federal Institute for Statistics, in 2012, agriculture, hunting and forestry contributes around 4.5 % to GDP in FBIH. The total area of FBiH is 2,728,040 hectares, of which 42.1% is agricultural land (1,148,979 hectares). According to the Single Registry of Approved and Registered Facilities in FBiH, 86 slaughterhouses are currently registered in FBiH. Federal Institute for Statistics reported that 93,205 t of livestock and poultry were slaughtered in FBiH in 2013.

The current difficult situation FBiH industry is mainly caused by destruction due to the war. According to the document Development of Industrial Politics in FBiH, the pre-war industry greatly depended on the military defense industry. Prior to the dissolution of SFRY, more than 55% of the defense industry was based in BiH. After the end of the war, the military industry did not recover.

According to the Privatization Agency in FBiH, 72.48% of enterprises were privatized between 1999 and 2006 after the enactment of Law on Privatization of Enterprises in FBiH in 1997.

Industry as well as manufacturing sector has been presently characterized by low productivity and lack of competition according to the State of Environment Report of BiH. A low level of technological development and lagging in the field of business strategy and quality management also contributed to a low level of productivity. Low competitiveness and productivity are insufficient to enable the financial sector to provide greater support. The institutional responsibility for these sectors lies within the Federal Ministry of Energy, Mining and Industry.

Coal is one of the most important energy sources in FBiH. Major reserves of brown coal and lignite are located throughout FBiH. In 2012, total production of brown coal amounted to 4,158,094 t and lignite coal 2,812,441 t. There are 10 currently active coal mines and two potential deposits in FBiH. Also, there are currently 9 metal and non-metal mines in FBiH.

Even though the majority of mine sites use settling tanks as the only type of treatment, only Coal Mine Kakanj has a wastewater treatment plant. In FBiH only Coal Mine Banovici implements constant wastewater quality control, while coal mines Djurdjevik, Kakanj, Zenica implement the control once in 2 years. Other mines do not implement wastewater control at all.

According to the Federal Institute for Statistics, the manufacturing sector in FBiH is divided into 22 sub-sectors, including manufacturing of food and beverages, textile, leather, rubber, basic metals, etc. The number of employees in manufacturing business declined to 79,749 in 2012 in comparison with 81,875 in 2011. The number of employees in different sectors changed slightly between 2009 and

2012, but the largest difference is visible in furniture manufacturing where the number of employees decreased by almost a thousand between 2011 and 2012. The percentage of women in the manufacturing in total has been increasing constantly since 2009. The largest percentage of female employees in 2012 was in manufacturing of wearing apparel, where the percentage decreased by 1,5% since 2009. The smallest percentage of women in 2012 was in manufacturing of basic metals, but it increased by 0.4% since 2009.

Except of several facilities[7], in majority of cases other industries in FBiH still do not perform any pre-treatment or wastewater.

A 6.2.4 Industrial Activity and Hazardous Waste Disposal Sites as a Cause of Soil Contamination

After the war of 1992-95, majority of the FBiH's metallurgic industry (located in Zenica, Mostar, Jajce and Tuzla), metal industry (located in Sarajevo and Zenica), chemical industry (located in Tuzla, Lukavac, Mostar, Sarajevo, Jajce and Vitez), textile industry (located in Visoko, Travnik, Sarajevo and Mostar), food and wood industry have ceased to operate. However, some of these facilities are still in function today and, due to inadequate treatment of generated air emissions, wastewaters and wastes, these industries continue to cause environmental pollution which subsequently causes soil contamination.

Based on the Rulebook on plants and facilities subject to obligatory environmental impact assessment, and plants and facilities that can be constructed and commissioned only if granted an environmental permit (Official Gazette of FBiH, No. 19/04), mines, plants and facilities that might be considered as potential hot spots have been caused by:

- mining (identified 23),
- chemical industry (identified 5),
- metal and military industry (identified 9),
- mineral industry (identified 2),
- textile, leather, wood and other industry (identified 4).

According to the Study "Environmental Protection Assessment Report for Industrial, Medical and Other Hazardous Wastes in BiH" from 2002, authors reported ten hazardous waste disposal sites in FBiH classified into three main groups:

1) Highly hazardous wastes(waste generated from zinc and lead production in Vareš and red mud generated from aluminium production industry in Mostar);
2) Hazardous wastes (ashes and slag generated from power plants in Kakanj and Tuzla; waste from generated from paper production in Maglaj; waste generated from ferro-silicate electrolysis in Jajce; White Sea in Lukavac and waste generated from leather tanning industry in Visoko); and
3) Low hazardous wastes (steel slag generated from iron production industry in Zenica).

Transformer stations were destroyed during the war, which might caused significant spills of transformer oil containing hazardous material, polychlorinated biphenyls (PCBs). According to the article "Determination of Polychlorinated Biphenyls in the Soil in Canton Sarajevo", only 9 out of a total of 42 individual analysed samples had total PCB concentration higher than 0.5 ppb (parts per billion), and the highest concentration found was 1.53 ppb. The depth of 50 cm contained the same PCB concentration as the surface layer (5 cm), which implies continuous contamination.

[7] The meat industry Lijanovići, Prevent Leather Sarajevo d.o.o. Visoko, Coca-cola factory in Hadzici, Aluminium factories "Aluminij" in Mostar and "Feal" in Široki Brijeg, Power Plant Kakanj, Arcerol Mittal Zenica, Natron-Hayat d.o.o. Maglaj, Sisecam soda Lukavac, and the brewery "Uniline" in Grude which uses municipal treatment plant Grude for the treatment of its wastewater.

Most of landmines, which might cause of soil contamination, have been left after the war. Around 6,000 ha of land have been estimated to be covered with 15,000-20,000 mines and more than 1 million of other explosive devices during the war in BiH. It has been estimated that landmines currently cover 1,443 km^2, which is 2.8% of total BiH territory. In 2008, mined areas in FBiH occupied 1,224.3 km^2.

A 6.3 Legal and Institutional Framework

(The chapter of "Legal and Institutional Framework" is skipped in Annex 6 because its summary is already explained in the related section of Chapter 3 and Chapter 11.)

A 6.4 Draft Master Plan

One of the objectives of the "The Project for the Master Plan for Remediation of Hotspots in Bosnia and Herzegovina" is to formulate a Draft Master Plan for sustainable management and adequate treatment of environmental hotspots located in FBiH. JET is responsible for developing a Draft Master Plan.

The aim of the Draft Master Plan is to support the relevant authorities of FBiH to:

- Develop technical and regulatory framework for remediation of environmental hotspots;
- Remediate some of the priority sites; and
- Develop capacities of environmental officers and other stakeholders

The planned period for development of regulatory framework and for environmental risk management at priority sites is planned for the year 2020.

The Draft Master Plan aims to identify sites contaminated with hazardous materials. It will take into account the following sites:

- Industrial sites
- Mining sites
- Waste disposal sites
- Others (military sites, dry cleaning shops, sites polluted with PCBs and other POPs, storage of hazardous materials, sites with large leaky underground storage tanks, other sites of special interest).

The draft version of the Draft Master Plan has the following five major components:

(i) Baseline Survey and Analysis of Situation
(ii) Development of Institutional Framework
(iii) Development of Technical Guidelines
(iv) Remediation of Priority Sites, and
(v) Capacity Development.

Proposed actions in the draft version of the Draft Master Plan are summarised in the Table A 6.4-1.

Table A 6.4-1 Proposed Actions in the Draft Master Plan

Proposed Actions in the Draft Master Plan	
(i)	**Baseline Survey and Analysis of Situation**
	Federation-wide survey of contaminated sites
	Development of a provisional site inventory and an official site registry
	Analysis of general status of contaminated sites in FBiH
(ii)	**Development of Institutional Framework**
	Definition of contaminated sites

	Proposed Actions in the Draft Master Plan
	System of site identification
	Liability framework
	Institutional controls
	Risk communication and public involvement
	Financing of remediation projects
	Enactment of the legal framework
(iii)	**Development of Technical Guidelines**
	Site identification
	Preliminary investigation
	Preliminary evaluation of contamination
	Detailed investigation
	Risk assessment
	Development of remediation plan
	Implementation of remediation plan
	Monitoring and follow up
(iv)	**Site-level activities**
	Urgent measures
	Pilot projects
	Remediation of priority sites
	Development of strategies for other sites
(v)	**Capacity development**
	Capacity Development of Environmental Officers
	Awareness Building of Stakeholders

Component (i) - Baseline Survey and Analysis of Situation proposes a series of activities to gather basic information on contaminated sites and broadly analyse the current status of contaminated sites in FBiH. This component includes survey of contaminated sites in the entire FBiH and compilation of the provisional site inventory, based on data and information collected and analysis of the general statuses of the hotspots in FBiH. The results are expected to give overview of the situation in FBiH with regards to hotspots - number of hotspots, which sites are considered priority, financial sources and technical capacities available in FBiH, environmental liability problems, etc. The provisional site inventory will serve as the basis for official site registry, which is planned to be established once the regulatory framework for contaminated sites is formally set.

Component (ii) - Development of Institutional Framework proposes a series of activities necessary to develop institutional framework in FBiH in order to legally manage contaminated sites. The most important issues that should be analysed include legal definition of contaminated sites, environmental liability framework, risk communication, institutional controls, and financial mechanisms.

Component (iii) - Development of Technical Guidelines proposes activities to develop technical guidelines and best practice guidance documents for remediation of contaminated sites. Those guidelines need to cover different steps of remediation works, namely, site identification, preliminary investigation, preliminary site evaluation, detailed investigation, risk assessment, development and implementation of remediation plan, and monitoring and follow-up. The main purpose of developing technical guidelines for remediation of contaminated sites is to make easier the quality control of remediation works.

Component (iv) - Remediation of Priority Sites- The results of the federation-wide survey of contaminated sites may reveal seriously contaminated sites whose remediation is considered a priority. Also, some sites in FBiH might require urgent measures to control immediate risks. Remediation of these sites has to be implemented as soon as possible. In addition, in order to remediate seriously contaminated sites safely and efficiently, environmental officials, consultants and other stakeholders need to gain practical experiences, which is planned to be achieved through implementation of pilot projects.

Component (iv) - Capacity Development includes activities of capacity building tailored environmental officers, environmental inspectors, consultants and other specialists who will manage and implement remediation projects. Also, another important area of capacity development is awareness raising of site owners, business owners, land management specialists, specialists in privatization/concession, and others.

A 6.5 Scoping

Scoping is a process which helps determine the direction and focus of the SEA. The process of scoping for SEA is defined as the procedure whereby the range of environmental issues and the level of detail to be included in the SEA Survey are decided upon, in consultation with the prescribed environmental authorities. Scoping is necessary in order to establish, with objectivity, the potential impacts of the implementation of the Draft Master Plan on a number of environmental elements from consultations with a range of environmental bodies and the incorporation of associated comments/opinions into the Draft Master Plan.

Identification and initial rating of a wide range of potential impacts (both benefits and negative impacts, as well as direct and indirect impacts), with regards to remediation of hotspots in FBiH, was performed and presented in the form of scoping matrix for different activities of the Draft Master Plan.

Five Project components were formed in three categories and initial rating was performed to each of the categories:

- A. Components 1,2 and 3 – Baseline Survey and Analysis of Situation, Development of Institutional Framework and Development of Technical Guidelines
- B. Component 4 – Remediation of Priority Sites
- C. Component 5 – Capacity Development

The rating criteria are presented in the Table A 6.5-1.

Table A 6.5-1 Rating Criteria

Criteria	Description
+	Benefit is expected
-	Negative impact is expected
+/-	Benefits and negative impact are expected
Unknown	Extent of benefit/negative impact is unknown (further examination is needed, and the benefit/impact could be clarified as the study progresses)
No impact	No impact is expected

Based on the results of scoping, the items evaluated as “-“, “+/-“ and “Unknown” and their factors will be extracted and the expected impact on society and environment as well as on interests of stakeholders will be considered and assessed in the next chapter.

The summary of the Scoping Matrix is presented in the Table A 6.5-2 below.

Table A 6.5-2 Scoping Matrix - Summary

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
Pollution control				
1.	Air pollution	No impact No impacts related to air pollution are expected in this stage of the Project.	- Increased content of soil dust in the air as a result of earthworks and construction of access roads and increased content of dust particles of inorganic and organic origin in the air (depending on the site and its potential contamination) are impacts that are expected to be temporary and to last short-term, predominant in the vicinity of the contamination site.	+ Awareness building of stakeholders will empower them to understand the issues and procedures of contaminated sites (this refers to all other items below). Activities of capacity development will create benefits by the implementation of pollution control measures, as well as ensuring that all proposed mitigation measures will be implemented to reduce or eliminate air emission and consequently, air pollution during remediation activities.
2.	Surface water pollution	+ These components propose a list of activities to introduce and/or improve the management of contaminated sites in FBiH. This will help to improve the management of contaminated sites, which indirectly will have beneficial effect and protect surface water quality by reducing of surface water pollution.	+/- - Adverse environmental impacts on surface waters may be reflected in the increased content of potentially harmful dust particles and dissolved gas emitted from the contaminated site in the water body due to remediation activities. These impacts are expected to be temporary in the vicinity of the contaminated site during remediation process. + Remediation of contaminated sites will prevent future pollution of the watercourses and improve its quality in the long-term.	+ Activities of capacity development will have beneficial effect by implementing of pollution prevention and control measures, as well as by ensuring that all proposed mitigation measures to reduce or eliminate surface water pollution during remediation activities and further to protect surface water quality are in place and implemented.
3.	Ground water pollution	+ As stated in the cell above, proposed activities will ensure improvement of the management of contaminated sites, which indirectly will have beneficial effect by reducing ground water pollution.	+/- - During remediation activities, contamination of groundwater might occur as a result of accidental release or spill of hazardous chemicals, wastewaters, residues and/or waste disposed on site, inappropriate temporary storage of or contaminated soil hazardous materials. + Remediation of a contaminated site is expected to reduce and/or fully eliminate existing environmental impacts of the site, and protect of	+ Activities of capacity development will have beneficial effect by implementing of pollution prevention and control measures, as well as by ensuring that all proposed mitigation measures to reduce or eliminate groundwater pollution during remediation activities and protect groundwater sources are in place and implemented.

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
			groundwater sources from further pollution.	
4.	Waste generation (construction debris, contaminated soils excavation and movement on the site)	No impact No impacts related to waste generation are expected in this stage of the Project.	- During remediation, depending on the type of contaminated site, various types of wastes are expected to be generated (inert waste, hazardous construction and demolition waste which includes contaminated material excavated from remediation site, packaging waste, wood, various metal and plastic materials, oil, lubricants, fuel, oily rags, oil filters, smaller amounts of municipal waste, etc.). If not properly managed, these wastes will generate negative impact on workers, environment and the local community.	+ Activities of capacity development will have beneficial effect by ensuring that all proposed mitigation measures during remediation activities (waste management plans) are in place and implemented.
5.	Soil contamination	+/- + These components aim to improve the management of contaminated sites in FBiH, by proposing a series of activities for development of technical, institutional and organizational frameworks. Activities proposed within this, will indirectly have beneficial effect on soil quality and reduce of soil contamination. - However, during sampling activities envisaged under Preliminary survey of contaminated sites, and based on method of sampling, special attention needs to be carried out to avoiding possible cross-contamination.	+/- - During remediation activities potential adverse impacts on soil that may occur, include accidental release or spilling of oils, fuels, grease and other pollutants, leakage of oils from construction equipment and inappropriate temporary disposal of contaminated soil and storage of hazardous materials and hazardous waste. + The primary goal of remediation of a contaminated site is to restore the location in satisfactory and adequate condition. Therefore, remediation is expected to reduce existing negative impacts and protect the soil quality from further deterioration.	+ Activities of capacity development will have beneficial effect by implementing pollution prevention and control measures, as well as by ensuring that all proposed mitigation measures to reduce soil contamination during remediation activities and protection of soil quality are in place and implemented.
6.	Damages to environment caused by mining activities	+ Activities proposed will help to improve the current management of contaminated sites, which includes improving gas, waste and wastewater management generated during mining activities. This will help to reduce environmental impacts and prevent damages to environment caused by mining activities. Therefore, these activities will indirectly have beneficial effect.	+/- - Depending on the site and remediation project, remediation of mining sites, if not carefully planned and implemented, may have negative impacts on environment which are related to contamination of air, surface and ground water sources as well as soil and stability of tailings impoundments if built on site. + If implemented successfully, remediation of mining site will have beneficial effects on future	+ Activities of capacity development will have beneficial effect by implementing of pollution prevention and control measures, as well as by ensuring that all proposed mitigation measures to prevent accidents or large-scale disasters are in place and implemented.

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
			sustainable development in the area.	
7.	Noise and vibration	No impact No impacts related to noise and vibrations are expected in this stage of the Project.	- Remediation activities will potentially cause increased noise generation, especially if demolition and removal of construction structures are involved. Vibration from compaction and/or demolition activities at sites, rock and/or and contaminated soil excavation may cause structural damage to nearby communities and their infrastructures.	+ Activities of capacity development will have beneficial effect by implementing of pollution prevention and control measures, as well as by ensuring that all proposed mitigation measures to reduce emission of noise and vibrations during remediation activities are in place and implemented.
8.	Ground subsidence	No impact No impacts related to ground subsidence are expected in this stage of the Project.	- In case of dewatering or groundwater pumping (depending on the remediation project) lowering of the water table can result in the subsidence of buildings and structures—particularly in loose or collapsing soils and uncontrolled fill sites. This could cause impacts on the communities nearby.	+ Activities envisaged in this component include training on development and implementation of remediation measures (including design of remediation measures to minimize environmental risks and different technical options) which will have beneficial effect by ensuring that all proposed mitigation measures during remediation activities are in place and implemented as well as by overseeing of remediation works.
9.	Offensive odour and gaseous (volatile) emissions	No impact No impacts related to offensive odour are expected in this stage of the Project.	- Generation of odour depends on the type of hazardous materials, wastewaters, residue and/or waste deposited on the site causing contamination. Many chemicals particularly those associated with petroleum hydrocarbons, organic solvents, etc., may induce chemical reactions which could generate offensive odours or noxious vapours.	+ Activities of capacity development will have beneficial effect by ensuring that all proposed mitigation measures during remediation activities are in place and implemented as well as by overseeing remediation works and its subsequent monitoring.
Natural Environment				
10.	Protected area	+ Implementation proposed activities will help to improve the management of contaminated sites, which will indirectly have a beneficial effect on even remotely located protected areas.	+ Remediation of contaminated sites which are located in a relative vicinity of protected areas will have beneficial effects in terms of their future sustainable development, their promotion and visits. .	+ Implementation of the Master Plan will have beneficial effects by improving conservation of protected areas and their future sustainable development.

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
11.	Flora and fauna	+ Implementation proposed activities will help to improve will help to improve the management of contaminated sites, which will indirectly have beneficial effects on flora and fauna on and around contaminated sites.	+/- - Areas of sensitive vegetation and significant trees have substantial environmental value and should be protected, even where site contamination may be located. + Remediation of contaminated site will have beneficial effects on the future development of flora and fauna on the site and the nearby area and communities.	+ Implementation of the Master Plan will have beneficial effects by providing conditions to improve biodiversity conservation.
12.	Hydrological situation (including ground water)	No impact No impacts related to hydrological conditions are expected in this stage of the Project.	- Depending on the type of remediation project, construction and/or excavation activities may have impacts on flow rate of surface waters and groundwater recharge (if remediation is performed in the vicinity or in the watercourses).	+ Activities envisaged in this component of the Draft Master Plan include training on development and implementation of remediation measures which will have beneficial effect on implementation of the Master Plan.
13.	Topography and geographical features	No impact No impacts related to topography and geographical features are expected in this stage of the Project.	+ Remediation of contaminated sites and converting land to its final purpose is expected to have beneficial effect on topography and geographical features of the area.	+ Capacity development of all stakeholders is expected to contribute to the overall implementation of the Master Plan.
Social Environment				
14.	Land Acquisition /Resettlement	No impact No impacts related to land acquisition and/or resettlement are expected in this stage of the Project.	Unknown It is unlikely that resettlement or full land acquisition will be required within the Project. However, partial expropriation of privately owned land plots may be necessary during site-level activities, including loss of perennial crops.	No impact No impacts related to land acquisition and/or resettlement are expected in this stage of the Project.
15.	Impacts on vulnerable groups (children, unemployed population, population with very low or without any income, elderly	+/- + Vulnerable groups may gain from the development of a proper legal framework pertaining to remediation management if particular attention is paid to their rights, needs and interests. -Vulnerable groups may be disadvantaged when a legal framework is developed if particular attention is not paid to their rights, needs and	- Vulnerable groups may be at higher risk of site-level activities (impacts on living conditions) if located in the vicinity of the site.	+ Vulnerable groups (poor people, children, minorities) will gain from being involved in the stakeholder engagement activities if particular attention is paid to their rights, needs and interests.

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
	population or population living in isolated areas which may be located in the vicinity of hotspots)	interests, because their availability of access to information is limited and their rights tend to be diminished.		
16.	Regional economy (i.e., job opportunities or livelihood)	No impact No impacts related to regional development are expected in this stage of the Project.	+ Remediation activities can be expected to contribute to economic growth by generating employment opportunities for local workers, supporting a variety of businesses, and establishing new growth in areas with existing infrastructure.	+. The capacity development and awareness raising activities intended for owners of contaminated sites, business owners, investors / developers; general land owners and the general public may have beneficial albeit indirect impact on regional economy due to knowledge sharing and its transfer.
17.	Restrictions on land use and utilization of local resources	No impact No impacts related to land use restrictions are expected in this stage of the Project.	- Occasional but temporary land-use is possible during site-level activities, concerning the disposal of non-hazardous materials (earth/soil excavation) in agreement with the owners of the land.	No impact No impacts related to land use restrictions are expected in this stage of the Project.
18.	Water usage or water rights	No impact No impacts related to water usage are expected in this stage of the Project.	Unknown Remediation activities may cause impacts on water usage, especially on downstream from the site users as well as cause negative impacts on ground waters described above. However, this will depend on the type and the scope of the remediation activities, and this impact needs to be clarified in the later stages of the Project.	No impact No impacts related to water usage are expected in this stage of the Project.
19.	Living environment of residents	No impact No impacts related to the living environment of residents are expected in this stage of the Project.	- Temporary impacts on living conditions may be expected during remediation activities, such as construction works nuisances (noise, dust or odour), including nuisances caused due to demolition of buildings activities and structural damage to nearby structures (houses, pipelines, cables) caused by vibration.	No impact No impacts related to the living environment of residents are expected in this stage of the Project.

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
20.	Local conflict of interests	No impact No impacts related to the local conflict of interests are expected in this stage of the Project.	Unknown The future (planned) use of the remediated site/area may be an issue and a cause of conflict of local interests. Future use of remediated sites may be controversial for political, economic or social reasons.	No impact No impacts related to the local conflict of interests are expected in this stage of the Project.
21.	Historical and cultural heritage	No impact No impacts related to historical and cultural heritage are expected in this stage of the Project.	+/- - It is possible that excavation or earthmoving activities may uncover artefacts of cultural or historical significance. + Remediation of these sites will have positive effect on historical and cultural heritage in terms of its promotion and touring of nearby archaeological sites.	+ Capacity development of environmental officers who will be responsible for managing contaminated sites on the ground and awareness building of stakeholders are expected to contribute to the overall implementation of the Master Plan.
22.	Destruction of landscape	No impact No impacts related to landscape are expected in this stage of the Project.	+ The area designated for remediation may have valuable landscape features that could be located above soils or groundwater that may be contaminated. Remediation of contaminated sites will have beneficial effects on visual sensitivity and value of landscape features of nearby area.	+ Capacity development of environmental officers who will be responsible for managing contaminated sites on the ground and those who will be responsible for development of relevant regulatory frameworks as well as awareness building of stakeholders are expected to contribute to the overall implementation of the Master Plan.
23.	Work environment including work safety	+/- The development of a comprehensive legal framework pertaining to remediation management will have a beneficial impact on occupational health and safety of workers working on site. However, during baseline survey of contaminated sites, experts engaged on sampling of might be exposed health risk and the appropriate measures to prevent occurrence of health risks should be envisaged.	- The health and safety of employees undertaking assessment and remediation works may be endangered, depending on the types of chemical substances present, their toxicity and the types of operations to be carried out. Special attention needs to be paid to cumulative exposure effects on workers engaged in the remediation works.	+ The capacity development and awareness raising activities intended for environmental officers, as well as owners of contaminated sites, business owners, investors / developers, will enable the key stakeholders to better understand the issues of compliance with work environment related regulations.
Others				
24.	Accident	+ Strengthening of existing legislation would have beneficial effect by preventing of accidents in	- During remediation activities, various types of accidents may occur due to improper	+ Activities of capacity development will have beneficial effect in terms of ensuring that all

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
		later stage of the Project development.	management, carelessness and/ or oversight of the employees. Accidental gas, wastewater and/or waste releases or spills, and in the worst cases, explosion may occur. Also, accident situation can occur during transportation of hazardous materials.	proposed mitigation measures to prevent accidents or large-scale disasters are in place and implemented.
25.	Impacts on human health, including risk of infectious diseases	No impact No impacts related to human health are expected in this stage of the Project.	- The public may potentially be at risk caused by earthworks, exposure to deposited hazardous chemicals, wastewaters, residue and/or waste on contaminated site. During remediation activities the sensitive receptors (e.g. remediation workers, surrounding community) adjacent to the site could be exposed to increased levels of dust and other air pollutants causing harmful health impacts.	+ Activities envisaged in this component include training on evaluation of environmental and health risks, implementation of emergency measures and institutional controls, which will enable better understanding of possible impacts on human health and measures that need to be undertaken to prevent those impacts.
26.	Cost	- Activities related to the development of a regulatory and institutional framework may realistically be expected to have great financial implications for the FBiH Government	- Site level activities which include site assessment and environmental remediation may realistically be expected to have great financial implications for the liable party (site owner and/or public authorities, depending on the liability framework to be established)	- Activities related to capacity development may realistically be expected to have great financial implications for the FBiH Government.
27.	Asset value	+/- - If the baseline survey of contaminated sites and the site registry indicate that certain sites are contaminated, it will certainly cause a decrease in asset value. + The positive results of the preliminary survey and site registry may eliminate doubts and have beneficial impacts on asset value.	+/- - If the contamination of a certain site is confirmed and remediation activities are commenced, the availability of land use options may become limited and the economic value of adjacent property may be affected. + The positive result of survey which shows the site is classified as non-contaminated land may have beneficial impacts on asset value.	No impact No impacts related to the conflict of local interests are expected in this stage of the Project.
28.	Acceptance by society	+ It is expected that the society in general will encourage and accept the development of a regulatory and institutional framework that will enable proper management of contaminated	+ It is expected that the society in general will encourage remediation site level activities intended to eliminate/prevent health risk hazards.	+ It is expected that the society will accept any awareness raising activities involving the general public which are related to remediation of contaminated sites.

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
		areas.		
29.	Anxiety and panic within the local communities or general public after the revelation of seriously contaminated site or/and environmental issue	- If the baseline survey of contaminated sites and the site registry indicate that certain sites are contaminated, it might lead to anxiety and panic within the local communities or general public.	No impact	No impact
30.	Serious damage to the image of the polluter company	- If the baseline survey of contaminated sites and the site registry indicate that certain sites are contaminated, the image and business reputation of the company managing the contaminated site might be damaged or threatened in view of the general consumer public.	No impact	No impact
31.	Increase in administration work (of related federal and cantonal governments and agencies)	- The relevant federal level or cantonal level authorities may experience an increase in administration related work with regards to the development of an institutional and regulatory framework.	- The relevant federal level or cantonal level authorities may experience an increase in administration related work with regards to the performance of site-level activities.	- The relevant federal level or cantonal level authorities may experience an increase in administration related work with regards to the capacity development activities.
32.	Increased number of litigation cases	- The number of environmental litigation cases may increase due to new safety considerations regarding remediation and redevelopment.	No impact	No impact
33.	Site investigation and remediation requirements are too strict	- The developed requirements in the previous project phase of development of legal/regulatory framework may prove to be too strict to comply with during the site-level activities.	No impact	No impact
34.	Costs of site investigation and/or	No impact	- The costs of investigation and/or remediation activities may prove to be too high to carry out	No impact

No.	Item	Initial Rating		
		A Baseline Survey and Analysis of Situation Development of Institutional Framework Development of Technical Guidelines	B Remediation of Priority Sites	C Capacity Development
	remediation too high to comply with the new regulations and technical guidelines		fully in compliance with the legal/regulatory framework developed in the previous project phase.	
35.	Brownfield issue (inability of land owner to pay the remediation costs or sell the land)	- The requirements regarding the liabilities of land owners to be set out in the new developed legislation and technical guidelines may lead to the inability of the owner to pay for the costs of remediation of the site and his/her inability to sell the land if the costs of remediation are higher than the land price, thus discouraging further economic development and land development.	No impact	No impact

A 6.6 Potential Environmental/Social Impacts of The Projectand Proposed Mitigation Measures

A 6.6.1 Environmental/Social Impacts and Mitigation Measures

The Scoping Matrix from Chapter A 6.5 presents the initial rating of potential benefits and/or negative impacts related to remediation of contaminated sites (so called, hotspots) in FBiH.

On the basis of the results of the Scoping Matrix, the Project activities which may have negative environmental or socio-economic impacts (items evaluated as "+/-", "-", and "Unknown") are considered and assessed qualitatively based on updated Draft Master Plan and the result of questionnaire from the Stakeholder Meeting, which was held on 18 March 2014 in Sarajevo.

The following activities are considered the most important as they represent the key proposal actions for hotspot remediation which might cause substantial impacts:

- Preliminary survey of contaminated sites and development of provisional site inventory and official site registry
- Development of institutional framework and development of technical guidelines
- Site investigation and remediation activities

For each potential environmental and social impact identified in the Scoping Matrix, mitigation measures are proposed with the aim to eliminate or reduce the negative impacts to the greatest extent possible.

Major impacts identified and proposed mitigation measures are presented in Table A 6.6-1.

Table A 6.6-1 Results of Assessment and Mitigation Measures

No.	Impact	Mitigation Measures	Implementing Agency
Preliminary survey of contaminated sites and development of provisional site inventory and official site registry			
1.	Anxiety and panic within the local communities or the general public after the revelation of seriously contaminated site or/and environmental issue	Public dissemination of information should be established in the early phases of the project and continue throughout the entire project lifecycle, through online disclosure and other media as deemed necessary. An information contact point should be formed with the relevant authorities to address any issues/questions regarding community concerns related to real or perceived environmental and human health impacts associated with contamination and/or the environmental effects and nuisance conditions arising from remediation and management. Any technical information should be communicated to the public in plain and understandable language. In cases of significant site contamination or controversial sites, proper and timely information disclosure through affected local communities should be ensured, and evaluation and feedback from all parties involved on the effectiveness of the consultations should be planned.	FMoET and cantonal authorities
2.	Decrease in asset value of neighbouring land plots/structures		
3.	Serious damage to the image of the polluter company		
4.	Soil contamination during basic site survey	During sampling activities, and based on method of sampling, special attention needs to be paid to avoiding possible cross-contamination. Extra care is needed to ensure that the surrounding area is not affected by excavated soil and this process does not leave contaminants exposed on the surface.	Company/experts engaged for basic site survey (sampling)
5.	Work environment including work safety during basic site survey	Consideration must be given to appropriate occupational health and safety measures for people working on sites from the time of the preliminary assessment of a site through to completion of remediation. Workers who perform site survey activities need to be trained and informed about: ▪ Types of chemicals present on the site, their nature and characteristics and their likely health impacts; ▪ The toxicity of chemicals (via all exposure routes) as well as specific safety hazards (e.g. explosion from specific gases or vapours, etc.); ▪ The types of operations to be carried out on site—equipment to be used, the way in which the chemical materials, residues and/or	Company/experts engaged for basic site survey (sampling)

No.	Impact	Mitigation Measures	Implementing Agency
		waste are to be dealt with, specific tasks of workers on site, etc.	
6.	Increase in administration work (of related federal and cantonal governments and agencies)	The work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities to be involved in the Project
Development of institutional framework and development of technical guidelines			
7.	Brownfield issue (inability of land owner to pay the remediation costs or sell the land)	The expert teams involved in developing new regulations should take the brownfield issue into particular consideration, and organize consultation meetings with such land owners as necessary in order to fully evaluate all the challenges faced and the proposed options. Such regulations should provide for assistance/incentives to land owners who are unable to pay the remediation costs. Clear identification of the criteria for such assistance/incentives must be developed carefully.	FMoET
8.	Increased number of litigation cases	A grievance mechanism may be established through the new regulatory framework to address any such disputes. The relevant authorities should attempt to resolve any arising disputes related to remediation amicably and efficiently.	FMoET and cantonal authorities
9.	Costs of activities related to the development of a regulatory and institutional framework	The financial sources necessary to cover the expected costs need to be clarified and agreed upon prior to the commencement of all actions.	FMoET and cantonal authorities
10.	Impacts on vulnerable groups (children, unemployed population, population with very low or without any income, elderly population or population living in isolated areas which may be located in the vicinity of hotspots)	In the process of development of a legal and regulatory framework, vulnerable groups need to be identified and their rights, need and interests to be taken into consideration and properly addressed. The stakeholder engagement mechanisms need to involve special provisions for vulnerable groups, such as the identification of vulnerable groups on a case-by-case basis and special consultation meetings with vulnerable persons.	FMoET
11.	Increase in administration work (of related federal and cantonal governments and agencies)	The work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities to be involved in the Project
12.	Site investigation and remediation requirements are too strict	The regulatory framework and technical guidelines should be developed by expert teams with relevant experience in contaminated site remediation in order to develop adequate regulations applicable in FBiH. A public consultation process involving in particular owners of polluted sites should be carried out.	FMoET
Site investigation and remediation activities			
13.	Costs of site investigation and/or remediation too high to comply with the new regulations and technical guidelines	The institutional framework and technical guidelines should provide for assistance/incentives for remediation activities on a case-by-case basis.	FMoET
14.	Air pollution	**Dust**. Prior and during remediation activities the following issues need to be considered: ▪ Sources of dust generation ▪ Toxicity of dust (e.g. silica, asbestos, and chemicals) ▪ The size of the remediation area ▪ Timing of remediation works (remediation undertaken at the end of the rainfall season is likely to minimise dust exposure because of soil moisture content) ▪ Choice of remediation technique/s ▪ Distance to nearest sensitive receptors ▪ Dust monitoring (appropriate methodologies/protocols) ▪ Background measurements of concentrations of dust(before and during remediation) ▪ Methods used to minimise or eliminate dust generation, e.g. Management practices ▪ Weather station monitoring (before and during remediation)	Site owner, Company engaged for site remediation

No.	Impact	Mitigation Measures	Implementing Agency
		For large projects, local conditions well before starting work should be taken into account. Also, good housekeeping practices should be implemented such as minimising traffic and its speed on exposed soils, minimising exposed working areas during remediation, minimising loose soil, light application of a water spray to dampen the soil but not saturate it, effective covering of stockpiles of excavated soil, etc. **Exhaust gasses.** In order to minimise air pollution caused by exhaust gasses from construction vehicles and other machinery on site, maintenance of equipment and vehicles needs to be prepared in advance and mitigation measures during remediation activities need to be implemented. **Asbestos fibres.** Asbestos that may be found on a site requires specialist skills and care in handling, removal, transportation and disposal to prevent the likelihood of asbestos fibres becoming air-borne causing harmful health impacts to workers and communities nearby. Asbestos-specific knowledge and management skills may also be needed to address potential impacts to workers and the community.	
15.	Surface water pollution	Management of surface waters during remediation activities is an essential part of protecting the quality of waterways and preventing their pollution. Negative impacts on surface waters associated with remediation activities should be reduced by strict implementation of mitigation measures, and application of adequate working and housekeeping practices (use of temporary rainproof covers, temporary bunding around stockpiles, location of stockpiles on waterproof surfaces such as asphalt or concrete, minimising the area being treated at any one time, installation of temporary barriers (e.g. hay bales, geo-fabric or similar), excavation of drainage or run-off water diversion trenches, collection or absorption pits, etc.). Remediation activities within the water bodies need to be carefully planned and implemented in order to reduce negative environmental impacts. Prior and during remediation activities the following issues need to be considered: ▪ Local weather patterns and expected direction and pathways of run-off flow ▪ Location and size of the affected area ▪ Sensitivity of surrounding environments and proximity of nearby watercourses ▪ Remediation work methods and works plans ▪ Likely causes of surface water pollution (for example, caused by stockpiled, pre-excavated materials run off and/or leakage) ▪ Any on-site or off-site areas susceptible to negative impacts ▪ Requirements under the FBiH Law on Waters	Site owner, Company engaged for site remediation
16.	Groundwater pollution	When undertaking remediation, specific requirements must be complied with to ensure that water quality is protected. Such impacts should be eliminated or mitigated by strict implementation of mitigation measures and good working and housekeeping practices. For some remediation projects, off-site groundwater monitoring may be necessary to assess the effectiveness of remediation activities or the extent of remediation required. Prior and during remediation activities the following issues need to be considered: ▪ Geology and hydrogeology (type and number of aquifer systems, depth to groundwater, hydraulic pressures, flow directions and velocities) ▪ Type of soil and organic content (adsorption characteristics) ▪ Physical properties of chemicals disposed in hotspots ▪ Potential for contaminated site chemicals spreading in soil and/or groundwater ▪ Size and structure of the contamination source (e.g. if remediation implies construction of tailing impoundments) ▪ Dewatering	Site owner, Company engaged for site remediation

No.	Impact	Mitigation Measures	Implementing Agency
		▪ Treatment, reuse or disposal of extracted leachate Assessment of groundwater conditions and characteristics requires specialised knowledge. The above mentioned issues need to be considered depending on the type and location of a remediation project.	
17.	Waste generation (construction and demolition debris, excavated soils and/or excavated deposited waste)	Adverse impacts associated with waste generation and its temporary storage on site are expected to be temporary and they could be eliminated or mitigated by strict implementation of mitigation measures and good working practices based on the activities specified in the waste management plan. Major issues that need to be solved during remediation activities include management of: ▪ Hazardous construction and demolition waste which includes contaminated material from remediation activities ▪ Other hazardous wastes (oil, lubricants, fuel, oily rags, oil filters) ▪ Municipal waste generated on the site, including packaging waste; ▪ Inert waste (construction and demolition waste) and wastes that can be recycled (wood, various metal and plastic materials). Appropriate handling, collection, temporary storage, hazardous waste during on-site remediation activities should be implemented to protect workers and nearby residents' health and wellbeing and to ensure that further site contamination is avoided.	Site owner, Company engaged for site remediation
18.	Soil contamination	During sampling activities, and based on method of sampling, special attention needs to be paid to avoiding possible cross-contamination. Selection of appropriate sampling methods and protocols should be implemented. Surrounding area should be protected from improper management of excavated soil. Negative impacts on soil during remediation activities should be eliminated or mitigated by strict implementation of mitigation measures and good working and housekeeping practices (adequate waste management, covering of exposed soil to prevent losses from wind or water erosion and vertical migration of chemical substances in the soil from rainfall events, adequate management of contaminated soil and stockpiles, adequate wheel-wash operations,etc.) Prevention of contamination of nearby soils should be prevented to reduce the spread of chemical materials, and to minimise the amount of contaminated soil needing to be treated. Attention should also be paid on prevention contaminated liquid (such as leakage) generated from contaminated site to be discharged on soils nearby. Prior and during remediation activities the following issues need to be considered: ▪ Likely sources of cross-contamination; ▪ Types and concentrations of chemical materials deposited onto and/or into the contaminated site; extent of the remediation area needed; ▪ Duration and timing of the remediation works; ▪ Choice of remediation technique; ▪ Remediation work methods and plans; ▪ Classification and management of waste generated and/or waste excavated during by remediation activities; ▪ Sensitivity of surrounding environments and proximity of nearby watercourses.	Site owner, Company engaged for site remediation
19.	Damages to environment caused by mining activities	Negative environmental impacts that may occur during remediation of mining sites may be reduced through transparent planning, proper and adequate management of remediation activities, as well as taking into account existing knowledge of practices in remediation of mining sites. Prior and during remediation activities the following issues need to be considered: ▪ Detailed engineering-geological site investigation; ▪ Zone of potential environmental, health and safety impacts;	Site owner, Company engaged for site remediation

No.	Impact	Mitigation Measures	Implementing Agency
		▪ Migration pathways of potentially generated pollution; ▪ Experience and knowledge of the implemented remediation projects.	
20.	Noise and vibration	**Noise.** These impacts should be temporary and short term and can be prevented through implementation of mitigation measures and good housekeeping practices (use of noise suppression on machinery or equipment with low sound outputs, restriction of working hours of noisy machinery, proper maintaining of all equipment, with special attention to mufflers and other noise control devices, placing of noisy equipment on the site at maximum distance from neighbouring houses, etc.) Issues that must be considered in addressing noise impacts include: ▪ Identification of likely sources of noise; ▪ Distance to nearest sensitive receptors ▪ Noise modelling and monitoring ▪ Obligations under FBiH Law on Noise Protection **Vibrations.** These impacts can be mitigated by implementation of mitigation measures in the design and in the phase of on-site remediation phases of the project. Issues that must be considered to address vibration impacts include: ▪ Identification of the zone of impact ▪ Identification of the distance to nearest sensitive receptors ▪ Vibration modelling and monitoring	Site owner, Company engaged for site remediation
21.	Ground subsidence	Adequate civil engineering practices need to be implemented. Prior and during remediation activities the following issues need to be considered: ▪ Identification of the zone of impact; ▪ Level of compaction required.	Site owner, Company engaged for site remediation
22.	Offensive odour and gaseous (volatile) emissions	Prior and during implementation of remediation activities the following issues need to be considered: ▪ Potential volatility and toxicity of the chemicals disposed onto and/or into the contaminated site ▪ Weather conditions; ▪ Location and extent of potentially affected areas; ▪ Distance to nearest sensitive receptor; ▪ Determination of acceptable off-site concentrations of pollutants in environment; ▪ Duration of potential exposure to pollutants generated by the contaminated site; ▪ Potential soil subsurface migration of volatile sources during remediation ▪ Environmental and occupational health requirements ▪ Contingency planning for unexpected releases. Potential mitigation measures include: undertaking work in favourable weather conditions (e.g. lower temperatures, favourable winds), covering exposed surfaces overnight, timing excavation activities to minimise off-site nuisance, immediately and completely removing offensive odorous material offsite, etc.) If gaseous emissions are envisaged to be generated during a particular remediation project, an assessment of their potential impacts should be undertaken during the planning stage to determine the need for special measures to prevent and control these emissions.	Site owner, Company engaged for site remediation
23.	Flora and fauna	Remediation activities need to be undertaken in compliance with all FBiH legislation covering sensitive or threatened species of flora and fauna. Prior and during remediation activities the following issues need to be considered: ▪ Size and location of areas of high environmental value in surrounding areas; ▪ Size and if possible location of populations of possible threatened species; ▪ Alternative appropriate remediation strategies.	Site owner, Company engaged for site remediation
24.	Hydrological situation	These impacts can be avoided or reduced in the planning and design stage of remediation activities by application of special construction	Site owner, Company engaged

No.	Impact	Mitigation Measures	Implementing Agency
		measures and by implementation of mitigation measures and good working and housekeeping practices.	for site remediation
25.	Land Acquisition /Resettlement	Any full or partial (temporary) expropriation activities must be conducted in compliance with the FBiH Law on Expropriation.	
26.	Impacts on vulnerable groups (children, unemployed population, population with very low or without any income, elderly population or population living in isolated areas which may be located in the vicinity of hotspots)	Vulnerable groups need to be identified and their rights, need and interests to be taken into consideration and properly addressed through the stakeholder engagement and consultation process. The stakeholder engagement mechanisms need to involve special provisions for vulnerable groups.	FMoET
27.	Restrictions on land use and utilization of local resources	Any temporary land-use restrictions that may occur during site-level activities, especially concerning the disposal of materials and/or waste excavated on site, should be carried out in agreement with the owners of the land.	FMoET
28.	Water usage or water rights	These potential impacts needs to assessed and if possible quantified in the later stages of the Project.	
29.	Living environment of residents	The local communities should be properly informed of the likelihood of any impacts on living conditions that may be expected during remediation activities, such as construction works generating nuisances (noise, dust or odour), including nuisances generated by demolition of buildings and infrastructures.	FMoET
30.	Historical and cultural heritage	Prior and during remediation activities the following issues need to be considered: ▪ The heritage significance of structures, archaeological deposits, artefacts that may be present at a site; ▪ Training and awareness of workers working on the site related to h historical and cultural heritage values; ▪ The type of remediation activities to be undertaken on such a site; ▪ Procedures to be taken following discovery of any heritage features.	FMoET
31.	Work environment including work safety	Consideration must be given to appropriate occupational health and safety measures to be implemented from the time of the detailed assessment of a site through to completion of remediation works. Special protective measures should be implemented to protect workers from cumulative exposure effects on workers who regularly undertake assessment and remediation works. Consideration must be given to implementation of adequate and appropriate occupational health and safety measures from the earliest phases of site surveys and continuing throughout to completion of remediation projects. Workers who perform remediation activities need to be trained and informed about: ▪ Types of chemicals present on the site, their nature and characteristics and their likely health impacts; ▪ The toxicity of chemicals (via all exposure routes) as well as specific safety hazards (e.g. explosion from specific gases or vapours, etc.); ▪ The types of operations to be carried out on site—equipment to be used, the way in which the chemical materials, residues and/or waste are to be dealt with, specific tasks of workers on site, etc. **Dangerous/hazardous substances.** Adequate handling, collection, temporary storage, and use of dangerous or hazardous materials during on-site remediation activities should be planned and implemented to protect workers and nearby residents and to ensure that further site contamination does not occur. Issues that need to be considered prior and during remediation: ▪ Potential for loss of containment (deliberate and accidental) though environmental release; ▪ Types and toxicity of chemicals deposited on site;	FMoET

No.	Impact	Mitigation Measures	Implementing Agency
		▪ Separation separate temporary storage and/or disposal of different hazardous materials to prevent occurrence of any chemical reactions; ▪ Determination of minimal distance among sensitive structures (in case of accidental spill, release or explosion); ▪ Emergency measures and response plans in the event of any accident (contingency planning).	
32.	Conflict of local interests	Any potential conflicts regarding the future (planned) use of the remediated site/area need to be identified and, if possible, resolved during the stakeholder engagement and consultation process.	FMoET and cantonal/municipal authorities
33.	Accidents	In case that contaminated materials from the site being remediated cannot be treated or safely disposed of in the vicinity of the site (or even on the territory of FBiH), these materials will need to be transported for treatment and/or disposal outside the country according to the principles of the Basel Convention. Possibility of occurrence of accidents may be minimised by implementing mitigation measures and good working and housekeeping practices, as well as developing and implementing Emergency Response Plan and Spill Response Plan.	Site owner, Company engaged for site remediation
34.	Impacts on human health (increased levels of dust and other air pollutants and risk of infectious diseases)	Adverse impacts of remediation activities on health of nearby residents will be reduced or mitigated by implementation of mitigation measures and good work and housekeeping practices.	Site owner, Company engaged for site remediation
35.	Activities related to site assessment and environmental remediation may be expected to have great financial implications	Financial sources necessary to cover expected site remediation costs need to be identified and agreed upon prior to the commencement of all actions between the key project stakeholders and depending on the framework of liability to be established.	FMoET
36.	Increase in administration work (of related federal and cantonal governments and agencies)	The work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities involved in the Project
Capacity Development			
37.	Activities related to capacity development may be expected to have great financial implications	The financial sources to cover the expected costs need to be identified and agreed upon prior to the commencement of all actions between the key project stakeholders and depending on the framework of liability to be established.	FMoET
38.	Increase in administration work (of related federal and cantonal governments and agencies)	The work of public authorities should be planned carefully prior to the commencement of project activities in order to ensure that sufficient institutional capacities are in place.	All authorities involved in the Project

A 6.7 Stakeholder Engagement

A 6.7.1 Stakeholder Identification

Stakeholders are individual persons or group of persons who may directly or indirectly be affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. Table A 6.7-1 provides a preliminary list of stakeholders identified in FBiH.

Table A 6.7-1 List of Stakeholders

	Stakeholder	Key issues / focus of interest
1	Site neighbours (tenants, dwellers, visitors)	Direct risks to human health; decrease in commercial land value of adjacent land plots/property
2	Local communities	Environmental human health risks to the community; endangered living conditions; the future use of land
3	General public	Public health hazards; cost to society
4	Local NGOs dealing with the protection of human health and the environment	Support to the citizens in access to environmental information and proactive approach in resolving the identified issues in environmental matters
5	Media (local, regional, entity level and state level)	Dissemination of information to the public on the implementation of Project activities; raising public awareness
6	Academic institutions	Scientific contributions and research
7	Site workers	Occupational health and safety
8	Land owners (municipalities which are owners of waste disposal land)	Liability for remediation; land reuse
9	Business owner – polluter	Financial implications of remediation; compliance with environmental requirements in terms of contamination and remediation management; land reuse and land redevelopment challenges
10	Potential developers/investors	Liability for remediation; financial implications of assumed liability
11	Ministry of Foreign Trade and Economic Relations of BiH	Project counterpart organization and organizer of Steering Committee
12	Federal, cantonal and municipal regulatory, planning and inspection authorities (including FMoET)	Recognize remediation and redevelopment as a strategic objective and their significance for economic development; lack of experience in institutional, financing and technical aspects; incentives and financing options
13	International organizations	Support to the implementation of activities in accordance with international environmental protection standards; bringing in international experience
14	Aarhus Centres	Facilitating access of citizens and institutions to information, providing assistance in exercising the right to participation in decision making in environmental matters and support in the legal protection of human rights in the field of environment

A 6.7.2 Summary of the Stakeholder Meeting

The Stakeholder Meeting was organized on 18 March 2014 in Sarajevo, with the aim of presenting the Draft Master Plan and exchanging opinions about the various aspects of the Plan. The meeting was organized by Japan International Cooperation Agency (JICA) and supported by Enova d.o.o. Sarajevo, the consulting company engaged for preparation of the "Survey for Strategic Environmental Assessment (SEA) for the Project for Master Plan for Remediation of Hotspots in Bosnia and Herzegovina".

The meeting was moderated by the Project coordinator - representative of the Ministry of Foreign Trade and Economic Relations (MoFTER) of Bosnia and Herzegovina.

Table A 6.7-2 Results of the Stakeholder Meeting

a) Style of stakeholder meeting	Meeting
b) Date	18 March, 2014
c) Venue	Hotel Sarajevo, Sarajevo, Bosnia and Herzegovina
d) Purpose	• Presenting the Draft Master Plan to stakeholders • Confirmation of stakeholders' main concerns and issues related to the activities proposed in the Draft Master Plan • Obtaining the opinions of stakeholders and reflecting them in the Draft Master Plan
e) Participants	Representatives from: • Ministry of Foreign Trade and Economic Relations of BiH • Relevant federal ministries • Relevant municipal and cantonal authorities • Faculties of mining and technology of universities across FBiH • Agencies and institutes for water, food safety, geology, hydrology, inspection • International organizations (UNEP, OSCE) and Aarhus Centre • Public health institutes • The Federal Environmental Protection Fund • Relevant engineering companies
f) Summary	• JICA representatives explained the outline of the project • The technical guidelines for investigation and measures for contaminated sites and the three key processes were explained together with a case study • The liabilities, institutional controls, risk communication and community involvement and funding for remediation were discussed • It was suggested to include the question of ownership in the legal framework, as many of the properties connected to remediation might be privately owned • The participants discussed and suggested other important documents and regulations that could support the project • Type of modelling used for the purpose of the project development was discussed together with suggestions on the most appropriate models for future reference • Disclosure of information on the contaminated sites in the process of property purchase was discussed

A 6.7.3 Comments and Opinions from Stakeholders

Table A 6.7-3 presents summary of comments and opinions from stakeholders at the Stakeholder Meeting held on 18 March 2014.

Table A 6.7-3 Summary of Comments and Questions from Stakeholders

No.	Category	Comment by	Comments / Q and A
1	Institutional mechanisms	Representative of the company dealing with remediation of contaminated sites	Inclusion of the question of ownership in the legal framework, as many of the contaminated sites may be privately owned.
2	Privatization procedures	Representative of Federal Ministry of Environment and Tourism	Value of the expropriated property/asset should be included in the necessary remediation funds, i.e. to be included in the price of, for example, a company that was planned to be bought out for remediation purposes.
3	Project technical guidelines for investigation and measures for contaminated sites	Representative of Federal Ministry of Agriculture, Water Management and Forestry	The representative emphasized there is a rulebook on sensitive areas regulating that areas sensitive to nitrates should be identified. For example, the Agency for Watershed of Adriatic Sea has implemented a study regarding nitrate impacts and proposed monitoring for water quality focused mainly on nitrates.

No.	Category	Comment by	Comments / Q and A
4	EU directives	Representative of the Ministry of Foreign Trade and Economic Relations of BiH	Within the Project "Strengthening of Bosnia and Herzegovina's Environmental Institutions and Preparation for Pre-accession Funds" (ENVIS Project), there are three directive-related projects. A project on management of Sava Basin has also been initiated.
5	Project methodology	Representative of the company dealing with remediation of contaminated sites	The representative raised the question of used modelling for the project implementation, as sole measurement is not always the best indicator.
6	Project technical guidelines for investigation and measures for contaminated sites	Representative of Federal Ministry of Agriculture, Water Management and Forestry	In FBiH, in case underground waters may be contaminated, there is a legal right of use of the land provided by the owner for research purposes.
7	Future implementation of the Master Plan	Representative of the University of Tuzla, Faculty of Mining, Geology and Civil Engineering	The project has taken into consideration some of the hotspots in the mining industry. There was a regional study for mining foreclosure, which could be used for this project. It is recommendable to be very careful when designing such a master plan. This Plan should be carefully updated and adjusted for future reference.
8	Disclosure of information	Representative of the Ministry of Spatial Planning and Environment, Tuzla Canton	Question of disclosure of information to buyers in regards to purchase of properties containing contaminated sites.
9	Purpose of the Master Plan	Representative of the Federal Environmental Protection Fund	The Master Plan should regulate the legal framework, the definition of a contaminated site, the criteria for determining contamination, the most adequate measures, the manner of implementing these measures, and only after that to look into institutional mechanisms. The distribution of responsibilities is not recommendable in the early phase of Master Plan development.
10	Project goals	Representative of Federal Ministry of Environment and Tourism	The presented actions in the Master Plan are desired goals, the measures that need to be implemented in future when implementing the Master Plan.

A 6.7.4 Stakeholders Prioritization

For the needs of the Stakeholder Meeting, a comprehensive questionnaire was prepared and distributed to the participants, and the inputs were subsequently analyzed in order to obtain an insight into the priority areas identified by the stakeholders. In cases where more than one representative of a certain organization filled the questionnaire, the average rating of the importance of issues provided by these representatives was calculated. It should be noted that the opinions of certain representatives do not necessarily reflect the opinion of the entire organization.

The main findings of this analysis can be summarized as follows:

The **major negative impacts** identified (ranked in below given order as issues of highest impact/interest by the participants) are:

- Increase in hazardous waste despite the fact that there are no facilities for treatment of contaminated soil or waste in FBiH;
- The brownfield issue (inability of landowner to pay for remediation costs and/or sell the land in case the remediation costs are higher than the price of land, thus leaving the contaminated site non-remediated);
- High costs of site investigation (too expensive to obey the new regulation and technical guideline).

With regard to the **prioritization of activities** proposed in the Draft Master Plan, the participants prioritized the following activities (ranked in order of importance):

- Development of legal framework;

- Development of financial mechanisms;
- Development of technical guidelines for site identification, preliminary and detailed investigation, risk assessment, development of remediation measures, and others;
- Remediation of priority sites;
- Obtaining basic information and analyzing the current situation of contaminated sites in FBiH.

Based on the results of the questionnaires, the issues/impacts prioritized by the stakeholders are presented in the following table.

Table A 6.7-4 Stakeholder Interests and Concerns Identified[8]

Stakeholder	Interest and Concerns													
	Anxiety and panic in local communities due to revelation of seriously contaminated sites and/or env. Issues	Decrease in asset value of neighbouring land plots / structures	Serious damage to image of polluter	Regulations regarding site investigation and remediation too strict to comply with	Costs of site investigation and/or remediation too high	Increase in work of public administration	Brownfield issue	Increase in number of litigation cases	Increase in hazardous waste	Hazardous work environment	Soil and underground water contamination	Pollution during remediation activities	Impacts on natural env.	Social impacts
MoFTER	H	H	M	H	H	H	H	M	H	M	M	H	H	H
Municipalities	M	M	M	L	M	H	L	M	H	L	M	L	L	H
Environmental Protection Fund of FBiH	H	M	M	L	M	M	M	H	H	H	H	M	M	M
Public health institutes	M	M	H	M	H	L	H	M	M	L	L	H	M	M
Inspectorates	H	M	L	H	H	H	H	H	H	M	H	M	H	M
FMoET	H	H	H	H	H	M	H	N	L	L	N	L	L	M
Fed. Ministry of Agriculture, Water Management and Forestry	M	N	N	M	M	M	N	N	M	L	H	H	H	N
Fed. Ministry of Energy, Mining and Industry	M	H	M	M	M	H	H	M	H	H	M	L	L	M
Fed. Geology Institute	M	M	M	N	M	M	M	M	H	L	L	L	N	L
Cantonal ministries of env.protection	M	L	M	M	M	L	H	M	H	M	M	M	M	M
Cantonal ministries of	H	M	M	M	H	M	H	M	H	H	M	M	H	M

[8]The stakeholder interests and concerns identified on the basis of 27 stakeholder questionnaires filled during the Stakeholder Meeting held on 18 March 2014

Stakeholder	Interest and Concerns													
	Anxiety and panic in local communities due to revelation of seriously contaminated sites and/or env. Issues	Decrease in asset value of neighbouring land plots / structures	Serious damage to image of polluter	Regulations regarding site investigation and remediation too strict to comply with	Costs of site investigation and/or remediation too high	Increase in work of public administration	Brownfield issue	Increase in number of litigation cases	Increase in hazardous waste	Hazardous work environment	Soil and underground water contamination	Pollution during remediation activities	Impacts on natural env.	Social impacts
agriculture, forestry and water management														
Aarhus Centre in BiH	H	H	H	M	H	M	H	M	H	M	H	H	H	H
Public universities	M	M	M	H	H	M	H	L	H	L	M	M	M	M
Business sector	H	H	H	M	M	M	H	M	M	H	H	H	H	M

H: High interest or stake
M: Moderate interest or stake
L : Low interest or stake
N: Not concerned with

A 6.7.5 Stakeholder Engagement Plan and Information Disclosure System

On the basis of the requirements set out by the regulations in force in BiH regarding public consultations, as well as the *JICA Guidelines for Environmental and Social Considerations* (April 2004), in particular items 2.1 (Information Disclosure) and 2.2 (Consultation with Local Stakeholders), a Stakeholder Engagement Plan has been prepared and an Information Disclosure System suggested for projects or activities encountered by the Draft Master Plan.

A 6.7.5.1 Draft Stakeholder Engagement Plan

The Draft Stakeholder Engagement Plan includes arrangements for consulting the relevant stakeholders for different steps of the Draft Master Plan implementation. Special attention will be given to vulnerable groups and affected local communities.

The Draft Stakeholder Engagement Plan has been prepared on the basis of both the existing required procedures in FBiH as well as recommended disclosure procedures, and is presented in Table A 6.7-5.

Table A 6.7-5 Draft Stakeholder Engagement Plan

No.	Key output/information	Engagement Plan				
		Method	Responsible agency	Stakeholder	Timing	Note
1.	Announcement on commencement of project activities	Online disclosure	FMoET; MoFTER	Public	Prior to start of project	All project planning documents should be disclosed on the FMoET website
2.	Information on provisional site inventory and official registry	Online disclosure	FMoET	Public	2014-2016	The public should be advised that further investigations will be undertaken.
3.	Information on Analysis of General Status of Contaminated Sites in FBiH	Online disclosure	FMoET	Public; federal, cantonal and municipal regulatory, planning and inspection authorities	2015-2016	The main findings of the Analysis should be communicated to the public in plain language. Information should be provided on the future stages of the process and opportunities for the community to become involved.
4.	Information on technical guidelines related to site investigation and remediation	Public hearing Online disclosure Disclosure in Official Journal	FMoET	Public, land owners, polluters, developers, inspectorates	2015-2018	
5.	Information on developed standard format for remediation plan and prototype plans for selected sectors, as well as prototype QC plan	Online disclosure	FMoET	Land owners, polluters, developers, inspectorates	2015-2018	
6.	Information on developed prototype monitoring and maintenance plan	Online disclosure	FMoET	Land owners, polluters, developers, inspectorates	2015-2018	

No.	Key output/information	Engagement Plan				
		Method	Responsible agency	Stakeholder	Timing	Note
7.	Information on commencement and undertaking of urgent measures for priority sites	Online disclosure Local community meetings Public hearing (EIA procedure)	FMoET; cantonal ministries	Public, local communities, land/business owners involved	2014-2016	The options evaluated and the criteria selected should be discussed with the community.
8.	Information on commencement and undertaking of pilot remediation projects	Online disclosure Local community meetings Public hearing (EIA procedure)	FMoET; cantonal ministries	Public, local communities, land/business owners involved	2015-2017	
9.	Information on commencement and undertaking of priority site remediation	Online disclosure Local community meetings Public hearing (EIA procedure)	FMoET; cantonal ministries	Public, local communities, land/business owners involved	2016-2020	
10.	Information on capacity development activities	Online disclosure	FMoET	Public	2014-2020	
11.	Information on developed regulatory changes related to contaminated site management in FBiH	Public hearing Online disclosure Disclosure in Official Journal	FMoET	Public; federal, cantonal and municipal regulatory, planning and inspection authorities	2018-2020	
12.	Information on developed remediation plans for other sites	Online disclosure Public hearing (EIA procedure)	FMoET; cantonal ministries	Public, inspectorates	2018-2020	
13.	Data and information on monitoring	Online disclosure Public hearing (EIA procedure)	FMoET; cantonal ministries	Public	On-going	The results of remediation validation and/or the findings of on-going monitoring should be communicated to the public.

A 6.7.5.2 Public consultations and information disclosure during the development of the legal framework

A system of disclosure of information to the public and public consultations is in place in FBiH with regards to the adoption of laws and by-laws (including guidelines).

In the process of adopting laws, public hearings are organized in order to obtain the opinions of citizens, interested bodies, scientific and expert institutions on the draft law or other issues of special importance to FBiH. The FBiH Parliament adopts a Conclusion on carrying out a public hearing, which determines the manner of disclosure of information, the working body responsible for organizing and facilitating the public hearing, the financial means and sources, the time frame, the manner of receiving and analysing the opinions and proposals.

In the process of adopting by-laws, public consultations are regulated by the FBiH *Government Decree on the* Rules of Participation of Interested Public in the Procedure of Developing Federal Regulations and Other Acts (Official Gazette of FBiH, No. 51/12), adopted for the purposes of ensuring the participation of stakeholders. The key requirements set out by the Decree, with regards to the adoption of environmental by-laws by the Federal Ministry of Environment and Tourism, are as follows:

- The Ministry may carry out consultations in any phase of the development of the by-laws
- The Ministry is required to keep a list of organizations and persons interested in the legislative and other activities of the Ministry, and publish the list on its website (and the website of the FBiH Government)
- The Ministry is required, following the preparation of the by-law, publish the by-law on its website and allow for online commenting
- The Ministry is required to invite the organizations/persons on the above mentioned list to submit comments to the by-law
- The Minister may decide to carry out further consultations by organizing public meetings and roundtables, or through work groups involving experts and representatives of stakeholders
- The Ministry is required to take into consideration all received comments

A 6.7.5.3 Information Disclosure

(1) Proposed Information Disclosure Policy

The proposed policy on information disclosure for any project or activity defined by the Draft Master Plan is presented in Box 1. The proposed policy is entirely based on the provisions of the Law on Environmental Protection of BiH and the Law on Free Access to Information in FBiH.

Box 1: Proposed Information Disclosure Policy for Draft Master Plan

1. FMoET is committed to making information about this Project available to the public. FMoET considers public access to information for all stakeholders, including local communities, a crucial component of effective participation.
2. FMoET shall provide timely and clear information to the public in a transparent and efficient manner, particularly information about the environmental and social considerations of the project.
3. For the purposes of this Policy, information means all documents in writing, data, correspondence, handwritten notes or other materials, including a copy or portion thereof, irrespective of its form (in written, visual, audio, electronic or any other material form). Environmental information, in particular, includes information on the state of environmental elements (air, water, soil, biodiversity etc.), factors such as substances, energy, noise, radiation, activities and measures, the state of human health and safety, living conditions, cultural goods and structures, and the authorities and institutions responsible for environmental protection.
4. The public shall have access to information and be able to participate in decision-making without discrimination based on citizenship, nationality or residence.
5. FMoET may decide not to disclose information in case the disclosure of such information would have an adverse effect on:
   - International relations, defence or public security;
   - The course of justice, the right of persons to a fair trial and the ability of administrative authorities to conduct criminal or disciplinary proceedings;
   - Confidentiality of information relating to trade and industry and information on emissions which are essential for the protection of the environment, if it is determined by a special regulation in order to protect economic interests
   - Intellectual property rights;
   - The confidentiality of personal information and / or documents relating to individuals in the event that such persons have not given consent to the disclosure of this information to the public;
   - The interests of a third party that has provided the requested information he/she was not required to provide, and if that party does not consent to the disclosure of a given material,
   - The environment to which the information relates, such as breeding sites of rare species.

(2) Proposed Project Information Disclosure System

FMoET will ensure that all project related information is available to the public through its website and other media as deemed necessary (printed and electronic form accessible by the public, as well as through public information means). In addition, FMoET will keep an information repository at its premises in hard copies of all project related documentation for purposes of enabling access to individuals and organizations with no access to the internet.

FMoET will cooperate in particular with cantonal ministries responsible for environmental protection in establishing and maintaining an information disclosure system, and the relevant cantonal ministries will disclose information with regards to activities undertaken on the territory of their respective cantons.

The investigation, remediation and management of hotspots may cause a range of community concerns, related to real or perceived environmental and human health impacts associated with contamination and/or the environmental effects and nuisance conditions arising from remediation and management. High levels of stakeholder engagement and communication are of vital importance in preventing and managing undue concerns about the risks during site investigation and remediation work.

Public disclosure of information will begin early in the project. Information will be disclosed throughout the entire project lifecycle, and will involve information on planned activities, activities in progress and completed activities in accordance with the project components. In cases of significant site contamination or controversial sites, FMoET will, in coordination with relevant cantonal or municipal authorities, ensure proper and timely information disclosure through affected local communities, and plan for evaluation and feedback from all parties involved on the effectiveness of the consultations. In such cases, meetings with local communities will be organized in order to present information, obtain input and provide an opportunity for information dissemination and exchange.

A 6.8 Conclusions and Recommendations

Activities proposed in the Draft Master Plan have been assessed to be either compatible or not in conflict with the existing environmental policy and strategic and planning documents related to environmental protection in FBiH. The Draft Master Plan will provide a workable strategic framework for remediation of hotspots in FBiH.

A 6.8.1 Concerns

Investigation and remediation of hotspots entails a number of issues that need to be addressed, such as disputes over liability, conflicts among the site owner and the environmental authorities, spreading of contamination during remediation activities, incomplete or inappropriate remediation, lack of support for victims, and limited participation of stakeholders in various decision making processes. Even though there are laws and by-laws in force in FBiH regulating many, albeit not all, of the issues pertaining to pollution, the common concern among the key stakeholders (as set forward during the Stakeholder Meeting held on 18 March 2014) is the lack of enforcement of the existing regulations on all levels of the Government. Hence, it remains uncertain whether any new legislation proposed within the Draft Master Plan will be enforced by the relevant authorities.

In addition, one of the major concerns for implementation of the activities proposed in the Draft Master Plan is timely provision of financial resources. Lack of financial resources may significantly delay the implementation of activities within the framework proposed in the Draft Master Plan, i.e. the period 2014-2020. This primarily relates to Component (i) - Baseline Survey and Analysis of Situation and Component (iv) - Remediation of Priority Sites, if the financing mechanisms for the Project are not well established, its implementation will be at risk.

A 6.8.2 Recommendations

Efforts to improve environmental legislation in FBiH and harmonize it with EU legislation are under way. Although the international community has a strong partnership role to play in assisting BiH, the principle responsibility, though, rests within the country. The environmental ministries on federal and cantonal level, as well as municipal environmental departments, are expected to continue to grow and strengthen in capacities. Stronger partnerships will be needed among state, federal, cantonal, municipal, private and public actors. Therefore, the capacity building activities proposed in the Draft Master Plan will need to be planned carefully and focus on building partnerships among the public authorities involved in the activities as well. However, the current situation of multiple ministries in FBiH having responsibility for hotspot management will continue to make the remediation projects complex and in some cases very difficult to implement.

Environmental management sector in FBiH will need to further evolve. Environmental management policies will need to shift over time from emergency remediation and end-of-pipe solutions to prevention and sustainable development strategies. For successful implementation of the Draft Master Plan, clear and straight forward Government responsibility should be defined and concrete enforcement measures will need to be combined with economic incentives, etc.

Furthermore, the investigation, remediation and management of contaminated sites may cause a range of community concerns. Thus, effective community consultations and the proper implementation of the stakeholder engagement mechanism are of vital importance in preventing undue anxiety in communities and general public, and delays in the Project. The public disclosure and stakeholder engagement process should begin early in the Project.

The Draft Master Plan, once finalized, will need to be adopted at a higher FBiH's Governmental level as a strategic document in order to define and establish the ownership of activities and create a basis for its effective implementation.

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Annex 7

MEETING RECORDS

Annex 7 MEETING RECORDS

A 7.1 Minutes of Meeting on the First Meeting of the Steering Committee

MINUTES OF MEETING

ON

THE FIRST MEETING OF THE STEERING COMMITTEE

OF

THE PROJECT FOR MASTER PLAN FOR REMEDIATION OF HOTSPOTS

IN

BOSNIA AND HERZEGOVINA

Sarajevo, 20th September, 2013

Dr. Itaru Okuda	**Ms. Nermina Skejovic-Huric**
Team Leader/Environmental Management	Advisor
JICA Expert Team	Ministry of Foreign Trade and Economic Relations
Japan	Bosnia and Herzegovina

1. Objectives

The objectives of the 1st Steering Committee (S/C) meeting were as follows:

- To agree on the scope and contents of the project Inception Report (Ic/R)
- To agree on and to harmonize the chosen target sites for the survey
- To confirm the survey plan at selected target sites
- To discuss how to organize Technical Committee (T/C) meetings and topics to be discussed at the meetings

2. Date and Venue

Date: Friday, 20th September, 2013
Time: 11:00-13:00
Venue: Hall 208, Ministry of Foreign Trade and Economic Relations, Musala 9, 71000 Sarajevo

3. Program

As shown in Annex 1

4. Participants

As shown in Annex 2

5. Discussions and Conclusions

5.1. Inception Report (Ic/R)

Mr. Okuda, Team Leader, JICA Expert Team, gave a presentation to explain the summary of the project plan based on the Ic/R. The S/C members agreed on the overall contents of the Ic/R and proposed project activities.

5.2. Committee Members

Draft lists of S/C and T/C members were distributed to the participants. The members of these committees were confirmed as follows and agreed as shown in Annex 3.

1) Members of Steering Committee
   The S/C members agreed to add the representatives from Tuzla Municipality and Lukavac Municipality to the Steering Committee, as shown in Annex 3.

2) Members of Technical Committee
   The S/C members agreed with the members listed in Annex 3. Other members from the organizations related to the project activities will be added and confirmed later.

5.3. Target Sites

The S/C members confirmed the locations of the target sites in the project, which had been

A.O. [illegible]

already shared and agreed among the S/C members through emails. The following sites are the target sites in this project.

1) Former HAK site in Tuzla, Tuzla Canton
2) White Sea in Lukavac, Tuzla Canton
3) Lake Modrac, in Tuzla Canton
4) Abandoned mining site of Smreka iron mine, processing plant facility of Veovaca lead-zinc mine, and tailing dam of Veovaca, in Vares, Zenica – Doboj Canton

5.4. Plan of Survey

Based on the presentation of site investigation plans by Ms. Takeda, JICA Expert Team, the S/C members confirmed the survey plans for all target sites, after the following comment and response.

1) CRUX Issue in the former HAK site
   Mr. Goran Misic, Assistant Minister, Ministry for Spatial Planning and Protection of Environment of Tuzla Canton asked how to approach the CRUX (industrial waste from polyurethane manufacturing processes) issue on the former HAK site in this project. Mr. Okuda responded that sampling and chemical analysis of CRUX are not planned in the project because it has already been analyzed, but some suggestions for disposal of CRUX will be included in the remediation plan of this project.

5.5. How to Organize Technical Committee meetings

Mr. Okuda presented the ideas about how to organize the T/C meetings and what topics may be discussed at the meetings. The S/C members confirmed that T/C meetings will be held in total two times, at the end of October or the beginning of November 2013, and in January or February 2014. Other technical meetings will be held locally. The S/C members also confirmed that survey methodologies, risk assessment, remediation technologies, risk communication, responsibilities of different stakeholders and financial issues are among the possible topics to be discussed at the T/C meetings.

5.6. Conclusions

At the end of the meeting, the S/C members confirmed that the following items were agreed at the 1st S/C meeting.

- The contents of the Ic/R and activity plan in this project.
- The member of S/C.
- The member of T/C. More members will be added afterwards.
- Four target sites to be investigated in this project.
- The survey plans at all target sites.
- How to organize and what topics will be discussed at the Technical Committee meetings

5.7. Others

Mr. Okuda thanked for the Project office in Faculty of Mining, Tuzla University provided by the Bosnian side.

END

Annex 1: Program of the 1st Steering Committee meeting
Annex 2: Attendance list of the 1st Steering Committee meeting
Annex 3: Lists of committee members

Annex 1: Program of the 1st Steering Committee Meeting

Time	Content	Presentation
11:00 to 11:05	Welcome speech	Ministry of Foreign Trade and Economic Relations
11:05 to 11:10	Opening Remarks	Embassy of Japan
11:10 to 11:30	Project Presentation	JICA Expert Team (Itaru Okuda)
11:30 to 12:00	Plan of survey at the targeted sites	JICA Expert Team (Tomoe Takeda)
12:00 to 12:30	The theme for consideration for a technical committee - Survey methodology at selected locations and Risk Assessment - Selection of technical remediation measures - Risk Communication - The legal framework for environmental liability - Financial mechanism for remediation - Other	JICA Expert Team
12:30 to 12:35	The activities of JICA expert team in 2013th	JICA Expert Team (Itaru Okuda)
12:35 to 12:40	Conclusions	MOFTER
12:40 to 13:00	Preparation of minutes of meetings	MOFTER

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Annex 2: Attendance List of the 1st Steering Committee Meeting

No.	Name	Title	Name of Organization
1	Ms. Nermina Skejovic Huric	Advisor	Ministry of Foreign Trade and Economic Relations
2	Doc.dr.sc. Admir Softic	Advisor – Head of Deputy Minister Cabinet	Ministry of Foreign Trade and Economic Relations
3	Ms. Fadila Muftic	Official	Federal Ministry of Environment and Tourism
4	Mr. Armin Djuliman	Advisor	Federal Ministry of Energy, Mining and Industry
5	Ms. Mirela Uljic	Head of Department of Water Management	Ministry of Agriculture, Forestry and Water management, Tuzla Canton
6	Mr. Goran Misic	Assistant Minister	Ministry for Spatial Planning and Protection of Environment of Tuzla Canton
7	Prof. dr. Nedzad Alic,	Chief of Lab for Geology and Civil Engineering	Faculty of Mining, Geology and Civil Engineering, University of Tuzla
8	Mr. Brano Surkic	Expert Associate for Economic Development	Vares Municipality
9	Ms. Alma Bubic	Senior Associate for Communal Works	Tuzla Municipality
10	Mr. Jozo Tunjic	Chief advisor	Lukavac Municipality
11	Mr. Nedim Mujkic	Coordinator for Infrastructure Works	Lukavac Municipality
12	Mr. Yoshiaki Makino	First Secretary, Chief of Economic Affairs Section	Embassy of Japan
13	Mr. Jun Hirashima	Project Formulation Advisor	JICA Sarajevo Office
14	Dr. Itaru Okuda	Team Leader/ Environmental Management	JICA Expert Team
15	Mr. Hisamitsu Ohki	Member in charge of Hazardous Waste Management	JICA Expert Team
16	Dr. Masako Teramoto	Member in charge of Soil Pollution Control / Pollution Risk Analysis	JICA Expert Team
17	Ms. Tomoe Takeda	Member in charge of Environmental Pollution Survey /SEA/Coordinator	JICA Expert Team
18	Ms. Maida Beslagic	Secretary	JICA Expert Team
19	Ms. Amra Mehmedinovic	Staff	JICA Expert Team

Annex 3: Lists of Committee Members

1) *Steering Committee*

From Bosnia and Herzegovina side

No.	Name	Title	Name of Organization
1	Ms. Nermina Skejovic Huric	Advisor	Ministry of Foreign Trade and Economic Relations
2	Doc.dr.sc. Admir Softic	Advisor – Head of Deputy Minister Cabinet	Ministry of Foreign Trade and Economic Relations
3	PhD Mehmed Cero	Assistant Minister	Federal Ministry of Environment and Tourism
4	Ms. Fadila Muftic	Official	Federal Ministry of Environment and Tourism
5	Mr. Armin Djuliman	Advisor	Federal Ministry of Energy, Mining and Industry
6	Ms. Mirela Uljic	Head of Department of Water Management	Ministry of Agriculture, Forestry and Water management, Tuzla Canton
7	Mr. Goran Misic	Assistant Minister	Ministry for Spatial Planning and Protection of Environment of Tuzla Canton
8	Prof. dr. Nedzad Alic	Chief of Lab for Geology and Civil Engineering	Faculty of Mining, Geology and Civil Engineering, University of Tuzla
9	Mr. Edin Terzic	Minister	Ministry of Spatial Planning, Transport and Communication and Environment of Zenica-Doboj Canton
10	Mr. Sead Cizmic	Assistant Minister	Ministry of Spatial Planning, Transport and Communication and Environment of Zenica-Doboj Canton
11	Mr. Brano Surkic	Expert Associate for Economic Development	Vares Municipality
12	Ms. Kemal Kurevic	Chief Advisor for Communal Works	Tuzla Municipality
13	Mr. Jozo Tunjic	Chief Advisor	Lukavac Municipality
14	Mr. Nedim Mujkic	Coordinator for Infrastructure Works	Lukavac Municipality

From Japanese side

No.	Name	Title	Name of Organization
1	Mr. Toshiya Abe	Resident Representative	JICA Balkan Office
2	Dr. Itaru Okuda	Team Leader /Environmental Management	JICA Expert Team
3	Mr. Hisamitsu Ohki	Hazardous Waste Management	JICA Expert Team
4	Dr. Masako Teramoto	Soil Pollution Control /Pollution Risk Analysis	JICA Expert Team
5	Ms. Tomoe Takeda	Environmental Pollution Survey /SEA/Coordinator	JICA Expert Team

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2) ***Technical Committee (draft)***

From Bosnia and Herzegovina side

No.	Name	Title	Name of Organization
1	Ms. Nermina Skejovic Huric	Advisor	Ministry of Foreign Trade and Economic Relations
2	Doc.dr.sc. Admir Softic	Advisor – Head of Deputy Minister Cabinet	Ministry of Foreign Trade and Economic Relations
3	Ms. Fadila Muftic	Official	Federal Ministry of Environment and Tourism
4	Mr. Armin Djuliman	Advisor	Federal Ministry of Energy, Mining and Industry
5	Ms. Mirela Uljic	Head of department of Water Management	Ministry of Agriculture, Forestry and Water management, Tuzla Canton
6	Ms. Anto Bosankic	Advisor	Ministry of Agriculture, Forestry and Water management, Tuzla Canton
7	Prof. dr. Nedzad Alic	Chief of Lab for Geology and Civil Engineering	Faculty of Mining, Geology and Civil Engineering, University of Tuzla
8	Prof. dr. Franc Andrejas	Associate Professor	Faculty of Technology, University of Tuzla
	To be added		

From Japanese side

No.	Name	Title	Name of Organization
1	Dr. Itaru Okuda	Team Leader /Environmental Management	JICA Expert Team
2	Mr. Hisamitsu Ohki	Hazardous Waste Management	JICA Expert Team
3	Dr. Masako Teramoto	Soil Pollution Control /Pollution Risk Analysis	JICA Expert Team
4	Ms. Tomoe Takeda	Environmental Pollution Survey /SEA/Coordinator	JICA Expert Team

A 7.2 Minutes of Meeting on the Second Meeting of the Steering Committee

MINUTES OF MEETING

OF

THE SECOND MEETING OF THE STEERING COMMITTEE

OF

THE PROJECT FOR MASTER PLAN FOR REMEDIATION OF HOTSPOTS

IN

BOSNIA AND HERZEGOVINA

Sarajevo, 23rd April, 2014

Mr. Itaru Okuda
Team Leader/Environmental Management
JICA Expert Team
Japan

Ms. Nermina Skejovic-Huric
Advisor
Ministry of Foreign Trade and Economic Relations
Bosnia and Herzegovina

Witness:

Mr. Toshiya Abe
Resident Representative
JICA Balkan Office

1. Objectives

The objectives of the 2nd Steering Committee (S/C) meeting were as follows:

- To present the outcomes of the project, and
- To discuss ways forward

This S/C meeting was organized conjointly with the Final Seminar of the Project.

2. Date and Venue

- Date: Wednesday, 23rd April, 2014
- Time: 11:00-13:30
- Venue: Hotel Bristol, Sarajevo

3. Program

As shown in Annex 1

4. Participants

As shown in Annex 2 (S/C members and the observers)

5. Presentations

Following the opening speeches by Ms. Nermina Skejović–Hurić of Ministry of Foreign Trade and Economic Relations (MoFTER), Mr. Mladen Rudez of Federal Ministry of Environment and Tourism (FMoET) and Mr. Yoshiaki Makino of Embassy of Japan, the following four presentations were made in accordance with the program:

- "Outcomes of the Project" by Mr. Itaru Okuda of JICA Expert Team
- "Implementation of Stockholm Convention in BiH" by Ms. Nermina Skejović – Hurić of MoFTER
- "Directions to Remediation of Environmental Hotspots" by Mr. Dragan Sulovic of FMoET
- "Activities of Federal Environmental Protection Fund" by Ms. Sanja Bosiljcic-Pandur of Federal Environmental Fund

The seminar was closed with the closing remarks by Mr. Toshiya Abe of JICA Balkan Office and Ms. Nermina Skejović – Hurić of MoFTER.

6. Discussions and Conclusions

6.1. Final Report

With respect to Final Report of the Project, the following items were confirmed:

- The comments on the Draft Final Report from relevant organizations and responses by the JICA Expert Team are summarized in Annex 3. JICA Expert Team should reflect these changes, and finalize the report as the Final Report in May 2014.

- Ten (10) copies of the Final Report will be printed in Japan and forwarded to MOFTER for distribution.
- The electronic version of the Final Report will become available from the JICA Library in the future.

6.2. Conclusions

The S/C members confirmed the following:

- The project activities in BiH were successfully executed in accordance with the Scope of Work signed in December, 2012.
- The S/C members thanked the efforts made by all the participants, and also promised to make further efforts to resolve the issues of environmental hotspots in BiH.
- The Bosnian side hoped for further opportunities for bilateral cooperation with Japan, and the representative of JICA promised to convey the message to JICA Headquarters in Japan.

END

Annex 1: Program of the 2nd Steering Committee Meeting / Final Seminar
Annex 2: Attendance list of the 2nd Steering Committee Meeting / Final Seminar
Annex 3: Comments on Draft Final Report and Responses

Annex 1: Program of the 2nd Steering Committee Meeting / Final Seminar

Time	Content	Presentation
11:00 to 11:05	Welcome speech	Ministry of Foreign Trade and Economic Relations of BiH
11:05 to 11:10	Welcome speech	Federal Ministry of Environment and Tourism
11:10 to 11:15	Welcome speech	Embassy of Japan or JICA
11:15 to 11:40	*Presentation 1* "Outcomes of the project"	JICA Expert Team Mr. Itaru OKUDA (Team Leader of JICA Expert Team)
11:40 to 12:00	*Presentation 2* "Implementation of Stockholm Convention in BiH"	Ministry of Foreign Trade and Economic Relations of BiH Ms. Nermina Skejović – Hurić (Senior Advisor for Programs and Project)
12:00 to 12:15	Break	Coffee and Snack
12:15 to 12:35	*Presentation 3* "Directions to Remediation of Environmental Hotspots"	Federal Ministry of Environment and Tourism Mr. Dragan Sulovic (Advisor to the Minister)
12:35 to 13:05	*Presentation 4* "Activities of Federal Environmental Protection Fund"	Federal Environmental Protection Fund Ms. Sanja Bosiljcic-Pandur (Chief of Sector for Project Realization)
13:05 to 13:20	*Discussions*	-
13:20 to 13:25	Closing	JICA
13:25 to 13:30	Closing	Ministry of Foreign Trade and Economic Relations of BiH
13:30 to 14:30	Lunch	

Annex 2: Attendance List of the 2nd Steering Committee Meeting / Final Seminar (Steering Committee members and Observers)

Attendance from Steering Committee members

No.	Name	Title	Name of Organization
Members of Bosnia and Herzegovina Side			
1	Ms. Nermina Skejovic Huric	Senior Advisor for Programs and Projects	Ministry of Foreign Trade and Economic Relations (MoFTER)
2	Mr. Mladen Rudez	Assistant Minister	Federal Ministry of Environment and Tourism (FMoET)
3	Mr. Mehmed Cero	Assistant Minister	Federal Ministry of Environment and Tourism (FMoET)
4	Ms. Fadila Muftic	Official	Federal Ministry of Environment and Tourism (FMoET)
5	Ms. Mirela Uljic	Head of Department of Water Management	Ministry of Agriculture, Forestry and Water management, Tuzla Canton
6	Mr. Goran Misic	Assistant Minister	Ministry for Spatial Planning and Protection of Environment of Tuzla Canton
7	Mr. Brano Surkic	Expert Associate for Economic Development	Vares Municipality
8	Ms. Kemal Kurevic	Chief Advisor for Communal Works	Tuzla Municipality
9	Mr. Jozo Tunjic	Chief Advisor	Lukavac Municipality
Members of Japanese Side			
10	Mr. Toshiya Abe	Resident Representative	JICA Balkan Office
11	Mr. Itaru Okuda	Team Leader /Environmental Management	JICA Expert Team
12	Mr. Hisamitsu Ohki	Hazardous Waste Management	JICA Expert Team
13	Mr. Masako Teramoto	Soil Pollution Control /Pollution Risk Analysis	JICA Expert Team
14	Ms. Tomoe Takeda	Environmental Pollution Survey /SEA/Coordinator	JICA Expert Team

Observers

No.	Name	Title	Name of Organization
Bosnia and Herzegovina Side			
1	Ms.Azra Rogovic Grubic	Senior advisor for international cooperation	Ministry of Foreign Trade and Economic Relations BiH
2	Mr. Dragan Sulovic	Assistant Minister for Environment	Federal Ministry of Environment and Tourism, Environment Sector
3	Ms. Zijada Redzic	Expert Advisor for Water Protection	Federal Ministry of Agriculture, Forestry and Water Management

No.	Name	Title	Name of Organization
4	Ms.Aida Pilav	Assistant Minister for public health, monitoring and evaluation	Federal Ministry for Health, Sector for Public Health, Monitoring and Evaluation
5	Mr.Enes Alagic	Advisor to Director for Technical issues	Agency for River Sava Water Basin
6	Mr.Salih Krnjic	Advisor to Director for Technical issues	Agency for River Sava Water Basin
7	Mr.Ibro Kulin	Inspector for Environment	Federal Inspectorate
8	Mr.Ferid Osmanovic	Mining inspector	Federal Inspectorate
9	Mr.Safet Harbinja	Director of Environmental Protection Fund	Environmental Protection Fund
10	Ms.Sanja Pandur Bosiljcic	Expert Advisor for preparation and monitoring of projects	Environmental Protection Fund
11	Ms.Indira Sulejmanagic	Graduate Civil Engineer - Head of the Department	Environmental Protection Fund
12	Mr. Muamer Hajdarevic	Inspector for Environment, Tuzla Canton	Cantonal Environmental Inspectorate
13	Ms.Selma Azabagic	Doctor of medicine, Specialist Expert for Hygiene	Institute for Public Health of Tuzla Canton
14	Ms. Amra Pojskic	Expert Advisor	Ministry of Physical Planning and Environmental Protection, Zenica-Doboj Canton
15	Ms. Branka Pavlic	Expert Advisor for Agriculture	Ministry of Agriculture, Forestry and Water Management , Zenica-Doboj Canton
16	Ms. Senada Malicbegovic	Expert Advisor for Water Management Affairs	Ministry of Agriculture, Forestry and Water Management , Zenica-Doboj Canton
17	Ms. Elvedina Delic	Inspector for Environment, Zenica-Doboj Canton	Cantonal Environmental Inspectorate, Zenica-Doboj Canton
18	Mr. Fadil Sabovic	Manager for quality and human resources	Cantonal Institute for Public Health of Zenica
19	Mr. Nedim Mujkic	Coordinator for infrastructure works	Lukavac Municipality
20	Mr. Hamid Custovic	Full Professor	Faculty of Agriculture and Food Sciences, Sarajevo
21	Mr. Ejub Arapcic	Chief of dam team	Public Enterprise for Water Management Spreča
22	Mr. Enver Cosickic	Director	Public Enterprise for Water Management Spreča
23	Ms. Samila Fuka	Coordinator for public relation	Center for Civil Initiatives
24	Ms. Maja Daul	Company Representative	Dekonta

No.	Name	Title	Name of Organization
25	Ms. Melina Dzajic Valjevac	Water and Soil Survey Expert	Hydro-Engineering Institute, Sarajevo
26	Mr. Maid Hadzimujic	Director	Kemis, Lukavac
27	Mr. Damir Muratovic	Director	Kemokop, Tuzla
28	Ms. Sabina Jukan	Executive director	Association ARHUS
29	Mr. Mahir Madziabdic	Senior Consultant	Enova
Japanese Side			
30	Mr. Yoshiaki Makino	First Secretary, Chief of Economic Affair Section	Embassy of Japan
31	Mr. Jun Hirashima	Adviser for the formulation of projects	JICA Balkan Office
32	Ms. Maida Beslagic	Environmental Expert	JICA Expert Team / Staff
33	Ms. Amra Mehmedinovic	Environmental Expert	JICA Expert Team / Staff

Annex 3: Comments on Draft Final Report and Responses

Comments on Draft Final Report and Responses

19th April 2014

JICA Expert Team

No.	Comment	Responses
Ministry for Spatial Planning and Environmental Protection of Tuzla Canton, Mr. Goran Misic		
1	The master plan is in English language so I am not able to comment on the entire document. That is why I'll keep with the translated summary:	In accordance with the S/W, the report was prepared in English. We will consult with JICA whether it is possible to prepare a Bosnian summary report.
2	On page 3 in Table 1, and further, correct the use of the semicolon in marking numbers on the way that decimal comma is used to separate digits in point of numbers. So now we have the example of Pb max 1.124 mg (one comma one hundred and twenty four) and I guess it should be 1,124 mg (one thousand one hundred twenty four).	To be considered.
3	- On page 3 is listed Former Soda factory in Tuzla and should be in Lukavac.	This was changed from "in Tuzla" to "in Tuzla Canton". Because these sites are investigated only as pilot sites, and we have no intention of revealing the identify of these sites,
ZD Cantonal Ministry, Amra Pojskić ZD Cantonal Administration for Inspection, Ms. Elvedina Delic.		
4	We think related to the point (2), 1) it should be added that in the legal framework of the Federation of Bosnia and Herzegovina there is no law on the protection of land from pollution and there is no any other legislation that treats pollution of land from the aspect of environment.	The comment was noted. We pointed out the lack of specific legislation on management of contaminated sites, and this issue is discussed in Chapter 3 and Chapter 7 of the main report. With respect to protection of land, it covers much wider analysis, including protection of land from erosion, encroachment, and sealing.
5	Also, protection of the water, has not been legally treated in the field of environmental protection, but rather as an area is totally under the subject of the jurisdiction of Water Resources.	The comment was noted. In order to analyze this issue, probably the whole structures of the environmental and water resources laws have to be examined.
6	Related to the point (2), 2): The environmental authorities are exposed to serious shortages of staff, and it is necessary to point out that this problem is particularly pronounced at the cantonal level where this field is completely marginalized, especially if one bears in mind that by the Constitution of Bosnia and Herzegovina and the Constitution of Federation of Bosnia and Herzegovina,	To (2) 2), the following text was added: "both at the entity-level and the cantonal-level". The issue of shortage of staff is also elaborated in Chapter 3 of the main report. In Section 3.3.1 (3), on Ministry of Spatial Planning and Environment, the following sentence was added "For example, Zenica-Doboj Canton used to have only one environmental officer, now two." Also, in Section 3.3.2 (2) Shortage of Expertise, the following sentence

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	environmental protection is under the entity and cantonal jurisdiction. As an example we can mention the example of Zenica-Doboj Canton where Cantonal Ministry worked with one employee in the environmental sector (now we have two employees). It would be necessary to add that on the area of Federation there are no specialized laboratories for testing and measurement, and the existing institutes and other legal entities engaged in these activities are not in satisfactory communications with administrative authorities.	was added: "It was noted that environmental authorities have no in-house laboratories for environmental analysis."
Office for Geology, Mr.Toni Nikolic		
7	p 2-2, Priority Environmental Investment (tables and figures) are translated into hotspots of pollution, which in fact is not correct because in the same are mentioned Borac lake , Treskavica and Igman and other natural resources, in whose protection should be worked out and what's not in the context of this study, because these areas are not polluted to be counted in extra polluted sites, as shown on the map.	Thank you for the comment. The text was reworded to indicate some areas of high environmental values are included in the figure.
8	Page. 2-5, 14 registered landfills are in Tuzla (I would not agree) but well, we can comment this on the meeting with someone who is doing this study from where is collected data .	This is cited from the original Federal Waste Management Plan 2012-2017.
9	Page 3 PCB content (taken benchmark for Austria) What says our law on the contents of the PCB ?	To be checked. There is a new decision entitled "Decision on categorization of surface water and groundwater, reference conditions and parameters for evaluation of water conditions and water monitoring" (Official Gazette of FBiH, No. 01/14).
10	In all, the proposed measures of remediation, as well as the research itself are quite correctly done and I hope that at least some of these points to be processed by the end, and my suggestion would be, of course, if the Japanese are able to accept and finance, to take one point and processed as a pilot project, I think it would be good for both sides. We see that this can be done and possible solution for it, and for JICA to present its technology and expertise in the field of remediation, which should in future projects be supported by the budget of the Federation, or the state of BiH .	Thank you for your comment. This issue may be discussed with JICA.

End of document

Annex 8

CAPACITY DEVELOPMENT ACTIVITIES

Annex 8 CAPACITY DEVELOPMENT ACTIVITIES

This project was short, and after the project, relevant organizations will need to proceed with the actual remediation of hotspots by themselves. Thus, this project was used as an opportunity for capacity development of officers of relevant organizations. The following approaches were taken:

- Investigations of the target sites were treated as case studies, and activities were designed in such a way that officers of related organizations can actively participate in the activities and gain practical experience.
- Remediation of hotspots require concerted efforts of relevant organizations, current owners of the land and facilities and remediation specialists. Thus, various opportunities were created for those stakeholders to coordinate with each other, to exchange opinions, clarify issues, and build a network of skilled people.
- In order to design and implement remedial measures, officers have to understand industrial processes that cause pollution and how to remediate a site. Therefore, opportunities to exchange opinions with representatives of local industries and remediation specialists were created.
- The project also supported officers to learn mechanisms of pollution and risk assessment, which are important to design remediation measures and to communicate with local residents and other stakeholders.

The following activities were used for the approaches indicated above.

1) Joint implementation of site survey

   FBiH needs more experience of environmental surveys of contaminated sites. On the other hand, a survey of contaminated site requires some special attention and experiences. For example, the contaminated area for sampling needs to be estimated with little information. Also, secondary contamination during sampling activities should be prevented. In this project, JICA Expert Team (JET) used a simplified analytical tools as mentioned in Chapter 4 to prepare the sampling plan, and demonstrated to the counterpart and subcontractor how to use such equipment as explained below. Also, during the sampling, the methods of preventing contamination and ensuring safety were discussed with the investigators.

2) Organization of stakeholder meetings

   Two stakeholder meetings were held during the course of the site survey in order to discuss the directions of development of the remediation plans with the stakeholders, such as the officers of the local governments and the site owners. These meetings provided the stakeholders with opportunities to participate in the project activities. Their opinions were reflected in the plans. The summary of the stakeholder meetings are indicated below.

3) Other meeting opportunities

   In addition to the stakeholder meetings, other meetings, such as technical committee meetings, were organized to give stakeholders more opportunities to discuss issues and coordinate with each other. Typical pollution mechanisms and potential hazardous risks were also explained using examples. A large number of people participated in such meetings.

A 8.1 Introduction of Survey Method

Use of a portable X-ray fluorescence (XRF) analyzer, which can detect heavy metals in soil, was demonstrated to the counterpart of Tuzla Canton. The principle of the measurement and the way to use the instrument were explained at first and concentrations of elements in some real samples were measured. The operation is simple, and on site use of such instrument is expected in the future. This method was also introduced to subcontractor at other occasions. Because of the radiation, those who use an XRF analyzer should be properly trained.

Figure A 8.1-1 Introduction of Simplified Analysis Tool

A 8.2 Stakeholder Meetings

The stakeholder meetings were organized at Tuzla Canton on 7th Nov. 2013 and at Vares municipality on 11th Nov. 2013. The expected remediation plans for each target site were discussed with the counterparts from local cantonal or municipality offices, owners of the land/facilities and subcontractor, in order to decide the preliminary remediation plans. The summary of discussion is shown in Table A 8.2-1 and Table A 8.2-2.

Table A 8.2-1 Summary of 1st Stakeholder meeting

Item	Description
Date	7 November 2013
Venue	Tuzla, Ministry for Spatial Planning and Environmental Protection
Participants	Representatives from Ministry for Spatial Planning, Mr. Goran Misic and Mr. Anto Bosankic, Ministry of Agriculture Water and Forestry, Ms. Mirela Uljic, Tuzla Canton Inspectorate, Mr. Muamer Hajdarevic, representative from HEIS Team, representatives from local industries, and JET
Agenda	1. Information on the site survey 2. Presentations about the site survey in general and about the details of the sites: • Former Chemical Factory in Tuzla, • Former Soda Factory in Tuzla • Lake Modrac Tuzla
Summary of discussion	The results of the sampling activities, preliminary results of analysis, and directions for development of remediation plans, in particular the future use of the sites and alternative remediation plans, were discussed.

Source: JET

Table A 8.2-2 Summary of 2nd Stakeholder meeting

Item	Description
Date	11 November 2013
Venue	Vares, Municipality building
Participants	Representatives from Vares Municipality, the mayor of Vares Mr. Avdija Kovacevic, Mr. Brano Surkic and Mr. Ibrahim Spahic, representative from HEIS Team, representatives from local industry and JET
Agenda	1. Information on the site survey 2. Presentations were about site survey in general and about details from the sites: • Abandoned Mining Sites in Vares, for 3 locations
Summary of discussion	The results of the sampling activities, preliminary results of analysis, and directions for development of remediation plans, including issues of land ownership and the possibility of rehabilitation of existing facilities (the processing plant and the tailings dam), were discussed.

Source: JET


Stakeholder meeting in Tuzla


Stakeholder meeting in Vares

Figure A 8.2-1 Photos of Stakeholder Meeting

Annex 9

PHOTOS

	
1st Steering committee (Sarajevo, 20 September 2013)	Sampling survey (Former chemical factory site, Tuzla canton, 21 October 2013)
	
Sampling survey (Former soda factory site, Tuzla canton, 21 October 2013)	Sampling survey (Lake Modrac, Tuzla canton, 22 October 2013)
	
Sampling survey (Abandoned mining sites, Zenica-Doboj canton, 24 October 2013)	1st Technical committee (Sarajevo, 14 November 2013)

	
2nd Technical committee (Sarajevo, 25 February 2014)	Stakeholder meeting (Sarajevo, 11 March 2014)
	
Final seminar and 2nd Steering committee (Sarajevo, 23 April 2014)	

Source: JET