Government of Macedonia
Ministry of Environment and Physical Planning

Annex 9: Special Study E

Industrial Contaminated Sites ("hotspots")

National Waste Management Plan and
Feasibility Studies

Contract No.: 01/MAC05/05/002
Ref. No.: EUROPEAID/115138/D/SV/MK

European Agency for Reconstruction (EAR)
W8468.00.000
Registration number: W8468-C1-03-Annex 9-Special Study E (Industrial Contaminated Sites).doc

September 2005

An EU-funded project managed by the European Agency for Reconstruction
Associated Consultants: DHV-Prowa-SWC, Office address: III Makedonska brigada 10a, 1000 Skopje,
Tel: + 389 2 3289277, e-mail: wp_mepp@moepp.gov.mk

CONTENTS **PAGE**

LIST OF ABBREVIATIONS 3

EXECUTIVE SUMMARY 4

ИЗВРШНО РЕЗИМЕ 7

1 BACKGROUND 11
1.1 Rationale and Scope 11
1.2 Study Scope and Definitions 12

2 THE PROBLEM OF INDUSTRIAL CONTAMINATED SITES 14
2.1 General Issues 14
2.2 Environmental Aspects 14
2.3 Evaluation of the “Hazard Potential” 15

3 MAIN FINDINGS AND RESULTS 16
3.1 Present situation in Macedonia 16
3.2 Inventory and Data Collection 17
3.3 Data Collection and Site Visits 18
3.4 Priority List 18
3.5 Alternative Methods for “Hotspot” Remediation 19
3.6 Aftercare and Future Use of the Location(s) 21
3.7 Cost estimation 21
3.8 Financing of costs 22

4 METHODOLOGY USED 25
4.1 Methodological Approach 25
4.2 Rationale of the Set of Criteria and Scores 27
4.3 Geotechnical Investigations and Laboratory Analyses 28

5 ENVIRONMENTAL LIABILITIES 30
5.1 National Legislation 30
5.2 Environmental Liabilities in the Privatisation 31
5.3 Environmental Auditing and Due Diligence 31
5.4 Best International Practices and Examples of Other Countries 34

6 SITUATION IN THE PROJECT REGION 39
6.1 North-East Region 39
6.2 Central-East Region 40

7 CONCLUSIONS AND RECOMMENDATIONS 43
7.1 Main Conclusions and Recommendations 43
7.2 Medium and long-term actions 44
7.3 Key actors and their responsibilities 45

8 REFERENCES 47

9 COLOPHON 49

ANNEXES

A. Field Report
B. Overview inventoried information on Industrial hotspots
C. Collected data of hotspots per site
D. Summary of collected data of hotspots
E. Priority scoring sheets per hotspot
F. Final Priority Ranking
G. Classification of hazardous waste by limit values of constituents
H. Recommended remediation options and cost estimate details
I. Summary of recommended remediation options and cost
J. Monitoring pollutants
K. Applied unit cost for remediation options
L. GIS presentation of hotspots, Maps. Photo Documentation
M. Summary of required Geo-technical investigations and Laboratory analysis

Disclaimer

The opinions expressed in this Report are those of the authors and do not necessarily reflect the opinions of the European Agency for Reconstruction or any other organisation mentioned in the Report. As a result, this will be verified before implementation of any of the recommendations contained herein.

LIST OF ABBREVIATIONS

BAT	Best Available Techniques
CE	Central-East
DS	Dangerous Substances
EAR	European Agency for Reconstruction
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EU	European Union
GIS	Geographic Information System
GLPs	Good Laboratory Practices
GoM	Government of Macedonia
HWL	Hazardous Waste List
HZW	Hazardous Waste
HZWM	Hazardous Waste Management
IFI	International Financial Institution
IPPC	Integrated Pollution Prevention and Control (EU Directive)
ISIC	International Standard of Industrial classification Rev. 2 1968 (UNIDO)
LoW	List of Wastes
LSG	Local Self Government
LWM	Law on Waste Management
MoEPP	Ministry of Environment and Physical Planning
NACE	The EC statistical office (Eurostat) classification scheme of economic activities. ('Nomenclature générale des Activités économiques dans les Communautés Européennes' [General Industrial Classification of Economic Activities within the European Communities])
NE	North-East
NEAP	National Environmental Action Plan
NWMP	National Waste Management Plan
PEIP-REReP	Priority Environmental Investment Programme – Regional Environmental reconstruction programme
POPs	Persistant Organic Pollutants
REReP	Regional Environmental Reconstruction Program for South Eastern Europe
SMEs	Small and Medium Size Enterprises
SoEs	State owned entities
SW	Solid Waste
SWM	Solid Waste Management
TCLP	Toxicity Characteristic Leaching Procedure
TNA	Training Needs Analysis
ToR	Terms of Reference
UNEP	United Nation Environmental Programme
WG	Working Group
WWT	Waste Water Treatment

EXECUTIVE SUMMARY

Decades of industrialization and extensive exploitation of natural resources have left certain number of areas in the country heavily polluted. Over the past decade, Macedonia has moved from centrally planned economy, with government ownership and management of the means of production, towards free market economy, with varying level of privatisation. Within the process of privatisation, it is essential that old environmental burdens left behind by state-controlled industry be addressed: problems that were once (theoretically) the government's have now been transferred over to new owners, in most cases without clear specification of environmental responsibility. Old environmental contaminated industrial sites represent a serious risk for humans who live in or near the contaminated areas, because of either their direct negative impact on the human health or, indirectly, through pollutants in the food chain production. Currently, Macedonia has no systematic approach or policy for addressing and remediating these environmental hotspots. Their impact is not fully known, clean up costs not systematically estimated; funding for the most part is unavailable; and even "ownership" of these environmental burdens in a post- privatised setting is not clear.

Main findings and results of the study

- In total 16 Industrial Contaminated Sites- "hotspots" are identified and evaluated.
- The total cost of closure/remediation for identified 16 hotspots will require an estimated budget of about EUR 77,000,000 EUR (ranging from EUR 2,700 to 12,700,000).
- The "hotspots" are ranked as follows:

High environmental risk:

1. OHIS A.D (organic chemical industry) at Skopje
2. Bucim copper mine at Radovis
3. MHK Zletovo (lead and zink smelter) at Veles.

Medium environmental risk:

4. Lojane (former chromium, arsenic, antimony mine) at Kumanovo
5. Sasa (lead and zinc mine) at Mak. Kamenica
6. Silmak ferro-silicon plant (former HEK Jugochrom) at Jegunovce
7. Toranica (lead and zink mine) at Kriva Palanka
8. Makstil (iron & steel plant) at Skopje
9. Zletovo mine (lead and zink mine) at Probistip
10. REK Bitola (Thermal power plant and lignite mine) at Bitola.

Low environmental risk:

11. Feni Industry (ferro-nickel smelter) at Kavadrci
12. MHK Zletovo (fertiliser factory) at Veles
13. REK Oslomej - ESM (Thermal power plant and coal mine) at Kicevo
14. Godel tannery at Skopje
15. OKTA Rafinerija AD (oil refinery) at Skopje
16. Tane Caleski (metal surface treatment) at Kicevo.

- The cost of the most urgent top 3 ranked sites (OHIS – organic chemical industry, BUCIM –copper mine and MHK ZLETOVO – lead and zinc smelter) will amount to about EUR 37,000,000.

- 14 sites need additional exploratory soil & groundwater survey and delineation investigation, before feasibility studies and remediation planning can be carried out. The costs of these works vary per site from EUR 2,000 to EUR 200,000 and the total costs are estimated at EUR 900,000.
- At 9 sites permanent periodical monitoring of groundwater and/or surface water is required, of which the cost vary per site from EUR 650 to EUR 50,000 per year, and the total cost are estimated at EUR 150,000 per year.
- Proven contamination of the environment (exceeding standards for soil, groundwater and/or surface water quality) is found at 4 industrial sites:
  - Bucim copper mine at Radovis
  - MHK Zletovo (lead and zink smelter) at Veles
  - Lojane (former arsenic, antimony mine) at Kumanovo
  - Silmak ferro-alloy plant (former HEK Jugochrom) at Jegunovce.
- The following sites are considered too small to be classified as 'hotspots', and were omitted from the List of hotspots. They are nevertheless included in the list because they need eventually to be remediated by the government when no private takeovers will appear:
  - Godel Tannery (closed)
  - OKTA Rafinerija AD (operational)
  - Tane Caleski (closed).
- The following hotspots are already subject to former, ongoing or planned investigation and/or remediation:
  - Bucim copper mine: Ongoing EU remediation programme "Intreat"
  - Lojane (former chromium, arsenic, antimony mine): Planned UNDP remediation investigation
  - Silmak ferro-silicium plant (former HEK Jugochrom): Ongoing EAR funded restructuring plan
- The various remediation options are:
  - Selective demolition and safe removal of obsolete constructions.
  - Removal and repackaging of redundant hazardous substances for destruction abroad.
  - Excavation of hazardous waste and contaminated soil and safe disposal at secure HZW landfill.
  - Reshaping of dumpsites (bringing together of scattered waste dumps for further remediation).
  - Covering of existing large dumpsites of non-hazardous waste with soil followed by reforestation.
  - Isolation of dumpsites of hazardous or leacheable waste by bunding, capping with impermeable multi layer, and drainage system
  - Hydrological containment by groundwater extraction and treatment.
  - Special treatment such as temporary coating with polymer compound awaiting recovery, collection and treatment of runoff water, and excavation and crushing for use in (road) building materials.

Recommendations to the NWMP for remediation of 16 identified hotspots

- Follow up study/projects for exploratory soil & groundwater survey and delineation investigation, including feasibility studies and remediation planning for the 3 top

ranked sites (OHIS, Bucim and Zletovo Smelter); estimated cost about EUR 420,000 in 2006.
- Critical following and monitoring of 2 ongoing investigation/remediation projects (Lojane and Silmak).
- Fund raising and financial negotiations with new owners (Bucim and possibly Zletovo Smelter) based on the feasibility studies in 2007.
- Implementation of the closure/remediation measures (at a total estimated amount of about EUR 37,000,000) for the top 3 from 2008 to 2012.
- Implementation of groundwater monitoring programme for the top 3 “hotspots” at about EUR 70,000 per year estimated cost from 2012 onwards.
- Exploratory soil & groundwater survey and delineation investigation including feasibility studies and remediation planning for the remaining 11 sites from 2012 onwards; estimated cost at a total of about EUR 500,000.
- Implementation of closure/remediation projects for the remaining 13 sites (including Lojane and Silmak) at a total amount of about EUR 46,000,000 whenever the opportunity occurs in the current planning period (2006-2012), as alternatives.

Recommendations to the NWMP for environmental liabilities

- Given the lack of regulatory provisions, both in the privatisation law and in environmental law, as well as the present lack of the institutional framework and funding mechanism, there seems no other choice than to solve this problem on a case-by-case approach. However, it is recommended that the Government make some additional implementing regulations in this respect. This should include:
  - A representative of the MoEPP to be present within the Committee, making the decisions.
  - Compulsory Environmental Audit, responsibility of the Privatisation Agency.
  - As part of this audit to specify the remediation options and necessary investments.
  - Agreement on who will pay for the closure/remediation costs (e.g. state and/or buyer) and who will be responsible to execute the works involved.
  - Agreement that (hazardous) waste handling costs after taking over of the facility is fully the responsibility of the new owner.
  - Macedonia needs to develop sound legal system and procedures to address the liability issue in “hotspots” remediation. The legal system needs to incorporate:
    - Legal framework, as pre-condition for launching clean-up process of past environmental pollutions;
    - Solid institutional framework, with clear responsibilities of relevant institutions and other stakeholders;
    - Viable funding mechanism;
    - Remediation procedures based on Environmental Audit and Risk Assessment methodologies.

ИЗВРШНО РЕЗИМЕ

Декадите на индустријализација и засилено експлоатирање на природните ресурси оставиле одреден број на многу загадени региони во земјата. За време на изминатата декада, Македонија премина од централно планирана економија со владина сопственост и управување со производствените средства кон слободна пазарна економија со варијабилно ниво на приватизација. Со процесот на приватизација, основно е да се обрати внимание на старите еколошки жаришта оставени од индустриите, контолирани од државата. Проблемите што некогаш (теоретски) беа владини, сега се префрлени на новите сопственици, во повеќе случаи без јасно специфицирање за обврските кон животната средина. Старите еколошки контаминирани индустриски подрачја претставуваат сериозен ризик за луѓето кои живеат во или близу до контаминираните региони, било поради нивното директно негативно влијание на човековото здравје или индиректно преку полутантите во синџирот на производство на храна. Моментално, Македонија нема систематски приод или политика за третирање или рекултивација на овие еколошки "жешки точки". Нивното влијание не е целосно познато, трошоците за нивно чистење не се систематски проценети; финансирање за најголем дел од нив е недостапно; па дури и "сопственоста" на овие еколошки жаришта во пост-приватизационата поставеност не е јасна.

Главни заклучоци и резултати на студијата

- Вкупно 16 индусатриски контаминирани локации - "жешки точки" се идентификувани и проценети
- Вкупните трошоци за затворање / ремедијација на идентификуваните 16 "жешки точки" ќе бараат приближнопроценет буџет од 77,000,000 Евра (во опсег од 2,700 евра до 12,700,000 евра).
- "Жешките точки" се рангирани како што следува:

Висок ризик по животната средина:

1. ОХИС А.Д (органско хемиска индустрја) во Скопје
2. Бучим рудник за бакар во Радовиш
3. МХК Злетово (топилница за олово и цинк) во Велес.

Среден ризик по животната средина:

4. Лојане (поранешен рудник за хром, арсен и антимон) во Куманово
5. Саса (рудник за олово и цинк) во Македонска Каменица
6. Силмак погон за феро-силициум (поранешен ХЕК Југохром) во Јегуновце
7. Тораница (рудник за олово и цинк) во Крива Паланка
8. Макстил (производство/преработка на железо и челик) во Скопје
9. Рудник Злетово (рудник за олово и цинк) во Пробиштип
10. РЕК Битола (Термо Електрична Централа и рудник за лигнит) во Битола.

Низок ризик по животната средина:

11. Фени индустри (топилница за железо и никел) во Кавадрци
12. МХК Злетово (фабрика за вештачки ѓубрива) во Велес
13. РЕК Осломеј (Термо електрична централа и рудник за јаглен) во Кичево
14. Годел кожара во Скопје
15. ОКТА Рафинерија АД (рафинерија за нафта) во Скопје

16. Тане Цалески (површинска обработка на метали) во Кичево.

- Трошоците за најургентните три локации (ОХИС - органско хемиска индустрија, БУЧИМ- рудник за бакар и МХК ЗЛЕТОВО - топилница за олово и цинк) ќе изнесуваат околу 37,000,000 евра.
- За 14 локации има потреба од дополнителни анализи и истражување на почва и подземна вода пред да се изработат физибилити студии и планови за рекултивација. Трошоците за овие работи варираат според локација од 2,000 до 200,000 евра, а вкупните трошоци се проценети на 900,000 евра.
- На девет локации е потребно да се врши постојан периодичен мониторинг на подземна вода и/или површинска вода за што трошоците зависно од локацијата варираат помеѓу 650 и 50,000 евра годишно, а вкупните трошоци се проценети на 150,000 евра годишно.
- Докажана контаминација на животната средина (која ги надминува стандардите за квалитет на почва, подземна вода и/или површинска вода) има на 4 индустриски локации:
  - Бучим рудник за бакар во Радовиш
  - МХК Злетово (топилница за олово и цинк) во Велес.
  - Лојане (поранешен рудник за арсен и антимон) во Куманово
  - Силмак погон за феро-легури (поранешен ХЕК Југохром) во Јегуновце
- Следните локации се сметаат за многу мали за да бидат класифицирани како “жешки точки” и беа изземени од листата на “жешки точки”. Но, сепак тие беа вклучени во листата, бидејќи на крајот доколку тие не бидат приватизирани, нивната ремедијација ќе треба да ја направи Владата.
  - Годел кожара (затворена)
  - ОКТА Рафинерија АД (во функција)
  - Тане Цалески (затворена)
- Следните “ жешки точки” се веќе предмет на претходно, тековно или планирано истражување и/или рекултивација:
  - Бучим рудник за бакар: Тековна ЕУ програма за ремедиација "Intreat"
  - Лојане (поранешен рудник за хром, арсен и антимон) во Куманово, Планирано истражување од УНДП за ремедиација
  - Силмак погон за феро-силициум (поранешен ХЕК Југохром): Тековен план за рекултивирање, подржан од EAR
- Различни техники за ремедиација се:
  - Селективно рушење и безбедно отстранување на старите објекти
  - Отстранување и препакување на остатоци од опасни материи за нивно поматамошно згрижување (во земјата или пак во странство)
  - Откопување на опасен отпад и контаминирана почва и безбедно исфрлање на санитарна депонија за опасен отпад.
  - Земјени работи на постоечките локации со индустриски отпад (собирање на распростанетите индустриски мали депонии на едно место за понатамошна рекултивација)
  - Покривање на постоечките индустриски депонии со комунален отпад со земја и потоа засадување со култури.
  - Изолација со поставување на бариери, препокривање со непропуслива повеќеслојна подлога и систем за дренирање на индустриските депонии со опасен отпад или како и можноста од појавување на исцедок
  - Спречување на загадувањето на подземните води со третман на исцедокот

- Специјален третман, како времено препокривање со полимерни состојки, до очекуваното пречистување, собирање и третман на вода, ископување, како и кршење на градежни материјали за следна употреба (патишта)

Препораки на НПУО за ремедиација на 16 идентификувани "жешки точки"

- Следни предвидени студии/проекти за анализа и истражување на почва и подземна вода, вклучувајки физибилити студии и планирање за рекултивација за првите три рангирани локации (ОХИС, Бучим и топилница Злетово); проценети трошоци околу 420,000 евра, во 2006.
- Критичко следење и мониторинг на два тековни проекти за истражување/ ремедиација (Лојане и Силмак).
- Изнаоѓање на фондови и финансиски преговори со новите сопственици (Бучим и можеби топилница Злетово) базирани на физибилити студиите во 2007.
- Имплементација на мерки за затворање / рекултивација (на вкупно проценета сума од околу 37,000,000 евра) за првите три рангирани, од 2008 до 2012.
- Имплементација на програма за мониторинг на првите три "жешки точки" за околу 70,000 евра годишно, трошоци проценети од 2012 година, па натаму.
- Анализи и истражување на почва и подземна вода, вклучувајки физибилити студии и планирана рекултивација за останатите 11 локации од 2012 година па натаму; вкупно проценети трошоци од околу 500,000 евра.
- Имплементација на проекти за затворање / рекултавација на останатите 13 локации (вклучително Лојане и Силмак), во вкупна сума од околу 46,000,000 евра, како алтернативи кога ќе се укаже можност во тековниот период на планирање (2006-2012).

Препораки на НПУО за одговорност кон животната средина

- Поради недостатокот на регулаторни одредби и во Законот за приватизација и во Законот за животна средина, како и поради моменталниот недостаток на институционална рамка и механизми за финансирање, изгледа дека нема друг избор освен решавање на овој проблем случај по случај. Затоа, се препорачува Владата да направи дополнителни регулативи за имплементација, притоа треба да се вклучат:
  - Претставник на МЖСПП, кој ќе биде присутен во Комитетот за донесување на одлуки
  - Задолжителен аудит за животна средина, одговорност на Агенција за приватизација
  - Како дел од овој аудит да се специфицира опција за рекултивација и неопходните ивестиции
  - Договор за тоа кој ќе ги плати трошоците за затворање/рекултвација (пр. државата и/или купувачот) и кој ќе биде одговорен за извршување на работите.
  - Договор дека трошоците за постапување со (опасен) отпад по превземањето на постројката се целосна одговорност на новиот сопственик
  - Македонија има потреба да развие здрав правен систем и процедури кои се однесуваат на прашањата за одговорност при ремедиација на "жешки точки". Правниот систем треба да вклучува:
    - Правна рамка како предуслов за отпочнување на процеси за чистење на поранешни загадувања на животната средина
    - Здрава институционална рамка, со јасни одговорности на релевантните институции и другите носители.
    - Одржлив механизам на финансирање;

- Процедури за рекултивација базирани на аудит за животна средина и методологии за проценка на ризикот.

1 BACKGROUND

1.1 Rationale and Scope

Macedonia adopted its Act on Environment and Nature Protection and Promotion in 1996, and the now named Ministry of Environment and Physical Planning (MoEPP) was established in 1998. In the framework of the EU 2001 National CARDS Programme, support was foreseen to develop environmentally and financially sustainable solid waste management systems in Macedonia. In the framework of the EU 2001 National CARDS Programme, a contract has been formulated for; Component 1: preparation of a National Waste Management Plan and Feasibility Studies in the Macedonia and; Component 2: preparation of a bankable investment study for a Waste Management system in the North-East and the Central-East Regions. The total project budget (conform Addendum 3, November 2004) is € 1.398.199. The two project components concern the following:

Component 1: National Waste Management Plan and Feasibility Studies
This component concerns the development of NWMP for Macedonia. The document to be delivered will be a coherent and comprehensive National Waste Management Plan for Macedonia, which is compliant with common EU directives. The NWMP will recommend national waste management policies and principles, as well as plans of actions, timeframes for implementation, financing schemes and reporting/monitoring system. It will include proposals for the establishment of regional integrated solid waste systems and infra structures, including the recommendations for closure/remediation of illegal land-fills/wild dumps and industrial 'hotspots'. In order to substantiate the National Waste Management Plan, the following Special Studies will be executed:

- *Study A: Waste Reduction-Recovery-Recycling.* This study concerns the feasibility on a national scale of the options for reduction-recovery and recycling of solid wastes, in the perspective of the relevant EU directives.
- *Study B: Regionalisation of SWM systems.* This study concerns the analysis of the optimal solution for the establishment of regional WM systems, focusing on the optimal number of new landfills to be established in Macedonia.
- *Study C: Closure/Reclamation existing Landfills.* This study concerns the evaluation of the methods and involved costs of the closure and/or remediation of the many sub standard and environmentally dangerous landfills in Macedonia.
- *Study D: Cost Recovery and Economic/Financial Instruments.* This study concerns the feasibility of additional financial measures and instruments to be introduced, to arrange for an increased financial sustainability of improved WM systems.
- *Study E Contaminated Industrial Sites.* This study concerns the evaluation of the methods and involved costs of the rehabilitation and/or temporary solutions for of the various heavily polluted industrial sites in Macedonia.

In order to facilitate the sustainability of the project outcomes, also a capacity building, a database and monitoring and a public awareness program for the Ministry of Environment & Physical Planning will be developed in the course of the project.

Component 2: Regional Waste Management Plan for NE/CE-Region

This component concerns the development of a bankable feasibility study for the North-east and Central-East Regions of Macedonia. These both regions include 25 Municipalities and about 375.000 inhabitants. The feasibility study comprises the development of a technical and institutional regional waste management concept – for improved collection, transport and disposal – as well as the related cost estimates. Next to this it will focus on plans for improved handling of other waste streams (industrial hazardous waste, medical waste, agricultural waste) and on recommendations to close or remediate illegal landfills/wild dumps, as well as on remediation measures for industrial polluted industrial sites ('hotspots'). The feasibility study comprises the two main elements:

- *Present Situation ('Without Scenario').* This analysis concerns primarily the assessment of the present WM situation and practices in both North-East & Central-East Region.
- *Future Situation ('After Project/EU Scenario').* This part of the study concerns the set up of the investment/feasibility of an upgraded regionalized waste management plan, meeting the main requirements of the most relevant EU directives for waste management

1.2 Study Scope and Definitions

Within Component 1 some special studies are identified. This report is dealing with: Special Study E: Industrial Contaminated Sites ('hotspots'). The general objectives of this special study are:

- Gathering and reviewing existing data on 'hotspots'
- Specification of a methodology to identify the potentially most environmental dangerous industrial 'hotspots' in Macedonia, including sample taking of the identified and selected industrial 'hotspots'
- Prioritisation and selection of the potentially most environmental dangerous industrial hotspots
- Formulation of Conclusions and Recommendations for mitigation/remediation of the hotspots
- Estimation of involved cost of mitigation/remediation.

It needs to be stated that this special study was confined to closed and operational industrial sites where potentially hazardous waste in the past was or still is stored or disposed of in an uncontrolled way. Hence this report does not deal with the environmental aspects of industrial sites and processes that potentially generate hazardous waste or endanger the environment by the use or emission of (potentially) hazardous substances.

Definitions

In this study, the definitions apply as listed in the national Law on Waste [Ref 1]. Besides these formal definitions, for the purpose of this study, the following special definitions apply:

Hotspot:	An industrial site where in the past or currently significant quantities of waste with hazardous characteristics are stored or deposited in an uncontrolled way.

Dumpsite:	A site within or outside an industrial enterprise were waste is deposited in an uncontrolled way.
Hazardous waste:	Any waste that has one or more hazardous properties such as: explosive, reactive (oxidizing), flammable, irritant, corrosive, toxic, infectious, carcinogenic, mutagenic, toxic to reproduction, eco-toxic, and properties of toxic gasses release when getting in contact with water, air or acid, specified in accordance with this Law or other regulation, and listed and specifically designated as hazardous in the List of Wastes, including any waste that is mixed with hazardous waste
Secure landfill:	Landfill designed according EU guidelines (Directive 91/689/EEC), and equipped and operated to deposit hazardous waste in a controlled and secure way.
Sanitary Landfill:	Landfill designed according EU guidelines (Directive 99/31/EC), and equipped and operated to deposit domestic waste in a controlled way.
Capping:	Covering of a waste deposit or landfill with a multi layer capping, consisting of clay or bentonite, followed by a synthetic liner, a separation fabric, a sand or gravel layer, a filter fabric and a final layer of clean, native soil.
Freatic	The often seasonally fluctuating ground package firstly under the ground water surface.
Piezometer:	A filter tube with a diameter of 25 or 50 mm, placed in a borehole with gravel or sand bed, reaching 2 m below the lowest freatic groundwater level, meant to measure the groundwater table and to take representative samples of the freatic groundwater.
Leachate:	Percolation water and runoff rainwater of a landfill or waste deposit.

2 THE PROBLEM OF INDUSTRIAL CONTAMINATED SITES

2.1 General Issues

The mining and metallurgy sector in Macedonia have a long history. Lead and silver, for instance had been produced at several locations of the Zletovo region during the Roman period. Most of the industrial capacities, however, have been built during the 1970's and 1980's. The core technologies applied were state-of-the-art for several years after the start-up period, but the auxiliary facilities and the management practices were far below the standards required for minimising waste generation and proper waste management. There is a number of reasons for this gap between the core technologies and the waste management practices such as: lack of knowledge and information of the seriousness of the problem, lack of relevant law covering waste management and subsequently lack of enforcement, undefined property of landfill sites, inadequate ground water monitoring etc. As the waste on the landfills accumulated, its impact on the environment increased: heavy metals reported in groundwater at some industrial locations and organic compounds at others, while mines produce considerable amounts of mine and/or flotation tailings.

Lignite, copper ore, nickel ore and non-metal minerals are extracted by open pit mining in Macedonia, while lead and zinc ores are extracted by underground mining. The latter technique was also applied to antimony ore and asbestos extraction. Apart from the continuous impact on the environment several major accidents resulting in flooding a wide area around the landfills and contaminating the surface and ground water have already been experienced. The most recent accident happened in Sasa lead and zinc mine in 2003. Couple of years earlier a similar accident happened in the Bucim copper mine.

Macedonian companies faced severe problems during the transition period and some of them even prior to it. Several companies have stopped their activities with no chances to be restarted in the near future. Their landfills are also abandoned and little or no information can be obtained on the history of waste disposal and waste management. Due to indistinct ownership, allocation of the environmental liability is a very difficult task. In most cases the state is the only responsible party left.
Other companies have temporarily stopped production but hopefully will continue to operate soon after transferring the ownership. Clear indication of environmental liabilities in the contracts between the Government/present private owners and the new owners is of utmost importance for ensuring proper remediation and further use of the sites.

2.2 Environmental Aspects

The main environmental risks of uncontrolled dumpsites of industrial hazardous waste are:

- Contamination with hazardous substances of freatic groundwater under and downstream of the dumpsite by percolating and runoff rainwater (generally referred to as ‘leachate’).
- Contamination of surrounding land by infiltration of runoff rainwater and/or deposit of airborne dispersion of hazardous substances.

- Contamination of nearby surface water through direct discharge of runoff water or contact/exchange with contaminated groundwater.

The main possible impacts of above listed risks are:

- Contaminated well water intended for drinking water, livestock feed, and irrigation water thus threatening the health of humans and animals.
- Contaminated surface water causing damage to aquatic life and limiting the use as feedstock for drinking water preparation.
- Bioaccumulation of toxic substances in the food chain, and in the natural flora and fauna.
- Deterioration of the quality and decrease of the value of agricultural land and urban development land (loss of property).

2.3 Evaluation of the "Hazard Potential"

The hazard potential of hotspots are mainly defined by the following parameters:

- Hazard and toxic characteristics of the disposed waste
- Leacheability of the waste
- Height or thickness of the waste dump
- Level of the freatic groundwater
- Permeability of the sub-soil (k-factor)
- Presence of nearby surface water
- Erosion of the top layer of the dumpsite causing airborne dispersion

These critical parameters have been quantified and used in the methodology of prioritisation of the hotspots (refer to Chapter 4).

3 MAIN FINDINGS AND RESULTS

3.1 Present situation in Macedonia

3.1.1 Existing reports and data

For the selection of known, suspected, and potential industrial hotspots a desk study was carried out and the following documents were consulted and reviewed:

- NEAP I; Part "Analyses and Estimation of the Conditions and the Solid Waste Management", 1996
- Hazardous Materials Study, Mining institute, Skopje, 1996
- National Solid Waste Management System, Krueger/VKI/Symonds, 1999
- Post Conflict Environment Assessment for Macedonia; UNEP, 2000
- Feasibility Study for Urgent Risk Reduction Measures at hotspots in Macedonia; UNEP, August 2001
- Report on HZW Management in Republic of Macedonia, EPR-2002,
- Developing a Priority Environmental Investment Programme for South Eastern Europe (PEIP-REReP), August 2003
- National Cadastre of Polluters, MOEPP, 2002
- Environmental Audit; Adam Smith Institute (ASI), 2003
- NEAP II; Draft DPSIR Report – Waste; 2004
- Draft regulation on Hazardous Waste Management, GOPA Consultants, 2004
- Other documents where some data could be found [Ref 5].

The information found in these documents is presented in Annex B. Based on this information the following 16 (former) industrial dumpsites have been selected for further investigation. The map with the locations of the “hotspots” identified in Republic of Macedonia is presented in Figure 1. Table 1 is presenting the name, type of industry and the municipality of the “hotspot”.

Figure 1: Hotspots” in Macedonia

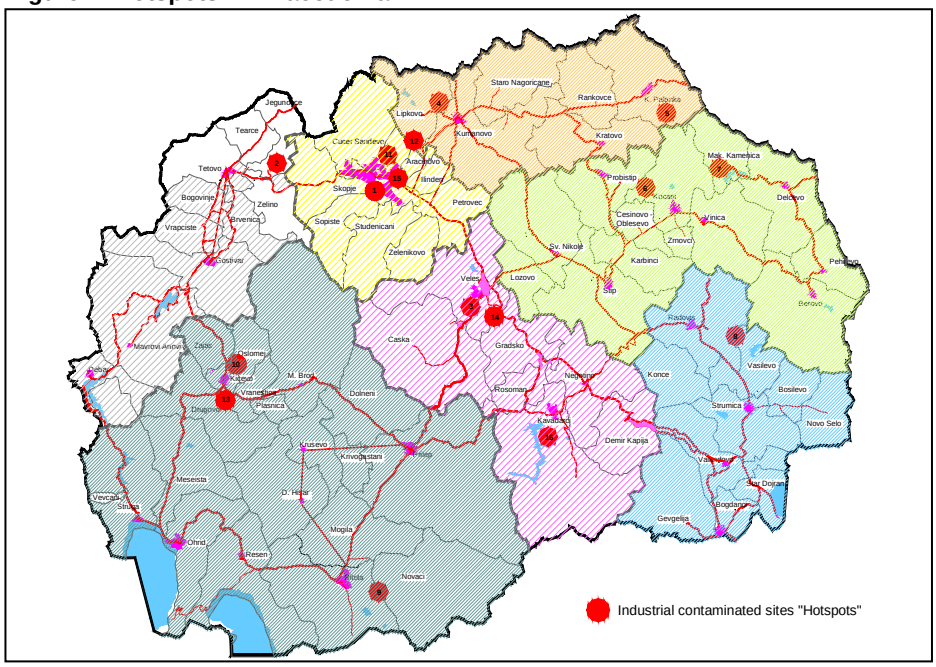


Table 1: Identified industrial contaminated sites - "hotspots"

Nr.	Site ('hotspot')	Municipality	Status of operation	Environmental Liability
1.	OHIS Chemical Industry	Skopje	Abandoned, partly operational	Macedonia /OHIS
2.	Silmak Ferro/Silicium Smelter (former HEK Jugochrom)	Jegunovce	Dumpsite closed	Arbitrary
3.	MHK Zletovo Lead/zinc Smelter	Veles	Closed (2 yrs)	Due diligence
4.	Lojane Chromium/antimony Mine	Lojane	Abandoned (30 yrs)	Macedonia
5.	Toranica Lead/zinc Mine	Kriva Palanka	Closed (>5 yrs)	Macedonia
6.	Zletovo Lead/zinc Mine	Probistip	Closed (3 yrs)	Macedonia
7.	Sasa Lead/zinc Mine	Makedonska Kamenica	Closed (3 yrs)	Macedonia
8.	Bucim Copper Mine	Radovis	Operational	Arbitrary
9.	REK Bitola (lignite mine/power plant)	Bitola	Operational	REK Bitola
10.	REK Oslomej (lignite mine/power plant)	Kicevo	Operational	REK Oslomej
11.	Makstil Steelworks	Skopje	Operational	Makstil
12.	OKTA (petroleum refinery)	Skopje	Operational	OKTA
13.	Tane Caleski (metal products)	Kicevo	Closed (3 yrs)	Macedonia
14.	MHK Zletovo Fertilizer Plant	Veles	Closed (2 yrs)	Macedonia
15.	Godel Tannery	Skopje	Closed (5 yrs)	Macedonia
16.	Feni Industry (ferro-nickel alloys)	Kavadarci	Operational	Feni industry

3.2 Inventory and Data Collection

Based on the review of the listed documents and subsequent site visits, the data of the suspected hotspots have been inventoried. A database of the Industrial hotspots has been prepared. Separate spreadsheets indicating data from every source available on each of the listed hotspots have been developed. The collected data of each site is presented in Annex C and the summary of all inventoried hotspots is given in Annex D.

At most of the inventoried sites (11) a field visit has been paid (refer Annex A: Field Report).

The following key information was found in the desk study and field visits:

- The aggregate number of potential industrial hotspots is 16 (listed above), with following characteristics:
  - 5 non-ferro metal mines of which 4 are closed (Sasa, Toranica, Zletovo and Lojane), and one is recently reopened (Bucim)
  - 2 Power stations with lignite mines (both operational)
  - 4 Metallurgical industries (MHK Zletovo (smelter), Silmak, Makstil, Feni) of which 1 closed (MHK Zletovo (smelter))
  - 2 Chemical industries (OHIS, MHK Zletovo (fertiliser plant)) of which OHIS is partly operational and MHK Zletovo (fertiliser plant) is closed
  - 1 Petroleum Refinery (operational)

- 2 other industries, all closed (Godel Tannery, Tane Celesky).

- Two sites were or will be subject to an environmental assessment other than this NWMP project. This concerns Silmak (former HEK Jugochrom) at Jegunovce, which was a subject of an EAR funded project (2003-2004), and Lojane chromium & antimony mine, which is presently concerned in an UNDP funded project in 2005. These studies will provide sufficient information for prioritisation, so these sites were excluded from further investigation under the NWMP project.
- Groundwater monitoring wells are already in place in a few sites; 3 of them are operational (Silmak, Sasa mine, and Zletovo mine). The field study revealed that groundwater is/or was monitored at 9 sites. However, reliable groundwater quality data could not be obtained due to the different purposes and parameters monitored. At fly ash landfills, for instance, only the water level is monitored. At flotation tailings landfills a limited number of parameters are monitored and the piezometers are located in the core of the dam, which do not present a clear situation of the quality of ground water.
- A selection of those monitoring wells properly constructed, is proposed to be used for sampling of groundwater under this project.
- For most sites (14) a geotechnical site investigation by sampling and analysis of waste, soil, and groundwater is indicated to obtain a better understanding of the existence, extent, and potency of environmental hazard and pollution of soil, groundwater and surface water.

Basic information about each of the “hotspots” (as a GIS presentation) can be found in Annex L, followed by maps as well as photo documentation of the sites.

3.3 Data Collection and Site Visits

Some crucial data were missing in the reviewed documents. For most of the hotspots no data were found on the size of the area. For few sites groundwater samples have been taken in the past, however these data are not fully available or reliable. A UNEP team of experts has made initial investigations at nine contaminated sites, of which 2 in more detail. No deeper soil or groundwater samples, however, have been taken. Evidence was found of presence of deposited hazardous substances, but there is no evidence of substantial groundwater pollution.

None of the industrial dumpsites operates as properly constructed landfills. Moreover, there is clear evidence of inadequate manners of disposing the hazardous waste. In the organic chemicals company OHIS, for example, layers of lindane waste fractions and soil are stacked alternatively over each other. This way of operation has increased the volume of hazardous waste by a factor of 2.5 and has made some of the remediation methods inappropriate.

3.4 Priority List

Each selected site has been scored for the specified risk criteria (refer to chapter 4.2), allowing a priority ranking of most polluted or potentially environmentally dangerous sites. The outcomes of the scoring exercise for each site are presented in Annex E and the

resulting priority ranking of hotspots is presented in Annex F. The results are summarised in the Table 2.

Table 2: Summary of priority ranking of industrial contaminated sites - "hotspots"

Rank	Hot-spot	Status of operation	Municipality	Score *)
1	OHIS A.D (organic chemical industry)		Skopje	0.99
	- former chlor-alkali plant	abandoned (5 yrs)		
	- former lindane plant	abandoned (30 yrs)		
	- HCH dump site	Abandoned (covered)		
	- mixed waste dump site	operational		
2	Bucim copper mine [1])	operational	Radovis	0.96
	- flotation tailings dumpsite	recently reopened		
	- mine tailings dumpsite			
3	MHK Zletovo (lead and zink smelter)	partly closed (2 yrs)	Veles	0.89
	- oven slag disposal	reopening under		
	- coke and slag tip	negotiations		
	- diffuse cadmium contamination in surrounding village			
4	Lojane (former chromium, arsenic, antimony mine)[2]	abandoned (30 yrs)	Kumanovo	0.76
5	Sasa lead and zinc mining	closed (3 yrs)	Mak. Kamenica	0.73
6	Silmak ferro-silicium plant (former HEK Jugochrom)[3]	closed (10 yrs)	Jegunovce	0.71
7	Toranica lead and zink mining	closed (>5 yrs)	Kriva Palanka	0.63
8	Makstil (iron & steel plant)	operational	Skopje	0.61
9	Rudnici Zletovo (lead and zink mining)	closed (3 yrs)	Probistip	0.60
10	REK Bitola (Thermal power plant and coal mine)	operational	Bitola	0.53
11	Feni Industry (ferro-nickel smelter)	operational	Kavadrci	0.39
12	MHK Zletovo (fertiliser factory)	closed (2 yrs)	Veles	0.38
13	REK Oslomej-ESM (Thermal power plant/coal mine)	operational	Kicevo	0.37
14	Godel tannery [4])	closed (5 yrs)	Skopje	0.35
15	OKTA Rafinerija AD (oil refinery) [4])	operational	Skopje	0.34
16	Tane Caleski (metal surface treatment) [4])	closed (3 yrs)	Kicevo	0.34

Legend

[1] Ongoing EU remediation programme "Intreat"

[2] Ongoing UNDP remediation investigation

[3] EAR funded remediation project (2003-2004)

[4] Possible soil & groundwater contamination likely not caused by waste disposal

High risk (proven contamination to a large extent of soil & groundwater)

Medium risk (potential contamination of soil & groundwater to a significant extent)

Low risk (no or limited contamination expected to a small extent)

3.5 Alternative Methods for "Hotspot" Remediation

The following methods have been selected by the team of experts and are evaluated for remediation of the hotspots:

1. Reshaping of dumpsites in order to limit the surface to be covered.
2. On-site covering of dumpsite with soil and reforestation (if necessary after re-shaping).

3. On-site insulation: bunding with drainage system for collection of (unpolluted) runoff water, and capping of dumpsite with impermeable multi layer (if necessary after reshaping).
4. Hydrological barrier (extraction and treatment of contaminated ground water).
5. Demolition of obsolete contaminated constructions.
6. Excavation of HZW and contaminated soil.
7. Disposal of HZW and contaminated soil at secure HZW landfill.
8. Incineration of combustible waste (local or abroad).
9. Special methods such as:
   - Erection of a temporary hut above the excavation site with room for excavation and transport equipment and vehicles, to prevent rainwater runoff and to control malodours.
   - Drainage system for collection of leachate for treatment or recovery options.
   - Temporary covering or coating with polymer compound for later recovery.

For each site a recommendation has been made of the most effective and feasible method or combination of methods. The final choice of method and design of the remediation plan can only be made after detailed soil & groundwater investigation and delineation survey, which were not in the scope of this project.

The applied basic criteria for allocation of recommended remediation options are:

- Contaminated constructions should be demolished and the debris should be disposed of at a secure landfill (1 site: former lindane plant and chlor-alkali plant at OHIS);
- Relatively small dumps of highly toxic hazardous waste (cat. a and b of Annex G) should be excavated including contaminated soil, and removed for final disposal at either secure landfill or incineration (4 sites: OHIS HCH dumpsite; MHK Zletovo Smelter cadmium and lead containing coke and slag tip at; Godel chromium containing tanning waste; Tane Caleski chromium containing electroplating waste);
- Reshaping of large dumpsites (4 sites: OHIS mixed waste dumpsite; MHK Zletovo Smelter slag dumpsite; Godel whole plant site; Tane Caleski whole plant site);
- On-site covering of dumpsite of low toxic HZW and non-HZW (4 sites: Bucim, flotation tailings dumpsite; Makstil, oven slag dumpsite; REK Bitola and REK Oslomej, coal ash and cinder dumpsites);
- On-site insulation for large dumpsites with recognised HZW (7 sites: OHIS mixed waste dumpsite; MHK Zletovo Smelter slag dumpsite; Lojane mine tailings, Sasa mine tailings, Silmak, former HEK Jugochrome dumpsite; Toranica mine tailings; Zletovo mine tailings);
- Hydrological barrier for unprotected waste dumps with proven groundwater contamination or recognised HZW of cat. a and b and high freatic groundwater level (5 sites: OHIS, HCH- and mixed waste dumpsites; Bucim mine tailings; Lojane mine; Sasa mine, Toranica mine).

The systematic results of this exercise are summarised in Annex I and presented in detail in Annex H.

3.6 Aftercare and Future Use of the Location(s)

The aftercare for remediated sites consists of monitoring of the groundwater concentration on a permanent basis (at least once a year). The recommended international standard for this monitoring can be derived from e.g. Dutch norms as presented in Annex J. The general number of piezometers and samples of a suspected site with diffuse heterogeneous spread pollution is 4 per ha. The sites that are recommended for permanent monitoring (9 sites) are:

- OHIS former lindane factory and dumpsite (6.5 ha)
- Bucim mine (50 ha)
- MHK Zletovo lead and zink smelter (7 ha)
- Lojane mine (10 ha)
- Sasa mine (28.5 ha)
- Silmak (former HEK dumpsite, 8 ha)
- Toranica mine (2.5 ha)
- Zletovo mine (28 ha)
- OKTA Refinery (1 ha)

3.7 Cost estimation

Based on the methods of closure/reclamation methodology (refer to 3.5), the costs of all recommended measures are calculated by applying the specified unit cost to the different remediation options. The applied unit costs and their basis are presented following Table 3 and details can be found in Annex K.

Table 3: Unit cost

No.	Activity	Unit price	Unit	Source
A	Exploring soil & groundwater survey	0.40	Eur/m2	UNEP Feasibility Study Macedonia (2001)
B	Annual soil & groundwater monitoring	0.11	Eur/m2	DHV Tender Documents Macedonia SWM project
C	Demolition of constructions	3.00	EUR/m2	UNEP Feasibility Study Macedonia (2001)
D	Excavation of soil	14.00	EUR/m3	UNEP Feasibility Study Macedonia (2001)
E	Transportation of debris and soil	11.50	EUR/m3	UNEP Feasibility Study Macedonia (2001)
F1	Disposal of waste at secure landfill	44.63	EUR/m3	DHV Calculation below
F2	Incineration locally or abroad	167.61	EUR/t	UNEP Feasibility Study Macedonia (2001)
G	Reshaping of dumpsites	20.00	EUR/m3	UNEP Feasibility Study Macedonia (2001)
H	Covering of dumpsite with soil and reforestation	25.00	EUR/m2	DHV estimate
I	Capping of dumpsite with impermeable layer + drainage	40.00	EUR/m2	UNEP Feasibility Study Macedonia (2001), corrected by DHV
J	Hydrological barrier and groundwater treatment	2.00	EUR/m2	DHV calculation from HEK project (see below)
K	Construction of secure landfill [1])	54.86	EUR/m2	DHV Calculation below
K	Construction of temporary building (Romney hut)	20.00	EUR/m2	DHV estimate from local contractors

These unit cost are linked to the selected remedial measures and related to the physical properties of the sites (m^2 surface and/or m^3 dumped waste), thus resulting in cost per measure per site, total cost per site, and total cost per type of measure. Summary of the remediation costs per site are given in Table 4, and for details refer to Annex I.

Table 4: Remediation costs per site

Rank	Hotspot	Quantity (t)	Surface (m^2)	Explora-tory cost (soil & ground-water) (EUR)	Annual groundwa-ter & soil monitoring (EUR)	Total remedia-tion cost (EUR)
1	OHIS A.D	252,200	76,725	28,490	6,890	10,936,076
2	Bucim copper mine	196,000,000	900,000	360,000	53,000	12,663,000
3	MHK Zletovo smelter	1,115,000	95,000	30,000	7,420	5,689,317
4	Lojane	1,000,000	100,000	40,000	10,600	4,250,600
5	Sasa mine	13,000,000	285,000	114,000	30,210	12,114,210
6	Silmak ferro-silicon plant	851,000	80,000	/	8,480	2,568,480
7	Toranica mine	3,000,000	25,000	10,000	2,650	1,062,650
8	Makstil	2,500,000	125,000	50,000	/	3,175,000
9	Zletovo mine	14,000,000	280,000	112,000	29,680	11,901,680
10	REK Bitola	11,000,000	100,000	40,000	/	2,540,000
11	Feni Industry	6,800,000	167,000	/	/	1,670,000
12	MHK Zletovo fertilizer	3,700,000	70,000	/	/	700,000
13	REK Oslomej	2,000,000	280,000	112,000	/	7,112,000
14	Godel tannery	5,600	500	/	/	402,708
15	OKTA	3,000	6,000	2,400	636	3,036
16	Tane Caleski	10	100	/	/	2,701
	Average/Total	**255,226,810**	**2,590,325**	**898,890**	**149,566**	**76,791,458**

From the calculations for the remedial measures the following conclusions can be drawn:

- Total cost of remediation of 16 sites: about EUR 77,000,000 (ranging from EUR 2,700 to 12,700,000, average 4,500,000 per site)
- Total cost of exploratory soil & groundwater survey, delineation investigation, and remediation plan: about EUR 900,000 (ranging form EUR 2,000 to 200,000).
- Total cost of aftercare and monitoring for 9 indicated sites: about EUR 150,000 per year (refer section 3.6).

3.8 Financing of costs

The options for funding the cost of closure/remediation of industrial contaminated sites are limited since these cost are to be considered as ‘sunk’ cost, e.g. these costs will not bring any return or future financial benefits. Therefore the options of financing of these costs by the private sector, Commercial Financing Institutions, or through long-term loan capital from International Financing Institutions (IFIs as EIB, EBRD, WB/IFC) are to be considered not feasible.

In principle for this type of pollution, also the Polluter Pay Principle should be applied, e.g. the industry/company who caused this pollution should pay for the closure/reclamation of the polluted areas. In case this company or industry doesn't exist any more, and also if it concerns a state owned company, than the Government of Macedonia is liable and has to cover the costs for closure or reclamation of the contaminated industrial dumpsites / hotspots.

In case companies/industries are privatised in the period after the transition, and no arrangements have been made with the new owners with respect to the costs for closure or remediation of the respective contaminated dump sites, than the environmental liability lies again with the Government of Macedonia, as well as the responsibility for cleaning or remediation of these polluted dump sites and for raising the required funds for this.

For the Government of Macedonia, the main options for raising the required funds are basically:

1. Transfers (partly) from the *regular State budget*:

   It seems unlikely that the capital investments required to close/remediate the industrial contaminated sites will be financed to a significant extent through *transfers from the regular state budget*. The available state budget is already very tight, and financial support from central government may be expected to be confined only to such areas as grant contributions towards the feasibility study costs, e.g. further delineation survey costs, or (potentially) the provision of guarantees for international / bilateral loans to finance the construction of major regional facilities for processing municipal wastes.

2. Capital grants or long-term loans on preferential terms from *an earmarked Environmental Investment Program Budget:*

   These programs and/or funds are usually the main sources of state financing for public and private sector environmental investments, primarily in the form of capital grants and soft loans. The Funds' capacities to provide financial support for investment projects are very much determined by their available financial resources, and the revenues they receive from pollution fees and other earmarked charges. Certainly, the overall demand for environmental investment finance will always far exceed the resources available, and so the Funds will need to focus their scarce resources on those projects and investments that are strategically important for achieving compliance. Opportunities for using the Funds for providing the co-financing required in order to leverage capital investment finance from foreign and other sources can also be considered.
   In case of funding the costs for closure/remediation of contaminated industrial sites, the possibilities are to be considered limited, since no earmarked or dedicates fee or charges to be made to industries are presently being considered or have been considered in the past.

   It seems that during the past privatisation process of various state owned companies an opportunity has been missed in Macedonia, to make a clear provision or state fund for the closure and reclamation of the polluted industrial areas, as

part of the state revenues for these privatisations. For instance, in the Czech Republic a part of the state revenues resulting from the privatisation of various state companies was set aside in a special fund for the closure and remediation, which in total amounted to about € 500 million. From this budget a multi-year program for closure and reclamation was developed and executed. It seems that the present option for such an approach is limited in Macedonia, since the major part of the state owned companies is already privatised, and no such provisions were made.

3. Capital grants from the European Union's *Instrument for Structural Policies Pre-Accession (ISPA)*:

   This is the European Union's principal mechanism for providing financial assistance for compliance-related investments in the accession countries. Its key features and conditions are:
   - ISPA support is available for investment projects in the transport and environment sectors, and is provided in the form of (non-repayable) grant contributions.
   - ISPA support is not available to private sector or commercial investors.
   - The total cost of the investment project should be Euro 5 million or greater.
   - In principle, up to 75% of the total investment cost of a suitable project could be financed by ISPA. In practice, however, ISPA is unlikely to cover much more than 50% of the total cost.

   Since Macedonia is presently not eligible for ISPA funding this isn't short-term option yet for closure and reclamation of polluted industrial sites, and also questionable whether it will apply to closure/reclamation of polluted industrial sites.

4. *Bilateral (Environmental) Co-operation:*

   Many countries, including most of those in Western Europe, the USA, Japan and Canada, provide financial assistance and grants to central and eastern European countries through so-called *bilateral financing institutions and or co-operation agreements*. Also the EU, and in particular EAR programs, are relevant for possible funding options. These arrangements differ in their areas of interest and *modus operandi* but, in general, operate along similar lines.

   This option seems the most promising for funding of the costs for closure/reclamation of industrial hotspots. Based on the present survey of the 16 identified hotspots, and the first cost estimates made for each sites, including the principle methods for closure/reclamation, these donors and institutions may be approached for possible (grant) funding for individual polluted sites.

   To organise, by the MoEPP, a multi-donor conference on this issue would be an efficient and probably effective way of arranging for this.

4 METHODOLOGY USED

4.1 Methodological Approach

Although systematic and computerised models exist for risk assessment of soil & groundwater contamination, no standard methodology is known for prioritisation of industrial contaminated sites. The risk models require pertinent and detailed data of the pollutant concentrations in soil and groundwater, and geophysical and morphological characteristics of the subsoil and groundwater hydrology, which are not available in this study.

For this reason a specific methodology has been developed for this study in consultation with international and local experts in the fields of geology, geo-hydrology, landfill engineering, and industrial pollution control.

The method is based on the following four main criteria for which weighted scoring factors are applied:

1. Hazardousness of the pollutant(s): toxicity of the waste, leacheability, and exceeding of an international quality standard for leachate, ground water or surface water.
2. Extent of the site: volume and area of the dumpsite.
3. Site characteristics and hydro-geological conditions: covered site, local morphology (geological composition), permeability, and depth of the freatic groundwater table.
4. Sensitivity of the location: distance to surface water or groundwater extraction wells, land use of location up to 500 m off the site, and possibility of dispersion of airborne pollutants.

In order to take into a consideration the situation when the actual hotspot has more than one polluted site/location fifth criteria is introduced.

A template for scoring per site was developed and all hotspots were scored, based on the results of the data collection, resulting in a table with scores per site and a final score for priority ranking of each site.

It was planned to complete and adjust the preliminary priority list based on the pertinent results of a sampling & analysing programme. A basic soil & groundwater sampling programme for 14 sites has been drawn up as described in section 4.3 of this report. This soil and groundwater sampling programme will be executed later.

The presented prioritisation of the 16 hotspots has been made on the basis of the inventoried data and the risk assessment for exposure of the environment to soil and groundwater pollution based on collected data and professional judgement. The template with an imaginary example scoring is presented bellow, and detailed explained in 4.2

All individual scores per site are given in Annex E.

Methodology for Prioritisation of Industrial Hotspots

Name of site: Pilot Site X Name of scorer: Ary de Koning CRITERIA	Value	Weight Score	Criteria Score
1. Hazardousness of pollutant(s)			
1.1 Toxicity (for pollutants exceeding the threshold value for hazardous waste, refer to sheet 'Classification')		**0.15**	
Class A: 50 mg/kg (pesticides, dioxines, PCB's, PAH, radioactivity, Cd, Hg, CN^-, etc.)		100%	
Class B: 5,000 mg/kg (heavy metals, chlorinated hydrocarbons, etc.)	10,000	50%	0.08
Class C: 20,000 mg/kg (acids, alkalines, fluorides, bromides, aromatic compounds, etc.)		25%	
Class D: 50,000 mg/kg (aliphatic and naphtenic hydrocarbons, inorganic compounds, etc.)		10%	
1.2 Exceeding the standard of key pollutant for groundwater, surface water, or leachate		**0.15**	
>100%		100%	
25-100% or unknown	35%	50%	0.08
<25%		25%	
no exceedance		0%	
Total score for hazardousness		**0.30**	**0.15**
2. Extent of the Site (if 1. is >0)			
2.1 Area of the dumpsite [m^2]		**0.10**	
> 10,000 m^2		100%	
2,500 – 10,000 m^2 or unknown	5,000	50%	0.05
< 2,500 m^2		25%	
2.2 Volume of the waste [m^3]		**0.10**	
> 10,000 m^3		100%	
2,500 – 10,000 m^3 or unknown	3,000	50%	0.05
< 2,500 m^3		25%	
Total score for extent of the site		**0.20**	**0.10**
3. Hydrogeological Conditions			
3.1. Morphology of the site		**0.10**	
a) on river bed / in pit / in quarry		100%	
b) on surface / on slopes / in valley or unknown	b	50%	0.05
c) constructed / covered / contained / sanitary		0%	
3.2. Permeability of the subsoil		**0.10**	
high: K = > 10^{-5} cm/s or sandy soil (L = <25%)		100%	
medium: 10^{-5} > K >10^{-7} cm/s or standard soil (L = 25%, H = 10%) or unknown	10^{-6}	50%	0.05
low: K = < 10^{-7} cm/s (L = >25%)		25%	
3.3. Depth of freatic groundwater table		**0.10**	
< 5 m	2.5 m	100%	0.10
5 - 15 m or unknown		50%	
>15 m		0%	
Total score for hydrogeological conditions		**0.30**	**0.20**
4. Sensitivity of Location			
4.1. Distance to surface water or groundwater extraction wells		**0.05**	
< 100 m		100%	
100 - 300 m or unknown	250 m	50%	0.03
> 300 m		25%	
4.2. Land Use of location up to 500 m off the site		**0.05**	
a) Protection or Buffer zones of water economy facilities		100%	
b) Agricultural land / Irrigation land / Forests / Natural Heritage PA / Inundation area	b	75%	0.04
c) Residential housing zone		25%	
d) Fallow rural land		10%	
4.3. Airborne dispersion		**0.10**	
a) highly eroded surface and flat surroundings close to residential housing	a	100%	0.05
b) eroded surface and hills or vegetation in the surroundings		75%	
c) eroded and/or no sensitive surroundings		50%	
d) hardly eroded and/or no sensitive surroundings		25%	
Total score for sensitivity of the location		**0.20**	**0.11**
5. Other (extra score for special cases like more locations at one Hot Spot site)		**0.00**	0.00
Total weighted score		**1.00**	**0.56**

K = Permeability factor

L = Lutum (silt and clay fraction)

H = Humus (organic matter content)

4.2 Rationale of the Set of Criteria and Scores

The rationale of the used criteria and weighted scores is the following.

- Hazardousness of pollutant(s), determined by:
  - Toxicity: pollutants exceeding the limit value for hazardous waste, based on the Basel Convention [Ref 2], completed with the 4 categories with limit values of the Dutch sub-legislation for identification of HZW [Ref 3] (refer to Annex G for the full list of categories and substances).
  - Exceeding the standard of key pollutants for groundwater or surface water: there are not yet legal standards for the quality of groundwater in Macedonia, so international standards had to be used like EC Directive 2000/60/EC (Water Framework Directive), and Dutch sub-legislation 'Regulation Environmental Quality Standards for Hazardous Substances in Surface Water'.
- Extent of the Site, determined by:
  - Area of the dumpsite in m^2: this is an important parameter for assessment of the extent of possible groundwater contamination (the so-called 'dispersion cloud'); the larger the site the greater the risk and extent resulting in higher remediation cost; dumpsites larger than 10,000 m^2 (1 ha) are regarded as the highest risk for potential contamination of groundwater and emission of airborne pollutants.
  - Volume of the waste in tonnes or m^3: the total amount of the deposited waste is mainly of importance for the evaluation and cost of remediation method in case of desired removal. For risk assessment and on-site remediation this parameter hardly plays a role.
- Hydrogeological Conditions, determined by:
  - Morphology of the site: it makes an important difference where an uncontrolled dumpsite is located; the following situation are distinguished in descending order of risk:
    1. on river bed / in pit / in quarry
    2. on surface / on slopes / in valley or unknown
    3. constructed / covered / contained / sanitary
  - Permeability of the subsoil: it is of great influence on the risk of dispersion of contaminated groundwater; hydro-geologists recommend the following rating of risk: high: $K = > 10^{-5}$ cm/s or sandy soil; medium: $10^{-5} > K > 10^{-7}$ cm/s or standard soil; low: $K = < 10^{-7}$ cm/s or clay(ish) soil
  - Depth of freatic groundwater table: how deeper the groundwater table how smaller the risk of leachate and runoff to reach it. Practical experience in a.o. The Netherlands indicated the a depth of 0 to minus 5 m poses the highest risk; minus 5 to minus 15 m has reduced risk, and deeper than minus 15 m is almost free of risk due to the absorptive and assimilative capacity of the subsoil.
- Sensitivity of Location, determined by:
  - Distance to surface water or groundwater extraction wells: this is an evident criterion, how closer sensitive objects are to a possible source of pollution, how greater the risk. The following distances have been applied based on experience elsewhere (Netherlands and Czech Republic): high: < 100 m; medium: 100 - 300 m or unknown; low: > 300 m
  - Land Use of location up to 500 m off the site: the distance of the site to sensitive objects is of importance for exposition of humans, animal and crops to

hazardous substances; an arbitrary safety distances of 500 m is applied towards:

1. Protection or Buffer zones of water economy facilities
2. Agricultural land/Irrigation land/Forests/Natural Heritage/Inundation area
3. Residential housing zone

- Airborne dispersion: the possibility of release, dispersion and deposition of airborne particles containing hazardous substances is greatly determined by the physical appearance and sensitivity to erosion of the surface of waste dumps.

4.3 Geotechnical Investigations and Laboratory Analyses

The desk study and filed visits did not reveal sufficiently pertinent data on existing soil & groundwater pollution. Therefore, there is a need to carry out further investigation by field tests of the actual situation concerning hazardous properties of the dumped waste, and evident soil & groundwater contamination (refer Annex M). The results of the programme can be used to adjust the priority scores and possibly the ranking and remedial options of the hotspots. The minimum required items per site are displayed in the Table 5 and the chemical analyses for soil and groundwater is presented in Table 6.

Table 5:Overview of numbers of field investigations (samples and analyses per site)

No.	Sites ("hotspots")	Sampling				Physical analysis			Chemical analysis		
		1.1 New piezometers	1.2 Cleaning of existing piezometers	1.3 Sampling of existing piezometers	2.2 Additional soil sampling*	3. Field measurements	4. Physical soil analyses***	5. Leaching test**	6. Groundwater samples	7. Soil samples	8. Leachate samples
1	Sasa mine	1	-	-	-	1	1	2	1	2	2
2	Zletovo mine	1	1	-	2	2	-	2	2	4	2
3	Toranica mine	1	1	-	-	2	1	2	2	2	2
4	Bucim mine	-	2	-	2	2	-	2	2	2	2
5	Zletovo smelter	-	2	-	2	2	-	2	2	2	2
6	Zletovo fertilizer	1	-	-	-	1	2	-	1	1	-
7	OHIS	1	-	2	2	3	2	-	3	2	-
8	OKTA	-	-	3	-	3	-	-	3	-	-
9	Tane Caleski	-	-	-	1	-	1	1	-	1	1
10	REK Bitola	-	-	-	-	-	-	1	-	-	1
11	REK Oslomej	-	-	-	-	-	-	1	-	-	1
12	Feni industry	-	-	-	-	-	-	1	1	-	1
13	Makstil	1	-	-	1	1	2	2	1	1	2
14	Godel	-	-	-	1	-	2	1	-	1	1
	TOTAL	**6**	**6**	**5**	**11**	**17**	**11**	**17**	**18**	**18**	**17**

* = only topsoil (0.5 m)

** = from waste sample

*** = from whole bore core and 2 m of saturated zone per piezometer

Table 6: Overview of chemical analyses

No.	Parameter	Sasa mine	Zletovo mine	Toranica mine	Bucim mine	Zletovo smelter	Zletovo fertiliz-er	OHIS	OKTA	Tane Caleski	REK Bitola	REK Oslomej	Feni industry	Makstil	Godel	Total
	No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	
1.	Ag				6											6
2.	As	5	8	6	6	6	2				2	2				37
3.	Cd	5	8	6		6	2				2	2				31
4.	Co												2			2
5.	Cr^{6+}									2					2	4
6.	Cr_{tot}						2	5		2	2	2			2	15
7.	Cu				6	6	2			2	2	2		4		24
8.	Hg						2	5			2	2				11
9.	Mn	5	8	6										4		23
10.	Ni						2			2	2	2	2			10
11.	Pb	5	8	6		6	2	5	3		2	2		4		43
12.	Sb	5	8	6		6										25
13.	Sn					6										6
14.	U						2				2	2				6
15.	Zn	5	8	6		6	2			2	2	2		4		37
	Subtotal heavy metals															280
16.	R.A						1				1	1				3
17.	CN	5	8	6												20
	Subtotal inorganic/physical other analysis															23
18.	AOX							2								2
19.	BTEX								3	2					1	6
20.	EOX							2		2						4
21.	PAH							2	3							5
22.	TPH								3	2				4		9
23.	TOC	1	1	1											2	5
	Subtotal organic compounds															31

5 ENVIRONMENTAL LIABILITIES

5.1 National Legislation

The problem with the 16 industrial contaminated sites listed in this study, closely connected with the regulation/practice of transfer of state ownership, either via a purchase agreement or in a different way (joint ventures, workers' shares, etc.). In any case it should be clearly defined, who is responsible for the past contamination. All these hot-spots have been in state ownership, thus the responsibility to make any action in order to solve this problem is main responsibility of the state. It is no use to look at the liability provisions of any kind in general legal regulation related to liability – such as the Civil Code or Environmental Law – because the problem is not connected with the ongoing actions or pollution, but with the past pollution, which may go back to decades. As the (draft) environmental law does not touch this problem at all, reference should be found either in the Law on Privatisation or in a specific legal measure. It must be underlined that in every Civil Code there is a reference on the compensation of damages, which most probably covers past contamination from this point of view, even without mentioning it in a special regulation. Thus, at least in the case of third party liability, the one who actually owned the facility or who had control over the activity shall be taken liable.

The Law on Privatisation of State Capital of Enterprises is a very short piece of legislation, the provisions, which leave most of the decisions open for negotiations. The whole process is the responsibility of the Commission for Privatisation, while the practical work is executed by the Agency of Privatisation. Everything is specific or in direct agreement based upon a public announcement procedure for gathering offers or in case of a direct agreement with the interested strategic investors. The conclusion is that the environmental liability shall form a part of the agreement in the cases of selling the whole industry.

The Environmental Law does not cover past liabilities directly, but refers to existing operations and environmental audits, but not serious enough to be taken into consideration with the privatisation. The following selected articles may have some relevance, when the new Law of Environment is entering into force:

- Art. 134: existing installation listed (IPPC list) shall ask for an adjustment permit, based upon an adjustment plan.
- Art. 135: procedural issues. Who is responsible for the procedure and deadlines for application (01.01.2006 - 31.12.2008).
- Art. 137 content of adjustment plan, covering the way in which the requirements are met.
- Art. 138 implement the adjustment plans within the individually set deadline, but not later than 01.04.2014.
- Art. 140 content of the adjustment permit.
- Art. 141 the negotiation procedure on the basis of which the adjustment plans are concluded.

Thus the solution for the past pollution of the contaminated industrial sites relies mostly upon negotiations, upon individual arrangements, when developing the final format of the adjustment plan and consequently adjustment permits.

5.2 Environmental Liabilities in the Privatisation

A characteristic example for the above mentioned agreements is the 'Assets Purchasing Agreement' (06.09.2002.) of HEK JUGOHROM AD – Jegunovce, Tetovo. The agreement followed a bankruptcy procedure. In Art. 9 – Obligations and rights of the seller – the first point (9.1.) is on 'Liabilities related to environment'. This Art. 9.1. says:

- "The Seller hereby confirms that all direct and indirect subsequent liabilities related to environmental matters, sourced by acts and situation taking place before the transfers of ownership of assets of the Company ... to the Buyer, or that could appear or occur after that transfer of ownership, remains Seller's responsibility, and all the costs shall be on the Seller's account."
- refers to an environmental audit, under the control of the Buyer, the costs covered by the Seller
- defines that this audit shall "define the type and the nature of existing and potential risks and disorders related to the previous activities of the Company, including risks and disorders outside the limits and scope of the work of the Company properties."
- speaks about employment conditions related to improve environmental conditions.

Also in Art.10 – Obligations and rights of the Buyer – 'environmental matters' are mentioned in 10.4. This is again focusing on the future:

- "The Parties agree that the liability of the future operating company related to environment matters shall be strictly limited to actions and operations taking place after the date of transfer of ownership."
- Even third party claims are mentioned in 12.4., the method of which is similar to the above defined agreement.
- The same 10.4. later also speaks about some special benefit to enjoy the 'status quo', which is a temporary relief from the compliance with environmental legislation up to 5 years.

5.3 Environmental Auditing and Due Diligence

The privatisation process involves the sale to a private sector purchaser of part or all of entities, which are majority-owned by a national Government. Two aspects of importance exist here in relation to environmental matters:

1. A change of majority ownership or shareholding commonly results from privatisation; and
2. The Government authorities are at liberty to specify how environmental issues should be addressed within the privatisation procedure as a whole.

Although there are often unique facets to the privatisation of SoEs, at the most basic level this constitutes a change of ownership (and/or majority shareholding) of the entities. During the last three decades, there has been a growing understanding internationally that environmental issues should be addressed when properties or companies change hands. Thus:

- The classical practice was that financial due diligence would be completed at a change of ownership of land or an industrial facility, and that this provided a sufficient basis for the sale.

- As environmental regulations were strengthened in many western nations (mostly from the mid-1970s onwards), it became apparent that significant costs could be associated with the need to remedy environmental problems and liabilities, which are acquired by an investor during a change of ownership. Thus, hidden costs may exist in acquisitions, relating in general to elements of non-compliance with the requirements of the environmental regulatory authorities.
- In certain cases, the costs to cover environmental compliance may be very significant. A cautious purchaser will therefore wish to identify these costs prior to the sale being concluded, and to take account of the costs for generating environmental compliance as a part of the negotiations for the sale (in some cases, by adjusting the price paid for the entity being purchased).

The recognition of the importance of environmental issues has given rise to the techniques to identify environmental problems, prior to the sale. These were mostly developed in the USA and Canada during the 1970s and early 1980s, and they were imported to Europe in the late 1980s. They generally involve the completion of Environmental Audits, which are specifically designed to identify and quantify environmental liabilities, which may attach to the sale of land and facilities thereon.

In most cases, the seller and/or the purchaser will also request the Auditor to quantify these environmental liabilities in financial terms. This generally involves the estimation of costs to generate environmental compliance, and there are a number of distinct methods that are used to accomplish this. The following three matters are relevant:

- Environmental Audits are best to be completed before the sale of a facility is concluded. This is because the environmental liabilities are generally considered to be the responsibility of the seller, and under most legislation, these are deemed to pass to the purchaser at the time of sale. A cautious purchaser will therefore wish to negotiate how these liabilities are addressed within the legal documentation covering the sale. It is now widely recognised that this is also often in the best interests of the seller.
- Environmental liabilities arise due to non-compliance with environmental statutes or laws. However, in some cases there will be a distinction between national environmental legislation and “international best practice”. It may be noted that this is certainly the case in Macedonia, where the environmental legislation remains in a nascent phase, at present.
- Not all environmental liabilities, which may attach to an entity subject to a change of ownership can be fully quantified. Thus, while certain types of environmental liabilities can be shown to exist and can be quantified in financial terms, others may be contingent in nature and/or may be unquantifiable at the time of an Environmental Audit (for various reasons). Both contingent and unquantifiable environmental liabilities may be addressed in negotiations between the vendor and the purchaser, although they are commonly treated distinctly from each other.

Once the environmental liabilities have been identified and (where possible) quantified, the seller and the purchaser may address these as an integral part of the negotiations concerning the sale. It is relevant to note here that different countries utilise distinct rules in relation to the retrospective allocation of environmental liabilities. For example, the Canadian legislation relies mainly on the principle of *Caveat emptor* (buyer beware), and environmental liabilities, which are not identified and negotiated at the time of sale, cannot be retrospectively allocated thereafter to a previous owner. By contrast, the European Union legislation relies heavily on the Polluter Pays Principle, and this implies that it should be possible to allocate environmental liabilities retrospectively to a previous

owner of a site, which is not in environmental compliance. However, this may eventuate only if it can be shown that the previous owner was responsible for the lack of environmental compliance. The Law on Environmental Protection in Macedonia also cites the Polluter Pays Principle, and it is widely accepted that Macedonia is likely to approximate to the European Union legislation over time.

The present situation relating to the retrospective allocation of environmental liabilities is complex in many of the individual Member States of the European Union. Thus, for example, the legislation on contaminated land in England and Wales mandates a chain of liability for environmental damage, from the original polluter, through the current owner, and potentially to a tenant or operator. Other Member States of the European Union utilise different approaches to identify parties, which are responsible for discharging environmental liabilities.

Macedonian Situation

Certain general comments may be made here in relation to the privatisation programme in Macedonia. The first point to note is that the GoM may utilize a number of distinct financial and tactical strategies to privatise the remaining SoEs. These range from privatisation *per se* (involving the complete sale of an entity, through shares or as assets, to a private sector investor), through partial or phased sales of entities or shareholdings therein. Although there may be differences in detail relating to the handling of environmental issues in these cases, it is always beneficial to address environmental issues during the process of privatisation.

Secondly, it is important to note that the current Macedonian legislation concerning the environment remains relatively immature. This implies that there will be a significant difference between the scale of environmental liabilities when these are quantified against the basis of the national legislation, and when they are assessed against a background of “international best practice”. This is especially the case in relation to specific types of liabilities, such as those involving asbestos-containing materials or polychlorinated biphenyls. It is particularly notable that Macedonia has no standards for soil contamination, which constitutes a very common (and important) form of environmental liability.

The preference of assessing environmental liabilities against international best practice comes from the fact that an investor may wish to see the likely longer-term requirements for compliance, and these will be reflected by the international legislation. In this respect, it is important to note that the Government entities seeking to privatise SoEs should on no account permit investors to discount the sale price for liabilities which reflect international best practice, rather than the existing Macedonian legislation.

Thirdly comment concerns the types of facilities and enterprises being offered by the GoM for sale, as part of the privatisation procedures. Studies to date have concentrated on SoEs, which are considered likely to exhibit environmental liabilities of significant consequence, and this has indeed been found to be the case. Thus, for example, the lead-zinc mines in the east of Macedonia and the smelter at Veles have all been found to exhibit major environmental liabilities. However, this will not be the case for all of the SoEs to be privatised and the various enterprises will differ markedly in their attached environmental liabilities. The required privatisation process in the future will thus involve

the pre-selection of the entities, which are likely to exhibit environmental problems or impacts, and the identification and quantification of the environmental liabilities attached to these. It is also notable that a similar procedure can be utilized with respect to private sector enterprises, which the GoM may wish to control more rigorously over time, and the use of Environmental Auditing and Risk Assessment techniques.

Finally, the responsibility of the GoM as a whole for the privatisation procedures should be mentioned. It has been shown in many countries that privatisation of the state property should not simply be the delegated task of a single Government entity, but should involve the Government as a whole. This is because privatisation touches upon the responsibility of many Governmental bodies (e.g. those involved in land ownership and land use or zoning; in the monitoring and/or regulation of manufacturing industries; in the appropriate and sustainable use of resources; etc.). In the ongoing privatisation programme in Macedonia, it is recommended that the MoEPP should be formally involved alongside the Ministry of Economy, where environmental matters are of importance [Ref 4].

In Annex I an indication is given of the possibly liable entities for the remediation of the hotspots. In 7 cases of closed and abandoned sites ((OHIS partly, Lojane mine, Sasa mine, Toranica mine, Zletovo mine, Godel, Tane Caleski) it is clearly Macedonia. In the other case there might be shared liability with (new) owners.

5.4 Best International Practices and Examples of Other Countries

5.4.1 Hungary

Overview of legal situation

There have been two major means to transfer state ownership to investors:

- Via privatisation process (it was characteristic till the end of the 90s)
- Via bankruptcy, which is not specific, both state or private ownerships could be covered

The privatisation regulations did not have direct reference on how to solve the problem of past environmental damage, they left it on the individual contract, on a case-by-case basis. Thus there are many different cases with many different solutions. This had been criticised by environmentalists, as sometimes it could also happen that there were no mention about environmental issues.

As a consequence, there are individual cases, where the new owner started a litigation in order to prove that the environmental damage had not been tackled in the purchase process, but the state should still be held liable, as this had been a hidden mistake of the agreement. This kind of argument could be used properly as in most of the cases the new owner had several changes in the activity, thus it could be proved that the contamination has such characteristics which refer to the previous – state owned – period of operation.
It has to be added here, that although environmental consequences have not been discussed in details within the privatisation legislation, from the first half of the 90s – unfortunately not from the very beginning - there has been a change in the internal by-laws of the Privatisation Agency, the invitation of the representative of the Ministry of Environment in the decision-making bodies. It was a direct consequence of the numerous

problems, which had been raised during the first wave of privatisation by the potential buyers.

In case of bankruptcy procedures, it is in the law from the beginning of the 90s that the liquidation procedure should reveal all the costs and damages, covering also the environmental conditions. This is also very important from the point of view of privatisation, as in a number of cases the procedure started with bankruptcy and ended up in a privatisation in a way that the investor bought the company. The environmental part of the bankruptcy procedure should be done in the following way:

- The operator under the procedure has to send an environmental declaration to the environmental authority, providing short information on environmental consequence of its operation. This declaration should also mention means and methods of decontamination, but in a very limited way.
- The authority may either accept this declaration, which then may be implemented or refuses this in a way to ask for further clarification. This can be done on the basis of specific conditions, such as if the information on environmental conditions which are known by the authority are different than that which are presented by the interested party
- In case if the authority gives back the case to further studies, a detailed environmental statement shall be presented, the format and the major content of which are given by the law.
- On the basis of providing the detailed statement the authority may issue a decision, covering the needs of action and the major cost items.
- When the rank of debts and costs are made in order to clarify what can or can not be satisfied from the assets of the company, environmental debts – the decontamination costs and remediation costs are taken as special forms of debts – are among the first priority, just after the payment for employees, and before any other debts (such as unpaid bank loans).

In order to make a better clarification of the situation, the regulations on groundwater from 2000, made a clear distinction related to past contamination. The starting point is that contamination should lead to decontamination, which is the responsibility of the operator. If the operator is not know, or if there is no direct continuation of the ownership, then the limit is December 1995, when the Law on Environmental Protection came into force. The options:

- If the operation has been an ongoing one at the time of entering into force of the Law or if the contamination is caused after that date, then the landowner is responsible for decontamination.
- If the contamination happened before the entering into force of the Law, the state is responsible.

Case studies

1. Electrolux - Lehel

Lehel had been a huge refrigerator company, state owned. In the privatisation process, which took place in the early 90s, ended in 1993, the Swedish company, Electrolux bought it. In the privatisation process the buyer took over the environmental responsibilities in a way that a indemnify itself from the purchase price. They agreed with a deadline of 3 years after the purchase agreement, the buyer paid the price and according to the contract had the right to claim the costs of necessary environmental decontamination and investments to the level of the price, based upon invoices.

There had been an initial environmental audit, but is was not meant to serve as the basis for action, but instead of this it was only made for orientation, commissioned by the buyer. Which has not been agreed upon was what shall be the basis of any such steps – the existing Hungarian legal framework, EC legal framework, Swedish standards, etc. – that could lead to a situation, within which there were no chance for the Hungarian privatisation agency to question any of the costs. This could finally end up in getting the entire purchase price back, while the environmental investment most likely went far behind the necessary limit. Of course, this was good for the environment, good for the buyer, who could make all the investments for the future from the purchase price, but it proved to be fatal for the privatisation itself.

2. Power stations

The privatisation of thermal power stations took place soon after the above-mentioned case. The privatisation agency ordered a general environmental audit, not very detailed, in each and every case of power stations, and they also developed a model contract with reference to environmental liabilities.

This model contract limited the indemnification to 20% of the purchase price as a maximum limit. The other condition was to stick to the requirements of existing Hungarian legislation, and to the requirements presented by the authorities in their decisions, based upon the legal requirements. Thus there was no room for going beyond what may be taken as necessary condition of decontamination of environmental investment.

3. Aluminium industry (Ajka)

At the end of the 90s. the main problem was the existence of huge red-mud ponds, containing waste from the historical operation. The condition for the privatisation was that the new owner should take over the responsibility. Huge international investors agreed that they are not willing to take over the responsibility of the closed ponds, but they are willing to do this in connection with everything, which is in the operational phase. The outcome was that the industry has been privatised by a group of Hungarian investors, who promised to solve the problem, although their existing capital was very limited. The red-mud ponds are still there.

5.4.2 Czech Republic

The Czech experience in the assessment and remediation of past environmental damage is driven by an ongoing process of widespread privatisation coupled with the need to address problems of historical environmental liabilities. After the collapse of the Soviet state-controlled economy, environmental burdens resulting from 40+ years of state controlled ownership of the means of production were transferred to new, private owners. The magnitude and seriousness of these burdens, however, was beyond the scope of what private owners could deal with on their own and required the development of a republic-wide system of assessment and state-supported remediation. The Czech experience is unique in its systematic, national approach and in that it was put in place at the initial outset of the privatisation process.

The framework of this new environmental policy to address environmental burdens in the Czech Republic, including significant financial support, has accelerated the growth of the Czech “environmental market”. The high level of Czech geology, hydrogeology and engineering professionals was a positive precondition in this regard.

On the other hand, lack of practical experience in effective environmental management presented a serious obstacle. These factors influenced new approaches in environmental protection in the Czech Republic and exposed both strong and weak points of remediation techniques and technologies and of the decision-making process as well.
In acquiring experience in solving various types of practical problems at hundreds of environmentally damaged sites in the Czech Republic, it became clear that a regulatory framework, a systematic approach and clear responsibilities within the decision-making process are crucial factors for effective identification, assessment and remediation of environmental damages.

Legal Framework
Based on the above preconditions, the clean-up process of past environmental damages in the Czech Republic was launched by adopting a series of environmental and privatisation laws and specific Government resolutions concerning contaminated land.

Institutional Framework
In addition to a solid legal framework, a second essential step was the establishment of clear responsibilities of relevant institutions and other stakeholders. At present, there are two key institutions dealing with managerial issues of hotspots assessment and remediation: the National Property Fund of the Czech Republic (NPF) and the Ministry of Environment (MoE). Another important institution is the Czech Environmental Inspection (CEI) agency, an independent authority responsible for setting and controlling remediation targets and criteria. Other institutions enter the process according to their competencies and responsibilities laid out in legal frameworks (e.g., building authorities, water protection authorities, authorities dealing with waste management, mining authorities) or according to their professional status (e.g., the Czech Geological Survey and the State Health Institute, which work as advisory bodies for the MoE).

The new owner of the contaminated site is legally responsible for remediation but may apply for reimbursement of the remediation costs.

Involvement of other private actors (remediation, engineering or consultancy companies and independent experts) is conducted mostly by public tenders published at different stages of site assessment or the remediation process. Among them, the role of independent supervisors working for either the NPF or the MoE is important. Their task is to guarantee the effectiveness and efficiency of operations from the professional point of view.

Funding Mechanism
In addition to the legal and institutional frameworks, another necessary precondition is the establishment of a viable funding mechanism. State guaranties for past environmental liabilities in privatised state companies correspond to the purchase price of the privatised properties and form the upper limit for possible reimbursement of site assessment and remediation costs. These funds belong to the Ministry of Finance and are administrated by the NPF.

In specific cases of contaminated sites that cannot be remediated through the environmental liability agreement (or directly by the polluter), there are some limited funds

for regional authorities, guaranteed by the Water Act. Other funds are approved directly by the Government for regional programs of revitalization, mostly in former mining areas and other brownfields.

5.4.3 Romania – Case Study

1. Pharmaceutical Industry “Terapia”’ at Cluj, Romania

The former State-owned enterprise (SoE) Terapia has been taken over by a British consortium “Advent”, to be continued in a slimmed and modernized form. The site area of approximately 15 ha, includes 35 obsolete buildings with annexed underground and aboveground constructions. The former activities of Terapia included besides the preparation of pharmaceuticals, the production of base chemicals for the pharmaceutical industry. The chemicals production activity is reduced significantly; almost all chemical products are phased out. The main activity of Terapia will now be focused on pharmaceutical formulation and packaging. For this activity only a smaller area (3 - 5 ha) is needed which results in the wish of decommissioning of most of the buildings on the remaining 10 – 12 ha, and the need of removal of waste chemicals and installation hold-up, followed by cleaning up the existing soil and groundwater contamination to enable the development of new industrial or commercial activities on the site.

Previous environmental auditing and soil & groundwater investigations by a British consultant have identified significant soil and groundwater contamination on site mainly consisting of volatile hydrocarbons (aromatics), chlorinated hydrocarbons (dichloromethane), and polycyclic aromatic hydrocarbons (PAH).

Terapia used in the past a now closed landfill, and is currently using an operational landfill on leased land for hazardous waste disposal. However, this landfill is not sealed and protected properly. Rain can penetrate the waste and leach contaminants which has already been detected downstream of the site. At present, the hazardous waste, which is still produced at Terapia, cannot be deposited in a proper way. A new secure landfill for hazardous waste was part of the take-over and reactivation agreement.

The new owner and the State have made a Due Diligence agreement on the liabilities and cost of the required environmental remediation. The new owner will invest more than 2 million Euro in remediation of the production site, removal and remediation of the operational landfill site, and construction of a new secure landfill. The liability and cost for remediation of the former, closed landfill stay for the State. Except for an EBRD loan for industrial restructuring, no international donor funding was applied, however the State of Romania may file a request for the still pending investigation and possible remediation of the old landfill.

6 SITUATION IN THE PROJECT REGION

6.1 North-East Region

Decades of industrialization and extensive exploitation of natural resources have left certain number of areas in the country heavily polluted. Over the past decade, Macedonia has moved from centrally planned economy, with government ownership and management of the means of production, towards free market economy, with varying level of privatisation. Within the process of privatisation, it is essential that old environmental burdens left behind by state-controlled industry be addressed: problems that were once (theoretically) the government's have now been transferred over to new owners, in most cases without clear specification of environmental responsibility. Old environmental contaminated industrial sites represent a serious risk for humans who live in or near the contaminated areas, because of either their direct negative impact on the human health or, indirectly, through pollutants in the food chain production. Currently, Macedonia has no systematic approach or policy for addressing and remediating these environmental hotspots. Two industrial contaminated sites are recognized in the North-East Region: Toranica (lead and zinc) mine and abandoned Lojane (antimony) mine. The Lojane chromium & antimony mine is presently concerned in an UNDP funded project in 2005 for remediation. Their location is presented in Figure 2.

Figure 2: "hotspots" in North-East Region



Data collected for Toranica (lead and zinc) mine and Lojane chromium & antimony mine as well as the proposals for their further investigation and remediation measures with estimated costs can be summarised in the Table 7.

Table 7: Basic information

Hotspot	Status of operation	Quantity (t)	Surface (m^2)	Exploratory cost (soil & groundwater) (EUR)	Annual groundwater & soil monitoring (EUR)	Total remediation cost (EUR)
Toranica mine	Closed (> 5yrs)	3,000,000	25,000	10,000	2,650	1,062,650

Hotspot	Status of operation	Quantity (t)	Surface (m^2)	Exploratory cost (soil & groundwater) (EUR)	Annual groundwater & soil monitoring (EUR)	Total remediation cost (EUR)
Lojane mine	abandoned (30 yr)	1,000,000	100,000	40,000	10,600	4,250,600

The main environmental risks of uncontrolled dumpsites of industrial hazardous waste are:

- Contamination with hazardous substances of freatic groundwater under and downstream of the dumpsite by percolating and runoff rainwater (generally referred to as 'leachate').
- Contamination of surrounding land by infiltration of runoff rain water and/or deposit of airborne dispersion of hazardous substances.
- Contamination of nearby surface water through direct discharge of runoff water or contact/exchange with contaminated groundwater.

The main possible impacts of above listed risks are:

- Contaminated well water intended for drinking water, livestock feed, and irrigation water thus threatening the health of humans and animals.
- Contaminated surface water causing damage to aquatic life and limiting the use as feedstock for drinking water preparation.
- Bioaccumulation of toxic substances in the food chain, and in the natural flora and fauna.
- Deterioration of the quality and decrease of the value of agricultural land and urban development land (loss of property).

The proposed remediation options for both sites are exploratory soil & groundwater survey, delineation investigation, and remediation plan, annual soil & groundwater monitoring, capping of dumpsite with impermeable multi layer and hydrogeological barrier and groundwater treatment.

Given the lack of regulatory provisions, both in the privatisation law and in environmental law, as well as the present lack of the institutional framework and funding mechanism, there seems no other choice than to solve this problem on a case-by-case approach.

6.2 Central-East Region

Decades of industrialization and extensive exploitation of natural resources have left certain number of areas in the country heavily polluted. Over the past decade, Macedonia has moved from centrally planned economy, with government ownership and management of the means of production, towards free market economy, with varying level of privatisation. Within the process of privatisation, it is essential that old environmental burdens left behind by state-controlled industry be addressed: problems that were once (theoretically) the government's have now been transferred over to new owners, in most cases without clear specification of environmental responsibility. Old environmental contaminated industrial sites represent a serious risk for humans who live in or near the contaminated areas, because of either their direct negative impact on the human health or, indirectly, through pollutants in the food chain production. Currently, Macedonia has no systematic approach or policy for addressing and remediating these environmental

hotspots. Two industrial contaminated sites are recognized in the Central-East Region: Sasa (lead and zinc) mine and Zletovo (lead and zinc) mine. Their location is presented in Figure 3.

Figure 3: "hotspots" in Central-East Region



Data collected for Zletovo (lead and zinc) mine and Sasa (lead and zinc) mine as well as the proposals for their further investigation and remediation measures with estimated costs can be summarised in the Table 8.

Table 8: Basic information

Hotspot	Status of operation	Quantity (t)	Surface (m^2)	Exploratory cost (soil & groundwater) (EUR)	Annual groundwater & soil monitoring (EUR)	Total remediation cost (EUR)
Sasa mine	Closed (> 3yrs)	13,000,000	285,000	114,000	30,210	12,114,210
Zletovo mine	Closed (> 3yrs)	14,000,000	280,000	112,000	29,680	11,901,680

The main environmental risks of uncontrolled dumpsites of industrial hazardous waste are:

- Contamination with hazardous substances of freatic groundwater under and downstream of the dumpsite by percolating and runoff rainwater (generally referred to as 'leachate').
- Contamination of surrounding land by infiltration of runoff rainwater and/or deposit of airborne dispersion of hazardous substances.
- Contamination of nearby surface water through direct discharge of runoff water or contact/exchange with contaminated groundwater.

The main possible impacts of above listed risks are:

- Contaminated well water intended for drinking water, livestock feed, and irrigation water thus threatening the health of humans and animals.
- Contaminated surface water causing damage to aquatic life and limiting the use as feedstock for drinking water preparation.
- Bioaccumulation of toxic substances in the food chain, and in the natural flora and fauna.
- Deterioration of the quality and decrease of the value of agricultural land and urban development land (loss of property).

The proposed remediation options for both sites are exploratory soil & groundwater survey, delineation investigation, and remediation plan, annual soil & groundwater monitoring, capping of dumpsite with impermeable multi layer and hydrogeological barrier and groundwater treatment.

Given the lack of regulatory provisions, both in the privatisation law and in environmental law, as well as the present lack of the institutional framework and funding mechanism, there seems no other choice than to solve this problem on a case-by-case approach.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Main Conclusions and Recommendations

The main conclusions of the study on Industrial Contaminated Sites ('hotspots') are following:

- In total 16 hotspots are identified and evaluated. Proven contamination of the environment (exceeding standards for soil, groundwater and/or surface water quality) is found at 4 hotspots:
  - Bucim copper mine at Radovis
  - MHK Zletovo (lead and zink smelter) at Veles
  - Lojane (former arsenic, antimony mine) at Kumanovo
  - Silmak ferro-alloy plant (former HEK Jugochrom) at Jegunovce.
- The following 3 hotspots are ranked as highest priorities in terms of highest (potential) environmental thread:
  - OHIS A.D (organic chemical industry) at Skopje
  - Bucim copper mine at Radovis
  - MHK Zletovo (lead and zink smelter) at Veles.
- The following 7 hotspots are ranked as medium priorities:
  - Lojane (former chromium, arsenic, antimony mine) at Kumanovo
  - Sasa (former lead and zinc mine) at Mak. Kamenica
  - Silmak ferro-silicium plant (former HEK Jugochrom) at Jegunovce
  - Toranica (former lead and zink mine) at Kriva Palanka
  - Makstil (iron & steel plant) at Skopje
  - Rudnici Zletovo (former lead and zink mine) at Probistip
  - REK Bitola (Thermal power plant and lignite mine) at Bitola.
- The following 6 hotspots are ranked as low priorities:
  - Feni Industry (ferro-nickel smelter) at Kavadrci
  - MHK Zletovo (fertiliser factory) at Veles
  - REK Oslomej - ESM (Thermal power plant and coal mine) at Kicevo
  - Godel tannery at Skopje
  - OKTA Rafinerija AD (oil refinery) at Skopje
  - Tane Caleski (metal surface treatment) at Kicevo.
- The following sites are actually to small to be designated as 'hotspots', and can be omitted justifiably from the List of hotspots and being put under IPPC regulations for operational enterprises and normal cleaning actions for new owners in case of transfer of property. They are nevertheless included in the list because they need eventually to be remediated by the government when no takeovers appear:
  - Godel Tannery (closed)
  - OKTA Rafinerija AD (operational)
  - Tane Caleski (closed).
- The following hotspots are already subject to former, ongoing or planned investigation and/or remediation:
  - Bucim copper mine: Ongoing EU remediation programme "Intreat"
  - Lojane (former chromium, arsenic, antimony mine): Planned UNDP remediation investigation
  - Silmak ferro-silicium plant (former HEK Jugochrom): Ongoing EAR funded restructuring plan

- 14 sites need additional exploratory soil & groundwater survey and delineation investigation, before feasibility studies and remediation planning can be carried out. The costs of these works vary per site from EUR 2,000 to EUR 200,000 (average EUR 56,000), and the total cost are estimated at EUR 900,000.
- At 9 sites permanent periodical monitoring of groundwater and/or surface water is indicated, of which the cost vary per site from EUR 650 to EUR 50,000 per year, and the total cost are estimated at EUR 150,000 per year.
- The most appropriate and feasible remediation options are:
  - Selective demolition and safe removal of obsolete constructions.
  - Removal and repackaging of redundant hazardous substances for destruction abroad.
  - Excavation of hazardous waste and contaminated soil and safe disposal at secure HZW landfill.
  - Reshaping of dumpsites (bringing together of scattered waste dumps for further remediation).
  - Covering of existing large dumpsites of non-hazardous waste with soil followed by reforestation.
  - Isolation of dumpsites of hazardous or leacheable waste by bunding, capping with impermeable multi layer, and drainage system
  - Hydrological containment by groundwater extraction and treatment.
  - Special treatment such as temporary coating with polymer compound awaiting recovery, collection and treatment of runoff water, and excavation and crushing for use in (road) building materials.
- The total cost of application of (a combination of) above referred methods at the identified 16 hotspots will require an estimated budget of about EUR 75,000,000 EUR (ranging from EUR 2,700 to 12,700,000, average 4,500,000 per site). The cost of the most urgent top 3 ranked sites will amount to about EUR 37,000,000.

7.2 Medium and long-term actions

Recommendations to the NWMP/ RWMP for remediation of 16 identified hotspots:

- Exploratory soil & groundwater survey and delineation investigation followed by feasibility studies and remediation planning for 3 top ranked sites (OHIS, Bucim and Zletovo Smelter) at about EUR 420,000 in 2006.
- Critical following and monitoring of 2 ongoing investigation/remediation projects (Lojane and Silmak).
- Fund raising and financial negotiations with new owners (Bucim and possibly Zletovo Smelter) based on the feasibility studies in 2007.
- Implementation of the remediation measures at a total amount of about EUR 37,000,000 for the top 3 from 2008 to 2012.
- Implementation of groundwater monitoring programme for the top 3 at about EUR 70,000 per year from 2012 onwards
- Exploratory soil & groundwater survey and delineation investigation followed by feasibility studies and remediation planning for the remaining 11 sites at a total of about EUR 500,000 from 2012 onwards.
- Implementation of remediation projects for the remaining 13 sites (including Lojane and Silmak) at a total amount of about EUR 46,000,000 whenever the opportunity occurs in the current planning period (2006-2012), or following a practicable timetable to be drawn up after the previous activity.

Recommendations to the NWMP/ RWMP for environmental liabilities:

- Knowing the lack of regulatory provisions both in the privatisation law and in environmental law, as well as lack of the institutional framework and funding mechanism, from a short-term perspective, there is no other choice but the stick to the case-by-case agreement. It would of course be better to have at least some reference to this solution in the privatisation legislation – for example, one paragraph in Art. 5 under the competences of the Commission, or one paragraph in Art. 9 under the competences of the Agency, but it is also possible, that the Government make some implementing regulations in this respect. What could be taken as useful is:
  - There shall be a representative of the MoEPP within the Committee, making the decisions.
  - To undertake an Environmental Audit, which is the responsibility of the Agency, but the costs may be covered either by the Agency or by the buyer – this may also be a part of the agreement.
  - On the basis of this audit to clarify the likely environmental remediation situation and necessary investments.
  - Agree that past damages are covered by the state, either in a way that the state is contracting out such activities, or in a way that the buyer undertakes this job and presents the invoice.
  - Agree that the environmental consequences after the taking over of the facility are fully the responsibility of the new owner.
  - Agree that if a third person claim comes up, the above agreement shall be taken as the basis – if past contamination had been the source, the state is liable, but the new owner is liable outside of this scope.
- Macedonia needs to develop sound system and procedures to address the liability issue in hot-spots remediation. The system needs to incorporate:
  - Legal framework, as pre-condition for launching clean-up process of past environmental damages;
  - Solid institutional framework, with clear responsibilities of relevant institutions and other stakeholders;
  - Viable funding mechanism; and
  - Remediation procedures, based on Environmental Audit and Risk Assessment methodologies.

7.3 Key actors and their responsibilities

- Ministry of Environment (MoEPP): programme planning, fund raising, project implementation and supervision), inspection and monitoring.
- Ministry of Transport & Communication: logistical arrangements, packaging, labelling and transport of hazardous substances
- Ministry of Health: monitoring of drinking water wells and consumer products
- Ministry of Agriculture, Forestry and Water Management: supervision of landscape, reshaping and reforestation, monitoring of soil quality, livestock, and agricultural products
- Ministry of Economy / Ministry of Finance: privatisation process, funding mechanisms
- Private sector:
  - Transporters of HZW (currently none)

- Processors of HZW (currently some in fields of spent oil recovery)
- Operation of waste disposal facilities (landfills and incinerators).

8 REFERENCES

Ref 1 Waste Law on Waste Management; Official Gazette of the Republic of Macedonia, No. 68/2004, amended by No. 71/2004

Ref 2 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal Adopted by the Conference of the Plenipotentiaries on 22 March 1989

Ref 3 State Gazette of the Netherlands 663: Ministerial Decree of 8 December 1997 concerning the designation of hazardous wastes and waste oils

Ref 4 Environmental Audit; Adam Smith Institute (ASI), 2003

Ref 5 Other documents

a) Study on the condition of the hazardous waste materials disposal, II and III Book, Mining Institute, Skopje, 1996.
b) Project for biomeliorate revitalization for the flotation tailings in "Topolnica" at Bucim, Radovis, Radovis/Strumica, 1997.
c) Elaborate on the technical observation-osculation of flotation tailings "Topolnica" at Semkorp mine, Radovis for 2003, Geing Krebs and Kifer International, Skopje, 2004.
d) Elaborate, analyses and estimation of the stability and functionality of the dump, auxiliary objects and accumulation area in Sasa mine, Mining Institute, Skopje, June, 2000.
e) Elaborate for the field and laboratory geotechnical investigation of tailings No. 3 for lead and zinc mine "Sasa"- Makedonska Kamenica and the study on the stability of tailing damp in the "Sasa" mine for the conditions in September 2003, mining Institute, Skopje, 2003.
f) Project on the draining of surface and ground waters and drainage waters from the flotation tailings dump in Sasa mine - Makedonska Kamenica, Construction Institute "Makedonija", Skopje, December, 2003.
g) Revision on the technical documentation: Elaborate for field and laboratory geotechnical investigation of tailings No. 3 for lead and zinc mine "Sasa"- Makedonska Kamenica and the study on the stability of tailing damp in the "Sasa" mine for the conditions in September 2003, Construction Institute "Makedonija", Skopje, December 2003.
h) The Report on the Technical control - Revision of technical documentation for the project for draining of surface and ground waters and drainage waters from the flotation tailings dump in Sasa mine - Makedonska Kamenica, Construction Institute "Makedonija", Skopje, December, 2003.
i) Study for the static stability of the flotation tailing dump at Sasa mine in Makedonska kamenica for the conditions in September 2003, Faculty of Construction, University of Skopje, Skopje, November 2003.
j) S. Lipitkova, B. Boev, The distribution of the heavy metals in the soil along the River Zletovica and its tributaries, Geologica Macedonica, 8, 28-32 (1994).
k) B. Boev, S. Lipitkova, Geochemical investigations of the soil in the Republic of Macedonia, Geologica Macedonica, 11, 51-56 (1997).
l) T. Stafilov, R. Bojkovska, M. Hirao, Anthropogenic effects on the air pollution in the City of Skopje, Republic of Macedonia, *1st International Workshop on the Project "Anthropogenic Effects on the Human Environment in the Tertiary Basins in the Mediterranean"*, Štip, *Proceeding*, 16-24 (2004).

m) B. Boev, S. Lipitkova, hotspot in the vicinity of the River Zletovica, *1st International Workshop on the Project "Anthropogenic Effects on the Human Environment in the Tertiary Basins in the Mediterranean"*, Štip, *Proceeding*, 31-39 (2004).

n) T. Serafimovski, G. Tasev, V. Zajkova, metal pollution around the Toranica lead-zinc mine, *1st International Workshop on the Project "Anthropogenic Effects on the Human Environment in the Tertiary Basins in the Mediterranean"*, Štip, *Proceeding*, 40-51 (2004).

9 COLOPHON

Client	:	Government of Macedonia - Ministry of Environment & Physical Planning
Project	:	National Waste Management Plan and Feasibility Studies
File	:	W8468.00.000
Length of report	:	49 pages
Author	:	Ary de Koning (International Industrial Pollution/HZW Expert
Contributions	:	Guyla Bandi (International Expert on Environmental Liabilities) Konstantin Siderovski (Special Study Coordinator) Maja Georgieva (Junior S.Waste Expert / final editor) Liljana Peeva (Local Hazardous Waste Expert) Boško Nikov (Local Industrial Pollution Expert) Trajče Stafilov (Laboratory Analysis Expert)
Project Manager	:	F.J.H. van Woerkom
Project Director	:	J. P. Kool
Date	:	02 November 2026
Signature	:	

ANNEX A

Field Report

ANNEX B

Overview Inventoried Information on Industrial Hotspots

ANNEX C

Collected Data of Hotspots per Site

ANNEX D

Summary of Collected Data of Hotspots

ANNEX E

Priority Scoring Sheets per Hotspot

ANNEX F

Final Priority Ranking

ANNEX G

Classification of Hazardous Waste by Limit Values of Constituents

ANNEX H

Recommended Remediation Options and Cost Estimate Details

ANNEX I

Summary of Recommended Remediation Options and Cost

ANNEX J

Monitoring Pollutants

ANNEX K

Applied Unit Cost for Remediation Options

ANNEX L

GIS Presentation of Hotspots, Maps and Photo Documentation

ANNEX M

Summary of Requested Geo-technical Investigations and Laboratory Analyses