DEVELOPMENT OF REMEDIATION PLANS WITH FINANCIAL REQUIREMENTS FOR ELIMINATION OF INDUSTRIAL HOTSPOTS

(EUROPEAID/123674/D/SER/MK)

FEASIBILITY STUDY – Volume III – Silmak Chromium Dumpsite - Jegunovce

Development of Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots
An EU-funded project managed by the European Agency for Reconstruction

FEASIBILITY STUDY – Volume III – Silmak – Chromium Dumpsite - Jegunovce

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LIST OF ABBREVIATIONS

AP	Action Plan
BAT	Best Available Techniques
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
CARDS	Community Assistance, Reconstruction, Development and Stabilisation
CE	Central-East
CHIP	Chemicals Hazard Information & Packaging
COSHH	Control of Substances Hazardous to Health
DALY	Disability Adjusted Life Years
DS	Dangerous Substances
EAR	European Agency for Reconstruction
EIA	Environmental Impact Assessment
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ESC	Environmental Steering Committee
€	Euro
EIONET	European Environmental Information and Observation Network
EU	European Union
GIS	Geographic Information System
GLPs	Good Laboratory Practices
GoM	Government of Macedonia
GPS	Global Positioning System
GTZ	Gesellschaft fuer Technische Zusammenarbeit
HWL	Hazardous Waste List
HZW	Hazardous Waste
HZWM	Hazardous Waste Management
IFI	International Financial Institution
ISC	Inter-ministerial Steering Committee
ISPA	Instrument for Structural Policies for Pre-accession
IPH	Institute for Health Protection
IPPC	Integrated Pollution Prevention and Control
ISIC	International Standard of Industrial Classification Rev. 2 1968 (UNIDO)
KfW	Kreditanstalt für Wiederaufbau (German Bank for Reconstruction)
LOAEL	Lowest-Observed-Adverse- Effect Level
LoW	List of Wastes
LSG	Local Self Government
LWM	Law on Waste Management
maSL	meter above Sealevel

MoEPP	Ministry of Environment and Physical Planning
MoH	Ministry of Health
MoF	Ministry of Finance
MoE	Ministry of Economy
MoTC	Ministry of Transport and Communication
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
NOAEL	No-Observed-Adverse-Effect Level
NWMP	National Waste Management Plan
REC	Regional Environmental Centre for Central and Eastern Europe
REReP	Regional Environmental Reconstruction Programme
RfD	Reference Dose
POPs	Persistent Organic Pollutants
REReP	Regional Environmental Reconstruction Program for South Eastern Europe
PPP	Public Private Partnership
RIHP	Republic Institute for Health Protection
SAA	Stabilisation and Association Agreement
SC	Steering Committee
SMEs	Small and Medium Size Enterprises
SoEs	Social owned entities
SW	Solid Waste
SWM	Solid Waste Management
TA	Technical Assistance
TCLP	Toxicity Characteristic Leaching Procedure
TNA	Training Needs Analysis
ToR	Terms of Reference
UNDP	United Nation Development Programme
UNEP	United Nation Environmental Programme
WHO	World Health Organization
WG	Working Group
WWT	Waste Water Treatment
YYL	Years of life lost

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Volume 00_B	Process Assessment
Volume 00_C	Environmental Impact Assessment
Volume 00_D	Public Information Assessment and Action Plan
Volume 00_E	Geotechnical Assessment
Volume 00_F	Geo referencing and Mapping
Volume 00_G	Samples and Analyses
Volume 00_H	Economical and Financial Evaluation

Извршно резиме

Главната цел на проектот е да помогне во елиминацијата на индустриските жешки точки во земјата, преку развој на 4 санациски планови со финансиски барања. Проектот е финансиран од ЕУ и извршуван од шпанската компанија Eptisa со Министерството за животна средина и просторно планирање како главен корисник

Во моментот, поранешната југословенска Република Македонија нема системски пристап или политика заремедијација на овие жешки точки. Нивното влијание не е целосно познатао,трошоците за расчистување, не се систематски проценети; финансирањето за најголем дел е недостапно; институциите за имплементација не се поставени, дури и сопственоста на овие еколошки товари во пост приватизациска поставеност е нејасна. Што се однесува до контролата на индустриско загадување и управување со ризикот, МЖСПП има собрано список од инсталациите кои ќе бидат подложни на интегрирани еколошки дозволи, но интегрирано спречување и контрола од загадување треба да стане оперативно. Некои елементи од ES легислативата во областа на контрола на хаварии кои вклучуваат опасни супстанции се транспонирани во националното законодавство, но сепак целосна транспозиција сеуште не е остварена. Капацитетоттреба да се зајакне. на МЖСПП и други заинтересирани страни (локална самоуправа, претпријатија итн.) за имплементирање на мерки за контрола на индустриско загадување и управување со ризикот треба да се зајакне. Во 2003 година, земјата започна со хармонизација на националното законодавство од областа на животната средина со законодавството на ЕУ. Пет основни закони (Закон за животна средина, Закон за управување со отпад, Закон за води, Закон за природа и Закон за квалитет на амбиентниот воздух) и неколку подзаконски акти (ИСКЗ Уредба за определување на инсталации за кои е потребна интегрирана еколошка дозвола и временски распоред за предавање на оперативните планови; ИСКЗ Уредба за постапката за А интегрирана еколошка дозвола; Правилник за транспорт, записник и известување за отпад; Правилник за листа на отпад) беа подготвени. Сите горе споменати закони и подзаконски акти се однесуваат целосно или во некоја мера на отпад и управување со опасен отпад, но ниеден од нив директно ги споменува или регулира „индустриските жешки точки".

Методологијата е базирана на :

- Проценка за ризикот по здравјето,
- Геотехнички истражувања,
- Проценка на јавната свест и информирање,
- Проценка на процесот и квалитативна и квантитативна идентификација на токовите на отпадот, проценка на влијанието врз =ивотната средина,
- Идентификација на опции за третман,
- Еколошко рангирање на идентификуваните опции за третман,
- Идентификација на економски индикатори,
- Финансиска евалуација на разни опции за ремедијација и економска евалуација на истите.

Во сите случаи се земени во предвид најдобрите можни пракси за поранешната Југословенска Република Македонија. Методологијата се состои наизменично од процедура на проверка и рангирање.

Главни загадувачи на локацијата се калиумхромати, поради поранешно производство на содиумбихромат. Производтвото е затворено во 90те години. Контролирано депонирање имало само во 84-85, додека голема количина на хром е дисперзирана низ целата депонија и подоцна била мешана со троска со цел да се зголеми растворливоста. Волуменот на депонијата е 882.175 m^3, што е еднакво на 2.029.000 Mg и содржи 296.260 Mg на хром кој се состои од троска со колишина од 7.388 Mg на хром. Депонијата има нето површина од 6,88 ha и просечна висина од 23 m и е лоцирана помеѓу реката Вардар на исток, Габровска Река на север, железницата Скопје-Тетово на запад и има главен влез од југ. Производните единици се одприлка 2,5 km на југ. Локацијата делумно е покриена со геомембранана, која има пукнатини на неколку места. Постои тековна инфилтрација во вода.

Идентификувано е дополнително загадување, што влијае на подземната вода во околната област на фабриката и во насока на селото Јргуновце. На сите три локации , инсталирани се системи за дренажа кои ја собираат загадената подземна вода и јсе испумпува во инсталацијата за третман на отпадни води, која се наога во рамки на објектот. Силмак го раководи објектот, додека МЖСПП ги покрива трошоците за работење. Истражувањата за студијата покажаа дека локациите на инсталациитеза дренажа се совршено одбрани и дефинитивно го намалиле драматично влијанието. Повеќето одлуки се врз основа на геотехнички истражувања, извршени од страна на институтот Черни-Белград. Во околната област, нивото на хром во подземната вода е намалено од 50 до 12 mg. 70% од моментално намалениот хром е предизвикан од депонијата, која е главен загадувач.

Околу загадента територија постојат повеќе од 18 инсталирани пиезометри кои се мониториаат од одделот за животна средина во Силмак, наречен ЕМАК. Треба да да се нагласи дека документацијата и резултатите се направени извонредно.

Во моментот нема знаци дека загадената подземна вода влијае на водоснабдувачкиот систем на Скопје (извор Рашче) но можноста не може да се исклучи.

Квалитативната проценка на ризик по здравјето (Volume 00_A) ги опишува ризиците и влијанијата, предизвикани од згадувачи на депонијата, Депонираниот хром на депонијата е назначен како опасна субстанција (каталгот за отпад) Во Јегуновце откриени се неколку опасни честициа: Cr, Fe, Cu и Zn и прав од железохромат во атмосферата. Постои загадување на почвата од прав депониран околу топилницата. Детектираниот ризик од респираторни болест кај деца во Јегуновце е поврзано со загадувањето на воздухот. Испуштањата на прав од фабриката ине е токсично само по себе. Други прашања вклучуваат депонија на отпад/троска и хемиско загдување. Добиените резултати од РЗЗЗ за дистрибуција на хром во подземната, вода покажуваат дека концентрацијата е минимална. Во согласност со проценката на животна средина рзикот е умерен, ризикот по човекот-висок.

Може да се каже дека сегашната операција на производните единици на Силмак предизвикуваат значајно поголем ризик по човечкото здарје, отколку акумулираниот отпад во истражуваните жешки точки. Се препорачува фокусирање на ИСКЗ процедурите , за да се спречи и намали ризикот на прифатливо ниво.

Ризикот кај Силмак кој е резултат на секундарни миграциони патишта (подземна вода/почва) е значаен и треба да биде приоритет.

Локација	Загадување	Опсност	Ризик	Влијание	Ранг
Силмак	CrVI	Висока	Умерен-Висок	Ниско-Умерено	3

Влијанието врз почвата од поранешните и сегашните производни активности и постоечката депонија за хром, од еколошка гледна точка може да се третира како умерено до високо или поврзано со долгиот период на акумулација на влијанието, како **ВИСОКО**. Поради фактот дрка селото Јегуновце употребува вода за пиење од јавнипот водоснабдувачки систем, ризкиот врз здравјето е **УМЕРЕН**. Врз основа на податоците може да се претпосрстави дека пред работата на пречистителнната станица, постоела голема концентрација на хром VI, течењето од локацијата се емитувало во реката Вардар. Моментално, површинската вода е умерено зафатена. Ризикот од загадување е висок, додека постои исклучителен третман од Силмак, влијанието може да се смета во моментот **НИСКО до УМЕРЕНО**. Како резултат на тоа дека ниту во објектите ниту на депонијата нема компоненти на хром во големи количини, влијанието преку трансмисија на ветер може да се смета за **НИСКО**. Проценката на ризик од чисти субстанции (хром VI) е проценето како многу висок, како што е покажано во додатокот за табелата на хром. За среќа во овој случај, поради концентрираните испумпувањеа и третман и поради тоа што субстанциите не влијаат директно или индиректно на здравјето на човекот, ризикот врз животната средина и здравјето е пид контрола, и може да се смета за **УМЕРЕН.**

ЛОКАЦИЈА	МЕДИУМ	КОНАМИНАТ и КВАЛИТЕТ	ВЛИЈАНИЕ и РИЗИК	ВРЕМЕТРАЕЊЕ И ДИМЕНЗИЈА
Депонија, куп од мешавина од троска и мил Површина на депонија: 80.000 m2 Делумно покриен со почва	**Троска, тешки метали** Mg (Fe, Mg, Al, Cr) **Мил** 296.260 Mg (7.388 Mg **Cr^{6+}**) **Вкупно** **2.029.000 Mg**	**Влијание: на површинската вода на Вардар и подземна вода** **Ризици:** Загадување на водоснабдувачкиот систем на Скопје_ВИСОК **Влијание:Ниско** **РИЗИКЧ стабилност на депонија – загадување на Вардар--НИСКО**	Декади и векови: Прекугранично загадување на вода и локално загадување Долгорочно загрозување на водоснабдувачкиот систем и барање за дополнителни трошоци 9дополнителен треетман на води) Како несреќа: нестабилност на депоија предизвикан од на пр. Сеизмичка активност	**Депонија, куп од мешавина од троска и мил** Површина на депонија: 80.000 m2 Делумно покриен со почва Long term Долгорочно
Загадена почва и подземна вода во фабриката	**Хром 6+** непознати квантитети Површина на контаминирана земја:непозната	**Влијание: На површинска вода на река Бистрица и подземна вода на селото** **Ризик:** Нема потенцијален ризик - Низок	Декади Прекугранично загадување на вода и локално загадување	

Со геоелектричните тестирања и во корелација со резултатите од геолошките и хидрогеолшките истражувања, се назначува дека северната страна од депонијата за отпад, кон реката Габровничка, како и на источната страна во близина на железницата, **не покажуваат индикации на загадување на истражуваната област. (Рrofil GE I и IV). Профилите 0E II и III покажуваат 4 аномални зони, додека оние кои се наоѓаат на јужниот дел, близу влезот, покажуваат површински контамнинациски карактерситики.** Длабочината на контаминацијта се зголемува во насока на пумпната станица, што покажува соодветност на инсталацијата. За хемиско тестирање на присуство на загадувачи на почва и подземна вода, достапни и доволни се пиезометрите на депонијата. Дополнителни бушења не се доволни.

Според правилата за згради, треба сите згради да бидат конструирани така да можат да издржат земјотрес со јачина **од 8 според меркалиеват скала. Сеизмичкиот ризик може да се смета за умерен** Евидентен е ризикот од дестабилизација на подземјето како резултат на поголем товар од дозволениот. Стабилноста на депонијата е 4,4 пати над дозвволеното ниво итреба да се израмни или стабилизира како резултат на нивелирање на подземна вода.

Санациските опции ги земаа в предвид алтернативите ex situ, на и надвор од локација. Тие алтернативи се поделени на фиторемедијација, хемиско-физичка и други санациски опции. За санација на локацијата со хром, земени се 10 можности во предвид, како 0 активности, фиторемедијација, управување со површински води, управување со подземни води, испирање на почва надвор и на локација, ископување и депонирање надвор од локација.

По оценувањето на животната средина, следеше следнот рангирање :

Третман на подземна вода WWTP + покривање +дренажа – 1

Рециркулација на подземна вода + агенти/ акумулација+покривање+дренажа – 2

Рециркулација на подземна вода / имобилизација + покривање +дренажа – 3

Испирање на локација / ископување и депонирање надвор од локација – 4

Третман на подземна вода WWTP + покривање +дренажа – 5

Испирање надвор од локација – 6

Економската проценка пресмета 4 различни опции за реактивирање на сегашната депонија на троска, како што се 0 активности, развој на зелена зона, r за земјоделски намени, развој на санитарна депонија и проширување на индустриските активности и депонирање. ension of dispoals and industrial activities. Развојот на санитарна депонија е проценета како најмногу ветувачка. Околните општини на Јегуновце (каде е семстен Силмак) се Желино и Теарце. Вкупната популација е Tearce 54.071 или 12.000 домаќинства. Според достапниот простор, потенцијалниот волумен на депонијата е 045.600m³ на површина од 6,54 ha, што значи дека депонијата може да служи 160.000 (многу повеќе од трите споменати) жители за 20 години. Ќе биде потребен финансиски инпут од 3.065.000 Euro за инвестиции и одприлика 150.000 Euro годишни оперативни трошоци. За ваков регионален пристап, услов би било отстранување на отпад.

Санациските трошоци на останатите опции од еколошката пресметка се пресметани и споредени со економската корист. Земени се во предвид трошоци за превоз, манипулативни трошоци, трошоци за третман, надзор, капитализција, инвестиции и трошоци за јавно информирање и споредени се со директниот потенцијал приход како резултат на рециклирање и реупотреба, понатаму со економскиот исход на различни опции. Споредувајќи ги финансиските инпути и аутпути, може да се направи следното рангирање.

Третман на WWTP, покривање, дренажа	-1
Третман на WWTP, покривање, дренажа	-2
Рециркулација на подземна вода , покривање, дренажа	-3
Акумулација на подземна вода, покривање, дренажа, надоместување на хром	-4
Рециркулација на подземна вода , имобилизација, покривање, дренажа	-5
имобилизација, покривање, дренажа	-6
Ископување и испирање на локација , надоместување на хром	-7
Ископување и испирање надвор од локација , надоместување на хром	-8
Ископување и депонирање надвор од локација	-9

Заклучок:

Економската евалуација на еколошки и финансиски рангираните алтернативи на третман овозможува препорака на третман од сегашната WWTP за период од 5 години, управување со површински води преку покривање и мерки за затворање и управување со подземни води преку конструирање на дренажен систем во западниот дел на депонијата. Предложеното одстранување и изградба на санитарна депонија до 160.000 PE и животен век од 20 години е економски најпогодна, но не може да ги совлада финансиските препреки, во оваа фаза. Финансискиот инпут на предложените мерки е 1.656.160 Euro. Надоместување и комерцијализација на хром бара поголема стоковна вредност од моменталната или поефикасна технологија за третман, како резултат на тоа дека цел хром е дисперзирана во 2.029.000 Mg of троска и отпадна троска.

Втора алтернатива е комбинацијха на третман на сегашната WWTP и управување со подземни води со покривање и мерки за затворање. Ќе биде потребен финансиски инпут од 1.698.108 Euro.

Executive Summary

The main purpose of this project is it to assist in the elimination of industrial hotspots in the country through the development of remediation plans for 4 hotspots with financial requirements. The project is financed by EU and executed by the Spanish Company Eptisa with the Ministry of Environment and Physical Planning as main beneficiary.

Currently, the former Yugoslav Republic of Macedonia has no systematic approach or policy for addressing and remediation of these environmental hotspots. Their impact is not fully known, clean up costs are not systematically estimated; funding for the most part is unavailable; implementing institutions not set up and even “ownership” of these environmental burdens in a post- privatised setting is not clear. Regarding industrial pollution control and risk management, the MOEPP has compiled an inventory of installations to be subject to integrated environmental permits, but integrated pollution prevention and control system has yet to become fully operational. Some elements of EU legislation on the control of major accident hazards involving dangerous substances appear to have been transposed into national law, but full transposition still has to be completed. The capacity of the MOEPP and other concerned parties (local governments, enterprises, etc.) to implement industrial pollution control and risk management measures needs to be strengthened. In 2003, the country started the harmonisation of the national environmental legislation with the legislation of EU. Five basic laws (Law on the Environment, Law on Waste Management, Law on Waters, Law on Nature and Law on Ambient Air Quality) and several sub-laws (IPPC Decree for determining the Installations for which an Integrated permit is required and time schedule for submission of the adjustment plans, IPPC Ordinance regulating the procedure for A integrated environmental permit, Regulation on Transportation, Recording and Reporting on Wastes, List of Wastes,) were prepared. All abovementioned laws and sub-legislation refer completely or to some extent to waste and hazardous waste management, but none of them directly mentions or regulates “industrial hotspots”.

The methodology is based on

- The assessments of health risk impact,
- Geotechnical investigation,
- Public awareness and information assessment,
- Process assessment and the identification of qualitative and quantitative waste streams, the environmental impact assessment,
- The identification of treatment options,
- The environmental ranking of identified treatment options,
- The identification of economical indicators,
- The financial evaluation of various remediation options and the economical evaluation of those.

In all cases have been taken best practise possibilities for former Yugoslav Republic of Macedonia into consideration. The methodology consists of a alternating procedure of screening and ranking.

Main pollutants on the site is Calciumchromate due to former prodution of Sodiumbichromate. The production is closed since the 90s. A controlled disposal took only place in 84-85, while the major amount of Chromium is dispersed within the whole dumpsite and was later on mixed with slag in order to decrease the solubility. The volume of the dumpsite is 882.175 m³, which is equal to 2.029.000 Mg and consits of 296.260 Mg of Chromium containing sludge with an amount of 7.388 Mg of Chromium. The dumpsite has a net surface of 6,88 ha and an average height of 23 m and is located between the Vardar river on the east, the Gabrovaska river in the north, the railway Skopje – Tetovo in the west and has the mainacess from the south. The production facility is approximate 2,5 km in the south. The site is partly covered with geomembrane, which shows cracks on several locations. Water infiltration is ongoing.

Additional contamination have been identified, which are impacting the groundwater int the surrounding area of the plant and in the direction of the village Jegunovce. On all three locations have drainage systems been installed to collect polluted groundwater and is pumped into the WWTP, located within the facility. Silmak is operating the facility, while the MoEPP is covering the operation costs. The investigations during this study have shown, that the locations of the drainage installations are perfectly chosen and have definitely decreased the impact dramatically. Most of the decision are based on the geotechnical investigations, conducted by the institute Cerni-Belgrade. In the surrounding area has the level of Chromium in the groundwater be reduced from 50 to 12 mg. 70% of the current reduced Cr is caused by the dumpsite, which is the mainpolluter.

Arround the polluted territory are more than 18 piecometers installed, which are monitored by the environmental department of Silmak, called EMAK. It has to be stated, that documentation and results are recorded in an exemplary manner.

Currently are no signs that the contaminated groundwater is impacting the water supply system of Skopje (Rasce Spring), but a possibility cannot be excluded.

The qualitative health risk assessment (Volume 00_A) describes risks and impacts, caused by the pollutants on the dumpsite. Disposed Chromium on the dumpsite are listed as hazard substances (waste catalogue). In Jegunovce have been detected several hazards as particulates: Cr, Fe, Cu and Zn and total ferrochrome dust to atmosphere. Soil contamination by the dust deposited around the smelter. Detected risk for respiratory diseases among children in Jegunovce is related to air pollution. The dust from the plant's exhaust appears not to be toxic in itself. Other issues include waste/slag dumps and process chemical pollution. Obtained results from RIHP for Cr distribution in groundwater showed that the concentration is minimal. In accordance with EH assessment was stated a moderate- high human risk

It can be stated that the current operation of the production facilities of Silmak causes significant higher Health Risks than the wastes accumulated on the investigated hotspots. It is recommended to focus on IPPC procedures in order to avoid and reduce the risk to a acceptable limit.

The risk on Silmak due to secondary migration paths (ground/soil) is significant and has to be given a priority.

Spot	Pollutants	Hazard	Risk	Impact	Rank
Silmak	CrVI	High	Moderate-High	Low-Moderate	3

The impact of former and existing production activities and existing Chromium dump site on soil could be from the environmental view of point treated as **moderate to high** or related to the long period of accumulation of the impact as HIGH. Because of the fact that the Jegunovce village are using drinking water from the public water supply system risk on health could be estimated as **LOW.** The risk on the environment is still open, particularly to the public water supply system of Skopje, so that risk could be estimated at least as **MODERATE.** Based on this data it can be assumed, that before the operation of the treatment plant has been a high concentration of Chromium VI, leacking from the site been emitted into the Vardar River. Current is surfacewater moderated impacted. The risk of a pollution is high, while due to the exemplary treatment by Silmak the impact can be stated currently is **LOW to MODERATE**. Due to the fact, that neither in the facility, nor on the landfill are Chromium components in a hughe amount uncovered, the impact due to windtransmission can be estimated as **LOW**. Hazardous risk assessment of pure substances (Chromium VI) is estimated as very high, as it is given in tables in the appendix for Chromium. Fortunately, in the particular case, because of the concentrated pumping and treatment activities and that the substance is not directly or indirectly impacting human health the_risk for the environment and health is under control and could be estimated as **MODERATE.**

LOCATION	MEDIA	CONTAMINANT and QUANTITY	IMPACT and RISK	DURATION and DIMENSION
Dumpsite, Pile of mixed slug and sludge Surface of dumpsite: 80.000 m2 Partially covered with soil	**Slag: heavy metals** 1.732 Mg (Fe, Mg, Al, Cr) **Sludge:** 296.260 Mg (7.388 Mg **Cr^{6+}**) **Total:** **2.029.000 Mg**	**Impact:** On surface water of Vardar River and ground water **Risks:** pollution of water-supply system of Skopje – **HIGH** **Impact: LOW** **RISK**: dump stability – pollution of Vardar River - **LOW**	Decades and centuries: Trans-boundary water **pollution** and local water pollution Long term jeopardizing of water supply system and request for additional costs (additional water treatment) As accident: dump instability caused e.g. by seismic impact	**Dumpsite**, Pile of mixed slug and sludge Surface of dumpsite: > 80.000 m2 Partially covered with soil Long term
Contaminated soil and **ground water** inside the factory	**Chromium 6+** unknown quantities Surface of contaminated land: unknown	**Impact:** On surface water of Bistrica River and groundwater in the village **Risk:** No potential risk - **LOW**	Decades **Trans-boundary water pollution** Local water pollution	

With the geoelectrical testing and with correlation of the results from geological and hydrogeological investigations, it is stated that the north side of the waste dump towards the river Gabrovnicka, as well as on the east side near the railway road, **do not show indications for contamination of the investigated area. (Profile GE I and IV). The profiles GE II and III are showing 4 Anomaly zones,** while those located in the southern part close to the entrance showing surface contamination characteristics**.** The depth contamination are increasing into the direction of the pumping station, which shows the appropriate sufficiency of this installation. For chemical testing of the presence of the soil polluters and the ground water, are sufficient piezometers on the dumpsite area available. Additional drillings are not required.

According to the building code have all buildings to be constructed to resist an earthquake rank 8 on the Mercali Ranks. The seismic risk can be evaluated as **moderate to high**. The risk on destabilisation of the underground to due a higher load than permitted is calculative evident. The dumpsite stability is 4,4 times above the permitted level and has to be flattened or stabilized due to underground water leveling.

The remediation options have taken in situ, ex situ, on site and off site alternatives into consideration. Those alternatives have certainly been divided into phytoremediaton, chemical physical, and other remediation processes. For the Chromium site remediation have been taken 10 possibilities into account, such as no activities, Phytoremediation, Surface Water management , Groundwatermanagement in various variations, on- and off site soil flushing and Excavation and off site disposal.

The environmental screening resulted in following ranking:

Groundwater treatment on WWTP + capping + drainage	**– 1**
Groundwater recirculation + agents / accumulation + capping + drainage	**– 2**
Groundwater recirculaiton / Imobilisation + capping + drainage	**– 3**
On site flushing / Excavation and off site disposal	**– 4**
Groundwater treatment on WWTP + capping – drainage	**– 5**
Off site fluhing	– 6

The economical assessment evaluated 4 different possibities of reactivating of the current slag dumpsite, such as o activities, green area development, reactivating for agriculture purposes, development of a sanitary landfill site and the extension of dispoals and industrial activities. The development of a sanitary landfill has been evaluated as the most promising one. The neighboring municipalities of Jegunovce (where Silmak is placed) are Zelino and Tearce. The total number of population in these municipalities is 54.071 or 12.000 households. According to the available space the potential volume of the dump site is 745.600m³ on a surface of 6,54 ha, which mean that this dump site can serve 160.000 (much more than the three mentioned one) inhabitants for 20 years. An financial input of 3.065.000 Euro for investements and approximate 150.000 Euro yearly operation costs would be required. A removal of the waste would be condition for such an regional approached situation.

The remediation costs of the remaining options from the environmental assessment have been calculated and compared with the economical benefit. Transport cost, manipulation costs, treatment costs, supervision, capitalisation, investments and public information costs have been taken into consideration and compared with the direct potential income due to recycling and reuse activities and further with the economical outcome of various options. Comparing financially in- and output can following financial ranking be stated:

Treatment on WWTP, capping, drainaging	-1
Treatment on WWTP, capping – without drainaging	-2
Groundwater recirculation, capping, drainaging	-3
Groundwater accumulation, capping, drainaging, Chromium recovery	-4
Groundwater recirculation, immobilisation, capping, drainaging	-5

Imobilisation, capping and drainaging	-6
Excavation and on site flushing, Chromium recovery	-7
Excavation and off site flushing, Chromium recovery	-8
Exacavation and off site disposal	-9

Conclusion:

The economical evaluation of the environmental and financial ranked treatment alternatives alow the recommendation of a combination of treatment by the current operated WWTP for a period of 5 years, surface water management by capping and closure measurements and groundwatermanagment by constructing a drainage system in the western part of the dumpsite. The proposed removal and developing of a sanitary landfill upto 160.000 PE and a lifespan of 20 years is economical most appropriate, but does not compete with the financial obstacles at current stage. The financial input for the proposed measurements are 1.656.160 Euro. A recovery and commercialisaton of Chromium requires a higher stock price than the current one or more efficient treatment technology due to the fact, that all the Chromium is dispersed within 2.029.000 Mg of slag and sluge waste.

Second alternative is the combination of treatment on the current operating WWTP and a surface water management by capping and closure measurement. A financial input of 1.698.108 Euro is required.

1 Introduction

The Stabilisation and Association Agreement (SAA) signed with the EU (in 2001and enforced since 2004) places new obligations on the administration in the vital task of combating environmental degradation. The Ministry of Environment and Physical Planning (MOEPP) has the responsibility to define environmental tasks, responsibilities and mandates and to arrange sufficient staffing to meet its obligations.

The former Yugoslav Republic of Macedonia faces similar problems in the environmental sector to those of many other former command economies in Central and Eastern Europe. In particular, inadequate solid waste management and numerous industrial hotspots (including historical industrial pollution sites) have in some cases led to threatened public health and environmental implications.

In the last two years, the MOEPP has worked on the development of five environmental laws, including the Law on Environment as a framework law in the area of environment, which transposes the *Acquis Communautaire* into the national legislation. The Law on Environment was adopted by Parliament in July 2005, and incorporates the basic principles of environmental protection, on the basis of which the relevant environmental management procedures are regulated.

Environmental management in the former Yugoslav Republic of Macedonia is guided by the second National Environmental Action Plan adopted by the Government in March 2005.

1.1 Current state of affairs in Industrial Hotspots Management

The lack of suitable infrastructure hampers adequate waste disposal in general and disposal of hazardous waste in particular. There is only one licensed (though not acquis-compliant) landfill in the country compared to around a thousand illegal dump sites, there are no incineration (except for medical waste), no composting and few recycling facilities. Hazardous waste is exported in accordance with the Basel Convention[1]. A register and maps for pollutants and polluting substances for solid and hazardous waste and wastewaters were completed in September 2005.

Regarding industrial pollution control and risk management, the MOEPP has compiled an inventory of installations to be subject to integrated environmental permits, but integrated pollution prevention and control system has yet to become fully operational. Some elements of EU legislation on the control of major accident hazards involving dangerous substances appear to have been transposed into national law, but full transposition still has to be completed. The capacity of the MOEPP and other concerned parties (local governments, enterprises, etc.) to implement industrial pollution control and risk management measures needs to be strengthened.

Environmental burdens left behind by state-controlled industry have now been transferred over to new owners, in most cases without clear specification of environmental liability. 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, the former Yugoslav Republic of Macedonia has no systematic approach or policy for addressing and remediation of these environmental hotspots. Their impact is not fully known, clean up costs are not systematically estimated; funding for the most part is

[1]Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

unavailable; and even "ownership" of these environmental burdens in a post- privatised setting is not clear.

Decades of industrialization and extensive exploitation of natural resources have left certain number of areas in the country heavily polluted. Since independence no significant concrete investments in this regard have taken place for the protection of the environment. As a result many uncontrolled municipal, as well as industrial landfills and wild dumps proliferated.

In the frame of CARDS 2001 project for development of National Waste Management Plan with Feasibility Studies 16 Industrial Contaminated Sites - "hotspots" were identified and ranked according environmental indicators. In the frame of Cards 2006, the project took additional indicators into consideration, such as:

- Environmental Indication from the Cards 2001
- Exclusion Criteria
    - Ongoing Donor Activities; avoiding of overlaps and replication; overwhelming factors
- Public Health
- Public Sensitivity
- Seismic and geotectonic Risk
- Climate impacting factors
- Cross Border pollution prevention in accordance with Cards 2003
- Economical Benefit and Impacts

Taken those indicators into consideration the project proposed to focuses on 4 prioritised "hotspots":

- **OHIS A.D (organic chemical industry) - Skopje**
- **MHK Zletovo (lead and zinc smelter) - Veles**
- **Silmak Ferro-silicon plant (former HEK Jugochrome) – Jegunovce / Tetovo**
- **Makstil (iron & steel plant) – Skopje**

2 Objectives / Results / Scope

"The overall objective of the project is to support the remediation of industrial hotspots on a environmentally and financially sustainable manner by promoting donor funding to the sector"

2.1 Specific objectives

The purpose of this contract is to assist in the elimination of industrial hotspots in the country through the development of remediation plans for 4 hotspots with financial requirements

2.1.1 Results to be achieved by the Consultant

- Baseline conditions at 4 Industrial Hotspots identified with project data room and Industrial Hotspot database established
- Qualitative human health and environmental risk assessment related to historical contamination at 4 Industrial Hotspots performed
- Remediation feasibility studies for 4 Industrial hotspots performed
- Pilot site selected based on applying additional prioritisation criteria
- Technical design/ technical specification documents, financial / economical appraisals of remediation alternatives and EIA (if needed) and ToR for remediation of selected pilot site prepared
- ToR for supervision services for remediation works on selected pilot site prepared

2.1.2 Scope of the work

2.1.2.1 Project description

The project will:

- Identify baseline conditions at 4 Industrial Hotspots through collection and analysis of existing data and performing additional site investigation
- Put a strong emphasis on training and capacity building of local stakeholders in the field of contaminated site assessment and remediation
- Estimate possible impacts to human health and environment through performance of risk assessment
- Include relevant stakeholders in the process of prioritising the sequence and identifying the extent of remedial action at individual hotspots
- Provide a prioritised and cost schedule of remedial actions needed to be performed at 4 Industrial Hotspots to mitigate human health and environmental risks
- For all the sites, evaluate the immediate need for implementation of heavy-cost site remediation investments as recommended in NWMP, identifying to whom those costs would accrue (whether public bodies or private sector companies) the current status of possibly ongoing remedial investment and the need for further investment as well as the likely sources of investment funding.

- Adopt clearly defined processes of internal quality assurance and external approval for all outputs.

The overall approach to implementing the project would involve:

- Preparation of Background Site Assessment Reports for 4 priority sites presenting the available data and findings of site visits and results of qualitative human health and environmental risk assessment
- Preparation of feasibility studies for remediation of 4 industrial hotspots, to include detailed evaluation of remedial alternatives and cost schedule for performing the additionally needed site investigation and undertaking the remedial action.
- Prioritising the sequence of remedial action for 4 Industrial Hotspots and selection of pilot site

2.1.3 Target groups

The ultimate target group is the population of the country, which will benefit from a clean environment developed by hot spots remediation activities. In particular, the status of population, of the area distressed by targeted industrial sites, as well as the industrial waste management entities whose capacities to manage waste management in the project area will be significantly enhanced.

2.2 Phases of the Project

The project is facing two phases:

- Inception Phase (Phase I)
- **Assessment and Feasibility Phase (Phase II)**
- Development of Terms for one selected site (Phase III)
- [Implementation Phase – not foreseen by this Project – Phase IV]

Within the implementation phase there are several stages, where decision-making process through the steering committee (SC) is required. The project is currently in phase II.

2.3 Contents of the Study

This Study is Volume III of various volumes and contains the Baselining including Qualitative Public Health Risk Assessment, Reevaluation of the former process and quantitative and qualitative assessment of the contaminants which can be expected, geophysical investigation, qualitative EIA of the current situation, Public Sensitivity assessment and institutional public information scheme, technical objectives of reuse and treatment potentials, EIA of various treatment options and financial/economical evaluation of various steps. The study comprises assessments, evaluations and conclusions. The legal and institutional part (funding mechanism and implementation body) is only short mentioned and can be referred to Volume V[2] and Volume VI[3]. This feasibility study is prepared in accordance with Fidic Guidelines for Reporting (2001).

[2] Feasibility Study – Volume V - Legal Gap Analyses for the Remediation Issues of polluted and contaminated sites

3 Generally Description of the Silmak Plant

Experimental production of sodium bichromate began in 1955. The plant was based on the so called Zehn Process in which chromite ore and limestone were calcined and the product was leached with Sodium bicarbonate. Due to a low efficiency and high Cr^{6+} concentration in the residue, the experimental production was stopped shortly after the beginning. The Government in 1952 as the country's sole producer of chromium minerals and Ferro-alloys established HEK Jugochrome employing almost 2.000 workers and with an annual production capacity of around 69.000 Mg.

A major reconstruction of the plant was undertaken in 1962 by the Polish company CEKOP. The production process was changed and the plant was operated under this process until 1993 when it was permanently shut down. Huge amount of sludge (about 300.000 t) containing chromates of Calcium, aluminum and sodium have been disposed of on the proprietary landfill. This landfill, together with the contaminated plant site, is the the major source of groundwater contamination with Cr^{6+}.

SILMAK is a company created with aim to restart the activities of ex Jugochrome, whose main activities were production of Ferro-alloys, which contains certain chemical elements such as silicon, chromium and magnesium for the needs of steel industry. The production in Jugochrome was stopped in December 2001. In 2002, The Macedonian Government conducted privatisation of Jugochrome in cooperation with the French investment group SCMM. Annual production now is 80.000 Mg, Ferrosilicon (Si-content 75%, 65%, 90%) and Silicon metal (small tonnages). Four main types of granulation: 10-50 mm, 10-80 mm, 3-10 mm, 0-3 mm Silmak is a leading producer of Ferro-alloys on the Balkans Peninsula Logistics: Annual processed: Quartz / quartzite 140.000 – 160.000 Mg; Coal 78.000 Mg; Lignite 82.000 Mg. The total power consumption is 713 GWh/y.

3.1 Geographical Description of the area

The SILMAK (former HEK Jugohrom) plant is located on the left bank of River Vardar, thirty kilometers upstream from Skopje, within the area of the village Jegunovce. The industrial chromium mud landfill is located in the vicinity of the plant, in the lowest part of the Polog Valley, upstream of the mouth of Gabrovacka and Vardar rivers, right before the latter enters the Dervent Gorge.

The location of the site (adjacent to the Vardar River and the spring Rasce) is a major concern because of the **presence of six-valent chromium**. Such a status is a potential threat to pollute the waters of the spring Rasce, which is the principal potable water supply source for the city of Skopje and the region.

The dumpsite, approximately 1 km north of village Jegunovce, is enclosed on three sides – by the rivers Vardar and Gabrovnica, and railroad Skopje – Tetovo. The Gabrovachka river flows on the northern side of the landfill. The railroad embankment is on the North-West and West. On the eastern side the Vardar River flows at a distance of 50 m. The landfill is accessible from the southern side, via a local asphalt road from the village Jegunovce. Jegunovce railway station is located approximately 400 m from the landfill, on the southern side.

[3] Feasibility Study – Volume VI – Funding Mechanism and institutional set up for the Remediation of contaminated and polluted sites

The Muzgi spring flows through the central part of the industrial landfill site. A concrete pipeline, 1200 mm, was installed on the surface of the ground, latter extended on both sides with 1000 mm pipes, in order to achieve free passage of the Muzgi stream waters without getting into contact with the landfill material, ferro-chromium slag and dichromium mud of different properties. Analysis of the water proved that the groundwater under the landfill is not significant carrier of chromium pollution, while a more serious chromium polluter of Vardar River is the Muzgi stream, in the part that flows through the landfill.

3.1.1 Climate Characteristics

The meteorological data for the location around the landfill are taken from the study from Jaroslav Cerni Institute, 1989 year. Annual precipitation in the Polog valley are 700-800 mm. Generally for this area it could be said that the maximal precipitations are in XI-XII month, while the minimal are in VII-VIII month. 40% of the precipitations are snowfalls. Average annual temperature in lower part of Polog valley is 11 º C. The warmest month is July with average temperature of 21º C, while the most cold month is January with average temperature of 1.5-12 º C. The maximal temperature is around 40 º C.

3.2 Topographical Description of the area

The location of the dumpsite area is about 1.5 km north from the factory "Silmak" - Jegunovce, between the river Vardar and the railway road Skopje-Kicevo. At the area of the location technological waste from the factory had been deposited, where ferro-silicium is currently produced. The waste dump has a size of 6,46 ha, while the whole area has a surface of 8 ha.

The position of the SILMAK factory is located at N 42º 05' 06.70" and E 21º 07' 36.48"[4]

SILAMAK dumpsite is located at N 42º 04' 58.72" E 21º 07' 19.24'' at elevation of ~396 maSl

3.3 Geological Description of the area

Both geological composition and tectonic structure vary significantly. Geomorphology and hydrogeology are complex, as well.

3.3.1 Geomorphology

Characterized by domination of highlands (Shara Mountain on North and carbonate rocks with karsts-shaped landscape on South-East). Following phenomena are present:

- Fossils glacial residues,
- Originally formed intensive fluvial-glacial deposits,
- Latter, these deposits did erode and were covered with younger structures/layers
- Karsts phenomena ("vrtache", "shkarpe", caves)

[4] source: Google Earth

3.3.2 Geological composition

- Old paleosoic formations
- Neogenic quarter sediments
- Zheden: Marble massiv
- Radusha: Peridotic & serpentine massive and neogenic rocks

Table 1_Layers of various piezometers from east into west direction

	Pc 36/2			Pc 37/2			SP-18			Pc- 2/1			P-1		
Layer 1		0,2	0,2	humus	0,2	0,2	dust,sand with small % of clay segments(5%) & by the end gravel with brown color	22,3	1,9	humus-dust,sand and clay 15%	0,3	0,3	sand clay 3.3*10??	4,1	4,1
Layer 2		1,6	1,4	Clay 4,8*10-8	2,0	1,8	gravel and sand with dust	24,8	2,5	sand,dust and gravel clay (40-50mm)	1,0	0,7	clay	4,7	0,6
Layer 3		3,6	2,0	gravelsand and dust	2,3	0,3	sand and dust	25,8	1	sand,dust partly with gravel	3,0	2,0	sand dust	5,0	0,3
Layer 4		8,0	4,4	sand,dust,clay(till 15%)	4,2	0,9	sand and gravel in the middle with dust of yellow color	26,5	1,3	gravel,sand,dust (<10%) brown	5,2	2,2	sand	6,0	1,0
Layer 5		9,0	1,0	dust, sand, clay (<10%)	5,0	0,8				sand, partly gravel (small particles of brown&black color)	7,5	2,3	cobbles 5.4*10??	6,5	0,5
Layer 6				gravelsand partly dust and clay (<10%)	8,8	3,8				sand,gravel and dust (<10%)	9,4	1,9	sand dust 2.4*10??	10,3	3,8
layer 7				dust, sand, clay 20%	10,0	1,2				clay,sand,gravel	13,0	3,6	clay sand	14,4	1,1
Layer 8				gravel, sand, partly dust and clay	15,0	5,0				sand,gravel and dust (brown+black dust)	14,0	1,0	clay sand grovel (40-50mm)	18,5	4,1
Layer 9											15,0	1,0		22,0	3,5

Figure 1_Example of profile of piezometer Pc2/1

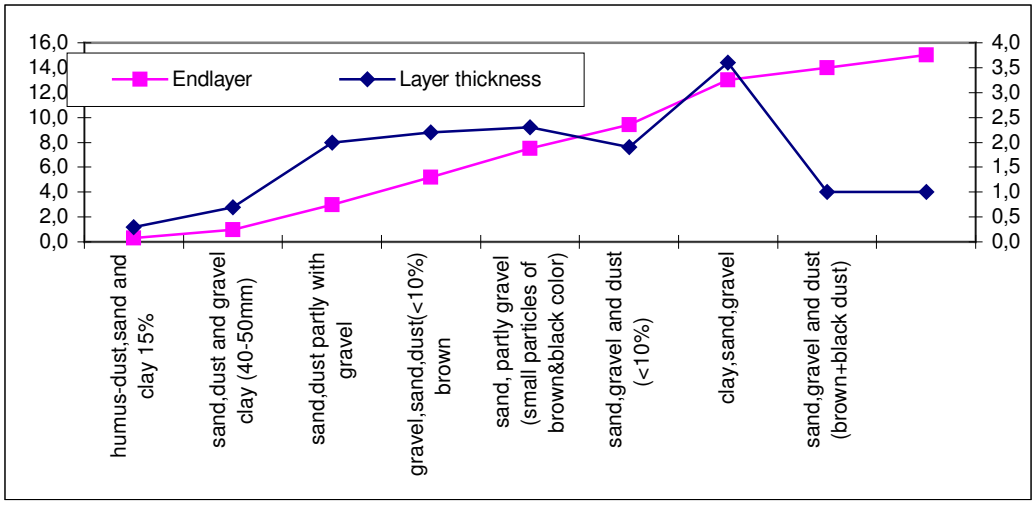
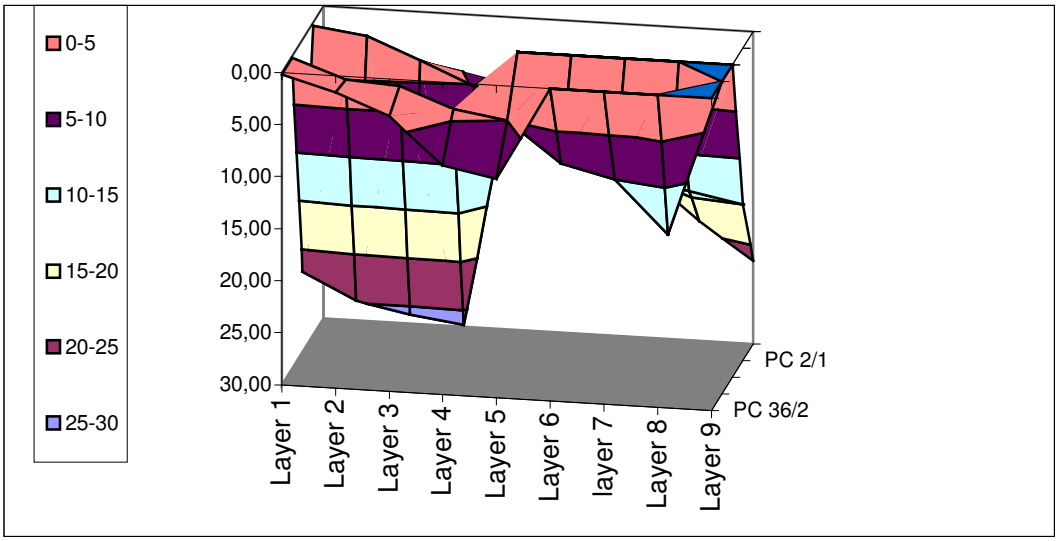


Figure 2_ Layers of various piezometers from east into west direction



3.3.3 Dumpsite characteristics

Dump site situated in the lowest part of Polog Valley. Constructed on the material of fluvial-glacial origin (close to Vardar River) and partially on the material of alluvial origin (50-60 m, near the River bank). Fluvial layers of course grained gravel with rounded stones and large irregular single stones. Presence of clay and clay-sand materials in the vicinity of Vardar River. Mineralogical composition of materials is complex and corresponds to the composition of the peripheral Shara rocks where they did origin by erosion and were transported downstream. Total layer thickness is 60-70 m with manifold repetition of waterbearing laers. The substrat is of gray mud clays from the Pliocene.

3.4 Hydro-geological Description of the area

3.4.1 Hydrogeological conditions

Rashche quell has a very wide feeding zone that consists of materials of fine porosity. Surface soil consists of sand + dust material, locally with gravel. Up to the 1 m – humus. Next are alluvial quarterly sediments, some 15 m tick. They are of sand + gravel with eventual significant presence of dust particles. Irregular participation of individual components.

3.4.2 Hydrogeological characteristics

Bottom part, 4 m thick: materials of poor permeability, filtration coefficient (4-5).10^{-6} m/s.

Upper part, 2-4 m thick: sand + gravel, locally dust. Filtration coefficient 10^{-3} – 10^{-4}.

Surface, 1-4 m thick: dust materials.

Bellow the surface sand-gravel dusty sediments are mud-dusty and clay materials thick more than 2-3 m. Low permeability, 10^{-8} m/s.

Depth from surface:

- in the factory yard = 12-13 m,

- closer to Vardar River – less,
- finally – reaches the surface and delivers the water free.

Principal water flow direction follows the slope of the ground and aims the Vardar River. Water collecting layers are less inclined towards Vardar River than the ground, so that they approach the surface and water exits as a number of quells.

3.4.3 Groundwater regime

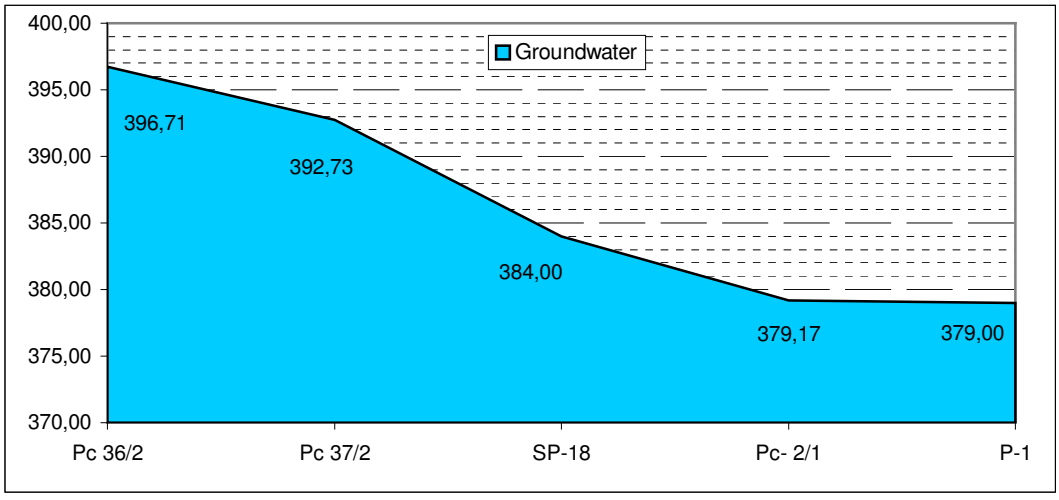
Creek Muzga, one of the Vardar River inlets, is located bellow the dump site. It was regulated and now flows through a concrete pipeline of 1000 mm diameter.

The material is multilayer, with complex inter-granular porosity. General direction of groundwater flow is perpendicular to the Vardar River. Gradient of piezometric groundwater level is 1 to 4 %. Near the Vardar River good hydraulic connection with the groundwater.

Secondary quell formed at the dump site location due to (i) creek's erosive activity, that left the bank vicinity without surface humus layer of low permeability, so that rise of groundwater level is now without barrier and (ii) reduced evaporation from dump site ground (some 6 ha in toatal). As a consequence, the level of groundwater is now higher than the level of original ground, and they reach the material dumped at the site, leaching chromium out of it. Part of this Cr^{6+} containing groundwater enters the creek's concrete pipeline and expands the contamination further.

The substrate of the alluvial deposit is composed of Pliocene sediments of layered, poorly bonded dust-clay sandstones, conglomerates and marls, marly clays etc. Thin layers of marls and clays are water non-permeable, while the sandstones and conglomerates are of poor water permeability (with a filtration coefficient of probably 10^{-4} or even lower).

Figure 3_Groundwater level – west – easte driection



4 Legal Perspective

The purpose of this chapter is to present the summary of the legal analysis regarding Industrial Hotspots. The legislation which has been taken into consideration for the purpose of this analysis is the following and has been detailed described within the **Volume V** "Legal Gap Analyses for the Remediation Issues of polluted and contaminated sites".

- Law on Waste Management (Off. Gazette no. 6/2004); and amendments (Off. Gazette no. 68/2004; 71/07; 107/07)
- **Article 80, from the Law on Waste Management (Off. Gazette no 6/2004; 68/2004; 71/2004) regulates the conditions for establishing a landfill. This article , under paragraph (8), clearly states that the Minister managing the body of the public administration responsible for environmental affairs may request, as a condition to the issuance of permit for establishment of a landfill, that the founder join other municipalities to the contract provided, if doing so, it contributes to more economic and improved waste management, in accordance with the Waste Management Plan of the Republic of Macedonia**
- Law on Environment (Off. Gazette no. 53/05 and 81/05);
- Law on Privatisation (Off. Gazette no. 37/96; 25/99; 81/99; 49/2000; 6/2002; 74/05);
- The draft Law on Hazardous Waste (which is being produced in the CARDS 2004 Programme, and was provided by them).
- Law on Budgets (Official Gazette of the Republic of Macedonia no. 79/93; 3/94; 71/96; 46/2000;11/2001, 93/2001; 46/2002; 24/2003; 85/2003 and 96/2004 and Decision of the Constitutional Court no. 180/98 (Official Gazette of the Republic of Macedonia no. 15/99)

The following subsequent Legislation was also reviewed:

- Decree on the criteria and manner for B IPPC permit (Off. Gazette no. 04/2006); Decree on the level of charges for A IPPC permit (Off. Gazette no. 04/2006);
- IPPC Ordinance - A permits (Off. Gazette no. 4/06);
- IPPC Ordinance - Adjustment permits (Off. Gazette no. 04/2006);
- IPPC Ordinance - B permits (Off. Gazette no. 4/06);
- Rulebook on the form and content of the application form, and the content of the permit for collecting and transporting urban and other types of non-hazardous waste as well as on the minimum technical requirements for performing the economic activity of collecting and transporting urban and other types of non-hazardous waste (Off. Gazette no. 23/2007);
- Rulebook on the format and the content of the Journal for records keeping on the waste handling, the format and the content of the forms for the annual report on waste handling by legal entities and natural persons and the format and the content of the annual report on waste handling by the mayor (Off. Gazette no. 7/2006);
- Rulebook on the functioning methods and conditions of the integrated waste disposal network (Off. Gazette no. 29/2007);

- List of Waste Types (Off. Gazette no. 100/05);
- The Law on the ratification of the Basel Convention (Off. Gazette no.49/97); Rulebook on the form and contents of the forms for transboundary movement of hazardous waste (Off. Gazette no. 37/03 and 38/03);
- Law on Mineral Resources (Off. Gazette no. 24/2007); the content comprises the subject of regulation of the Law on mineral resources. The analysis of this law discovered that the subject of regulation of the law is general, and there is no relevance to remediation purposes of hotspots;

It has also been taken into account several Tables of Concordance (TOC), produced by the Ministry of Environment and Physical Planning, and the CARDS 2005 Programme. Those are the TOC's for the Waste Framework Directive; the Landfill Directive; the Directive for PCB's and PCT's, Hazardous Waste Directive; IPPC Directive. (It should be noted that the TOC on Mineral Resources haven't been delivered by the relevant Ministry). References were also taken from the National Waste Management Plan (NWMP), as well as the National Environmental Action Plan (NEAP) and the 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. There is a lack of regulatory provisions both in the privatisation law and in environmental law, as well as lack of the institutional framework and funding mechanism.

As a result of this legal gap analysis the following conclusions and recommendations are made:

- A lot of interpretation is required to identify direct links to the terminology of industrial hotspots. The terminology of hotspots is not clear. Definitions for industrial hotspots and hotspots closely related issues are missing. Terminology regarding "hotspots' can be found only in the Waste Management Plan, but without any legal meaning. It is recommended to include these definitions in the existing Law on Environment, Law on Waste Management, Draft Law on Hazardous Waste. Another recommendation is adoption of a framework Law on soil contamination, which has not been adopted so far. Such a law will give a legal base for subsequent legislation, which could be in the form of technical guideline for remediation of contaminated sites. Such a rulebook could contain the terminology regarding "hotspots", remediation plans, and the question of environmental liability and funding.

- Subsequent legislation on protection from pollution from priority substances is missing, however the Draft Law on Waters provides a legal base for such a rulebook (Article 107, paragraph 2).

- The question of responsibility for environmental liability should be clearly stated and solved. So far this issue was open for negotiations, which cannot remain the case. A cut off date after which any pollution arising is the liability of the installation, is also missing. Amendment of the law on Environment (in the chapter for environmental damage) is recommended to state whether the Government will be responsible or the potential buyer, as well as the time frame of clean up responsibility, or as mentioned, a new rulebook should be issued, for remediation of the contaminated sites, where the environmental liability will also be tackled.

- The monitoring and reporting system regarding the industrial hotspots is relatively poor. This can be understood, because the legal system of the country tackles very little of the hotspots issue. A standard for monitoring and elf-monitoring and reporting procedures is needed (sub-laws, forms, guidebooks).

- There is a lack of an appropriate funding mechanism. No earmarked or dedicates fee or charges to be made to industries are presently being considered or have been considered in the past. Appropriate funding mechanism needs to be established. That is

why it is proposed to create a separate law on trust funds, which will enable the establishment of an earmarked fund, under the MOF, independent from the MOEPP.

- So far Law on Soil Protection hasn't been adopted. Such a law could be a legal base for subsequent legislation for remediation of hotspots, which could include technical guidelines for remediation of "hotspots", terminology regarding "hotspots", also the question of environmental liability.

4.1 Gap analyse

The legal framework of the country does not give a clear picture and solutions for remediation of these industrial hotspots, and the purpose of this analysis is to identify the gaps and give some recommendations concerning the legal aspect of this matter.

4.1.1 Gap Identification

1. Crucial gaps have been identified within the legal framework related to industrial contaminated sites such as: missing definitions (example: definition of “hotspots”; “dumpsite”; “secure landfill” “sanitary landfill”, “contamination”). These definitions can only be found in the NWMP- Annex 9, Special Study E, and nowhere in the environmental legislation. Clear distinction between the terms “polluted” and “contaminated” is not made, very often a mistake is made with identification of both terms having the same meaning.

2. Another gap, within the terminology, is the incompliance of the existing definitions with the EU Directives

3. The issue of pollution from priority substances is not yet solved, however in the Draft Law on Waters there is a legal base for adoption of subsequent legislation for regulating this matter.

4. The monitoring system should be further developed. There are monitoring provisions found in the Law on Environment, Law on Waste Management, Draft Law on Waters, Law on Ambient Air Quality, IPPC Ordinances, however standards for monitoring and self-monitoring and reporting procedures is needed (sub-laws, forms, guidebooks). Inadequate secondary legislation (existing secondary legislation is not following the requirements of European directives, absence of emission limit values, outdated standards and limits Also there are overlaps in the institutional responsibilities and activities regarding some environmental media

5. The main gap is the clear statement regarding environmental liability, which might be handed over from the Government to a potential buyer of industrial sites within the privatisation activities. None of these articles (listed above) tackles directly the question of historical industrial contamination, or states clearly who is responsible for the clean up of the contaminated sites. A cut off date after which any pollution arising is the liability of the new owner of an installation, is also missing

5. In case of funding the costs for 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. A new law for a trust (remediation) fund is missing

6. There is no Law on soil protection; No legislation on Remediation of “hotspots”

7. There is no time frame in the NWMP, till when the “hotspots” should be remediated

4.1.2 Gap Summary

1. **Unclear, and missing terminology**
2. **Lack of regulation for protection from pollution of priority substances**
3. **Lack of monitoring and reporting regulations**
4. **Missing environmental liability**
5. **Lack of fund establishment and procedure regulations**
6. **Missing legislation on soil contamination**
7. **Missing time frame for remediation of "hotspots"**

4.2 Terms of References

- Terms of References, staff-, time and budget schedule is developed in accordance with the required input to minimize the legal gaps. The ToRs, Time schedule and budget calculation can be seen in Annex 11.1.1. The expertise and timeframe shall be as following
- Foreign Institutional Expert- 4 months within 9
- Local Legal Expert- 6 months within 9
- Local Institutional Expert- 3 months within 9
- Local Technical Expert- 3 months within 9

4.3 Ammendments on the law of waste management

There have not been significant changes in respect of remediation and rehabilitation of contaminated sites, therefore are the terms of references, developed also for the purpose of Silmak Chromium dumpsite valid.

5 Institutional Perspective

5.1 Funding Mechanism and set up of an implementation agency

The overall objective of this chapter is to propose an approach to building an effective financing and institutional system for remediation of industrial hotspots and is described in detail in the **Volume VI "Funding Mechanism and institutional set up for the Remediation of contaminated and polluted sites"**.

It is to achieve the greatest hand in hand environmental and economy benefits given the available resources and institutional capacity. It is apparent that the approach to building an effective financing system for remediation of contaminated sites is inextricably linked with the legal provision for environmental liability, with the privatisation process (since the value of property assets is directly linked to environmental conditions and obligations) and with the institutional framework for pollution control. On-going problems in environmental protection are encountered in connection with unclear ownership relations to properties, especially old environmental burdens and the limited capacity to date to evaluate environmental damage and environmental benefits of cleanup. It is proposed that environmental liabilities for historical pollution are clearly defined in legislation. Pros and cons of various approaches to environmental liabilities for past pollution are presented. It is acknowledged that application of the polluter pays principle is a precondition for an effective and fair remediation system. It is proposed that regarding the privatised sites that require cleanup, the state is liable for remediation and that a system of pollution taxes should be introduced to raise revenue for cleanup works. In case of sites that are subject to privatisation, it is proposed that the new owners introduce measures to contain contamination (if necessary) and the state assumes environmental liabilities for a limited period of time (10 years) during which time cleanup should be completed by the state. After remediation, all liabilities should be transferred to new owner. Privatisation receipts should cover the costs of cleanup. Priority sites of limited commercial value, and hence not subject to privatisation, should be remediated using state funds (pollution taxes and budgetary sources).

Various funding mechanisms are presented and discussed including their pros and cons for the specific Macedonian context. Remediation Fund is proposed as the most viable option for financing of cleanup works in Macedonia. The sources of financing and institutional aspects of the Remediation Fund are proposed. Estimation of the potential level of funding available from national sources is presented. It is estimated that some 3,5 M Euros can be raised from landfill tax for solid and for hazardous waste. In addition, part of the privatisation revenue and the donor funds are expected to contribute to financial basis of the Fund. Funding from the latter two sources is expected to vary substantially from year to year.

The Remediation Fund should have clearly defined and transparent financing strategies, expenditure priorities, operating procedures. Operation of the Fund should be supervised by the Supervisory Body (chaired by the MoEPP). The MoEPP should have a decisive role in establishing strategic directions of the Fund. Yet, the Fund should be independent and free of political influences that affect project selection procedures. The Fund's operation should be based on a long-term investment strategy and annual operating plans. Donor funding can be channelled to the Fund as individual trust funds or as direct contribution to the Fund's budget. This report is concluded with a simplified SWOT of the

The Cards 2001 project has addressed in their Annex 9 of the Waste Management Plan the need of a legal clarification, set up of institutional system for a sufficient implementation and establishment of funding mechanism.

Similar needs and requirements have been identified by the Cards 2006 program, which finances a project "Development of Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots". Investigations during the inception phase discovered the need of 4 pillars

- Legal Framework (Legal) – PILLAR I
- Funding Mechanism (Financial / Economical) – PILLAR II
- Implementation Body (institutional) – PILLAR III
- Technical set up (technical) – PILLAR IV

While the program is working on the Pillar IV, all other pillars have been identified as gaps. Funding mechanism and a strong implementing body, which can be an agency, a working group, departments or the funds integrated working unit have to be set up. Base for all the efforts is Pillar I (legal part), which is described in Volume V of the programme.

Taking a required investment volume of 200 – 250 Mio Euro for the rehabilitation of contaminated and/or polluted sites into consideration is an investment (funding) mechanism (Pillar II) required, which shall on the one hand guarantee a national (local) source of income for remediation purposes and on the other hand to attract donor and investment agencies and institutions to contribute within this framework.

Pillar III shall form the work- and implementation force, which shall develop remediation programs, request sufficient budget out of the funding pool, tender, contract, supervise and monitor all remediation related works.

Volume VI demonstrates models, case studies and propose the most appropriate one for the current situation of MK taken the technical most feasible and economical most affordable structure into consideration with the final output of an action plan for the stepwise implementation approach.

5.1.1 Recommendation for the Most Appropriate Financing Model for former Yugoslav Republic of Macedonia

5.1.1.1 Selection criteria and principles

Several alternative approaches can be applied to establishing an effective financing system for remediation of contaminated sites in Macedonia. Selection of the most appropriate financing system should be made taking into account international experience and the national conditions:

- The legal framework for environmental liabilities for past pollution.
- The stage of the privatisation process.
- The existing system of environmental financing.
- Experience with the operation of the Environmental Fund.
- Potential sources of revenue from pollution taxes and environmental fees.
- Potential sources of revenue from privatisation of state owned companies.
- Potential sources of funding from bilateral donors, international organisation and the EU.
- The existing human capacity for preparation and cleanup of contaminated sites.

The key principles that can be applied to develop an effective financing system include:

- **The polluter pays principles** - should be applied where feasible. Consequently, regarding the liability for past pollution the state should be liable for cleanup
- **The principle of earmarking** - Environmental revenues from various pollution and environmental taxes, user fees etc should be spent on environment (including cleanup of contaminated sites)
- **The principle of concentration of funding sources** - Ideally, all earmarked environmental funds and donor assistance funding should be concentrated in one Fund that will disperse the funds in an efficient way and at relatively low operating costs

5.2 Institutional Framework for the Remediation Fund

The main objective of this chapter is to put the recommendations from chapter 2 (legal framework and environmental liabilities) and chapter 3 (financing system) in a sound and coherent institutional framework.

5.2.1 Overview of existing institutional situation in Macedonia regarding remediation

The existing institutional arrangements for remediation of industrial hot spots in Macedonia have been influenced by constitutional changes, new legislation, and changes of ownership (privatisation). As a result, a number of overlaps, gaps and inefficiencies have been created that are hindering the process of remediation. This section provides an overall review of the institutional context. Table 5 presents summary of the key institutional weaknesses of the present system.

Table 2_Summary of key institutional weaknesses regarding remediation

Areas	Problems
Policy and legislative	Not clear remediation policy and environmental liabilities Incomplete legislation Lack of monitoring and enforcement
Institutional aspects	Lack of government implementation body Unclear roles and responsibilities of stakeholders Weak institutional implementation capacity within the government Insufficient communication between the national and local level Inappropriate conditions for Private Sector Participation No arrangements for financial / economic instruments in place
Economic/financial Issues	Lack of funds for industrial Hotspots remediation Sustainable financing instruments have not been introduced
Public Information	Lack of communication at all stakeholder levels

5.2.2 Selection of institutional set up for the Macedonian Remediation Fund

5.2.2.1 Selection principles

The institutional set up for the Remediation Fund has to accommodate the recommended financing system, and the proposed environmental liability arrangements. The following principles were applied to select the most appropriate institutional set up for the Remediation Fund:

- The MoEPP takes strategic decisions regarding the Remediation Fund
- Operational independence from MoEPP
- Clearly defined operation strategy
- Adequate level of funding
- Closer working with ministries & other funding agencies
- Clearly defined management structures
- Appropriate and adequately trained staff
- Open and transparent project selection procedures
- Regular monitoring & reporting on projects & programmes
- Formal and independently audited annual reports.

5.2.2.2 Management of the Remediation Fund

The Remediation Fund should be established as an independent institution with clear formal institutional links to the government, and cooperating closely with donors. The mission of the Remediation Fund should be efficient disbursement of funds for remediation of contaminated sites.

Remediation Fund will be a specialised environmental financing institution that determines and follows criteria for funding in accordance with the state environmental policy. The Fund's independence should be ensured through clear operating and decision-making procedures. The government (the MoEPP) should have an important role in strategic decisions of the Fund but not in daily operations. The Fund will play a key role in the hot spot remediation through development of a pipeline of projects and implementing them. It is also expected to attract funding sources additional to those provided by environmental taxes and the privatisation revenue (in particular donor funding).

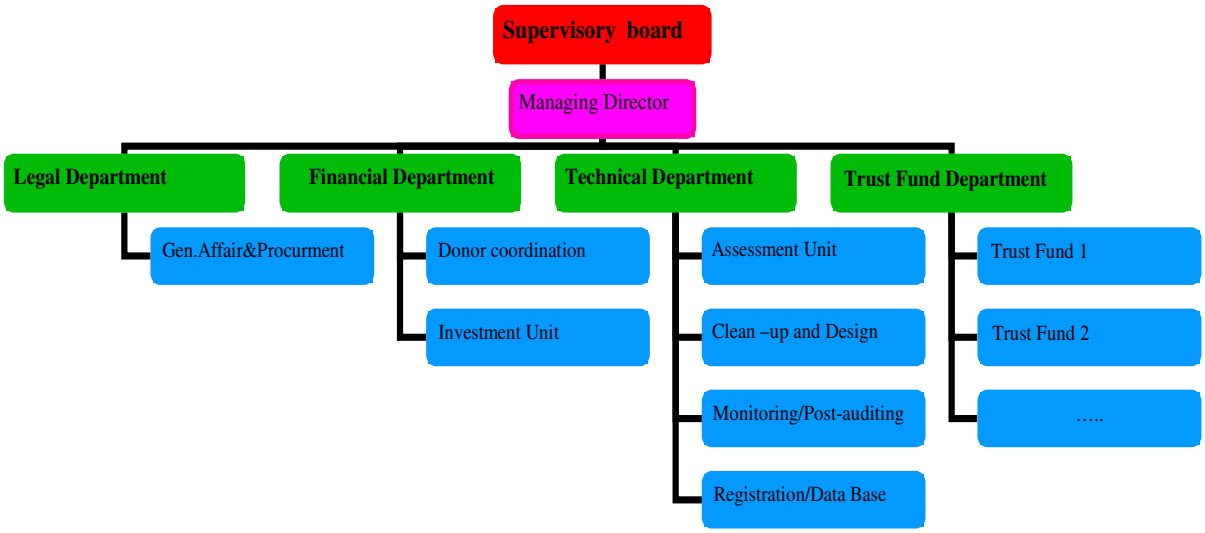
The priority remediation projects for the Fund should be established on the basis of risk assessment. Initially, the 2nd National Environmental Action Plan (NEAP) can be used for reference regarding the funding priorities. Investment strategy and priorities should be prepared by the Fund, approved by the Management Board of the Fund, made widely available, and regularly reviewed.

The Remediation Fund should be supervised by the Management Board, represented by the following institutions (see figure 2)

- Ministry of Environment and Physical Planning (chairperson)
- Ministry of Finance
- Ministry of Economy
- Ministry of Local Self Government

- Ministry of Health
- Ministry of Agriculture Forestry and Water Economy
- International donors

Figure 4_Recommended organizational Chart of the Remediation Fund



Establishing of the Remediation Fund can be divided into 3 operational phases:

- Phase 1 (12 months), with the key objective of establishing a framework (legal basis, funding, director, staff, procedures, priorities) that will ensure that the Fund is capable of operating effectively as an independent agency;
- Phase 2 (30 months), of demonstrating the credibility and effectiveness as an independent agency, and its impact on the (environmental investment) market;
- Phase 3 (3 years), develop the links between the Fund and other funding agencies in order to provide a wider range of financing options that will increase its impact in the market.

5.2.3 Operational procedures of the Remediation Fund

The project cycle operating procedure should become the main operating manual of the Fund. The simplified procedural steps (based on international experience) are presented below:

- **Site identification**
  - Sites, which have been previously identified and investigated, are included in the database
  - Other sites will require environmental audit to evaluate environmental damage
  - The site owner in case of the privatized companies covers the costs of environmental audit. The Fund will cover audit expenses for the state owned sites
  - The MoEPP evaluates the audit results. When approved, the site is included in the database. The Remediation Fund covers all subsequent costs
- **Ranking and registration of sites**
  - Risk assessment study is prepared by the Fund. The results are included in the database of past environmental damages
  - Sites in the database are ranked according to a prioritization methodology (based on risk assessment) prepared by the Fund and approved by the Supervisory Board
- **Design of remediation strategy**
  - The Fund proposes priority sites for remediation in the Annual Operation Plan (the list of priorities should much the funding available)
  - The MoEPP approves by the Supervisory Board and the Annual Operating Plan. The Plan should include cleanup target criteria, time schedule and remediation method
  - ToR for remediation project is prepared and approved (field investigation may be required) by the MoEPP (the Inspectorate of Environment)
  - Tendering of remediation works is initiated by the Fund
  - Selection of supervisory body by the Fund (approval by the Supervisory Board)
- **Post-auditing and site deletion procedures**
  - Remediation works are conducted and supervised by the Fund
  - Verification of remediation works by the Fund. The verification report to be approved by the Supervisory Board and the MoEPP
  - Post-remediation monitoring and supervision conducted by the Fund
  - Completion of remediation process and deletion of the site from the register (approval by the Supervisory Board and the MoEPP)

5.3 Public Awareness and Information

This chapter intends to facilitate the attempts of the MOEPP and its Public Relation Office to support a public awareness campaign in order to raise public awareness and educate citizens as to the new regulatory structure and how they will interact with it. It can be seen as an important tool to ensure successful implementation of the proposed remediation measures for Silmak – Jegunovce is public consultation and participation. This chapter is required in order to achieve understanding of the key issues of concern to stakeholders/actors in the remediation process. While the technical aspects are of great importance, it is recognized that public involvement and participation is of equal importance. This public awareness programme has been produced following discussions within the Ministry of Environment and Physical Planning, representatives of the municipality of Jegunovce as well as representatives of Silmak.

5.4 Objectives

Overall objective of this Chapter is to facilitate the attempts of the Project to develop public awareness campaign in order to raise public awareness and inform and educate citizens about mitigation measures and solutions of main environmental problems in Silmak – Jegunovce.

5.4.1 Specific objectives are formulated as follows

- To increase knowledge/awareness of the different target groups concerning the pollution problems in Silmak
- To develop a Public Awareness Campaign (PAC) approach at local level

5.5 Approach

In general, the measures to increase public awareness and participation that are proposed should both support Macedonian's progress through the process of economic transition, and support the process of alignment with the EU environmental acquis. Member states (and the accession countries) have had the latitude to inform and involve public in decision-making and to enhance public participation in the planning.

The approach has been followed here is in favor of stepwise, incremental changes that build on existing resources and capacity.

5.5.1 Causes related to public awareness on environmental issues

The general level of environmental awareness within the country and especially in the rural areas as Jegunovce is low. Local population pressed by social and existential problems has insufficient understanding of environmental problems. This is largely caused by

a) Gaps in formal environmental education in schools, etc;

b) Limited informal education or dissemination of environmental information.

c) Insufficient capacity within the Ministry of Environment and Physical Planning (MOEPP) to promote and facilitate better environmental education and awareness related to environmental issues

d) Insufficient and improper information transfer through or by media

e) Lack of understanding of the local authority in enforcement of public information (Aarhus perspectives) systems

5.5.2 The core issues related to PA can be summarized as follows

- Low public information and awareness in general and poor public participation
- People are not aware of the industrial pollution problems and the effect on their environment and health
- Lack of understanding of importance to pay for ”cleaner environment”.
- Companies responsible for pollution do not pay enough attention to public awareness
- Lack of information and access to public information
- Public acceptance of illegal dumping of waste, including hazardous waste.
- Current negative perceptions based on bad local experience
- Many isolated, not coordinated PA activities financed by different donors
- Insufficient institutional capacity to cope with and to promote of the public awareness and environmental education.
- Misuse of environmental topics for political issues

5.6 Experiences of past Public Awareness activities in the Polog region

There are very limited experiences of public awareness on environment protection issues in the region. PA programmes mainly are performed as a side activities within the bigger international projects. Usually target groups were general public, civil sector, pupils, etc.

The most frequent used communication tools are as follows:

1. Publication of brochures and leaflets,
2. Lectures and workshops,
3. Media coverage,
4. Articles in newspapers

The effects of the activities focused on general public are not really measured until now (indicators missing). The citizens are not enought familiar with topics for environment protection, and those topics are still under foreign responsibility (shifting of responsibilities).

The general impression is that the protection of the environment is not important issue for older population. This behavior has impact to the behavior of young population. The PA campaigns focused to children can be treating as a complementation of formal education for protection of the environment.

Performed PA activities were depending on investor’s program and not all direct reflect the really necessity and needs of local population. This is one of the reasons for non-continuation of activities after finishing of the projects (missing sustainability)

Economical Ecology vs. Ecological Economy – no environment protection without economical solid base.

5.7 Target Groups, Information Needs, Communication Techniques

5.7.1 General public

People need to see that their government, neighbors and community leaders will join the pro-environmentally sound activities.

- **Information needs:** This target group demands regular information about environmental issues, problems, success stories and proposals how individuals can contribute to preservation of environment. Electronic and printed media could play the important role for public environmental awareness raising, mainly through presentation of collected and processed relevant information in this respect.
- **Communication techniques:** Since it is hard to reach the general public directly, useful communication technique could be combination of media campaign that will ask citizens to initiate proactive action at personal level. For the maximum benefit of the environmental public awareness campaign it is extremely important to provide new possibilities that will offer to people how to change their current behavior into more environmentally friendly. In the media campaign that should follow after these possibilities are provided, simple explanations for the environmental, health and financial benefits should be addressed.
- Local communities of the villages are good tool for individual proactive action. All citizens in an interactive action show their commitment for cooperation in every project they see important for their life.

5.7.2 Schools

School children are very important target group as they represent the future population; therefore the local, national and international efforts for conservation of this area have to ensure building of the future human resources in appropriate way.

- **Information needs:** This target group has need for permanent education about environmental issues and problems at local, national and global level. Different ages of pupils need different types of information.
- **Communication techniques:** Pupils need to learn through well-designed and interactive approach using outdoor experiments. These practical exercises should be combined with messages that adults are personally responsible for growing and development of their society, whereas their pro-environmentally behavior largely contributes to the community. Establishment of local education / visitor centers can be a useful tool for generating interest among young people and demonstrating environmental activities. Specific training and education can be organized for the teachers and their cooperation with local or specialized NGOs can be facilitated.

5.7.3 National (Central) Government

Governmental Ministries (Ministry of Economy, Ministry of Transport and Communication, Ministry of Agriculture and water management, Ministry of Education and Science) Agencies and relevant bodies are specific target group that needs to recognize that environmental problems caused by Silmak –Jegunovce should be posted on their priority agenda.

- **Information needs**: This target group needs explanatory information, which will help it to understand why is it necessary to consider that environment should be put in the list of top priorities. It is important to simply explain the environmental

policy at local and global level where environment is given same level of priority as to political, economic and social issues. Environmental problems need to be linked with the impact to the economic development, social and health issues. Finally, specific information should be provided how decision-makers could think in environmental friendly manner when making their decisions and how they can benefit from it.

- **Communication techniques:** The first step will be to get the attention of these institutions to environmental issues. This can be achieved indirectly through the awareness raising of the general public, success stories on specific projects or through initiative of NGOs. Ministry of Environment and Physical Planning should lead this process.

5.7.4 Media

It is evident that media are playing the key role for distribution of environmental information to the public for raising its awareness. It is necessary to recognize that this is a target group of special importance and has specific information needs and requirements.

- **Information needs**: Media need to have broad access to the results of the different Project activities, Local and national Authorities - including the goals, work, strategies, pilot-projects, achievements and failures. In this way they will consider these structures as trustworthy sources of information in the long term. Second type of very important information for media is the state of environment in the region, country and globally.
- **Communication tools**: Media should be treated as partners, not as negative observers and criticizers. Press conferences should become part of the regular agenda of Silmak. Special attention should be given to the editors in relation to their recognition for importance on environmental coverage in the media.

5.7.5 NGOs

The NGOs in the Municipality of Jegunovce have not sufficient level of self-organization and have no track record in awareness raising activities. They need strong support and capacity building for designing and implementing well defined, targeted and topical campaigns. They also need stable and long term funding sources to be able to focus on longer-term priorities. The capacity of NGOs can be improved by their involvement as partners in the planning and implementation of awareness raising activities of the PPP, Local authorities and other stakeholders.

- **Information needs:** The NGOs most urgently need free access to environmental information according to the Aarhus Convention. They also need regular information about the activities of other actors in the country in order to be able to coordinate activities and set their own priorities.
- **Communication tools:** Both environmental and PR department of Silmak should directly cooperate with local NGOs and provide them with exact and on-time delivered information. The NGOs can also be informed through specialized environmental magazines, news services or electronic networks. There should be regular events that provide opportunity for informal communication with the NGOs.

(Municipality of Jegunovce has no record of NGOs registered on its territory.)

5.7.6 Business sector

Currently there is insufficient environmental communication with the business sector in the country, apart from occasional inspection visits and the permitting process. The experience shows on the other hand, that the business sector can be a very effective partner in solving environmental problems and raising environmental awareness. Onve of the main actor can be the owner of Silmak and the environmental related department EMAK, which has an excellent data record about the past and ongoing environmental data. Silmak is in the process of IPPC. Other located businesses are gaining a gap on information about the ongoing national and even local activities.

- **Information needs:** The business sector needs support to gather information about the legal requirements and procedures, about the state of environment, environmental technologies and in particular market opportunities in the field of environment. In drafting new laws and regulations, it is important that the business sector is informed about the new requirements early enough, so that they can adapt to these requirements within their regular investment cycle.
- **Communication tools:** The environmental experts/managers in the companies can be invited to join the communication networks with the local authorities, or to create their own network. Regular business conferences, trade fairs and similar events can provide an important opportunity for informal communication.

5.7.7 Local Authorities

The Municipality of Jegunovce has very limited experience with environmental awareness raising activities, and needs serious capacity building efforts to be able to perform all their environmental duties foreseen in the new legislation on local self-government. The Municipality should be staffed with specialists for environmental awareness activities, such as trainers, environmental experts and PR experts. This should enable it to prepare plan and implement awareness raising activities. More specific capacity building needs of the Municipality of Jegunovce are listed below:

- Providing training in developing Local Environmental Action Plans - LEAPs
- Systematization and standardization of information for all projects implemented on the territory of Jegunovce Municipality
- Enhancement of the communication with production facilities located at the territory of Jegunovce
- Enhancement of the communication with NGOs especially, Union of agricultures at the territory of Jegunovce
- Providing required transparency and
- Deliver it to the end user

The Municipality of Jegunovce is also primarily responsible for securing free access to environmental information about main polluting facility on its territory, including information for Silmak.

5.7.8 Ministry of Environment and Physical Planning (MOEPP)

As a support for the thematic areas under the responsibility of MOEPP, it is recommended to continue the operation of the Eco-Caravan (a Road Show including Public Relations office). It would be a very practical and useful tool for supporting awareness raising activities in different parts of the country and in relation to a variety of topics.

- There is a need for more strategic and planned approach for designing and printing MOEPP promotion materials and for improvement of their quality in terms of text (slogan, messages, information) and design.
- The web site of the MOEPP should be regularly up-dated with permanent and fresh information about the status of environment. One way how this communication tool can help citizens to raise their awareness is that in every section of the website information, a special attention can be given to advise citizens what they personally can do and how they can contribute to the particular effort of the MOEPP.
- The Public Relation Sector currently manages the media relations and other public relations of the Ministry. Ministry should dedicate sufficient resources to such a programme that could include: regular press conferences; regular press releases; media service to respond to specific requests of the journalists; and information about specific activities in the regular newsletter of the Ministry.
- MOEPP should give technical input in preparation of curriculum for environmental education
- With such a service the Ministry can improve its image in the eyes of the journalists, become a trustworthy source of information and gradually establish more close cooperation with media in the field of awareness raising.
- The Ministry should invest in internal formal and informal communication regarding the messages it would like convey to the public and other stakeholders. Only if all the staff shares the vision and positions of the Ministry as an organization, they will be able to present them to the public, defend them if necessary and actively implement them in their work.

5.7.9 Donor

Several donors are providing technical assistance in the Republic of Macedonia in terms of Hot Spots remediation or mitigation measures for industrial contamination.

The most active donors in this field are:

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- EAR - One of the Projects managed by EAR within the Programme CARDS 2006 is current one: “Development of Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots”
- The Dutch Embassy driving force with a SEE regional programming for the remediation of industrial hotspots. Implementing agency is UNDP. Feasibility studies for two locations, Lojane and Bucim, will be conducted.
- The Austrian Development Agency (ADA) supports a regional program (Envsec) for the remediation of abandoned mining areas. Implementing Agency for this program is UNEP Grid. Sasa and Toranica mines are focal areas.
- JICA (Japan International Cooperation Agency) in cooperation with the Ministry of Agriculture, Forestry and Water Economy (MAFWE) is presently working in phase two of the study on “Capacity Development for Soil Contamination Management related to Mining in the Republic of Macedonia” with focus on Zletovo mining area. In addition has JICA started to support the development of a feasibility for the Skopje Waste Water Treatment Plant.

- SECO, the Swiss Donor Agency is mainly involved in the construction and operation of waste water treatment plants.
- IFC (International Finance Cooperation) is in cooperation with ADA involved in strengthening the recycling market due to direct disbursement and micro crediting. The WB has signalised an interest in future financing strategies.

5.8 Key aspects of Public awareness rising

The mechanisms of public awareness rising and communication are important tools for better understanding of the problem, its acceptance and involvement of the citizens in the solution making. Thus, the way of implementation of public awareness rising campaign is crucial.

There are two principles in the campaign conducting:

- Awareness rising and participation increasing and
- Triggering behavioral change public

The messages that should be pointed out to the target groups are not only for how to protect the environment, but as well why it should be protected. The campaign must transfer information and stress the public motives to do that.

- The message should be simple, understandable for general public and accompanied by a slogans

5.8.1 Communication techniques in small groups

In case of small target group, the following communication techniques are proposed:

Interviews - Meetings between the stakeholders organized in order to get information of the public opinion, public participation perspectives and building of consensus programs. The interview provides an opportunity for getting direct information for public interest and gives possibility of asking questions. Enable to learn the best communication practice with the public and can be used for city committee members' assessment. Disadvantage is that interviews demand time. The invitation for the interview have to be encouraging, in opposite we are facing the risk of potential participants to refuse the interview. When possible the interviews should be taken head to head.

Small meetings (introductory meetings) with previously defined target groups or meetings related to other happenings. When organizing such meetings there is an opportunity to get an agenda and to plan the discussion in advance. Small meetings, if they are well organized, provide replacement of extensive informing such as a lecture to wider audience. The disadvantage of small meetings is that they can be too selective and important target groups can be left out. For such meetings it is important to know the audience previously. Small meetings give an opportunity for direct contact before or after the formal part of the meeting.

Visits and personal checking are organized to provide the available data. The checking is made by previously standardized questionnaires or methodology. The approach is "head to head" or to closely focused target groups. The advantage is that this approach provides a representative sample of examinees, but this is the expensive way. In this respect, we should have in mind that, sometimes, these focused groups could have a promotive approach. That's why we have to be sure in the purpose of the results before the data collecting technique is determined.

Coffee-chat: Small meetings between the neighbors usually in domestic atmosphere. The advantage of this type of communication is the relaxed surrounding, suitable for

effective dialogue. Maximum communication from both sides is obtained. But, these activities demand too much effort if we want to approach many people.

5.8.2 Techniques for large groups participation

In communication with large groups the following techniques are proposed:

Public meetings: Formal meetings with presentations give an opportunity to speak in front of the public without denial. Public convocations satisfy the legal requirements but by them the dialog is not upgrading and there is little chance for discussion. In this form of communication, if the agenda is not precisely defined, there is a possibility of long, undesirable speeches. Detailed minutes that exactly reflect the meeting are usually made.

Leaflets/Survey leaves/Poster/Announcement/Billboard: Leaflets often include facts and other information of public interest. By this technique participation of the citizens that does not want to attend meetings is enabled. The existence of the mechanism that will provide regular up dating and extension of the address book for sending the leaflets is an important pre-condition for this form of communication. If feedback leaflet is required for certain information from the citizens, we should have in mind that there is a possibility of mistakes and results sophistication. The probability that leaflets will be sent back is bigger if the post tax is paid in advance.

Telephone contact: Random choice telephone contacts are useful for getting specific information for statistical analysis. This technique provides participation of individuals who do not want to attend meetings and individuals who are not in the address book of the organization that makes the survey and/or informing. Telephone calls provide bigger response compared to survey leaves sent by mail, but this is more expensive and it is harder to process them. The telephone surveys give opportunity for prejudice if the questions are not carefully formulated. Before investing in this kind of communication, it should be clear that statistically valid data are needed. The questionnaire used in telephone surveys has to be professionally made, to avoid possible prejudices. This way is recommendable for assessment of general attitudes.

5.9 Public awareness rising program

Activities for realization of PA Campaign:

1. Defining of general slogan for public awareness campaign;

   Defining of sub-slogan for each of the topics in the public awareness campaign

When forming the slogan we should always think about:

- what is the target group?
- What should the message mean?
- What will the public opinion to that message?
- What actions will the public undertake from that message?

2. Preparation of Leaflet: To contain information for the Remediation Project and its significance for the region; The leaflet should in simple and understandable way explain the term "hazardous waste" to the young population, where and when it is generated; to point out the advantages of separation and its treatment. A number of 1200 copies are proposed.

3. Designing and broadcasting of radio clips: Local Radio Stations have experience in designing and broadcasting of radio clips, but the implementer of this activity should have the rights to provide broadcasting of the radio clips to other national and local radio stations by which the number of listeners will increase.

During the realization of these activities the following tasks should be fulfilled:

- at least eight texts for radio clips to be prepared. The clips should last between 20 and 30 seconds.
- Recording the radio clips.
- Broadcasting according to the agreed media plan with the implementer

4. Realization of debate programs on National TV Station with the possibility to involve listeners in live programme.

At least two debate programs are proposed to be hold for all topics of the public awareness rising campaign for environment protection activities at Silmak factory. The following activities are proposed:

- Making of program scenario
- To determine the guests in the studio for each of the debates
- Making on time announcements for the debate programs in main terms

5. Survey on satisfaction of the population from the activities undertaken. The outcomes of the survey can serve for measuring of the effects from PA campaign and to direct the additional activities. This activity should be coordinate both by environmental and PR department of Silmak

The survey can be enforced in two ways:

- By telephone calls and
- Questionnaires

6. Billboards making: Billboards as a way of communication have advantages compared to other methods because through them it's easy to reach the general public. It is very important billboards to be made by a professional organization and/or experienced individuals. It is a custom to make a simple message on the billboard that will affect the local population. Often those are messages that appeal on protection of natural heritage and/or messages that provoke sustainable development. The billboards should be placed on frequent places in the Municipality of Jegunovce (2 billboards), on the high-way Skopje Tetovo (2 billboards) and in the city of Tetovo (2 billboards)
7. Round tables: To improve the campaign significance it is recommended to organize round tables to as higher as possible level. It is good if the Mayor has a conversation with the stakeholders of the public awareness on environmental issues. In that way mutual confidence will be achieved and the stakeholders will be motivated to continue with the activities in progress. It is proposed four meetings to be realized during the year
8. NGOs meetings: Regular meetings (at least once a month) where the PA activities of local NGOs will be briefly presented. It is useful the representatives of village communities and Municipality to attend these meetings
9. Activities in educational institutions - art exhibitions, show

Detailed plan and the separate activities in which the pupils will be included should be defined. It is proposed to organize art exhibitions with awards in all elementary schools in

the Municipality, and the chosen ones to participate in the group exhibition in the tracts of Municipality Jagunovce. Awards for the best works, should be provided by Silmak.

Figure 5_Proposed Public Awareness Rising Activities for the Remediation Activities in Jegunovce

Activity	Implementation	Stakeholders	Time frame (in months)	Predicted budget (in Euros)
Defining of general slogan and sub-slogans	Municipality, NGOs in cooperation with professional companies	Local self-government; Business community; Local population, Union of agricultures	0-2	250
Preparation and distribution of leaflets	Local NGOs in cooperation with professional companies	Local self-government; Business community; Local population	2 - 4	2000
Designing and broadcasting of eight radio clips	Experts; Local and national radio stations	Local self-government; Business community; Local population; The schools; Silmak	2 - 12	800
Debate programs on National TV	Experts and Local radio	NGOs; Local self-government; Business community; Local population; Union of agricultures	4-8	800
Billboards designing	Municipality, experts and professional companies	Local self-government; Business community; Local population; The schools	2-12	3000
Organizing of round tables	Municipality; experts	NGOs; Local self-government; Business community; Local population	3-12	100 (expenses for meetings organization)
Local NGOs meetings	Experts; Local NGOs	NGOs; Local self-government, Union of agricultures	0 - 12	250 (expert costs)
Afforesting actions	NGOs; Local population; Schools; Municipality	Local self-government; Business community; Local population; The schools	4-8	250 (expert costs)
To determine and organizing “open day” at Silmak	NGOs;	Local self-government; Business community; Local population; The schools	4-8	2000 (expenses for organization)
Organizing of the shows and art exhibitions in school	NGOs; Schools	Local self-government; Business community; Local population; The schools	6-12	550 (awards for the best works)

A budget of approximate **10.000 Euro** per year is required to perform a sufficient public awareness and information campaign supported by various experts and in cooperation with the central and local authorities and involved companies. A timeframe of **one till two years** seems sufficient to involve the public in activities of Silmak related to environmental protection and planned mitigation measures.

6 Technical Perspective - Assessments

6.1 Qualitative Health Impact Assessment

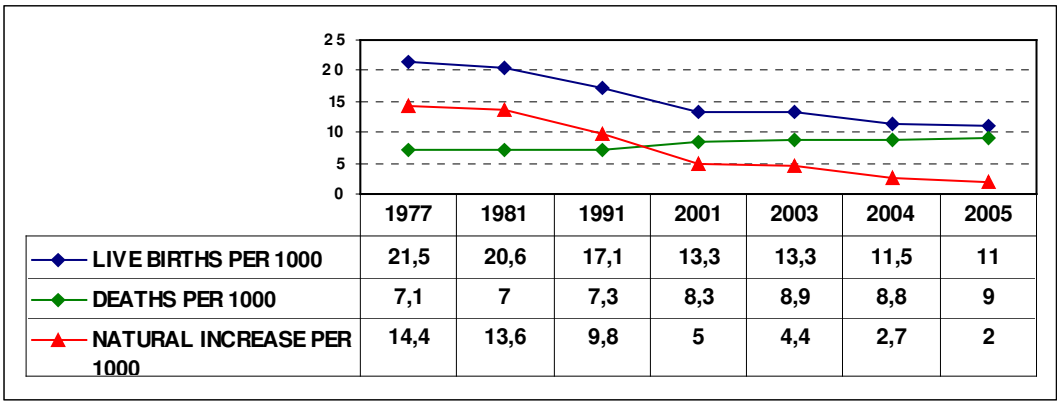
The qualitative Public Health Impact Assessment is a comprehensive study (**Volume 00_A**) about the current status and development of impacting factors on human health caused by historical and ongoing pollution. The study compared trends and tendencies of disease appearances for each site with those of Macedonia and the European Union. The following chapter focuses on the site of Silmak and the impacting situation of Chromium compounds.

6.1.1 Background- General profile of the Country

In demographic terms, Macedonia is an extremely heterogeneous area. The large demographic differences, especially if observed from higher down to lower regional levels in the country, are in essence a consequence of largely differentiated directions of the natural and migration component of the total population. According to the data of the population census in 2002, Macedonia has 2.022.547 citizens of whom around 60 % live in urban areas, with an average population density of 78.6 inhabitants/km^2. The number of citizens increased by 76,615 or by 3.9 percent as compared to the previous census of 1994. The average annual population growth rate in the period amounted to 0.48 percent.

The average life expectancy is 73,5 years (Females 76 years, and males 71 years). The demographic, economical, social, ecological and health characteristics of the population showed significant differences among urban and rural areas. The birth rate in Macedonia for 2005 is 11 per 1,000 populations, and the mortality rate 9 per 1,000, resulting in a natural increase of 2 per 1.000. The distribution of deaths by age shows the highest proportion of total deaths for age 75 and over (43,6%). Age group 65-74 accounts for 28%, and age group 55-64 for 13,4% of the deaths.

Figure 6_Natural demographic changes [1977-2005][5]



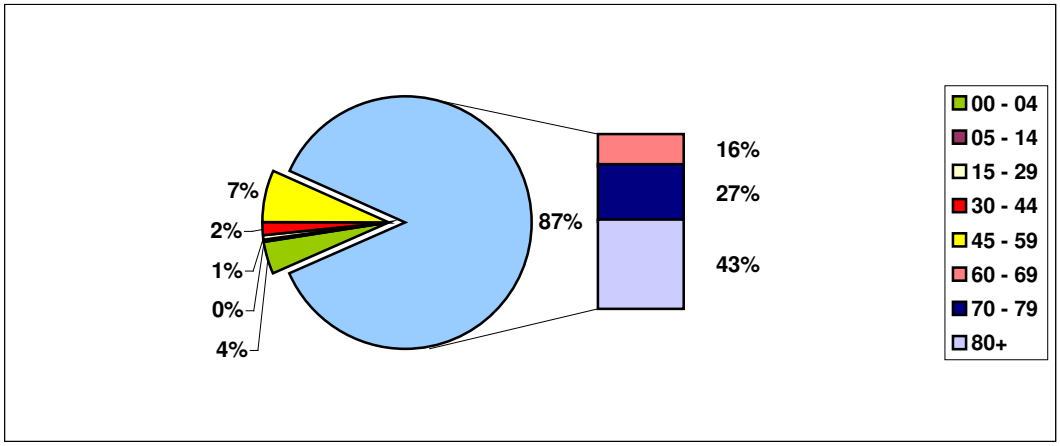
	1977	1981	1991	2001	2003	2004	2005
LIVE BIRTHS PER 1000	21,5	20,6	17,1	13,3	13,3	11,5	11
DEATHS PER 1000	7,1	7	7,3	8,3	8,9	8,8	9
NATURAL INCREASE PER 1000	14,4	13,6	9,8	5	4,4	2,7	2

From 1990 to 2005 the percentage of the population over 65 years of age increased from 7,97 to 11 % (males 4,8% and females 5,8%), while the population from 0-14 years decreased to 21% (males 10,8% and females 10,2%). Such tendencies have the negative influence to the transformation of age structure of the population, i.e. the process of continuing ageing is strengthening. In the demography aging process, except

[5] Source: Statistical Yearbook of the Republic of Macedonia, 2006

natural, the big influence has the migration component of the increasing of the population. Notwithstanding the increase in the proportion of the elderly population, the population is still relatively young in comparison with the averages for the EU and for Central and Eastern European countries. However, figures also suggest that the trend towards an ageing population is far less pronounced in the Republic of Macedonia than in most neighboring central and southeastern European countries (in 2003 only Albania had a younger population with 7,87% over 65 years) or the EU (in 2003 the percentage of the population over 65 years on average amounted to 16,13%, in 2004 it was 16,42%). This is further confirmed by the healthy life expectancy estimated at 62,2 years and the Disability-Adjusted Life Expectancy of 63,7. The UNDP Human Development Index for the Republic of Macedonia is 0,799 for 2004.

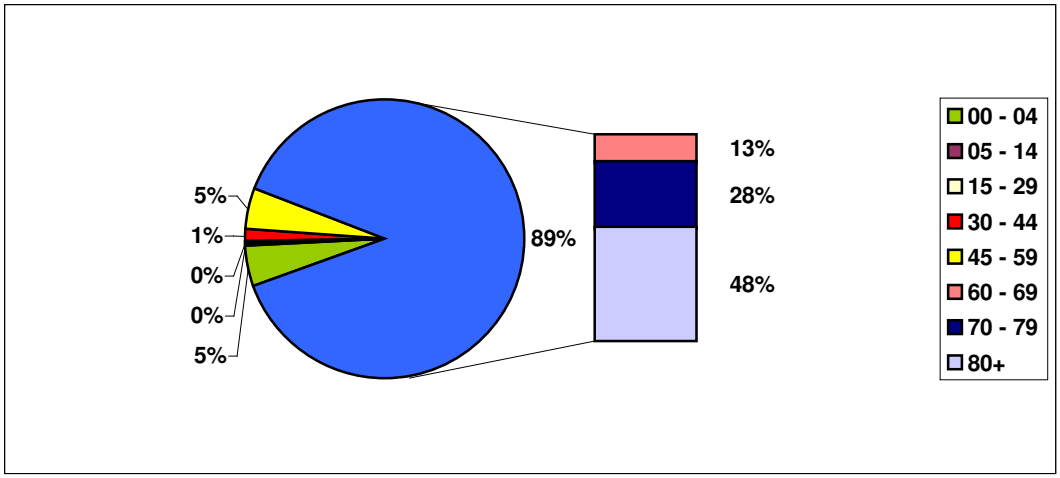
Figure 7_Years of Life Lost (YLL) by age groups among males, Macedonia 2002[6]



The distribution of years of life lost among age groups in Macedonia is similar to that of the WHO EURO region. The age distribution was 87% in older ages for males and 89% for females, and 4% for males and 5% for females in age group from 0-4, respectively.

Figure 8_Years of Life Lost (YLL) by age groups among females, Macedonia 2002[7]

[6] Source: Kendrovski V, Gjorgjev D. The Burden of disease in the Republic of Macedonia, 2005



The per capita Gross Domestic Product for 2004 was US$ 2,382. The unemployment rate in Macedonia in 2005 was 36.5% of the total labour force, placing Macedonia among countries with an extremely high unemployment rate in Europe. The relative poverty in the former Yugoslav Republic of Macedonia for 2004 is expressed with a Poverty Gap Index - the average proportionate expenditures shortfall for the total population - of 9,4, and with a Head Count Index - the percentage of persons living below the poverty line - of 29,3% (source: State Statistical Office, 2005). The population groups identified as being most at risk of poverty are the unemployed, socially imperilled households, pensioners and farmers. Larger households in rural areas, particularly those with members that are unemployed or have low educational levels, are identified as a specific risk together with the unemployed in urban areas. Poverty has a serious impact on the health status of the population and on the access to health services.

Figure 9_(Some indicators for the Republic of Macedonia in the period 2003-2005)

DEMOGRAFIC, VITAL AND SOME HEALTH INDICATORS IN THE REPUBLIC OF MACEDONIA, 2003, 2004, 2005

	2003	2004	2005
Area Km2	25713	25713	25713
Population places	1753	1753	1753
Municipalities	123	123	84
Population per 1Km2	78,82	79,05	79,21
Population			
Total	2026773	2032544	2036855
Male	1017274	1019903	1021772
Female	1009499	1012641	1015083
Urban	1207848	1211514	1215140
Rural	818925	821030	821715
0-6 age	174136	170418	167164
7-19 age	411441	404975	397289
20 +	1441196	1457151	1472402
20 - 64 age	1224459	1236642	1247537
65 +	216737	220509	224865
female 15-49 age	524156	525682	526456
female 15 +	805991	813769	820675
Vital indicators			
Natality per 1.000 population	13,3	11,5	11,0
Mortality per 1.000 population	8,9	8,8	9,0
Natural increase per 1.000 population	4,4	2,7	2,0
Infant mortality per 1000 livebirdhs	11,3	13,2	12,8
-Urban	13,5		
-Rural	8,6		
- Perinatal mortality	15,3	18,4	16,9
- Neonatal mortality	8,4	9,6	9,6
= early neonatal mortality	6,7	7,4	7,3
= late neonatal mortalityr	1,7	2,2	2,3
= post neonatal mortality	2,9	3,6	3,2
Morty natality	8,6	11,0	9,6
Maternal mortality	7,4	12,8	13,3
Health care personnel			
Physicians	4448	4490	4392
Dentists	1132	1134	706
Pharmacists	319	322	205
Health care personnel with higher level qualification	756	762	753
Health care personnel with mid level qualification	9773	9749	8967
Number of population per one:			
Physician	455,7	452,7	463,8
Dentist	1790,4	1792,4	2885,1
Pharmacist	6353,5	6312,2	9935,9
Hospital beds			
Total number	9743	9699	9569
Hospital beds per 1,000 population	4,8	4,8	4,7

One of the very positive developments in the Republic of Macedonia in the last decade concerns the infant mortality rate (IMR) that continued to fall and has halved, from 28,25 infant deaths per 1000 live births in 1991 to 12,8 in 2005. However, this figure is still three times higher than the EU average of 4,75. A decrease in IMR up to 2002 can partly be attributed to the many policy interventions carried out: significant outcomes have been achieved with the Perinatal Project (1999–2001) as part of the Health Sector Transition Project.

6.1.2 Legal Framework and Institutions

Article 43 of the Constitution affirms the right of every person to a healthy environment. The Law on Health Protection (Official Gazette Nos. 38/91, 46/93 and 55/95) sets the foundations for the current health care system in the country, including the health insurance system, the rights and responsibilities of service users and service providers, the organizational structure of health care and its funding. The State is responsible for the provision of preventive care for the population through the Public Health Institutes and for ensuring that health services are available. The Health Insurance Law of April 2000

underscores the basis of the health service funding process, establishes a compulsory health insurance scheme and confirms the independence of the Health Insurance Fund and its management board. The Law on Health Protection also provides the legal framework for the Programme for Human Preventive Health Protection, which is adopted yearly by the Government upon the proposal of the Ministry of Health. The Programme forms the basis for vertical primary prevention programmes as well for monitoring the population's health and for monitoring food, drinking water, air and ionising radiation. Health indicators are monitored on the basis of the relevant legislation, including:

- The Programme for Statistical Health Research for 1998-2000 (Official Gazette Nos. 64/97, 11/00 and 54/01);
- The Law on Health Records (Official Gazette Nos. 22/78 37/79, 18/88 and 15/95);
- The Law on Health Protection;
- The Law on Protection at Work (Official Gazette No. 13/98); and
- The Health Insurance Law (Official Gazette Nos. 25/00, 34/00 and 69/00).

The Republic Institute for Health Protection is the national centre for public health and the main body responsible for environmental health. It is involved in teaching at the medical faculty, supervises and oversees the activities of ten regional Public Health Institutes, and provides technical services to the clinical centres and to the country as a whole. Its main functions are:

- The collection of data on health for all indicators;
- Monitoring the health status of the population;
- Reporting and analysing the health status and the organization of the health care system;
- Epidemiological surveillance;
- Immunization;
- Environmental monitoring (air, food, drinking water, radiation);
- Surveillance of environmental health risks;
- Drug control; and
- Advising the Ministry of Health on matters related to health policy.

The ten regional Institutes have a total of 21 branch offices that provide services in the communities. Since 1993, the Institutes have been separate from health service delivery and, amongst other functions, are charged with the delivery of vertical primary prevention programmes such as that for HIV/AIDS. The regional Institutes are located in the major municipalities: Bitola, Kochani, Kumanovo, Ohrid, Prilep, Strumica, Skopje, Tetovo, Veles and Shtip. Each regional Institute employs around 100–150 staff. The 21 branch offices, or hygiene epidemiological surveillance stations, are located in health centres throughout the country. These also provide clinical laboratory services. The Public Health Institutes have four basic functions: microbiology, hygiene, epidemiology and social medicine. In addition to these functions, the Republic Institute for Health Protection provides virological, pharmacological, and toxicological and radiation protection services to the whole country. Although their functions are similar, the different institutions have different capabilities and equipment. This difference is partly compensated by the Republic Institute for Health Protection, which provides the others with technical and analytical assistance on those aspects, with which cannot be dealt directly (e.g. for analysis of

heavy metals). A form of coordination and planning of the activities of the 11 institutes takes place when the "Programme for Human Preventive Health Protection" is drawn up.

There is also an Institute of Occupational Health. It conducts health, methodological, educational and scientific activities following a multidisciplinary approach. It is a national coordination centre for the programme on Health, Environment and Safety Management in Enterprises (HESME) and is a base of the Medical Faculty Chair of Occupational Health. Occupational health comprises 146 occupational health specialists, other physicians, chemists, psychologists and other medical personnel. It has a network of 53 occupational health units as dispensaries, in health centres at municipal level, in industrial facilities, in governmental and inspection bodies as well as in private organizations. Their function is more curative than preventive. So the establishment of an adequately organized occupational health service providing monitoring, protection and the promotion of health at the workplace should be considered as an important goal for the health sector reforms.

In addition to the above structures, the Ministry of Health has inspection services, which receive expertise and technical and analytical support from the Republic Institute for Health Protection and other regional Public Health Institutes. At present, the main functions of the Inspectorate are the inspection of water (drinking and recreational), health care facilities (except medical waste), the surveillance of communicable diseases, food safety, cosmetic products, hygiene and epidemiological conditions in facilities and workplaces, drugs and medical devices, and the factories that manufacture them. In the past, the Inspectorate was also involved in the assessment of air pollution, waste and pollution from factories and in the system of permits for new activities. However, following the establishment of the Ministry of Environment and Physical Planning, the new Environment Inspectorate has in practice taken over those functions. As the redefinition of the responsibilities of each of the two Inspectorates has not yet been agreed, the consequent lack of clarity is occasionally a cause of conflict and competition between them. Total expenditure on health is around 5 per cent of GDP. More than 95 per cent of official health care finance is derived either from contributions levied by the health insurance fund or from user charges. Of the remainder, half is derived from the State budget (funding vertical primary prevention programmes, including environmental health and the care of the needy) and the other half comes from other sources such as international aid.

6.1.2.1 Approximation

By signing the Agreement for Stabilization and Association between the Republic of Macedonia and the European Union and its member countries on April 9, 2001 in Luxemburg, entering into force in June 2001, the Government of the Republic of Macedonia has undertaken activities for approximation of the national legislation to the EU legislation.

The approximation of the *Law on Air Protection* dated from 1974 was done in 2002 with technical support by the GTZ and the new Law on Air Quality was prepared. The new Law on Air Quality was adopted by the Parliament on 15th September 2004. Other environmental legislation related to air is in the process of adoption.

The EU requirements and standards in the water sector, prompted the preparation of a draft *Law on Water,* which is transposing six water related EU Directives, including the Water Framework Directive.

The *Law on Waste Management* transposes two Framework Directives *(75/442/EEC and 91/689/EEC)* has been adopted by the Parliament. MoEPP's and other entities' commitment in implementing the solid waste legislation will be strengthened by NEAP. That will not deny that implementation is hard and very costly. NEAP will pledge for strong support from the International Community to achieve this.

The *Law on Nature Protection* has been adopted in September 2004 and the draft Law for Environment is under the governmental procedures. Several secondary regulations for protection of nature are under preparation, inspired by EU's sixth EAP.

The *Law on Local Self Government* makes local communities responsible for the preparation and adoption of the urban plan for the settlement and the spatial plan for the municipality. The preparation of urban plans is a regular practice but depends on financiers. All the cities and big settlements have adopted urban plans. Municipalities have not prepared spatial plans since 1990. Spatial plans have to be prepared in compliance with the Law for Spatial and Urban Planning, which is under development.

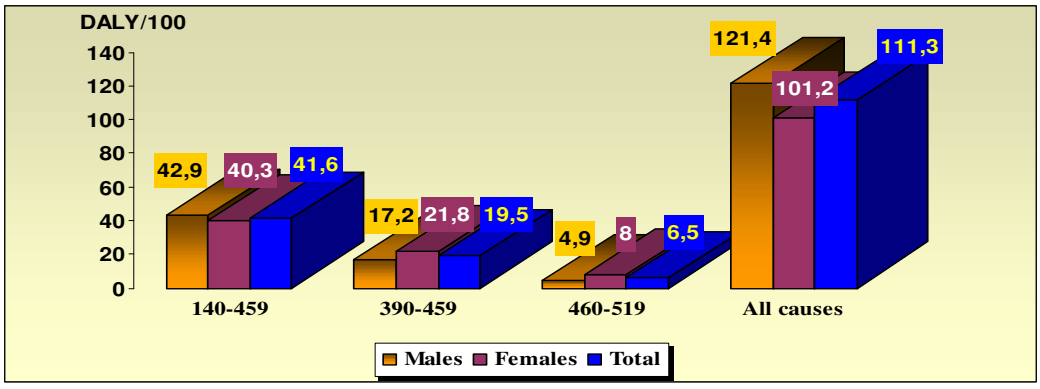
As yet this not extendedly is the case with Physical Planning and Environmental Health. However harmonization with EU Directives of the legislative framework for Regional Development has started. The same applies to the transposition of EU's Pharmaceutical Laws and Food Legislation, and specialized issues connected to chemicals, radiation, and GMOs.

The approximation of EU's laws for the protection of the environmental media is close to completion in the country. Now by-laws and directives are being transposed for air, water, waste and biodiversity.

6.1.3 State of the Environment and Health in the former Yugoslav Republic of Macedonia

The environment in which people live, work and play is an important determinant of health and well being, but the extent of its importance in developed economies is difficult to quantify. The non-communicable diseases present the biggest burden to public health analyzed by direct cost to the society as well as to the governance from aspect of disability adjusted life years (DALY) indicator. Due to fact that more and more citizens are elderly and because of that are more exposed to non-communicable diseases and disability, the needs for data, which will reflect the life quality, including the influence of environmental risk more precisely is essential. The summary measure of the population health and the methodology for the burden of diseases estimation nowadays is extraordinary indicators for the public health policy development as well as for actions needs for its reduction. The total burden of most frequent diseases in the Republic of Macedonia: circulatory, malignant and respiratory are estimated to 60,7% to DALY from all cause mortality, which is different than the percentage from the year of life lost, i.e. 52,4% respectively.

Figure 10_Total DALY for the Republic of Macedonia



The structure of deaths by cause shows that the highest number of deaths is due to circulatory diseases which present 58,4% of total number of deaths for 2005.

The standardised death rate (SDR) per 100.000 inhabitants for circulatory diseases has increased from 527/100,000 in 1991 to 599/100,000 in 2004. Overall mortality from malignant neoplasm as the second most important cause of death has also increased over the past ten years, from SDR 140 / 100.000 in 1991 to 165 / 100.000 in 2004, which is more than double that of the EU average. Injuries and poisoning are the third leading cause of death with same percentage as respiratory diseases 2003.

The most common diseases in the Republic of Macedonia – heart and circulatory diseases, cancer, respiratory diseases, injuries and non defined symptoms – have many causes which are often interconnected; including genetics, the condition people are in (via diet, exercise etc.), and the environmental circumstances to which they are exposed. Identifying cause-and-effect relationships is therefore very difficult, especially if the impact of the environment on health is delayed, or is the product of many perhaps small, environmental factors acting together.

The cancer incidence in the Republic of Macedonia has seen an increasing trend, though, unfortunately, during the last decade there have been flaws in its recording. However, the increase has been particularly notable in cancer of the lung and prostate among men, and cancer of the breast and cervix among women. Mortality from cancer related to tobacco and alcohol abuse has increased rapidly in the last decade, reflecting changes in consumption. Given the long lag phase in the progression of many types of cancer, it can be expected that rates will continue to rise for some years to come.

During the 1990s the incidence of tuberculosis (TB) decreased significantly, reaching the lowest rate of 27,61 per 100 000 inhabitants in 1999. Supported by the WHO and the World Bank, the Republic of Macedonia has successfully implemented the directly observed treatment (DOT) strategy, halving the number of patients with active tuberculosis between 1997 and 2001, and reducing the average length of hospital stay in both general and specialist hospitals by more than 20%. However, the Kosovo crisis and the conflict in the country resulting in a rise in the number of refugees and displaced citizens have had negative impacts on the health of the population, such as an increase in the incidence of TB, among other effects. In 2004 the incidence of TB was 31,72 per 100.000, representing a rate almost three times higher than the EU average of 11,85.

In international comparison the available data on lifestyle factors in the Republic of Macedonia do not seem to be very reliable and further field surveys should be conducted to consolidate these data. However, currently available data suggest that citizens of the Republic of Macedonia are less frequently victims of traffic accidents, drink much less alcohol, and eat slightly better (fewer calories, less fat, more fruits and vegetables), for example. Accurate data on smoking habits are missing. The low and overall decreasing trend regarding traffic accidents observed since 1996 (with a death rate of 8 per 100.000) seems to reflect more a stagnation of road traffic than improved road safety: the incidence of road injuries (95 per 100 000 in 2003) is three times lower than the EU average of almost 297 per 100 000 in 2004. Traffic traumatism in children and youths is a priority public health problem. The most recent mortality data show that road traffic injuries covers an amount of 30 – 50% of all injuries causing death in children and adolescents in different age groups. Severe traffic injuries are the leading cause of hospitalization (10%) and in 10% of cases the most severe traffic injuries have left children and youths disabled. A study in the year 2000 suggests that children and youths up to the age of 24 represent 43,6% of all injured people and 26,5% of casualties dying in car or traffic accidents. Over the coming years traffic is expected to increase and already a positive correlation between number of drivers, vehicles, accidents and deaths can be observed, whereas in western European countries the number of accidents and injured is higher but the death rate is much lower, owing to effective preventive interventions.

The state of oral health of the population in general and of children in particular is far from adequate. In some epidemiological studies in 2000, the registered index for decayed,

missing and filled teeth (DMFT-12) is over 5 *(13).* In comparison, in 2000 the DMFT-12 index was 1,47 in the 15 countries belonging to the EU prior to May 2004 and 3,71 in the 10 countries joining the EU in May 2004 (see European Health for All databases, January 2006. Against this background there is a need at national level for properly organized preventive programmes to improve dental hygiene.

Traditional public health activities working in concert with pre-school health protection programs have maintained vaccination coverage rates above 95%. Also, during the same period, no cases of neo-natal tetanus were reported and there have only been 27 cases of measles and 5 of pertussis. The certification for eradication of malaria has been achieved in 1973. The reported malaria cases were due to imported cases from countries where malaria existed. Since 1976 in the country there were no reported diphtheria cases and since 1987 there was no reported case of acute poliomyelitis, i.e. since 2002 the WHO has announced the Republic of Macedonia as polio free country and no cases of polio have been reported in the last five years.

Deaths due to diarrhoeal diseases among children under 5 years peaked to 100,6 per 100.000 in 1992 and have reduced to 16,4 per 100.000 in 2000. Much progress remains to be made, however, as these rates are still four times higher compared to the CEE average and almost thirty times higher compared to those of the European Union.

The Typhoid and Para-Typhoid is not an epidemiological problem in the Republic of Macedonia anymore because there has been registered only a sporadic cases during the period 1990-2003. The average registered cases for this decade were 4.1 cases per year. The Para-Typhoid was registered by 1 case per year. The Dysentery in the period 1990 - 2000 has been registered with average 258 cases per year and still presents a significant epidemiological problem, with higher registered number in 1998 (388 cases). The average morbidity rate of dysentery for the period 1990 - 2000 was 12,8 per 100.000. In 2001, only 107 cases where reported which shows a 7,3% decreasing compared with the year 2000.

This disease for the period 1990 - 2005 was registered with average 6.853 cases per year and average morbidity rate of 347,7 per 100.000 and enterocolitis is still a significant epidemiological problem in the Republic of Macedonia. The higher reported cases is detected in 2002 (Mb 335,3 per 100.000) and the smallest number in 1993. Disagreeing in criteria, methodology in practices and diagnostically procedures make some difficulties in proper definition of health condition for the diagnostics of entrocolitis. In the bigger part of the country there are laboratory capacities for its diagnostic. Therefore, there is relative high number of reported cases as well as the difference by years – 9.484 in 2000 and 3.007 in 1993.

The Hepatitis A diseases are actual epidemiological problem in the Republic of Macedonia with registered relatively high number of cases and showed high morbidity rate, too. The average number of registered cases was 1.075 per year and average morbidity rate was 53,6 per 100.000. The existing problem in the viral hepatitis diagnosed procedure is lack of markers for completely testing in some laboratories during the some period of the year, which resulted with registered a high number of so call "undiagnosed" Hepatitis (mostly Hepatitis A). The number of registered cases of Hepatitis A in 2005 was 706 registered cases.

The Republic of Macedonia adopted the “Health for All” policy after joining the World Health Organization in 1993. Cooperation with WHO started in 1992 when the WHO Humanitarian Assistance Office was opened. The WHO Liaison Office was established in Skopje in 1996.

6.1.4 Health Risk Impacting factors

There is a serious lack of data and information on exposures, effects and biological models that connect them. Therefore considerable uncertainty surrounds many issues of concern, such as air pollution, noise, water contamination, waste, climate change, chemicals (including endocrine disruptors and antibiotics), ionising and non-ionising radiation.

In many cases, however there is sufficient evidence to take preventive action, particularly where the impacts may be serious, large-scale and irreversible – circumstances which merit the use of the precautionary principle. Preventive action on many of the environmental hazards covered in this chapter is being taken, but more integrated and effective action is being proposed to reduce threats to health and well-being.

Risk and hazard are two distinct, but interrelated, concepts. A *hazard* represents a chemical, physical, or biological substance that has the potential to produce harm to health if it is present in the environment and comes into contact with people. The hazardous properties of an environmental agent are defined according to the nature and severity of its harmful consequences. Fortunately, many hazards can be either contained or avoided, so not every potential environmental hazard poses an actual health risk. A *ris*k, in turn, is defined as the likelihood of adverse health effects arising from exposure to a hazard in a human population, which is conceptually expressed as the product of two factors: the probability of exposure and the severity of the consequences.

Environmental health risk assessment is an essential element in environmental management and an important condition in precise priority setting to the necessary actions for its sanitation. At present there are not sufficient scientific data available for a large number of health-related environmental hazards representing risk on human health. In addition, even with the best possible information available on the nature and level of pollutants in the environment and about population exposure to different pollutants, environmental health risk assessment may not be complete because of difficulties in analysing the complexity of possible interactions in the case of multiple exposures. Even more complex is the assessment and comparison of costs and benefits of health risk elimination. This is partly because environmental health risk assessment is still limited in its effectiveness by the inadequacy of the information available, especially on exposure. In addition, even with the best possible information, an environmental health risk assessment may not be complete because of difficulties in analysing the complexity of possible interactions in the case of multiple exposures.

The country has a few environmental hot spots, characterized by high levels of pollution (air, water and soil), due to emissions from industrial facilities.

6.1.4.1 Air pollution

According the NEAP 2 there is a direct correlation between the air pollution and human health based on a number of research works performed in the period 1997 - 2002. The positive correlation was found between the monthly average concentrations of the black smoke and SO_2 and the increased respiratory morbidity for the children at the age 0-6 and 7-14. The air pollution problem is more acute in the winter period due to the effects of temperature inversion and climate circumstances in the country; this is supported by the 32% of all sold drugs being under the respiratory diagnosis, as reported by the Pharmacy Information System. Air pollution affects approximately 60% of the population, in particular those living in the cities of Skopje, Veles, Bitola and Tetovo.

According to the available data 66% of the total annual SO_2 air emissions originate from the combustion and transformation of energy. The major contributor to the total emissions of NO_x are energy production and mobile sources with 73% and the production processes are the main dust emission source with 85% of the total annual dust emissions in 2003.

The major source for CO emissions is the road traffic with approximately 65% of the total emissions in 2003.

In regard to the industry sector, obsolete equipment and non-existent modern technologies result that this sector represents a major air polluter. The main pressure on environment (in particular air quality) originates from the metallurgy sector (until 2003 the lead and zinc smelter MHK Zletovo in Veles and Ferro-alloy SILMAK in Jegunovce, MAKSTIL, FENI Industries-Kavadarci), and the chemical industry- refinery OKTA, OHIS chemical complex and TITAN cement factory.

Large metallurgical installations, oil refining plants, tanning and production of chemicals and cement are the main sources of pollution within the industrial sector.

Most probably due to reduced volume of production, the share of industry in overall environmental pollution is limited. However, some installations are big polluters creating severe problems to the environment and the health of the surrounding population:

- OKTA, the oil refinery, is the biggest source of VOCs emission and in addition some 3600 Mg/y SO_2 are emitted into the air from the petrol desulphurisation plant;
- Huge amount of dust (9000 to 17000 Mg/y) is being emitted by Ferro-alloys plant Silmak near Tetovo. 312.000 m^3/h of exhaust gas containing 2 - 6 g/m^3 dust are released without treatment.
- Until closure of MHK Zletovo in 2003, the lead and zinc smelting plant located in Veles operates a single absorption sulphuric acid plant with no additional treatment of the exhaust gas leading to an emission quantity of about 2100 t/y of SO_2. Additional 1800 Mg/y of SO_2 and 2.5 Mg per year of lead have been emitted through the ventilation system and the fugitive sources.
- While in operation, the shaft furnace of the Zletovo Smelter generates about 45.000 Nm^3/h low calorific value gas (LCV) containing 21% CO and about one third of it is released to the atmosphere.
- Considerable amounts of ammonia have been released to air from the mono ammonium phosphate production unit of the MHK Zletovo fertilizer plant. Both MHK Zletovo plants are closed at the moment, but their restarting is only a matter of time.
- Energy production in thermal power plants (especially significant is REK Bitola because it covers approximately 75 % of the total national demand) and in district heating facilities is an additional sector that severely impacts the environment.
- Emissions from mobile sources in the bigger cities with a high population density are also a big pressure on the environment. Air emissions from the mobile sources have been directly related to the fuel quality and the number and age structure of the vehicles. The total number of vehicles in Macedonia is about 220 per 1000 inhabitants. The average age of the vehicles is around 15,5 years, and around 51% of these vehicles were produced 20 or more years ago.

Main POPs air emission pollutants are inventoried and reported in the National Implementation Plan on reduction and elimination on Persistent Organic Pollutants

In Veles a significant correlation has been found between the emissions of lead, zinc and cadmium as well as SO_2 in the air and the health of inhabitants. The higher concentration of the lead in the blood was registered and it has been connected with occurrence of cancer, respiratory diseases, miscarriages and birth defects. The direct correlation has been found by the medical experts between the particulate matters with small dimensions ($PM_{2.5}$) in the form of dust originated by the REK Bitola Power Plant and health problems

with respiratory system at adults as well as bronchia at the children age. Although there are no any study in Macedonia presenting the direct correlation between the lead from mobile sources and human health, the medical experts uses the series of publications worldwide that confirms the harmful effect of lead.

6.1.4.2 Indoor air pollution

Indoor pollution in homes is not monitored. One Study in 1999 has carried out in Bitola the second largest city in Republic of Macedonia by RIHP and 352 selected children (aged – 9 - 10 years) where distributing in two groups in separated areas according to previous data for air pollution. Health data about respiratory (allergic and non-allergic) diseases; social - economic factors, passive smoking, cooking, etc. were collected prospectively by questionnaires. 135 children from both groups were chose randomly for Spirometry. In this Case-Control Study was examined the relation between prevalence of bronchitis and runny/stuffed nose with analysed risk factors. There were found statistically significant differences ($p < 0,05$) between cases of bronchitis and air pollution; association ($p < 0,05$) between bronchitis cases and runny/stuffed nose with cooking by gas and woods, and also association between Spirometry FEV_1 Parameter between two groups.

The use of asbestos is no longer allowed, but it is still present in buildings, which have been neither cleaned up nor demolished. Any problems of exposure to asbestos are considered to be of an occupational nature. Substantial health risks come from asbestos when, the crushed asbestos crystals are aerosolised and inhaled. It is important what the size and structure of the crystal is because it determines how far down in the lungs the crystals can get before getting stuck there and causing symptoms. Since the airways in the lungs get smaller as you get deeper into the lungs, smaller crystals will go farther. Also, if the structure of the crystal is very sharp, it will be better able to penetrate the tissues and get stuck there.

Smoking prevalence was assessed in a survey among 1.203 medical doctors (i.e. about 25 per cent of the total) in 1999. The survey estimated that approximately 36 per cent of the population over 15 years of age were regular smokers, with a higher prevalence among males (40 per cent) than females (32 per cent).

6.1.4.3 Drinking water

Approximately 60 per cent of the drinking water is supplied from karstic springs, 20 per cent from surface waters, and 20 per cent from groundwater. Current control measures, frequency and standards are not in compliance with EU regulations and WHO Drinking Water Guidelines. The chemical quality of drinking water varies with the origin of drinking water sources. Almost all karstic and surface water, and significant amounts of well water, are notably short in fluoride. Some wells in Veles, Shtip and Kochani have relatively high contents of iron and manganese, and nitrates range between 1 and 5 mg/l. During the summer higher nitrate concentrations have been found in wells in Prilep and Radovis (10 - 15 mg/l). Both wells are situated in regions where the land is intensively used for agriculture. The nitrite content is generally below 1 mg/lt. Toxic parameters, such as lead, arsenic, chromium and cadmium concentrations, meet WHO- standards. A few wells in rural settlements have unusual levels of for ammonia, nitrite, nitrate and $KMnO_4$. Five per cent of all wells assessed by the Public Health Institute are microbiologically contaminated. From 1970 to 1997, there were several water-borne epidemics, caused by serious failures in the distribution networks combined with poor local hygiene practices.

Management of the sewage systems is the responsibility of the same public utilities as the drinking water supply. Only 12 cities have constructed separate sewage systems. City of Skopje has constructed separate system for wastewater (56%) and for precipitation

water (18%). Collector network of City of Skopje is 280,6 km and 1.239,1 km of sewage network on national level.

6.1.4.4 Water for recreation purposes

The most seriously polluted waterways are reportedly the central and lower sections of the Vardar, Pcinja, Bregalnica and Crna rivers. Polluted groundwater is also an issue near Skopje, and especially in Veles. The most serious water pollution concerns are the discharge of untreated wastewater from mining and industry, as well was wastewater from urban centres and livestock breeding farms. Reportedly, only 6% of wastewaters in Macedonia are treated prior to their discharge in rivers

Mineral and thermal mineral water springs are used as spas, for tourism, and as a source of bottled water. Water quality and safety meet national standards. Only some artesian wells presented high mineralisation with the presence of iron, manganese and inorganic ammonia.

6.1.4.5 Wastewater discharges

Discharge of wastewater without treatment into aquatic recipients (especially groundwater) represents a serious health risk for the population in Macedonia taking into consideration very limited number of properly designed wastewater treatment plants and realistically low sewage network coverage. In practice the only treatment plants in the country are installed and operating in the areas around the three big lakes (Ohrid, Prespa, Dojran).

Consumed water by the industry is very variable, from year to year, without defined trend. It is also very important to emphasize that large number of industry facilities are not operating, due to difficult economic situation in the country. Some of the factories are closed, some of them are working with reduced capacities and other change their production. According to the data, totally consumed water for industry (water for cooling and of TPP and other industries) decreased from 240.000 m3/year in 1998 for 75% in 2002 on 67 000 (not including cooling water). The largest consumers are chemical industry, food processing, non-ferrous metal production, and textile fibre and fabric industry. Water used for production of electric energy, except for cooling of the thermo plants, is not actually spent or polluted, because it only passes through the turbines, without changing it quantity or quality. Existing thermo plants "REK-Bitola" and "REK-Oslomej", use technological water with re-circulation water supply systems. In these systems raw water is used only for covering the water losses. Thermo plant in Negotino is using running water from river Vardar. The cooling water consumption decrease in last years fro the same level as industrial water. There is no data on quality of the used water, whether that industry has water permission for abstraction of water, and if it has, whether it is respected, how much water is used for unit of product etc. Industry wastewater is one of the most dangerous polluter of the surface and groundwater. The quantity and quality are rather variable and depend on the technology process and capacity of the industry.

There is small number of industry wastewater treatment plants constructed in the Republic of Macedonia. Most of them have only mechanical treatment, while only limited number has mechanical and chemical (biological) treatment. Some of them are not under operation due to malfunction, there are no spare parts or it is too expensive to run. Even where wastewater treatment plant is functioning, the results are not meeting the requirements.

6.1.4.6 Waste

The current condition in the waste sector such as lack of integrated waste management system, illegal dumping sites or problems with the hazardous waste represent a serious health risk.

In their 2004 State of Environment Report (Republic of Macedonia, 2004), the Ministry of Environment and Physical Planning indicate that waste is a serious issue in Macedonia. They indicate that at least 150 x 106 Mg of mine waste (principally tailings containing Pb, Cd, Zn, Cu, and organic flotation reagents) are held on mine sites; that at least 6 x 106 t of metallurgical slag and cinder has been produced by smelters, and that the two largest mining-power generation complexes so far have produced about 330 x 106 Mg of waste (mine spoil/tailings, cinder and ash). Generally, this source indicates that some data on pollution and waste (and its speciation) is available, but that the affected areas have not been adequately delineated.

6.1.4.7 Noise

The current conditions in the country recognise insufficient attention to problems of noise abatement in Macedonia:

- No systematic questioning of the population about noise nuisances as an indicator of existing stage
- Sufficient attention is not given to the noise problem at early stages of planning, reducing it to general instructions which are not an adequate basis for effective implementation of the protection.

Introduction of noise abatement and protection in late stage of planning has only the nature of remediation. Measures recommended at that point are more expensive and less effective. Cross – sectional study was performed in 2002 with aim to assess community noise exposure in schoolchildren who live and study in Skopje and to make risk assessment of community noise in this vulnerable group. This study was performed by Ministry of health, Republic Institute for health protection, Clinic for paediatric diseases and Central Laboratory within the Ministry for environment and spatial planning. Noise measurements, performed within this study, showed that school children who live and study in mixed residential – administrative – market area are exposed to elevated noise level. School children who live and study in residential area in suburban area of Skopje are exposed to noise level below WHO guidelines for prevention of adverse health effects. Psychological testing of schoolchildren with aim to make assessment of mental health in those two study groups showed that schoolchildren exposed to elevated noise level have behavioural disorders (decreased social adaptability and increased opposing behaviour).

6.1.4.8 Food safety

About 25.000 samples of food are tested annually for their microbiological safety, 40 per cent of which are from imported foods and 60 per cent from domestic production. In 2006, 4,7% of domestically produced food samples of industrial origin and 11,5% of food samples from small enterprises were found to be contaminated and 14,5% of contamination cases occurred in the distribution chain. The large number of private farmers and small production enterprises, as well as the enormous number of small trade and catering firms make legal controls very difficult. Due to the ambiguity of the law, a number of those entities do not have suitable premises, equipment, staff, professional skills or standard hygiene conditions. The conditions prevailing in traditional markets are unhygienic.

6.1.5 Occupational Health

There are no official data on occupational diseases in the Republic of Macedonia, despite the numerous studies carried out by the Institute of Occupational Health. The official register for occupational diseases (under the Ministry of Labor) has not been updated to cover all relevant occupational diseases (in line with EU regulation).

6.1.5.1 Radioactivity

Exposure to ionising radiations in principle is limited to occupational exposures of health care workers, some researchers and workers in some industries where radioisotopes are used. The Ministry of Health has the responsible of controlling and authorizing the use of ionising radiations sources, with technical assistance by the RIHP. The Radiation and Dosimetry Department of the RIPH maintains the national registry of radioactive sources and controls occupational exposures. The Department participates in international projects led by the IAAE, such as one aiming at improving radiation protection. Next to the Radiation and Dosimetry Department, the Department of Radio-Ecology of the RIPH has the responsibility of monitoring ionising radiations in the environment and working areas. It also monitors radioactive contamination in domestic and imported/exported food, cosmetics, drugs and construction material, and issues certificates of compliance. Approximately 2000 samples / year are analysed, mostly for alpha- and beta-activity; others for total uranium. The Department of Radio Ecology prepares annual report on the results of his monitoring activities, provides information to the public and services to factories, municipalities, etc.

6.1.6 Health Risk Assessment Methodologies

In the context of environmental health, the risk management process can be organized into several distinct activities. The three core activities that constitute the essential decision-making steps in the risk management process are each involved in examining different aspects of the risk problem:

- Risk Estimation
- Risk Evaluation
- Risk Control

6.1.6.1 Risk estimation

The use of science-based risk information and analytical methods to characterize the nature and extent of environmental health risks in the human population;

6.1.6.2 Risk evaluation

Consideration of the economic, social, political, and legal factors that influence a decision to adopt a particular course of action to reduce health risks - in some risk frameworks, the quantitative economic analysis of the benefits and costs of risk reduction is combined with results of the risk estimation process, so that a, risk assessment may subsume part or all of risk evaluation;

6.1.6.3 Risk control

The selection of options and the commencing of actions intended to reduce risk to an acceptable or tolerable level; this activity is often referred to as risk management, but the term risk control is more specific and better reflects the objectives of the activities it denotes.

Risk assessment is the process of estimating the potential impact of a chemical, physical, microbiological or psychosocial hazard on a specified human population or ecological system under a specific set of conditions and for a certain timeframe. Risk assessment is intended to provide complete information to risk managers, specifically policymakers and regulators, so that the best possible decisions are made. There are uncertainties related to risk assessment and it is important to make the best possible use of available information.

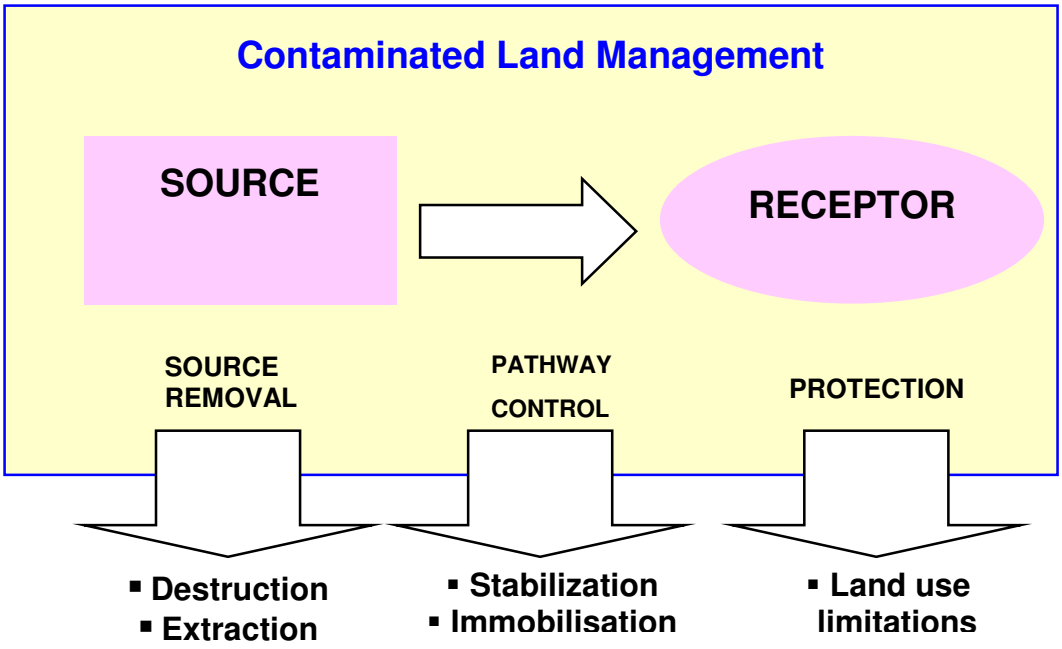
6.1.7 Methods

Retrospective epidemiological method was used in order the following four distinct and essential components of the risk assessment paradigm to be addressed:

1. Hazard identification - identification of the inherent capability of a substance to cause adverse effects by sides;
2. Assessment of dose-response relationships - involves characterization of the relationship between the dose of an agent administered or received and the incidence of an adverse effect;
3. Exposure assessment - the qualitative and/or quantitative assessment of the chemical nature, form and concentration of a chemical to which an identified population is exposed from all sources (air, water, soil and diet);
4. Risk characterization is the synthesis of critically evaluated information and data from exposure assessment, hazard identification and dose-response considerations into a summary that identifies clearly the strengths and weaknesses of the database, the criteria applied to evaluation and the validation of all aspects of methodology, and the conclusions reached from the review of scientific information.

The logical consequence of the process of assessment of potential risk is the application of the information to the development of practical measures (risk management) for the protection of human health. All available studies, articles and reports related to defined hotspots from 2000 to 2007 are included in the assessment.

The general approach for the identification of sources of contamination, associated hazards, migration pathways and sensitive receptors are as follows:



6.1.7.1 Advantage of various Methods

Many organisations are now actively involved in Environmental Risk Assessment, developing methodologies and techniques to improve this environmental management tool. Such organisations include OECD, WHO and ECETOC. One of the major difficulties concerning the use of risk assessment is the availability of data and the data that is available is often loaded with uncertainty. The risk assessment may include an evaluation of what the risks mean in practice to those affected. This will depend heavily on how the risk is perceived. Risk perception involves people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values that people adopt towards hazards and their benefits. The way in which people perceive risk is vital in the process of assessing and managing risk. Risk perception will be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures imposed are seen to resolve the problem. The procedures, methods and techniques for regulatory risk assessment of chemicals in the EU is described in both legislation and supporting Technical Guidance Documents. Implementation is supported by the European Chemicals Bureau, part of the Joint Research Centre, in Ispra.

Most methodologies for human health risk assessment of chemicals are based on the NAS model. A number of methodologies exist due to differences in the toxic mechanisms exerted by different classes of chemical and the toxicological end-point being assessed. The end-point being assessed could be death, or a specific pathological condition relating to exposure to a chemical. When attempting to assess the risks from an immuno-suppressant toxin, specific end-points may be difficult to determine, as may be the role of other agents and stressors on the body. This will lead to risk assessment methodology for immuno-suppressants being different from assessments for irritants for instance. All human health risk assessments of chemicals include hazard identification, dose-response assessment, and exposure assessment and risk estimation/characterisation. If the assessment is site-specific, then a release assessment would be required in the absence of good data of environmental levels or to account for non-routine, accidental releases.

6.1.7.2 Risks and Constrains of various Methods

Risk assessments may assess individual or population risks. Individual risks may be for the average (i.e. typical) individual or the highly exposed or particularly susceptible individual and the risks may be estimated for various duration of exposure (e.g. per year or per lifetime) or for different locations. Individual risk can only be assessed for a hypothetical individual with assume characteristics. Assessing the risk for any real individual will be frustrated by the fact that risk predictions for an individual can never be validated by experience. Any real individual will either experience the negative outcome or will not. Neither of these results can validate any risk prediction other than a probability of one or zero. Population risk may relate to the number of adverse health effects (eg. fatalities, cancers, or illnesses) in a population over a specified period of time or the rate of adverse effects for a given location or sub-population.

The UNEP/ILO/WHO International Programme on Chemical Safety (IPCS), in collaboration with the US Environmental Protection Agency (US EPA), the European Commission (EC), the Organization for Economic Cooperation and Development Cooperation, and other international and national organizations developed a working partnership to foster the integration of assessment approaches to evaluate human health and ecological risks. The overall goal of this project was to promote international understanding and acceptance of the integrated risk assessment process. Three specific objectives were identified to meet this goal: 1) enhance understanding of the benefits of integration, 2) identify and understand obstacles to integration, and 3) engage key scientific organizations to promote discussion of an integrated approach to risk assessment

A generic framework and associated documentation were developed to communicate how an integrated risk assessment could be conducted. Recognizing the similarities in risk assessment frameworks currently in use internationally, the integrated risk assessment framework is based on US EPAs framework for ecological risk assessment and its associated terminology (US EPA 1998). Ecological risk assessment frameworks have greater general applicability than do human health frameworks (or those environmental frameworks derived directly from human health frameworks) in that they 1) were developed to deal with a range of environmental stressors beyond toxic chemicals, 2) must describe the nature and role of the environment in the risk assessment process, and 3) must explicitly identify the endpoint to be assessed. Further, a well-developed body of concepts and terminology exist in the literature treating ecological risk assessment that supports integration. The integrated framework consists of three primary assessment phases. During the first of these, ***Problem Formulation***, the overall goals, objectives, scope, and activities of the assessment are delineated. The *Analysis* step consists of data collection and modelling exercises to characterize exposure in time and space, and to define the effects on humans and ecological systems resulting from exposure. The methods appropriate for the Analysis step may be stressor-specific, but also depend upon the nature of the systems identified to be at risk. Exposure and effect information are synthesized as estimates of risk in the ***Risk Characterization*** step. Ideally, these estimates are quantitative with respect to the level of risk expected under different exposure scenarios, although only qualitative estimates of risk may be possible in some circumstances. The integrated risk assessment framework treats the relationships among risk assessment, risk management, stakeholder input, and data collection activities in a general parallel and concurrent manner. Essentially, risk characterisation is a summary of the data compiled in the risk assessment process including the uncertainties associated with each stage and the presentation of a risk estimate.

6.1.7.3 Parameters and Indicators for choosing a methodology

Risks can be managed in many ways. They can be eliminated, transferred, retained or reduced. Risk reduction activities reduce the risk to an "acceptable" level, derived after taking into account a selection of factors such as government policy, industry norms, and economic, social and cultural factors. It is important to note that although risk assessment is used extensively in environmental policy and regulation it is not without controversy. This is also true for risk management.

There are various criteria for assessing risk assessment including:

The logical soundness of the method is eg. its justification based on theoretical arguments or scientific knowledge, and the validity of the underlying methodological assumptions.

- **Completeness** - (e.g. whether it can address all aspects of the problem and the degree to which it excludes issues because they are hard to accommodate).
- **Accuracy** - (e.g. the precision reflected in the confidence level associated with the results; biases resulting from undue weight given to specific interests or considerations; and the sensitivity of results to untested or untestable assumptions).
- **Acceptability** - (e.g. compatibility with existing processes; whether it is viewed as rational and fair; the level of understanding for all parties affected by it; and the confidence and familiarity of those who will use it).
- **Practicality** - (e.g. the level of expertise, time and input data required).
- **Effectiveness** - (e.g. usefulness of results; range of applicability across different risks and problem areas; the generalisability of the conclusion to other problem areas; and effectiveness and efficiency of linkage with other types of methods).

The level of risk can be described either qualitatively (i.e. by putting risks into categories such as ‘high’, ‘medium’ or ‘low’) or quantitatively (with a numerical estimate). Current risk assessment methods do not enable accurate quantitative estimates of risk for low levels of exposure to environmental hazards. Numerical estimates of risk will rarely be feasible because of variability in the agent and population and limitations in toxicological and exposure data that will be reflected in the uncertainty assessment, but a degree of quantification may be possible for some components such as data collection and exposure assessment.

6.1.7.4 Qualitative Risk Assessment Matrix

Regarding human health, the assessment was focused on exposure routes, both direct and indirect. For each of the sites we established what exposure routes exist and what routes are significant. We also established the number and type of people that may be affected to a significant extent, depending upon location, age and profession. Finally, using an expert judgement method the conclusions are based of principles used during a qualitative risk assessment for each of 4 hotspot sides.

Table 3_Illustration of principle, used during a qualitative risk assessment

Contaminant Hazard
- Significant (H)
- Moderate (M)
- Minimal (L)

Migration Pathway
- Evident (H)
- Potential (M)
- Confined (L)

Receptors
- Identified (H)
- Potential (M)
- Limited (L)

Contaminant Hazard Factor	Receptor Factor	Migration Pathway		
		Evident	Potential	Confined
Significant	Identified	HHH	HHM	HHL
	Potential	HHM	HMM	HML
	Limited	HHL	HML	HLL
Moderate	Identified	HHM	HMM	HML
	Potential	HMM	MMM	MML
	Limited	HML	MML	MLL
Minimal	Identified	HHL	HML	HLL
	Potential	HML	MML	MLL
	Limited	HLL	MLL	LLL

6.1.8 Site Specific Risk Assessment

6.1.8.1 Background

The structure of the Macedonian industry is in a favour of creating large amounts of waste. The biggest generators of waste in the industrial sector of Macedonia are: ferrous and non-ferrous metals production plants and solid fuel combustion units within the industry sector. Liquid waste is also generated from industrial operations. Most frequently it is oil or oil rich emulsion. There is no clear policy on the final faith of oily waste and some operators have been advised bay the authorities to pack liquid waste in barrels and dispose them on the nearest municipal landfill. It is estimated that about 5,5 Gg of waste are produced each year, out of which 4,5 Gg are flotation tailings. The air and water pollution as well as the waste generation contribute to the pollution of soil. During previous CARDS 2001 Project, 16 identified contaminated industrial sites were analysed and based on various environmental criteria 3 classes were developed: low, medium and high risk contaminated industrial sites. Methods for closure / remediation were developed and (unit) cost estimates made. The total remediation costs are estimated at € 70 million

from the Cards 2001 project, while the Cards 2006 project estimates a budgetary need of € 200 million taking all locations into consideration requiring remediation.

This Project is a follow-up project with objective to further investigate the total pollution and health environmental impact per 4 defined sites as well as to provide a more detailed specification of the proposed remediation/closure methodology and the related costs. As a primary task for this Project the health impact assessment was done for **4 marked** as "hotspots" Macedonia sites:

- OHIS, a chemicals producing company, has accumulated and disposed on site over 15000 t of α, β and δ HCH isomers. Considerable amount of mercury has been either discharged with the wastewater or leaked from the process equipment contaminating the former chlorine electrolysis plant site soil .
- The soil in a wide area around Veles has been contaminated with zinc, lead and cadmium arising from the lead and zinc smelter operation from 1973-2003. Due to the high mobility of airborne cadmium it has been found in even wider area.

  In addition to the smelter area, the region of Veles is affected by the gypsum landfill of the fertilizer plant located some 11 km south of the town of Veles.
- Huge amount of mono-chromate containing sludge has been deposited on a landfill near to the SILMAK (a ferroalloys smelting company) in the area of the village Jegunovce. This sludge is the solid waste produced during the operation of the sodium bi-chromate production plant. The Government of Macedonia has already undertaken measures to eliminate the risk of contaminating the river Vardar and the potable water springs.
- Iron and steel work in Skopje due to dust emission from the steelwork's EAF and the ferroalloys electric furnaces along with oily scale from the hot rolling mills is a significant source of pollution and in addition, it will be very difficult to control it because of the number of different operators.
- The old landfill of the former integrated steelwork is a potential source of groundwater contamination with

6.1.9 Specific Situation – Silmak - Jegunovce

Significant air pollution from the stacks, notably an estimated 9.000 Mg 17.000 Mg of dust and fly ash a year, is due to the plant's electric furnaces operating without any form of gas cleaning. A project to reduce these emissions and recycle energy from a number of the furnaces has been proposed by the plant management, but requires funding.

According to the NEAP, total dust, black smoke and particle-borne chromium standards have been breached in the past years in the vicinity of the plant. Lack of data makes it impossible to assess any health impacts on workers. HEK Jugochrome was planed to undertake three remedial activities under the direction of the Ministry of Environment and Physical Planning with EU funding. The measures include surface water management by capping partly, installing a drainage system to catch leachate and divert it to the waste water treatment plant (reducing Cr^{6+} to Cr^{3+} for discharching into the river) and further recultivating the dumpsite to abate rainwater infiltration, which was done partly.

6.1.9.1 Hazard identification

6.1.9.1.1 Chromium

Chromium occurs in the environment primarily in two valence states, trivalent chromium (Cr III) and hexavalent chromium (Cr^{VI}). Exposure may occur from natural or industrial sources of chromium. Chromium ^{III} is much less toxic than chromium (VI). The respiratory tract is also the major target organ for chromium (III) toxicity, similar to chromium (VI). Chromium (III) is an essential element in humans. The body can detoxify some amount of chromium (VI) to chromium (III). The respiratory tract is the major target organ for chromium (VI) toxicity, for acute (short-term) and chronic (long-term) inhalation exposures. Shortness of breath, coughing, and wheezing were reported from a case of acute exposure to chromium (VI), while perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, and other respiratory effects have been noted from chronic exposure. Human studies have clearly established that inhaled chromium (VI) is a human carcinogen, resulting in an increased risk of lung cancer. Animal studies have shown chromium (VI) to cause lung tumours via inhalation exposure. Chromium exists in several different oxidation states, the most stable and common of which are Cr^{3+} and Cr^{6+}. Due to the different chemical characteristics of Cr^{3+} and Cr^{6+} they behave differently in the environment. The redox-conditions in the aquatic environment are a very important factor in the precipitation of Cr^{3+} and the mobility of $Cr^{6+.}$ An Eh-pH stability diagram of chromium in aqueous solutions shows that Cr^{6+} compounds are generally strongly oxidizing agents that will only prevail in strongly oxidizing conditions. In the pH-range from about 4 and above, Cr^{6+} will mainly occur as $HCrO_4$ -. Above pH 6 it occurs as $(CrO_4)^{2-}$. Cr^{3+} is believed to be the most stable form of chromium at pH-values above 4. The presence of dissolved oxygen will cause a very slow oxidation of Cr^{3+} to $Cr^{6+.}$ This process will be very effective if MnO_2 is present.

6.1.9.2 Assessment of dose-response relationships

HEK Jugochrome groundwater remediation programme has been operating since 1989. Throughout its operation, water samples from the abstraction wells, the drainage system and several monitoring wells have been analyzed monthly during the period 1989 - 2000. Cr^{6+} concentrations have clearly decreased in the groundwater areas monitored.

6.1.9.2.1 Acute Effects – Chromium VI

- Chromium (VI) is much more toxic than chromium (III), for both acute and chronic exposures.
- The respiratory tract is the major target organ for chromium (VI) following inhalation exposure in humans. Shortness of breathing, coughing, and wheezing was reported in cases where an individual inhaled very high concentrations of chromium trioxide.
- Other effects noted from acute inhalation exposure to very high concentrations of chromium (VI) include gastrointestinal and neurological effects, while dermal exposure causes skin burns in humans.
- Ingestion of high amounts of chromium (VI) causes gastrointestinal effects in humans and animals, including abdominal pain, vomiting, and haemorrhage. Acute animal tests have shown chromium (VI) to have extreme toxicity from inhalation and oral exposure.

6.1.9.3 Acute Effects - Chromium III

- Chromium (III) is an essential element in humans, with a daily intake of 50 to 200 µg/d recommended for adults.

- Acute animal tests have shown chromium (III) to have moderate toxicity from oral exposure.

6.1.9.3.1 Chronic Effects (Non carcinogen) – Chromium VI

- Chronic inhalation exposure to chromium (VI) in humans results in effects on the respiratory tract, with perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, asthma, and nasal itching and soreness reported. Chronic human exposure to high levels of chromium (VI) by inhalation or oral exposure may produce effects on the liver, kidney, gastrointestinal and immune systems, and possibly the blood. Rat studies have shown that, following inhalation exposure, the lung and kidney have the highest tissue levels of chromium.
- Dermal exposure to chromium (VI) may cause contact dermatitis, sensitivity, and ulceration of the skin. The Reference Concentration (RfC) for chromium (VI) (particulates) is 0.0001 mg/m^3 based on respiratory effects in rats. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious non-cancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse health effect would necessarily occur. EPA has medium confidence in the RfC for chromium VI (particulates) based on medium confidence in the study on which it was based because of uncertainties regarding upper respiratory tract, reproductive, and renal effects resulting from the exposures.
- The Reference Concentration (RfC) for chromium (VI) (chromic acid mists and dissolved Cr (VI) aerosols) is 0,000008 mg/m^3 based on respiratory effects in humans. EPA has low confidence in the RfC based on low confidence in the study on which the RfC for chromium (VI) (chromic acid mists and dissolved Cr (VI) aerosols) is based. This is because of (1) the uncertainties regarding the exposure characterization and the role of direct contact for the critical effect; and (2) low confidence in the supporting studies which are equally uncertain regarding the exposure characterization. The Reference Dose (RfD) for chromium (VI) is 0,003 mg/kg/d based on the exposure at which no effects were noted in rats exposed to chromium in the drinking water.
- EPA has low confidence in the RfD based on: low confidence in the study on which the RfD for chromium (VI) was based because a small number of animals were tested, a small number of parameters were measured, and no toxic effects were noted at the highest dose tested; and low confidence in the database because the supporting studies are of equally low quality and developmental endpoints are not well studied.

6.1.9.3.2 Chronic Effects (Non carcinogen) – Chromium III

- Although data from animal studies have identified the respiratory tract as the major target organ for chronic chromium exposure, these data do not demonstrate that the effects observed following inhalation of chromium (VI) particulates are relevant to inhalation of chromium (III).
- EPA has not established an RfC for chromium (III).
- The RfD for chromium (III) is 1,5 mg/kg/d based on the exposure level at which no effects were observed in rats exposed to chromium (III) in the diet.

- EPA has low confidence in the RfD based on: low confidence in the study on which the RfD for chromium (III) was based due to the lack of explicit detail on study protocol and results; and low confidence in the database due to the lack of high-dose supporting data.

6.1.9.3.3 Reproductive/Developmental Effects – Chromium VI

- Limited information on the reproductive effects of chromium (VI) in humans exposed by inhalation suggest that exposure to chromium (VI) may result in complications during pregnancy and childbirth.
- Animal studies have not reported reproductive or developmental effects from inhalation exposure to chromium (VI). Oral studies have reported severe developmental effects in mice such as gross abnormalities and reproductive effects including decreased litter size, reduced sperm count, and degeneration of the outer cellular layer of the seminiferous tubules.

6.1.9.3.4 Reproductive/Developmental Effects – Chromium III

- No information is available on the reproductive or developmental effects of chromium (III) in humans.
- A study of mice fed high levels of chromium (III) in their drinking water has suggested a potential for reproductive effects, although various study characteristics preclude a definitive finding.
- No developmental effects were reported in the offspring of rats fed chromium (III) during their developmental period.

6.1.9.3.5 Cancer Risk – Chromium VI

- Epidemiological studies of workers have clearly established that inhaled chromium is a human carcinogen, resulting in an increased risk of lung cancer. Although chromium-exposed workers were exposed to both chromium (III) and chromium (VI) compounds, only chromium (VI) has been found to be carcinogenic in animal studies, so EPA has concluded that only chromium (VI) should be classified as a human carcinogen.
- Animal studies have shown chromium (VI) to cause lung tumours via inhalation exposure.
- EPA has classified chromium (VI) as a Group A; known human carcinogen by the inhalation route of exposure.
- EPA used a mathematical model, based on data from an occupational study of chromate production workers, to estimate the probability of a person developing cancer from continuously breathing air containing a specified concentration of chromium. EPA calculated an inhalation unit risk estimate of $1{,}2 \times 10^{-2}$ $(\mu g/m^3)^{-1}$. EPA estimates that, if an individual were to continuously breathe air containing chromium at an average of 0.00008 $\mu g/m^3$ (8×10^{-8} mg/m^3) over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased risk of developing cancer. Similarly, EPA estimates that continuously breathing air containing 0,0008 $\mu g/m^3$ (8×10^{-7} mg/m^3) would result in not greater than a one-in-a-hundred thousand increased risk of developing cancer during one's lifetime, and air containing 0,008 $\mu g/m^3$ (8×10^{-6} mg/m^3) would result in not greater than a one-in-ten-thousand increased risk of developing cancer during one's lifetime. For a detailed discussion of confidence in the potency estimates, please see IRIS.

6.1.9.3.6 Chancer Risk - Chromium III

- No data are available on the carcinogenic potential of chromium (III) compounds alone.
- EPA has classified chromium (III) as a Group D, not classifiable as to carcinogen in humans.
- EPA has stated "the classification of chromium (VI) as a known human carcinogen raises a concern for the carcinogenic potential of chromium (III)".

6.1.9.3.7 Exposure assessment

The production of the ferrosilicon is conducted in 7 electro furnaces, through the following processes: Preparation of the quartz (crushing and washing), melting, cooling and crashing of the ferrosilicon. Main raw materials used by Silmak for the production of FeSi come from Macedonia and nearby countries. 50% of suppliers are situated in Macedonia. Slightly over half of word consumption of ferrosilicon is used in cast irons, which contain between 1% and 3% silicon. Silicon reduces the stability of iron carbide in cast iron and promotes the formation of graphitic carbon by a process of inoculation. Cast iron output has been stagnant for a number of years because of declining use in automobile engines, and growth of continuous casting making redundant the use of iron ingot moulds in steel making.

In the past, the plant's chromium processing activities produced large amounts of ferrochromium slag (446.000 Mg), and other (chromate) slag (385.000 Mg). Since 1996, this slag was dumped in an open dumpsite located close to the HEK Jugochrome plant. The dumpsite is 25 meters high and covers 7 hectares. Plant management estimates that its total mass is approximately 1.200.000 Mg. The dump is covered with 2.000 m3 of soil, which was allowed to naturally re-vegetate with grass and some small trees. A concrete pipe was installed to allow a small creek called Muzga Spring to run under the dumpsite. Muzga Spring has a mean flow of 3 - 5 l/s. The concrete pipe, however, is broken (probably due to the waste load), allowing the creek water to absorb Cr^{6+} contamination, which it discharges into the Vardar River. HEK plans to implement three remedial measures under the direction of the MEPP. According to plant management, European Union funds will support the implementation of these measures.

UNEP team has assumption that the groundwater outside the contoured area is not polluted, therefore, cannot be considered reliable. The precise size of the plume is unknown. For conceptual purposes, however, the plume's order of magnitude can be assumed to be (400 x 100 m) 40.000 m2. Plant management reports that the deeper aquifers are not contaminated. Therefore, it can be assumed that the contaminated aquifer layer is less than approximately 8 meters thick. If the contamination were to reach the surface water, it could infiltrate into karst mountains (taking into consideration that Vardar River is both a discharging and recharging river). According to plant management, private homes outside of the site boundaries have suffered from chromium-contaminated groundwater creeping up the building walls through their capillaries..

Many walls and floors of the old chromium processing facilities are potentially contaminated with chromium compounds. However, the roofs of these buildings are in relative good condition. Therefore, the leaching of contamination into the soil and groundwater can be assumed to be limited.

Table 4_The monthly rate ($^{o}/_{oo}$) of registered patient with respiratory diseases (J00-J99) without (J10-J18) among preschool children in Tetovo in 2006

Month	Tetovo	
	Urban	Rural
I	165,9	177,2
II	198,3	130,6
III	173,9	173,4
IV	157,7	106,6
V	151,9	64,9
VI	134,7	72,0
VII	84,2	69,9
VIII	152,7	60,0
IX	78,4	123,5
X	37,4	111,5
XI	156,0	117,1
XII	188,0	137,0
Average	**139,9**	**119,4**

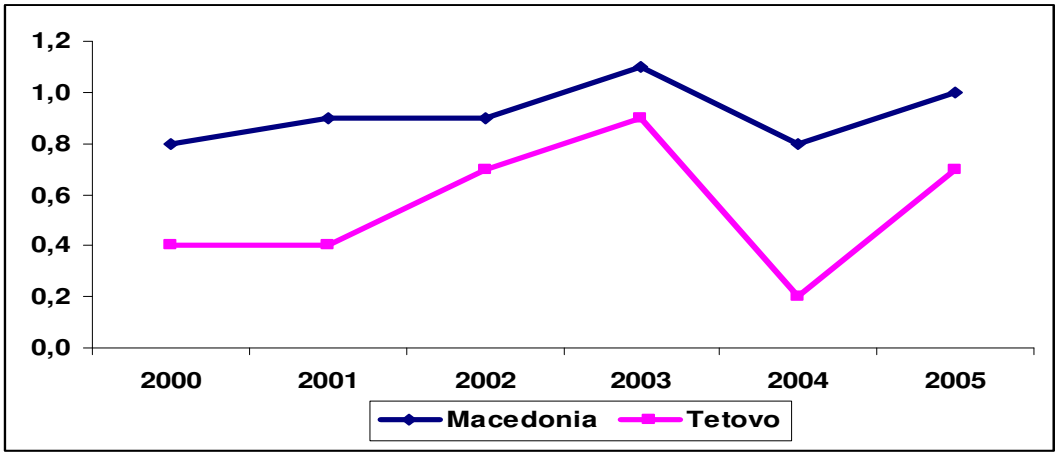
The average monthly rate registered patient with respiratory diseases (J00-J99) without (J10-J18) among preschool children in Tetovo Region in 2006, shows that in urban area the rate is almost same with rural area, especially in winter due to air pollution in Jegunovce area.

Table 5_The monthly rate ($^{o}/_{oo}$) of registered patient with respiratory diseases (J00-J99) without (J10-J18) among school children in Tetovo in 2006

Month	Tetovo	
	Urban	Rural
I	65,0	97,7
II	47,7	64,3
III	37,1	70,7
IV	26,3	31,6
V	52,6	41,4
VI	24,1	20,9
VII	18,4	16,0
VIII	19,2	19,9
IX	16,1	24,8
X	17,9	33,6
XI	31,5	38,5
XII	56,8	77,0
Average	**34,63**	**44,75**

The average monthly rate registered patient with respiratory diseases (J00-J99) without (J10-J18) among school children in Tetovo Region in 2006, shows that in rural area the rate is higher than in rural area, especially in winter due to air pollution in Jegunovce area which is unique for the country.

Figure 11_Distribution of mortality from malignant neoplasms of liver in the Republic of Macedonia and Tetovo region for the period 2000 - 2005 (rate / 10.000)



The distribution of Mortality from malignant neoplasms of liver in the Republic of Macedonia and Tetovo Region for the period 2000 - 2005 (rate / 10.000) has showed lower rate in Tetovo compared to Macedonian rate.

Figure 12_Distribution of Mortality from malignant neoplasms of lung and bronchial tubes in the Republic of Macedonia and Tetovo region for the period 2000 - 2005 (rate / 10.000)

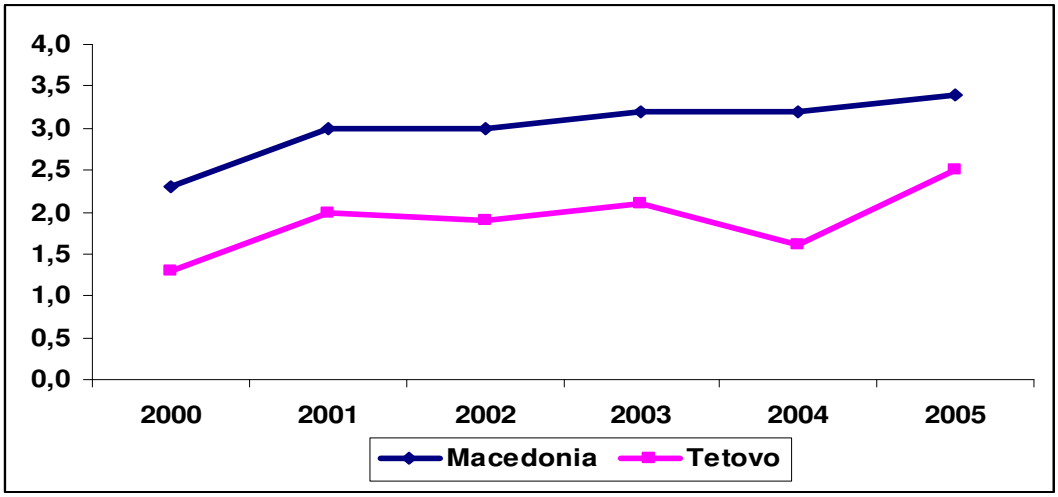
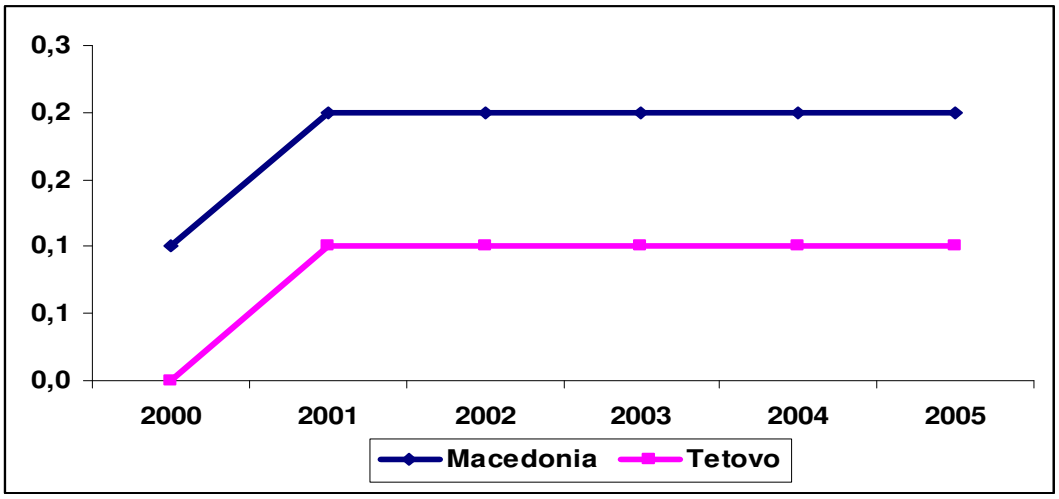


Figure 13_Distribution of mortality from malignant neoplasms of kidneys in the Republic of Macedonia and Tetovo region for the period 2000 - 2005



Also, the distribution of Mortality from malignant neoplasms of lung and bronchial tubes as well as kidneys in the Republic of Macedonia and Tetovo Region for the period 2000 - 2005 (rate / 10.000) showed the lower rate in Tetovo compared to Macedonia rate.

6.1.9.4 Risk characterization

FERROCHROME PRODUCTION

Particulates: Cr, Fe, Cu and Zn and total ferrochrome dust to atmosphere. Soil contamination by the dust deposited around the smelter. Cr and Fe occurred in the fine particulates of sizes less than 70 μm, Cu and Zn in the coarse particulates of size range 70–100 μm. Other issues include waste/slag dumps and process chemical pollution. Obtained results from RIHP for Cr distribution in groundwater showed that the concentration is minimal. The results for Cr in new drinking water supply system in Jegunovce have showed very low concentration. The results from old drinking water supply system have showed higher values compared with new one but under the MPL. The groundwater analysis for Cr showed the higher values. Also the several years trend for Cr in Rasce drinking water showed lower Cr values under MPL. Detected risk for respiratory diseases among children in Jegunovce is related to air pollution. The dust from the plant's exhaust appears not to be toxic in itself. However, dust generally causes coughing and creates a feeling of fatigue. People who have weakened physical conditions or dust allergies, such as asthma and bronchitis, will suffer from exposure to the dust. Dust also creates visual contamination, which is usually opposed.

6.1.10 Summary of Assessment Results

Environmental health risk assessment is an essential element in environmental management and an important condition in precise priority setting to the necessary actions for its sanitation. Risk assessment is intended 'to provide complete information to risk managers, specifically policymakers and regulators, so that the best possible decisions are made'. There are uncertainties related to risk assessment and it is important to make the best possible use of available information. Environmental Health Risk Assessment provides a tool for appraising health risks in the broader process of Health Impact Assessment.

Harm Potential damage to people, property, or the biophysical, social, or cultural environment associated with the primary industrial risks from affected hotspots. Found in this report include: chronic health effects associated with heavy metals poisoning in humans. The types of damage listed here have the potential to occur at site, local, sub-regional, regional and/or trans-boundary levels.

Likelihood The probability and frequency of the types of defined events that can cause harm and probability of specific outcomes were not assessed in this Report. However, as many pollution incidents have occurred, and many are ongoing, the likelihood of damage of the types discussed above (harm) are very high or certain in many instances. Further, the high number and common occurrence of "warning signals" as listed in the summary, indicate that many factors are present contributing to increased likelihood of incidents in site areas.

Hazards Many sources of potential harm and situations with a potential for harm were found in the study. Examples include: dissolved heavy metals; metals smelter stacks emitting near population centres; waste dumps for toxic materials located over groundwater resources; large uncovered toxic dust generating surfaces near agricultural land and population centres, and so forth and so on.

Consequence(s) The intermediate or final outcome(s) of events or situations affecting elements of the biophysical spheres observed in the study include: increased human mortality, and developmental problems in children;. Outcomes affecting elements of the social sphere include: rising opposition to mining and minerals processing from citizens; increased scrutiny and coordinated opposition from NGOs especially in Veles.

Risk The likelihood of damage to people, property, or the biophysical, social, or cultural environment listed above appears to be high. While only qualitative comments can be passed based upon this analysis, the fact that chronic damage is ongoing in many areas and that many major incidents resulting in acute effects have occurred, should underline the seriousness of the risks observed in this study.

Large quantities of industrial waste are generated in the mining, metallurgical, fertilizer, and chemical industries, as well as in the coal-fired power plants. Most of the larger industries have their own industrial waste sites.

The Table shows distribution of hazards, possible health effects and potential number of excised people by hazardous sides.

Table 6_Distribution of hazards, possible health effects and potential number of excised people by hazardous sides

Hazardous site	Hazards	Possible health effects	Potential number of excised people
SILMAK Jegunovce	Groundwater contamination by chromium; air pollution; chromium slag	Cr VI is carcinogenic to humans; lung diseases	10.000 inhabitants 1000 workers

Regarding human health, the assessment is focus on exposure routes, both direct and indirect as well as establishes the number and type of people that may be affected to a significant extend:

Contaminant Hazard

- **Significant (H)**
  Moderate (M**)**
- Minimal (L)

Migration Pathway

- Evident (H)
- **Potential (M)**
- Confined (L)

Receptors

- Identified (H)
- Potential (M)
- **Limited (L)**

Contaminant Hazard Factor	Receptor Factor	Migration Pathway		
		Evident	**Potential**	Confined
Significant	Identified	HHH	HHM	HHL
	Potential	HHM	HMM	HML
	Limited	HHL	**HML**	HLL
Moderate	Identified	HHM	HMM	HML
	Potential	HMM	MMM	MML
	Limited	HML	MML	MLL
imal	Identified	HHL	HML	HLL
	Potential	HML	MML	MLL
	Limited	HLL	MLL	LLL

Silmak – Jugochrome - Jegunovce
Contaminant Hazard

- **Cr**
- Fe
- Cu
- Zn
- Total ferrochrome dust to atmosphere

Depositional soil contamination, waste/slag dumps and process chemical pollution
Migration Pathway:

- air (dust and smelter emissions)
- water/ groundwater

Receptors: **Limited**
Defined environmental health risk: MODERATE to HIGH
Defined environmental health impact: LOW to MODERATE

Ranking Summary:

In Jegunovce have been detected several hazards as particulates: Cr, Fe, Cu and Zn and total ferrochrome dust to atmosphere. Soil contamination by the dust deposited around the smelter. Detected risk for respiratory diseases among children in Jegunovce is related to air pollution. The dust from the plant's exhaust appears not to be toxic in itself. Other issues include waste/slag dumps and process chemical pollution. Obtained results from RIHP for Cr distribution in groundwater showed that the concentration is minimal. In accordance with EH assessment was stated a moderate- high human risk

It can be stated that the current operation of the production facilities of Silmak causes significant higher Health Risks than the wastes accumulated on the investigated hotspots. It is recommended to focus on IPPC procedures in order to avoid and reduce the risk to a acceptable limit.

The risk on Silmak due to secondary migration paths (ground/soil) is significant and has to be given a priority.

Spot	Pollutants	Hazard	Risk	Impact	Rank
Silmak	CrVI	High	Moderate-High	Low-Moderate	3

7 Process assessment – qualitative and quantitative waste assessment

7.1 Sodium Bichromate Production Plant

Experimental production of sodium bichromate began in 1955. the plant was based on the so called Zehn Process in which chromite ore and limestone were calcined and the product was leached with Sodium bicarbonate. Due to a low efficiency and high Cr^{6+} concentration in the residue, the experimental production was stopped shortly after the beginning.

A major reconstruction of the plant was undertaken in 1962 by the Polish company CEKOP. The production process was changed and the plant was operated under this process until 1993 since when it has been permanently shut down.

7.1.1 Process Description and significant waste streams of Bichromate Production

Sodium Bichromate was produced in the state owned company Jugochrom for several years (from 1955 to 1993).

A total of 7.388 Mg of Sodium Bichromate have been produced during the lifetime of the plant. The annual production rates are given in the following table:

Table 7_Production of Sodium Bichromates during the years 1961 till 1993

Year	Production in Mg	Year	Production in Mg
1961	716,00	1977	3.796,00
1962	280,00	1978	3.923,00
1963		1979	3.549,00
1964		1980	4.601,00
1965		1981	4.466,00
1966	1.214,00	1982	4.889,00
1967	448,00	1983	4.893,00
1968	2.516,00	1984	4.924,00
1969	3.223,00	1985	4.857,00
1970	4.041,00	1986	4.418,00
1971	3.355,00	1987	4.740,00
1972	3.729,00	1988	4.691,00
1973	3.783,00	1989	7.024,00
1974	4.018,00	1990	4.293,00
1975	3.242,00	1991	3.737,00
1976	3.348,00	1992	2.814,00
		1993	1.393,00
SUM of Procution			**106.921,00**

7.1.1.1 Process Description

Chromite ore, dolomite and soda ash are separately dried, milled weighted and mixed after a predetermined amount of return fines is added. The mixture is than calcined in a rotary kiln at 1200 to 1250 ºC. Oxidation of chromites in presence of Na_2CO_3 begins already at 600 ºC, but at this temperature only 46% of chromite may be converted into chromate. Maximum conversion rate is about 96%.

Calcined material is leached with water. Sulphuric acid is added to neutralize the leachate and eliminate aluminium hydroxide. The pulp is than filtered and the cake is washed and disposed off onto the landfill. About 40 Mg/day of wet cake (35% water) were discarded from the plant. **This cake is of major concern regarding the groundwater pollution potential**.

Chromate solution is further treated with H_2SO_4 to convert sodium chromate into bichromate. Sodium sulphate is formed in this operation as a by-product. In the subsequent two-stage evaporation sodium sulphide is crystallised and removed from the $Na_2Cr_2O_7$ rich liquor from which the bichromate is crystalised, dried and packed as final product. Following data may help in establishing the material balance of the process:

7.1.1.1.1 Input:

Chromite concentrate **23,82 Mg/day**

Substance	%
Cr_2O_3	48
FeO	16
MgO	18.5
Al_2O_3	10
SiO_2	6.5

Soda Ash **13,4 Mg/day**

Substance	%
Na_2CO_3	98.5
$NaHCO_3$	0.3
NaCl	<0.7
Na_2SO_4	<0.07
Fe_2O_3	<0.005

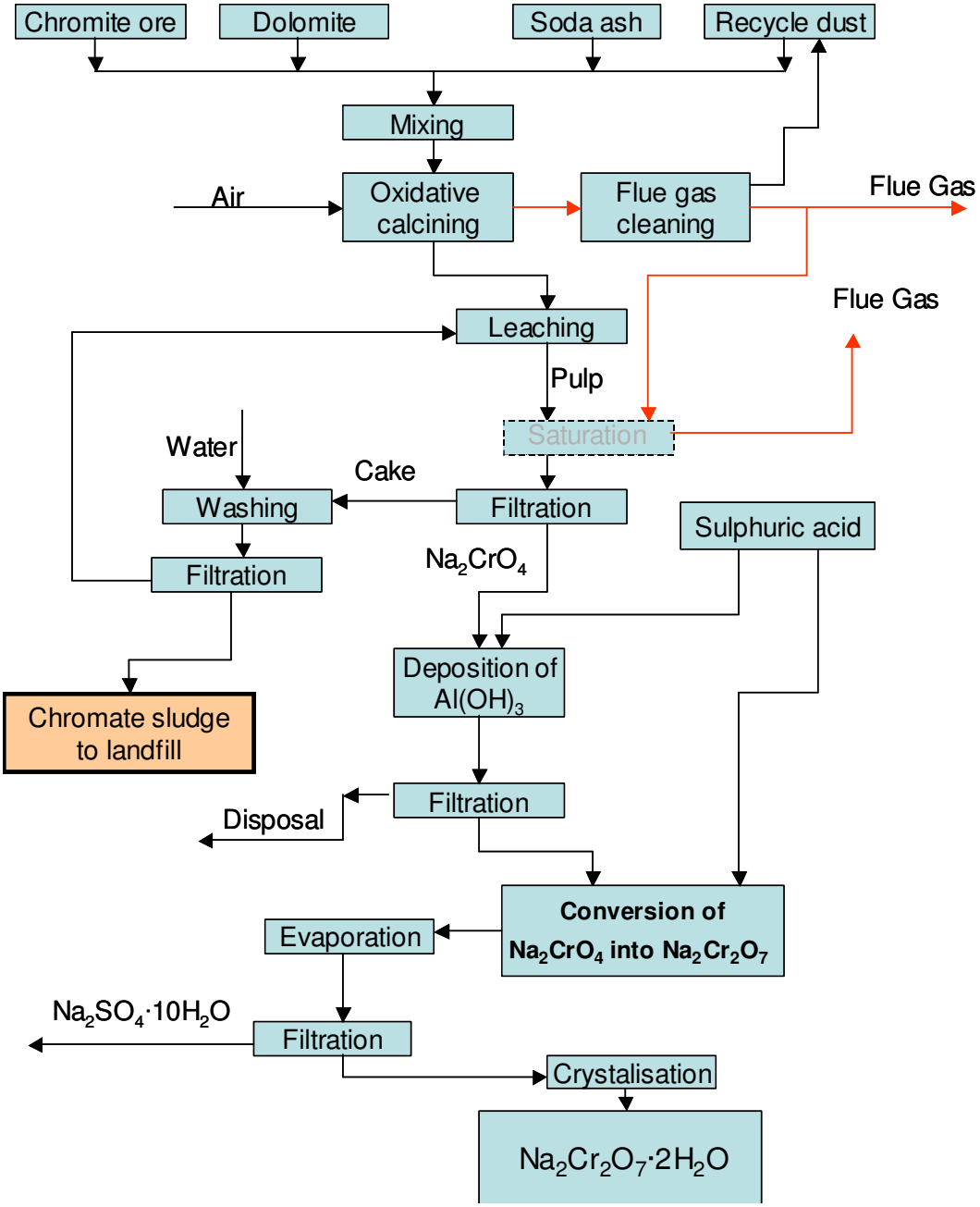
Dolomite **29,78 Mg/day**

Substance	%
CaO	51
MgO	21
SiO_2	0.5
Al_2O_3 and Fe_2O_3	0.2
Calcination loss	47

Table 8_daily Sodium Bichromate plant input

	Chromite ore		**Dolomite**		**Soda Ash**		**Total**
		23,82		**29,78**		**13,40**	**67**
	%	Weight	%	Weight	%	Weight	
Cr_2O_3	48,00	11,43	0,00	0,00	0,00	0,00	11,43
FeO	16,00	3,81	0,00	0,00	0,00	0,00	3,81
MgO	18,50	4,41	22,00	6,55	0,00	0,00	10,96
Al_2O_3	10,00	2,38	0,10	0,03	0,00	0,00	2,41
SiO_2	6,50	1,55	0,50	0,15	0,00	0,00	1,70
CaO		0,00	29,69	8,84	0,00	0,00	8,84
Fe_2O_3		0,00	0,10	0,03	0,01	0,00	0,03
Na_2CO_3		0,00	0,00	0,00	98,50	13,20	13,20
$NaHCO_3$		0,00	0,00	0,00	0,30	0,04	0,04
NaCl		0,00	0,00	0,00	0,70	0,09	0,09
Na_2SO_4		0,00	0,00	0,00	0,07	0,01	0,01
CO2			47,00	14,00			14,00
	99,00	23,58	99,39	29,60	99,58	13,34	**66,52**

Figure 14_ Flow sheet of the sodium bichromite production process applied in Jugochrom – Jegunovce



About 12 Mg/day of sodium bichromate are produced from the 67 Mg/day feed containing

Content	**Mg/day**
Na_2O	2,696
CrO_3	8,696
H_2O	0,783
Calculated Cr_2O_3	**6,60668**

Obviously, the efficiency was quite low as calculated: $\eta = \frac{6.60668}{11.4336} = 0.5778$

Assuming that all the silica content goes into the cake and its concentration is about 5,1%, the following quantities of cake and its composition have been estimated:

Table 9_Daily production of chromate cake in Jugochrom

		33,28
Content	**%**	**Weight (Mg)**
Cr_2O_3	14,50	4,82692
FeO	11,45	3,8112
MgO	32,93	10,9583
Al_2O_3	7,25	2,41178
SiO_2	5,10	1,6972
CaO	26,57	8,841682
Fe_2O_3	0,09	0,03045
Na_2O	2,00	0,666
Na_2SO_4		
Total	**99,89**	**33,24**

Although the figures fit quite well, it seems that an remarkable amount of Na_2O had been missing (about 2 Mg/day).

7.1.2 Qualitative assessment of waste streams

The main Cr^{6+} bearing waste is the filter cake consisting of components not dissolved under the leaching conditions after calcining. Small amount of Na_2CrO_4 may be present due to incomplete washing, but the solubility of sodium bichromate is so high that it would have been washed out from the landfill during the years after closing the plant.

$CaCrO_4$ is far less soluble in water compared to Na_2CrO_4. However, this fact should not be considered a reason for the presence of soluble CrO_4 in the chromate sludge as it used to be in the past, because the probability of its survival throughout the process of leaching is very low.

CaCrO4 reacts with NaOH

$CaCrO_4 + 2NaOH \leftrightarrows Ca(OH)_2 + Na_2CrO_4$ (1)

$$K_{(1)} = \frac{\left[CrO_4^{2-}\right]}{\left[OH^-\right]^2} = \frac{\left[Ca^{2+}\right]\left[CrO_4^{2-}\right]}{\left[Ca^{2+}\right]\left[OH^-\right]^2} = \frac{Ks_{CaCrO_4}}{Ks_{Ca(OH)_2}}$$

The solubility products are as follows:

1. $Ks_{(Cr2O4)} = 5 \cdot 10^{-3}$
2. $Ks_{(Ca(OH)2} = 2 \cdot 10^{-5}$

Therefore, the equilibrium constant of equation (1) **is ≈ 250**

During the leaching phase, $xCaO \cdot yCr_2O_3 \cdot zCrO_3$ hydrolyses producing $Ca(OH)_2$ and a low acid soluble alkaline calcium chromate ($CaO \cdot CaCrO_4 \cdot 3H_2O$). However, it is most likely that the largest amount of acid soluble CrO_3 losses is due to the formation of calcium chromate-aluminates. The amount of the latter can be significantly reduced by saturation (converting $Ca(OH)_2$ into $CaCO_3$ by admitting flue gases through the leached pulp). However, according to the data collected so far, no saturation had ever been performed in this particular plant.

🕮 There are three sources of soluble chromium in the chromate sludge:

1. **Calcium chromite-chromate ($xCaO \cdot yCr_2O_3 \cdot zCrO_3$)**
2. **Chromate-alluminate of calcium ($3CaO \cdot Al_2O_3 \cdot 3CaCrO_4 \cdot 12.7H_2O$)**
3. **Chemisorptions of $(CrO_4)^{2-}$ ions in some mineral phases.**

7.1.3 Quantitative Assessment of Waste

As shown in Table 9, about 33,25 Mg/day of dry sludge had been generated to produce 12 Mg/day of sodium bichromate. Based on the data obtained from the State statistical office, 106.921 tons of sodium bichromate has been produced from 1961 until the final closure of the plant in 1993.

Based on the above data, a simple calculation shows that **296.260 Mg** of mono-chromate containing sludge have been generated and disposed of onto the landfill.

According to the annual reports on the groundwater treatment plant [Annex 1] less than 4 Mg/year of Cr^{6+} are eliminated. It is reasonable, although not quite accurate, to assume that this amount of six-valent chromium has bled off in the years before the groundwater treatment plant was installed.

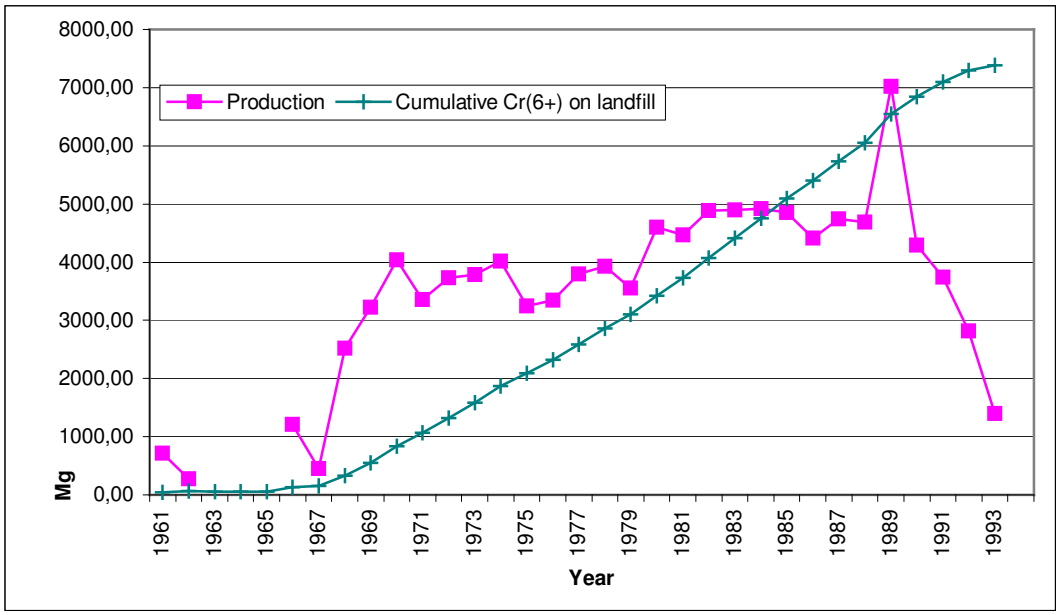
Figure 15 shows the sodium bichromate produced each year of the plant activity and the cumulative amount of Cr^{6+} on the landfill.

Figure 15_ Yearly production rate of Na2Cr2O7·H2O and Cr6+ accumulation on the Landfill

Table 10_ Yearly production rate of $Na_2Cr_2O_7 \cdot H_2O$ and Cr^{6+} accumulation on the Landfill

Year	$Na_2Cr_2O_7$ Production	Sludge	Cumulative Sludge	Cr^{6+} in Sludge	Net Cr^{6+} in Sludge	Cumulative net Cr^{6+} in Sludge
1961	716,00	1983,92	1983,92	50,36	46,36	46,36
1962	280,00	775,83	2759,75	19,69	15,69	62,05
1963		0,00	2759,75	0,00	-4,00	58,05
1964		0,00	2759,75	0,00	-4,00	54,05
1965		0,00	2759,75	0,00	-4,00	50,05
1966	1214,00	3363,79	6123,54	85,39	81,39	131,44
1967	448,00	1241,33	7364,88	31,51	27,51	158,95
1968	2516,00	6971,42	14336,29	176,96	172,96	331,92
1969	3223,00	8930,40	23266,69	226,69	222,69	554,61
1970	4041,00	11196,94	34463,63	284,23	280,23	834,83
1971	3355,00	9296,15	43759,77	235,98	231,98	1066,81
1972	3729,00	10332,44	54092,21	262,28	258,28	1325,09
1973	3783,00	10482,06	64574,27	266,08	262,08	1587,17
1974	4018,00	11133,21	75707,48	282,61	278,61	1865,77
1975	3242,00	8983,04	84690,52	228,03	224,03	2089,80
1976	3348,00	9276,75	93967,27	235,48	231,48	2321,28
1977	3796,00	10518,08	104485,35	266,99	262,99	2584,28
1978	3923,00	10869,98	115355,33	275,93	271,93	2856,20
1979	3549,00	9833,69	125189,02	249,62	245,62	3101,82
1980	4601,00	12748,60	137937,63	323,61	319,61	3421,44
1981	4466,00	12374,54	150312,17	314,12	310,12	3731,56
1982	4889,00	13546,60	163858,77	343,87	339,87	4071,43
1983	4893,00	13557,69	177416,46	344,15	340,15	4411,58
1984	4924,00	13643,58	191060,04	346,33	342,33	4753,91
1985	4857,00	13457,94	204517,98	341,62	337,62	5091,53
1986	4418,00	12241,54	216759,52	310,74	306,74	5398,27
1987	4740,00	13133,75	229893,27	333,39	329,39	5727,66
1988	4691,00	12997,98	242891,25	329,94	325,94	6053,60
1989	7024,00	19462,33	262353,58	494,04	490,04	6543,64
1990	4293,00	11895,19	274248,77	301,95	297,95	6841,59
1991	3737,00	10354,60	284603,38	262,84	258,84	7100,43
1992	2814,00	7797,13	292400,50	197,92	193,92	7294,36
1993	1393,00	3859,77	296260,27	97,98	93,98	**7388,33**
SU	**106921,00**	**296260,27**		**7520,33**	**7388,33**	

Figure 15_ Yearly production rate of $Na_2Cr_2O_7 \cdot H_2O$ and Cr^{6+} accumulation on the Landfill



🕮 Based on the calculation a total amount 296.260 Mg sludge containing 7.388 Mg of Cr6+ have been cumulated, while due to current treatment and losses a yearly amount of 4 Mg Cr^{6+} is reduced to $Cr^{3+,}$ which would require additional 1.848 years of treatment under current situation.

7.1.4 Chromium dumpsite

The dumpsite is located 2,2 km northern of the production facility close to Grabovnica and Vardar River and 2,5 km north of the village Jegunovce. The site is enclosed from the Skopje – Tetovo railroad. The Muzgi stream flows through a pipeline of a diameter of 1200 mm through the site in order to avoid direct contact with the chromium containing material.

Historically, the wste was not disposed off selectively. The slective disosal of monochromate slag has been performed within the period 1984 and 1985 into the central part of the site. After this period has the chromate containing sludge been mixed with ferros slag to form a less loluble mixture. The result is a quite heterogenous composition of the material.

The brut surface is 87.523 sqm and has a perimeter of 1.172 m. The area is fenced and accessable from two entrances one in the south and one in the north part of the site. The northern part of the site is used for ongoing disposal activities and has IPPC status. Both sites are within one boundary. The boundary from the current used and the former used sites are clear shareable.

The slopes of the former slag (chromium) dumpsite are very steep and reaches a gradient of 1:1. The dumpsite is split into VI sectors, while despite of zone Ia, VI and VII are covered with (PVC) geomembranes, which are partly broken due to mechanical torsion force. This geomembrane covers about 17.500 sqm, which is far less then half of the dumpsite surface. The geomembrane is covered by 0,5m of soil and clay and greened due to grass.

The water management of the site is more or less limited to the performing of the drainiage and pumping of chromium VI containing groundwater. This measurement has been undertaken due to the fact, that any hydraulic connection between the present aquifier and the Rasce spring, which supplies Skopje with potable water, cannot be excluded.

Groundwater contacts with the bottom of the site is limited. Floodings and swampy conditions are not reflected by the existing vegetation.

Groundwatermanagement includes the drainage to capture polluted groundwater from the disposal site, drainge for capping landfill leachate, the installation of a pumping station and a supply pipe to the WWTP plant withint the facilitiy of Makstil.

Surface water management was intented to solve by partly covering of the site. Due to the steep slopes and the insufficient surface profiling can ongong infiltration be expected, which is reflected in the increased concentration after rainfall. Open accessroads, insufficient profiled are also source for a surface pollution. Due to profiling activities is chromium visible on the surface.

Figure 16_Site layout

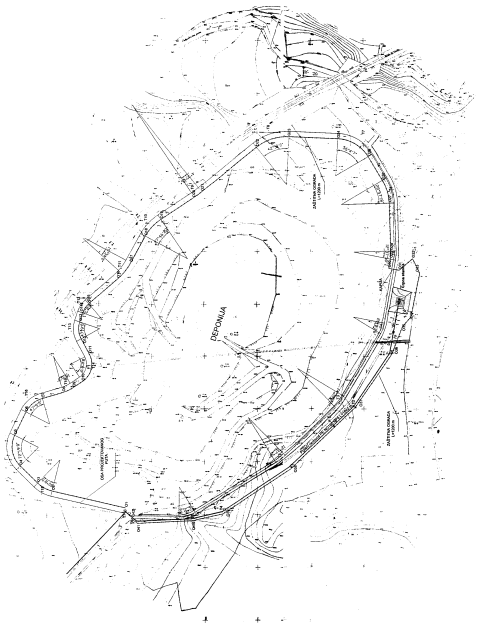
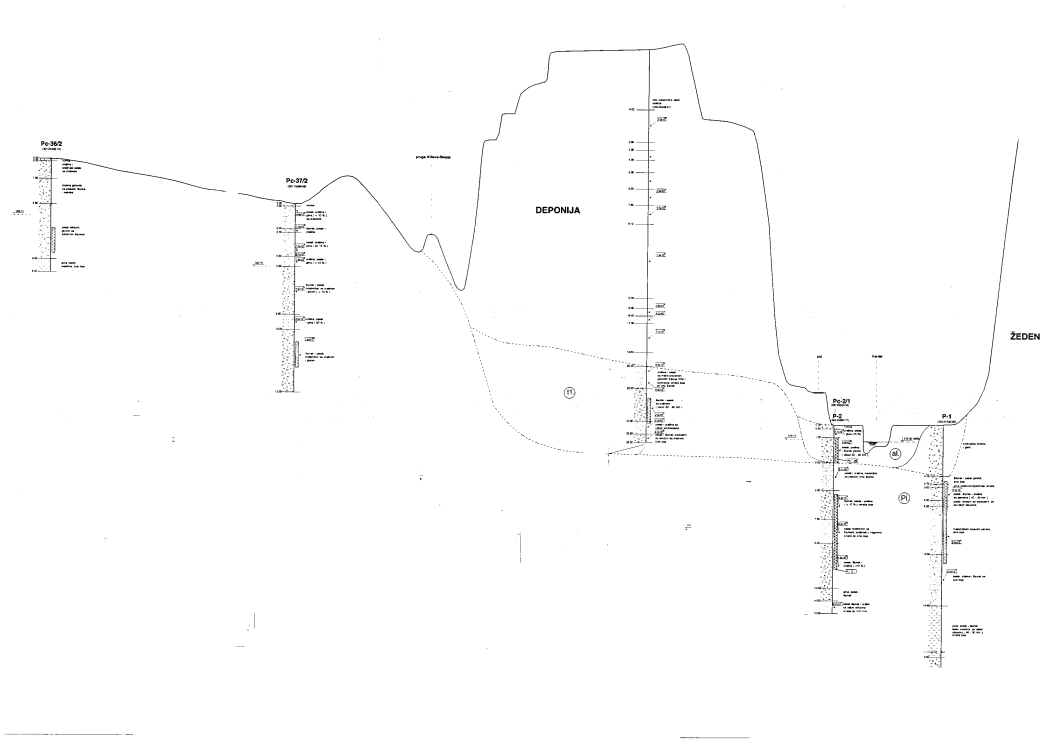
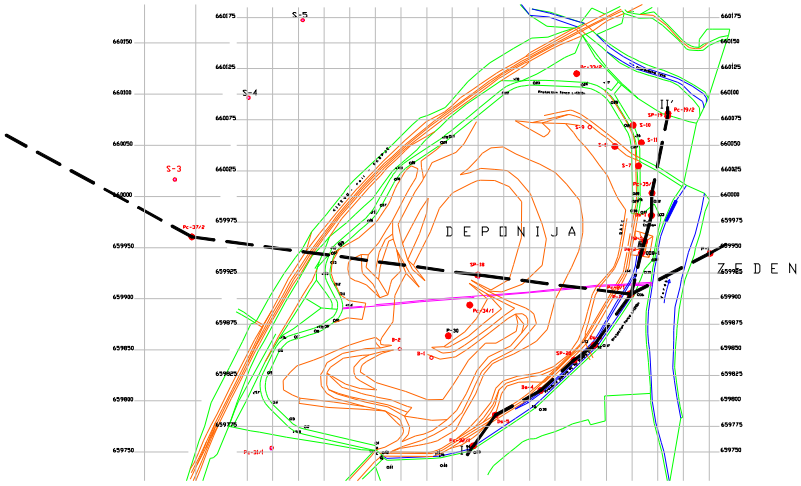


Figure 17_Site Profile (east – west)



Map 1_Layout of georeferenced chromium dumpsite



Picture 1_Sloping in northern direction

Picture 2_chromium content material on the surface

7.1.6 Relevant physically – chemical characteristics of the waste material

Table 11_physical chemical characteristics of Chromium

Name/Parameters	Cr	$Na_2Cr_20_7$ (2H20)	$CaCrO_4$
Atomic Number	24		
Molecular weight	51,996	261,98	156,08
Color	Steelgrey	Orange	Bright yellow
Physical state	Cubic crystalline		Rhombic crystalline
Melting point ºC	1857	357	
Boiling point ºC	2672	>400	
Density (g[sm3]-1)	7,19	2,35	2,89
Odor			
Solubility			
- in water g/l		7,3 (20℃)	170
- in	Hydrochloric and sulphuric acid		

7.1.6.1 Characteristics of chromium

- Chemical formula **$CaCrO_4$**
- Appearance Calcium chromate is a bright yellow powder, monoclinic, or rhombic crystals. It normally occurs as a dihydrate compound, which loses water at 200 degrees C.

7.1.6.2 Toxidity

- Chromium $LD_{50\ (rat)}$ 500 mg / kg
- Calcium chromate $LD_{50\ (rat)}$ 327 mg / kg
- it isn't combustible
- it isn't explosive

7.1.7 Pollution Dilution of Chromium

7.1.7.1 Current ongoing pollution by Chromium

The overall objective of the project is to support the remediation of SILMAK (former Jugochrome) - Jegunovce Site, an industrial hotspot, on an environmentally and financially sustainable manner by promoting donor funding to the sector and to assist in the elimination of existing impact through the development of hotspot remediation plan.

Main objective was it to prepare an overview of current vertical and horizontal pollution dilution situation for the mono-chromate (Chromium $^{6+}$ [Cr^{VI}]) by choosing low cost and non-destructive measurements to avoid drillings and the danger of increased pollution due to perforating geological barriers. The geoelectrical investigation (resistivity) shall underline or correct former investigation and give first overview of located contaminants for further decisions on required measurement and shall support estimations and interpretations of current impacting situation. The dumpsite contains six valent monochromatic slag (Chromium 6+ [Cr^{VI}]) within approximate 850.000 Mg of former disposal slag and sludge. Part of the area is covered with a PVC geo-membrane. Other

parts are covered with topsoil. Some areas are still open and showing Chromium on the surface.

Pollutants from the waste dump are contaminating the soil and the waters (surface and ground water), which move towards the river Vardar. The goal of the geoelectrical testing is to define the surface polluted, main directions and depth of the pollution. The terrain is in alluvial sediments and near location is the contact between alluvial sediments and Pliocene sediments.

Main objectives of the measures are not to investigate the conditions onto the dump, but much more in the surrounding area in order to identify the impacting rate of the site due to the development of pollution dilution profiles around the suspected area.

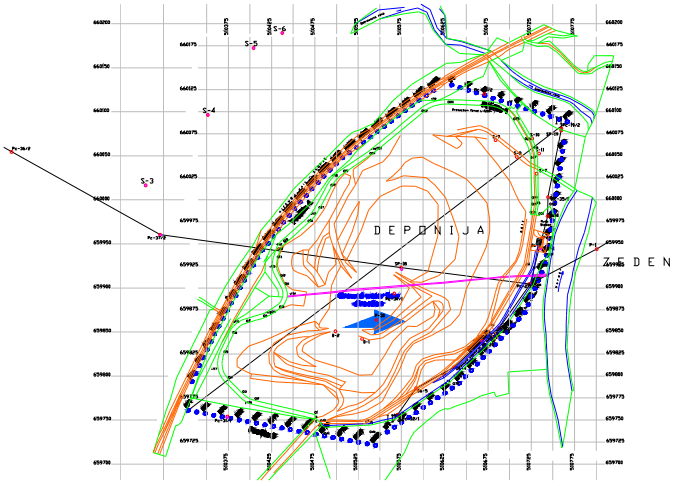
Base for the situation of the profiles have been former studies conducted by the Institute Cerny – Belgrade.The geoelectrical investigations are performed with the method of geoelectrical mapping of 3 depth entrances. Four probe profiles are performed with a total of 125 points, or 203 points for all four entrances (Table 1 and Map 1 – [11.7.1]).

Table 12_Scope of performed geoelectrical measuring

Profile	Length L (m)	Number of points	Points per depth entrances AB/2			
			AB/2=10m	AB/2=20m	AB/2=30m	Σ
I	140,00	15	12	9	6	27
II	410,00	42	39	19	11	69
III	220,00	23	20	9	5	34
IV	440,00	45	42	19	12	73
Total:	**1.210,00**	**125**	**113**	**56**	**34**	**203**

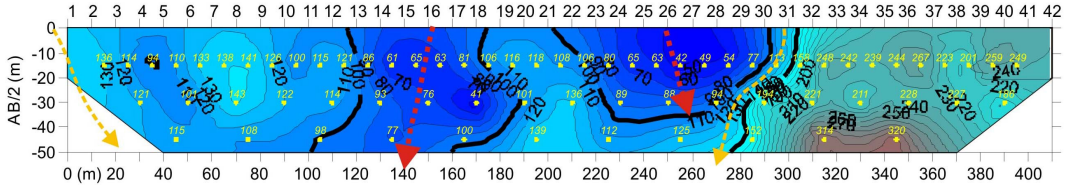
The terrain measurements are consisted of measuring of specific electrical resistance of the bottom, by emission of direct current in the ground (per two deliverable current steel electrodes A and B) and measuring the accepted voltage on the terrain surface (per two potential copper electrodes M and N). As a source for supply are used dry batteries with maximal voltage of 300 V. Profile I and II are facing on the pollution dilution of chromates.

Figure 18_Profiles for pollution dilution determination at Chromium dumpsite



The presence of the pollution in the tested geo-area, caused mostly by Cr^{6+}, should be characterized with decreasing the values of ρ_p. From the stockpile, Cr^{6+} can migrate in the ground water by penetrating of the surface water into the hydro collectors. With the geoelectrical testing, summarized influence is registered from the litho composition, from the ground water and from the migration polluters in the soil and the ground water. The registered values of ρ_p are shown per probe profiles with regions in 3 intervals as stated in Annex [11.7.3]. During the data processing the data was transformed into an adequate format and inverted with RES2DINV (industry standard) to obtain the true depth of the resistivity data. At 2,5 m depth, the shallowest depth, which could be mapped, data from the profile was taken and a contour map rendered, for a illustration of the low resistivity zones, which could be possible contamination zones.

Figure 19_Apparent resistivity cross section



7.2 Interpretation of pollution dilution

The testing is performed with electrical resistant mapping of 3 depth entrances (AB / 2 = 15, 30 and 45 m), with probe depths of above 5, 10 and 15 m;

contaminated area is a bit difficult because of missing detailed geological data, GWL and especially the underground infrastructure, that is quite developed;

The registered values of ρp are shown per probe profiles divided in 3 intervals: ρp < 50 Ωm, ρp = 25 - 50 Ωm and ρp < 25 Ωm;

The horizontal distribution of ρp is shown in depth entrances AB / 2 = 15, 30 and 45m. At the depth entrance AB / 2 = 15m, are registered two zones of ρp < 25 Ωm - the area contaminated with Chromium [Hg]. At the depth entrance AB / 2 = 30m, the values zones of ρp < 25 Ωm separated from the previous level are confirmed, and is registered influence of the Pliocene sediments in the gravel's basis. At the depth entrance AB / 2 =

45m, the influence of the ground water is increased as well as the influence of the Pliocene sediments in the gravel's basis. The registered values zones of ρp < 25 Ωm from the previous levels, are not confirmed on this level because of the increased influence to the values of ρp from the Pliocene sediments in the gravel's basis;

As can be seen in Annex [11.7.3], the low resistivity zones between -5 to 20 ohmm are displayed in **blue** and could be potential contaminated zones, and are marked with **red** lines. Due to measurement geometry (trapezoidal) and the lacking depth of the investigations, further areas, which could be possible contamination zones are noted with question marks. No interpretation can be made, but there's a possibility for a spreading of these zones in the subsurface.

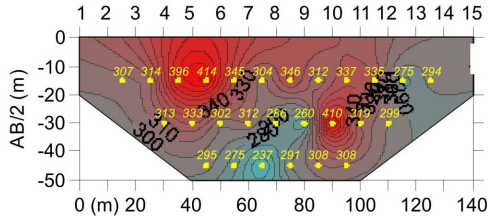
Annex [11.7.2] showing an interpretation of the data, which could be verified at the measurements, and four anomaly zones, were introduced. The **red lines** show the measured spreading of these zones, while the arrows indicate a possible migration, but can't be verified by measurements. The gap between the profiles, ranging from 30 to 60 m makes an interpolation not possible, since nothing is known of the sites facilities an and the sediment covering the plot, which is probably made of river-sediments, which is going by close to the site, and fits with an interpretation of mainly sand and gravel and there typical resistivity distribution which was obtained. The lower figure shows the verified low resistivity zones on the plot. Please mind the coherence of low resistivity data close to the Chromium dumpsite.

Both figures are geo-referenced according to the GPS measurements taken at the survey and illustrate the position of the survey lines and electrode locations[8].

Profile GE I:

The profile GE I is located on the north side from the waste dump, in order to define whether the groundwater and the pollution infiltrate in the river Gabrovnicka. In the plain of this profile are registered the highest values of ρ_p of the completely tested terrain from 237 ÷ 414 ohmm (average of 315 ohmm). They are reflection of the present lithological composition of the terrain, i.e. the terrace sediment deposits which are built of coarse grain material (gravels, sands, debris). The resistivity distribution is quite high, ranging from 200 to 500 ohmm, implicating coarse grained sediments (gravel), probably former riverbed sediments. We fully agree with the assignment to "terrace sediments" as written in the "Geing"-report. A small zone at running meter 110, about 8 to 10m in lateral extension down to approximately seven meters depth shows lower resistivity values (100 to 200 ohmm), which is probably due to deposition (sand lens). **No pollution could be found.**

Figure 20_Profile GE I

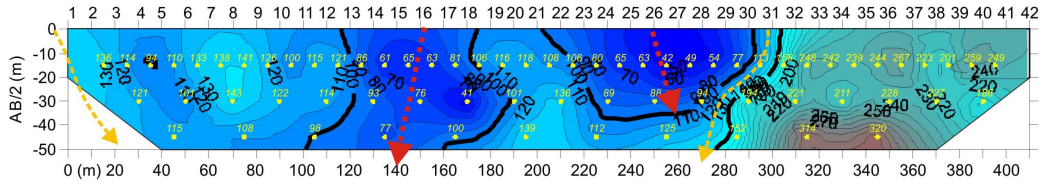


[8] All coordinates are in Gauss-Krueger (Potsdam Date)

Profile GE II:

The profile GE II is located on the east side from the waste dump, cross section of the moving direction of the ground waters and the pollution. In the plain of this profile are registered the lower values of ρ_p of the completely tested terrain from 41÷320 ohmm (average of 142 ohmm). The north part of the profile is characterized with higher values, where appear terrace sediments. The middle and the south parts of the profile are characterized with lower values of ρ_p, although the bores and the piezometers refer to the fact that on the terrain appear coarse-grained gravel silty dust materials, which origin from the movement of the ground waters and the pollution. Due to the groundwater flow direction from west to east especially the profiles GE II and III are the most important ones to define if there's already a migration of pollution and if the stratigraphy of the subsurface favours further spreading of any pollution infiltrating from the surface. Along Profile 2 three anomaly zones are introduced. Anomaly zone 2 ranges from running meter 0-50 and is close to piezometer PC-32/1, anomaly zone 3 from running meter 80 to 90 and anomaly zone 4 starts at running meter 100 up to running meter 310 with interruption from 180 up to 210m. The main pollution within anomaly zone 4 is at the location of the pumping station. On the whole it can be assumed that the whole profile from running meter 0 to 300 is probably a pollution-spreading zone.

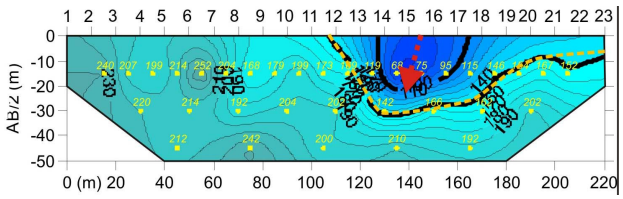
Figure 21_Profile GE II (410m)



Profile GE III:

The profile GE III is located on the south side from the waste dump, and passed beside a piezometer Pc-31/1, in order to define whether the groundwater and the pollution move in the same direction. At this profile are registered values of ρ_p in wide scope of 150 ÷ 252 ohmm (average of 178 ohmm). Here, higher values from 150 ÷ 252 ohmm prevail, which are characteristic for the present sandy-gravel layers, except in the east part of the profile, where are registered lower values. Profile GE III correlates well to Profile GE II. From running meter 0 to 120 no anomalies could be found and the subsurface consists of alluvial sediments. Starting with running meter 120 to 165 a low resistivity zone appears down to a depth of 7 to 9 meters. Resistivity values from 0 to 100ohmm could be considered as a pollution-spreading zone as in profile GE II The remaining part from running meter 170 until the end of the profile at running meter 220 shows slightly higher resistivity values but can be still considered as anomaly. The contaminated zone is close to the entrance and is caused due to contaminated surface waters running downhill along the access road.

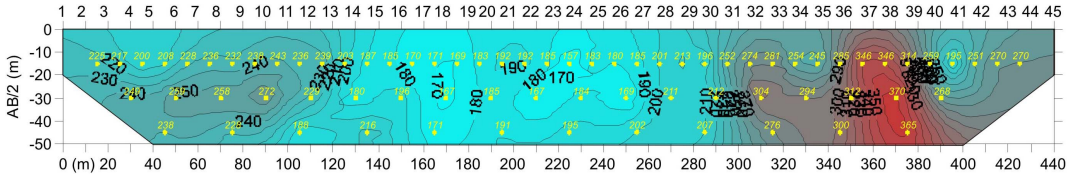
Figure 22_Profile GE III (220m)



Profile GE IV:

The profile GE IV is located on the west side from the waste dump, the railway road Skopje - Kicevo. At this profile are registered higher values of ρ_p from 157÷370 ohmm (average of 230 ohmm). The highest values are registered at the part of the profile between the points 31 and 40, where appear more coarse-grained fractions. In the plain of this profile are not registered any anomaly values as it was the case with the profile GE II, which would refer to pollution. Profile GE IV shows a "normal" resistivity distribution for alluvial sediments and contains no anomaly zone. According to the ground water flow directions from west to east it **can exclude that any pollution migrates to the west**. The higher resistivity values as they are found in the northern part of this profile as in profile GE I and profile GE II induces a change of sediment in the subsurface to more coarse grained particles.

Figure 23_Profile GE IV (440m)



7.2.1 Horizontal Contamination Dilution

The horizontal distribution of ρ_p is shown per depth entrances AB/2=15, 30 and 45 m. Having in mind the low level of the ground water, all three levels are revering to running areas.

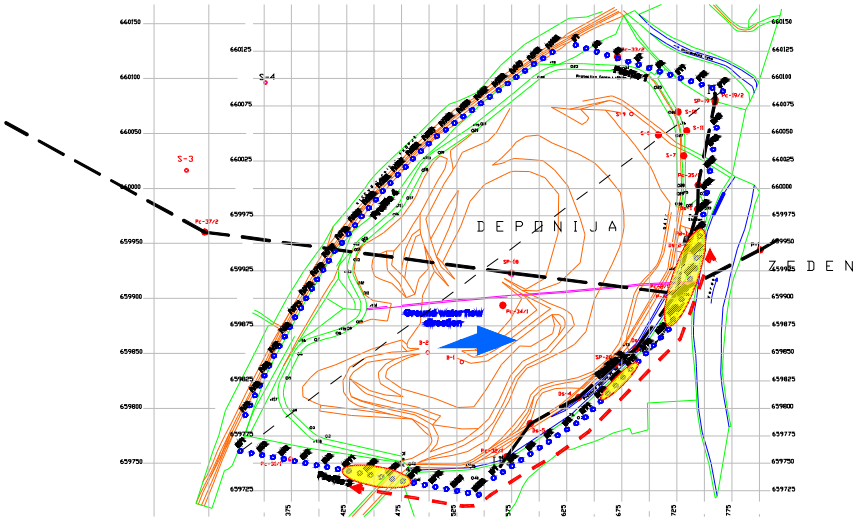
Analysing the results from the geoelectrical testing, which are shown through profiles and per levels of the contour resistivity maps, with correlation of the results from the hydrogeological investigation from 2001, the following can be stated;

On the north side from the waste dump towards the river Gabrovnicka, as well as on the east side near the railway road, there are no indications for contamination.

The same case is with the south side, except one part of the profile GE III, at the stretch from point II/12 (65 m east from the piezometer Pc-31/1) to the river Vardar. Pollution that is more intensive can be expected in the separated anomaly minimum of ρ_p between the points II/14 and II/17. However, this anomaly is with local character, because it is registered shallow on the depth level AB/2=15 m.

The most interesting is the east side of the waste dump, where are registered anomaly values of ρ_p, which refer to the moving direction of the groundwater and the pollution. That is confirmed with the results from the previous hydrogeological investigations, which define the piezometric contours and the moving direction of the groundwater. The pollution appears on wider area, from point II/1 (near the piezometer Pc-32/1) to II/31 (piezometer Pd-1). The most intensive flowing with faster filtration of the groundwater can be expected in the domain of two minimums of ρ_p, which are almost contoured with contour line of 100 ohmm. The first minimum is with centre at the points II/15-16 (piezometer Pd-1) and appears deeper (registered at all three levels), while the second is at the point II/15-16 (piezometer Ds-2 and DOB-1) is registered at the first two levels AB/2=15 and 30 m.

Figure 24_Pollution dilution from Chromium into eastern direction



7.3 Recommendations

The geoelectrical testing of the migration of polluting with high dense industrial waste at the location "Silmak" - Jegunovce, is realized in the frames of the Project for investigations of the most interesting four "Hotspots" in the Republic of Macedonia.

With geoelectrical testing is contoured the completely waste dump for compact technological waste, from which the soil and the groundwater are contaminated with Cr^{6+}.

The terrain at the location "Silmak" - Jegunovce is consisted of terrace, alluvial and Pliocene sediments, mainly coarse-grained gravels, sands and debris, and some of the clay-silty dust fraction.

The testing is performed with electrical resistant mapping of 3 depth entrances (AB / 2 = 15, 30 and 45 m), with probe depths of above 5, 10 and 15 m.

The registered values of ρ_p vary in interval from 40 ÷ 414 ohmm. The variations of the values for ρ_p are interpreted with the influence of the geoelectrical resistance of the present litho composition, ground water and migrated Cr^{6+} in the soil and the ground water.

With the geoelectrical testing and with correlation of the results from geological and hydrogeological investigations, it is stated that the north side of the waste dump towards the river Gabrovnicka, as well as on the east side near the railway road, **do not show indications for contamination of the investigated area. (Profile GE I and IV)**

On the east side, the pollution can be expected only at the part of the point II/12 towards the river Vardar. This anomaly is with local character, because it is registered shallowly on the depth level AB/2=15 m.

On the east side of the waste dump, potential pollution is registered on a wider area, from the piezometer Pc-32/1 to piezometer Pd-1. In the frames of this contaminated area are separated two minimums of ρ_p, which refer to the most intensive flowing with faster filtration of the ground water. The first minimum is around the piezometer Pd-1 and has deep dip direction, and the second with shallower dip direction is around the piezometer Ds-2.

- It is strongly recommended for the remaining two areas (surrounding Plant and direction of Jegunovce) to take measurements at 10 m electrode spacing in the direction of Jegunovce and 5 m electrode spacing around the plant, since the shallow subsurface contains the most contaminant zones, especially when dealing with mono chromates which is a quite immobile element in soils. Due to the electrode spacing of 10m and the used method the shallow subsurface in the range of 0 - 2,5 m couldn't be mapped during data processing.
- For chemical testing of the presence of the soil polluters and the ground water, are sufficient piezometers on the dumpsite area available. Additional drillings are not required.

Table 13_List of existing piezometer locations

Coding	Anomaly Zone	x-coordinates[9]	y-coordinates	Remarks
PC36/2	--	510124,7	660054,5	Existing – Western part
S3	--	510279,7	660016,5	Existing – western part
PC37/2	--	510296,0	659960,6	Existing – western part
SP18	--	539846,4	647032,7	Existing – on site
PC34/1	--	510575,0	659923,1	Existing – on site
B1	--	510529,7	659893,6	Existing – on site
B2	--	510498,9	659850,7	Existing – on site
PC31/1	A1	510374,0	659754,0	Existing – southern part
PC32/1	A2	510570,4	659755,9	Existing – southern part
DS5	--	510591,8	659786,0	Existing – south eastern part
DS4	--	510635,9	659810,0	Existing – eastern part
SP20	A4	510668,7	659839,6	Existing – eastern part
DS3	--	510688,0	659839,6	Existing – eastern part
PC2/1	A4	510722,7	659904,6	Existing – eastern part
P2	A4	510724,0	659904,2	Existing – eastern part
DS2	A4	510734,0	659944,6	Existing – eastern part
SP19	--	510759,6	660078,7	Existing – northern part
PC19/2	--	510759,9	650081,0	Existing – northern part
PC33/2	--	510671,0	660120,7	Existing – northern part

- The monitoring intervals shall be within the first year monthly, within the first year after remediation two-monthly, within the second year after remediation quarterly and shall included following parameter:
  - Heavy Metals
    - Cr_{tot}

[9] all coordinates are in Gauss-Krueger (Potsdam date)

- Organoleptic Parameters
  - Temperature
  - Conductivity
  - pH
  - Oxygen saturation

7.3.1 Seismic Characteristics and Risk Assessment of Tetovo Field

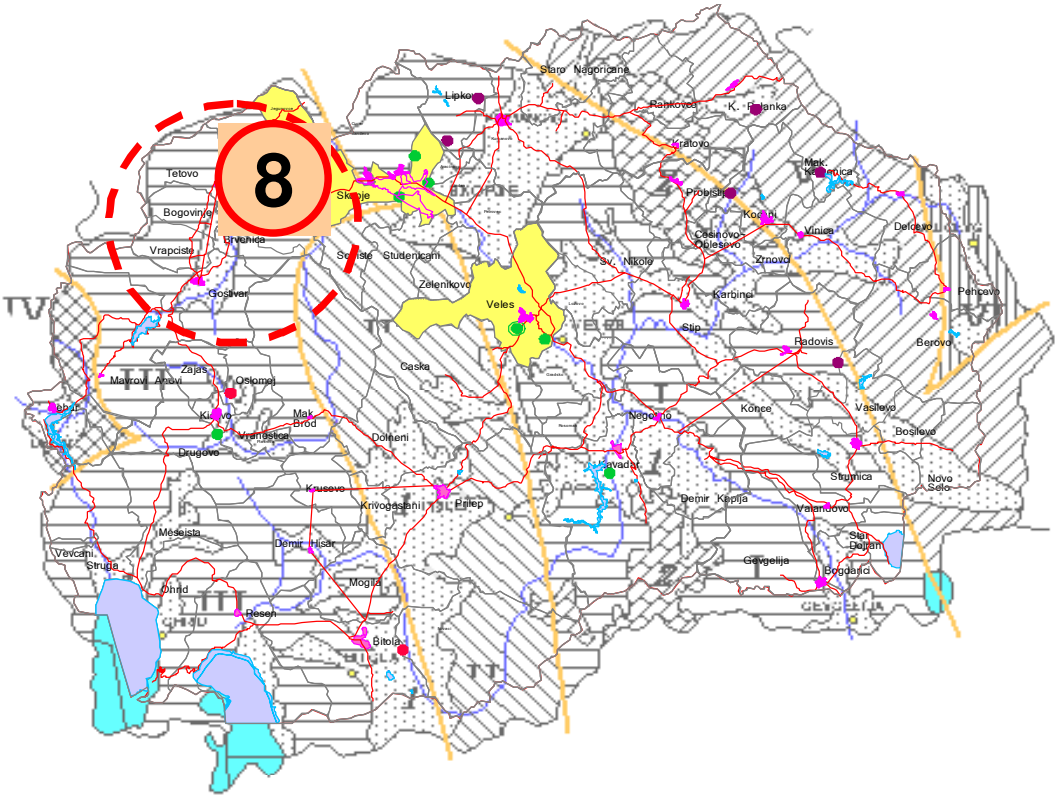
The wider area of the city of Tetovo is exposed to earthquakes originating from local, regional and remote seismic hot spots, having different impact on the terrain and the constructions.

The Tetovo epicenter area is located in a contact zone of opposite tectonic movements, more precisely, in the zone of crossing of the fault in the Vardar direction with the North-South one. Vertical and some left oriented horizontal movements dominate these faults.

A magnitude of 5,7[10] has been defined as the maximum expected magnitude. Other sources, however, indicate higher maximum expected magnitudes (5,1-6,5[11] and even 6,9[12]).

Earthquakes originated from remote (Romania, Greece, Bulgaria, Albania and Montenegro) and neighboring local seismic hot spots (Pehchevo-Kresna, Valandovo, Ohrid-Korcha, Debar-Pishkopeya etc.) also impact the seismic profile of this particular area.

7.3.2 Seismic Map



[10] Haxievski D., "Seizmi~nost na teritorijata na SR Makedonija", Seizmolo{ka opservatorija, Skopje, 1976

[11] UNDP/UNESCO Project "Survay of the seismicity of the Balkan Region", 1974

[12] Papazachos, B. i A. Papaioannou, "Seismogenetic Sources of Shallow Earthquakes in Greece and Surrounding Area", Thessaloniki, 1997.

7.3.3 Conclusion

According to the building code have all buildings to be constructed to resist an earthquake rank 8 on the Mercali Ranks. The seismic risk can be evaluated as moderate till high.

7.4 Site Stability, E-module and permitted loads

Investigation have shown, that a permitted load of 1,2 kg/cm² accures (equal to 12 N/cm²) which does not limit any proposed activities on site. The current load is average 23 m x 2,3 Mg/m³ = 52,9 Mg/sqm = 5,29 kg/sqm = 52,9 N/sqm. Therefore dumpsite stability is 4,4 times above the permitted level and has to be flattened or stabilized due to underground water leveling.

8 Environmental Impact Evaluation of existing contamination

8.1 Environmental Impact of Chromium dumpsite

SILMAK was found under the former name HEK Jugochrom in 1952 for the production of chromium compounds ($Na_2Cr2_2O_7$) and ferroalloys (ferrochromium, ferrosilicium). In1963 new products: CaC_2, $Ca(CN)_2$, lime and quicklime and in 1972 factory for concrete pre-fabricates and medical plastics were added to the original production.

In 1993 chromium processing facilities were closed down and new products were introduced (ferrosilicium and silicon).

Production of ferro-alloys continues for 50 years. Operation of bichromate unit (Cr^{6+}-compounds) stopped 30 years ago.

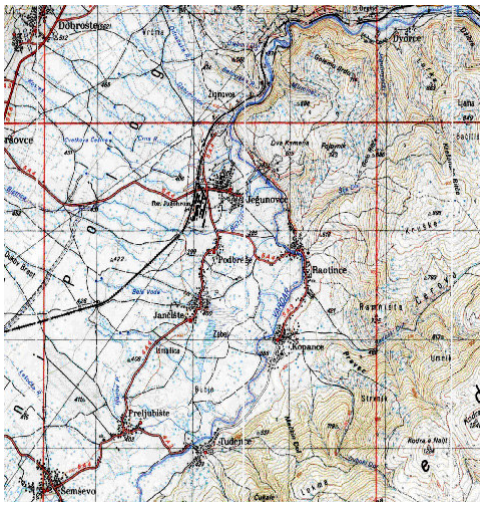
The location of the site (adjacent to the Vardar River and the spring Rasce) is a major concern because of the **presence of six - valent chromium**. Such a status is a potential threat to pollute the waters of the spring Rasce, which is the principal potable water supply source for the city of Skopje and the region.

There are two hotspots relevant for this EIA:

(1) old dumpsite in the factory and

(2) constructed dumpsite outside the plant.

Distance to the nearest farm land from the factory is 100 m and to the village Jegunovce is about 500 m (Distance to Tetovo is ~17 km).Distance from the landfill to the land farm is also only 100 m and at least one kilometer to the nearest village. Both, location of the factory and of the dumpsite are practically in the contact with the potable and surface waters.



The Muzgi spring flows through the central part of the industrial landfill site. A concrete pipeline, 1200 mm, was installed on the surface of the ground, latter extended on both sides with 1000 mm pipes, in order to achieve free passage of the Muzgi stream waters without getting into contact with the landfill material, ferro-chromium slag and dichromium mud of different properties. Analysis of the water proved that the groundwater under the landfill is not significant carrier of chromium pollution, while a more serious chromium polluter of Vardar River is the Muzgi stream, in the part that flows through the landfill.

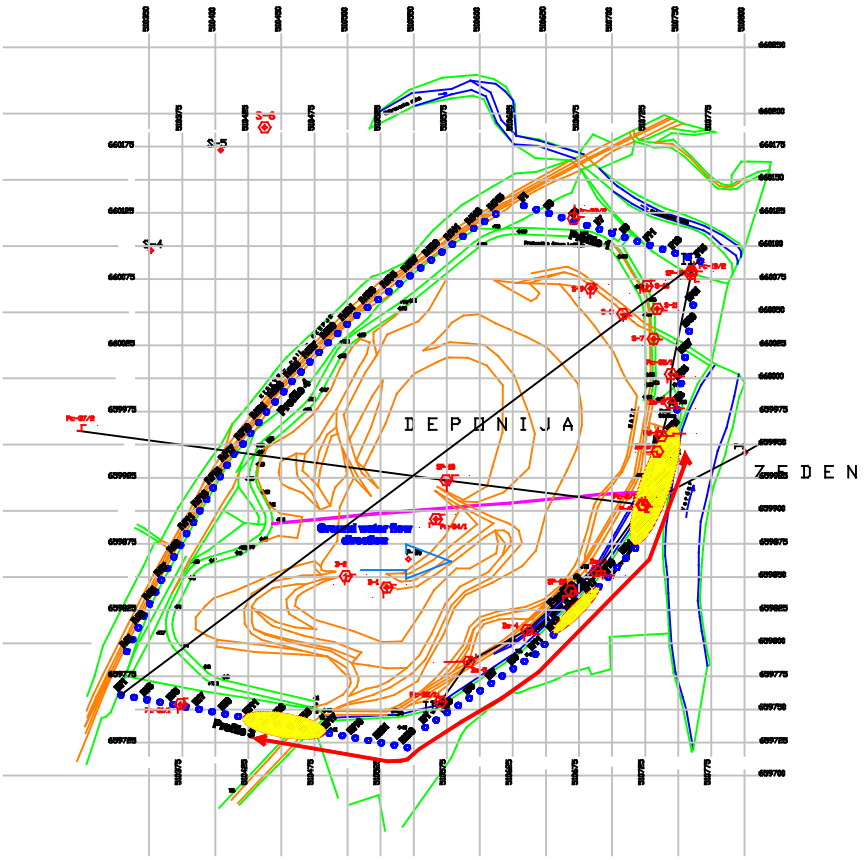
In 1982, the plant began monitoring soil and groundwater. Data confirmed that surface water and the upper secondary aquifer on the plant location had been contaminated by chromium. This contamination is caused by improper handling of material containing chromium salts.

In the first years of production sludge was dumped, uncontrolled in the plant area. Remediation started in earlier 90's. The contamination is still present.

8.1.1 Current situation

SILMAK which started as a new owner working in the end of 2002 and until 2005 had no proper waste dump for the industrial waste. In this period there was temporary landfill in the factory surrounding. The previous owner had his own landfill for industrial waste at a distance of 1,5 km north-east from the facility. The location for the landfill has not been used completely. Because of that deposition could be carried out in longer period of time. The purpose of this landfill would be only for inert industrial waste. Pollution coming from the factory is evident, polluter of the Jgunovce – village water wells and the constructed dumpsite is potential polluter of the aquifer that feeds Skopje with potable water (Rasce Spring).

Figure 25_Pollution dilution profile of the Chromium dumpsite



2.2.1. Problems identified

In the next Table main qualitative characteristics and impacts of treated hotspots are given. Under present condition the impact on environment will remain for decades, all soluble quantities of chromium will end in the environment, risk for water-supply system will strengthen and the potential risk for human health will remain too.

Table 14_Qualitative characteristics and impacts of treated hotspots

LOCATION	MEDIA	CONTAMINANT and QUANTITY	IMPACT and RISK	DURATION and DIMENSION
Dumpsite, Pile of mixed slug and sludge Surface of dumpsite: 80.000 m2 Partially covered with soil	**Slag: heavy metals** 1.732 Mg (Fe, Mg, Al, Cr) **Sludge:** 296.260 Mg (7.388 Mg **Cr^{6+}**) **Total:** **2.029.000 Mg**	**Impact:** On surface water of Vardar River and ground water **Risks:** pollution of water-supply system of Skopje – **HIGH** **Impact: LOW** **RISK**: dump stability – pollution of Vardar River - **LOW**	Decades and centuries: Trans-boundary water **pollution** and local water pollution Long term jeopardizing of water supply system and request for additional costs (additional water treatment) As accident: dump instability caused e.g. by seismic impact	**Dumpsite**, Pile of mixed slug and sludge Surface of dumpsite: > 80.000 m2 Partially covered with soil Long term
Contaminated soil and **ground water** inside the factory	**Chromium 6+** unknown quantities Surface of contaminated land: unknown	**Impact:** On surface water of Bistrica River and groundwater in the village **Risk:** No potential risk - **LOW**	Decades **Trans-boundary water pollution** Local water pollution	

8.2 Impact of Chromium and other heavy metals on soil

As was mentioned before, on the beginning of the operation the waste material was uncontrolled dumped inside the factory. This is now one of the problems.

But the soil is also contaminated from the air pollution particularly by dust. For example in the soil samples 500 m from the factory following pollution with heavy metals were found[13]:

Table 15_Soil samples 500 m from the factory – impact of airpollution on soil quality

Parameter	Unit	MPC[14]	Obtained value	Method
Lead, Pb	mg/kg	85	86	ISO 11885/1996
Zinc, Zn	mg/kg	140	543	ISO 11885/1996
Copper, Cu	mg/kg	36	344	ISO 11885/1996
Manganese, Mn	mg/kg	-	1242	ISO 11885/1996
Nickel, Ni	mg/kg	-	109	ISO 11885/1996
Chromium, Cr	**mg/kg**	**-**	**129**	**ISO 11885/1996**

Pollution dispersion is indicated due to geotechnical investigation as demonstrated in Figure 25_Pollution dilution profile. UNEP took samples from the sediments before and after the plant's wastewater pipe.

Table 16_Soil sample after the waster water effluent pipe

Parameter	Unit	MPC	Obtained value	Method
Lead, Pb	mg/kg	85	122	ISO 11885/1996
Zinc, Zn	mg/kg	140	1290	ISO 11885/1996
Copper, Cu	mg/kg	36	177	ISO 11885/1996
Manganese, Mn	mg/kg	-	1242	ISO 11885/1996
Nickel, Ni	mg/kg	-	265	ISO 11885/1996
Chromium, Cr	**mg/kg**	**-**	**88**	**ISO 11885/1996**

In the southern part, west of have been slightly surface pollution during the geoelectrical investigations been identified, which is definitely caused due to surface waters, contacting not covered Chromium components and streaming along the accessroad onto the western part. Primary measurement has to be the fully cover of all open surfaces to avoid contact of rainwater with Chromium sludge.

The impact of former and existing production activities and existing Chromium dump site on soil could be from the environmental view of point treated as moderate to high or related to the long period of accumulation of the impact as HIGH. **Because of the fact that the Jegunovce village are using drinking water from the public water supply system risk on health could be estimated as LOW.**

[13] Source: Cards 2001

[14] According Dutch Standard

8.3 Impact on Ground Water

Monitoring data confirm significant pollution of the ground water, caused particularly by uncontrolled disposal of production waste inside the factory, but partly also by dust. Following data are available:

- Analysis of the groundwater on the factory site give the concentration up to 200 mg/l in early 90's. Present concentrations are of few mg/l up to 10 (12) mg/l.
- Analysis of the groundwater in the village give the concentration up to 20 mg/l in early 90's. Present concentrations are of 2-3 mg/l. Concentration of total chromium in drinking water is 0,05 mg/l.
- Analyse conducted in June 2007 in Jegunovce, by the institute of public health [see Annex 11.4.1] show a value < 0,001.
- Analysis of ground water performed by Jaroslav Cerni Institute from Belgrade in 2000 show:
    - Outlet drain 4,4 mg/l Cr
    - Remediation wells (3) - 2,5 to 12,76 mg/l Cr
    - Monitoring wells (9) - 0,01- 206 mg/l Cr
- UNEP took samples after the plant's wastewater pipe.

Table 17_Water samples in comparison with groundwater limits

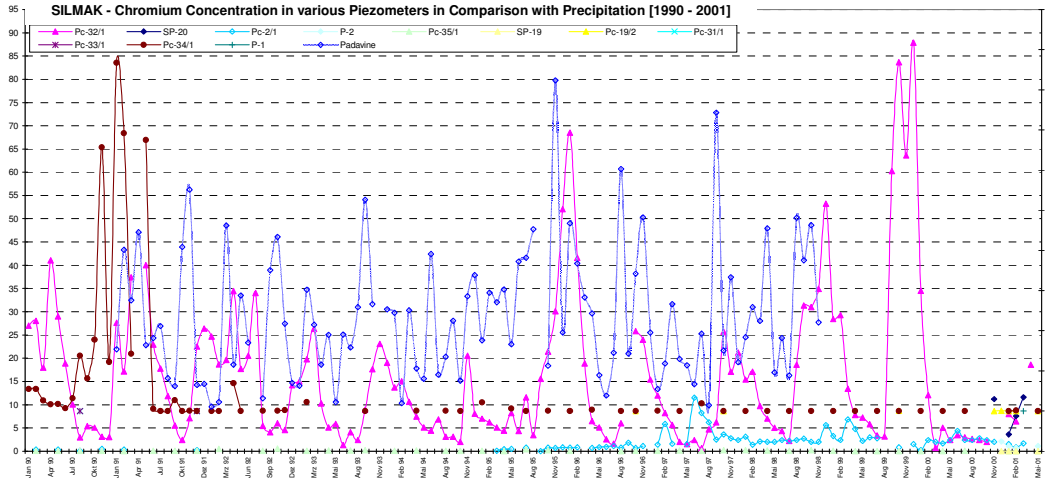
Parameter	Unit	MPC	Obtained value	Method
Zinc, Zn	mg/l	100	0,089	ISO 11885/1996
Copper, Cu	mg/l	10	0,040	ISO 11885/1996
Manganese, Mn	mg/l	--	0,025	ISO 11885/1996

Despite of remediation measures dumpsite has still evident impact on the environment. Pollution was newly indicated due to geotechnical investigation in chapter 7.1.7.

8.3.1 Correlation between precipitation and groundwater pollution

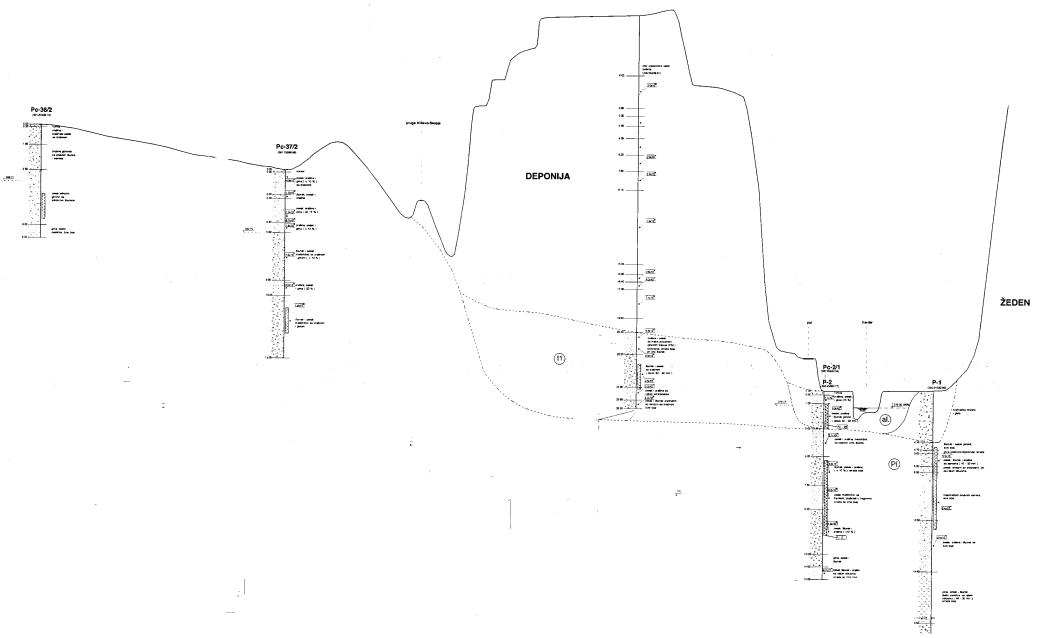
Investigations conducted by the institute Cerni and the department of EMAK listed the Chromium condamination in various piecometers for a period of several years (1990 – 2001). Those results allow assumption of infiltration rates, groundwater flow and contamination locations. It can be seen that according the groundwater flow, the piecometer 32/1 in the southern part of the drainage shows the highest concentration, followed by the piecometer 2/1. Due to the groundwater stream towards east direction and the location of piecometer 32/1 in southern direction can be assumed, that an infiltration stream from the site into south-east direction is existing. Another theory is, that the pollution is caused by surface waters, contacting not covered Chromium components during the flow along the stree into the direction of the entrance and further into eastern direction.

Figure 26_correlation between precipitation and Chromium concentration in groundwater along the boundary of the dumpsite



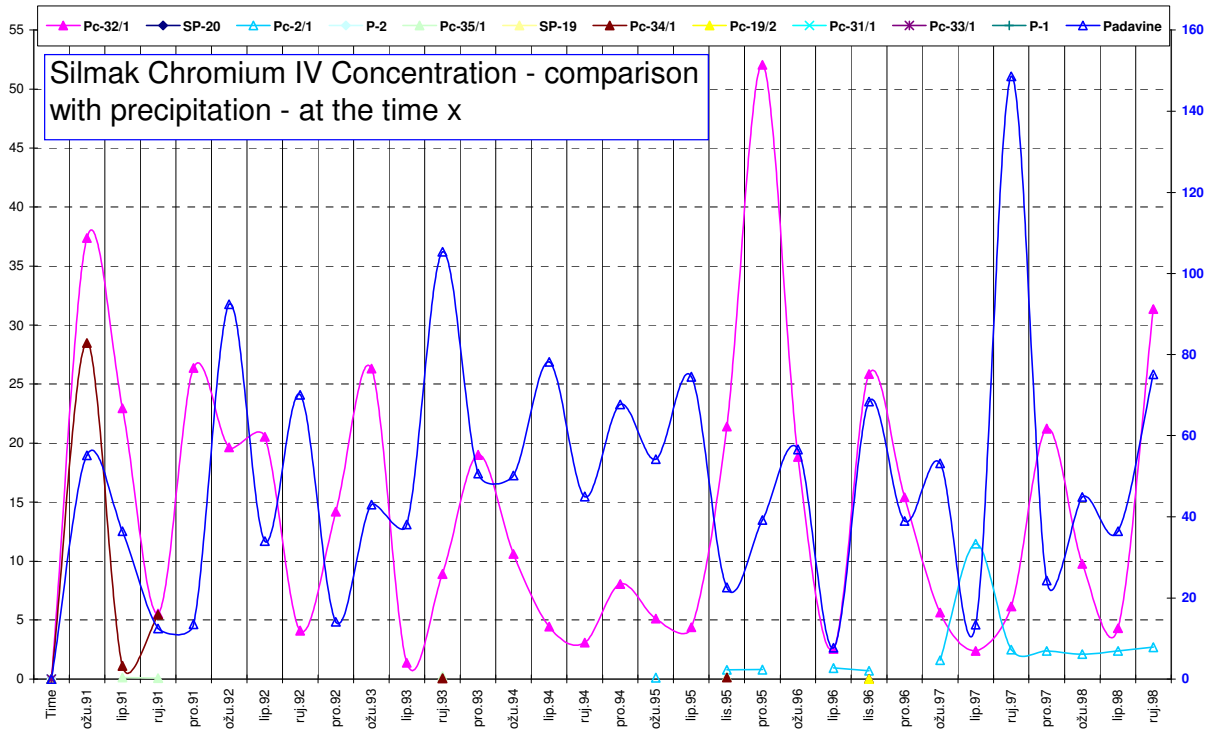
More appropriate is the assumption of the infiltration stream within the dumpsite body due to the fact, that the concentration increases after a periode of 2 to 3 months after precipitation, which shows the chart below. It could be identified, that depending from the density of the dumpsite and the height a period of almost 3 months as infiltration period is necessary till the infiltrated water reaches the groundwater layer. In addition is the groundwater level decreased after three months, so that an accumulation of the concentration occurs.

Figure 27_density of the dumpsite layers according to Cerni core drill study



Taken a permeability of 3 x 10^{-6} and a dumpsite height of 27m in average into consideration has water a retention time of 104 days in the dumpsite body. (27m / 3x10^{-6} / 3600sec*hour^{-1} / 24hour*day^{-1} = 104 days ~ 3 months)

Figure 28_Correlation of precipitation with Chromium concentration at the time x in a three months interval



Most of the water is captured due to drainages and pumped to the waste water treatment plant within the facility, while Chromium is reduced from six valent to three-valent before being released into the Bistrica river.

8.3.2 Changes of Chromium concentration and removal

Table 18_Changes of Chromium concentration during time x

Location	Concentration of Cr^{+6} on the beginning of measure – 1991	Concentration of Cr^{+6} present	Comment
Factory – potable water	80 – 100	4 – 5	
Village – water form the wells	20	2 – 3	Catch hold (water barrier) isn't in operation for last year
Landfill – leaching water	100 – 300	No reduction	

Improvement of the decreasing of chromium concentration in the potable water doesn't means that the problem will be solved in relatively acceptable time by using this remediation technology. Namely, the quantity of treated (removed) chromium is compared with the exact quantities very low, practically neglect, as this is shown in the following Table. But it should be emphasized that the reduction of the pollution form the factory site isn't result of the remediation measures but the results of the natural process

of washing out of the soluble chromium salts by ground water. The remediation contributed to the reduction of the Cr^{+6} in the ground water in the village[15] and decreasing of the Cr^{+6} quantities (not total chromium) dispersed in the environment.

Table 19_Treatment and removal capacity[16]

	Input	From drainage	Before treatment		After treatment		Eliminated		Volume
Months	**m3**	**m3**	**Cr/mg/l**	**pH**	**Cr**	**PC**	**kg**	**Cr in/g**	**Share**
January	10.340,00	605,00	12,58		0,09		129,15	130.077,2	5,85%
February	9.450,00	0,00	11,42		0,03		107,64	107.919	0,00%
March	10.340,00	2.166,00	29,89		0,03		308,75	309.062,6	20,95%
April	8.950,00	2.958,00	47,13		0,01		421,72	421.813,5	33,05%
May	8.130,00	1.670,00	54,31		0,01		441,46	441.540,3	20,54%
June	7.600,00	2.160,00	75,18		0,02		571,22	571.368	28,42%
July	4.500,00	2.428,00	107,52		0,00		483,84	483.840	53,96%
August	4.600,00	2.613,00	94,54		0,00		434,88	434.884	56,80%
September	8.900,00	1.347,00	45,29		0,05		402,64	403.081	15,13%
October	9.050,00	3.084,00	74,69		0,02		675,76	675.944,5	34,08%
November	9.000,00	2.200,00	69,12		0,01		621,99	622.080	24,44%
December	9.150,00	1.299,00	70,10		0,01		641,42	641.415	14,20%
	100.010,00	**22.530,00**					**5240,46**	**5.243.025,10**	
							436,71	**52,42**	

Yearly pumping capacity is 100.000 m³ (year 2006), the total Chromium elimination (reduction) is 5.240 kg per ano. The part of the landfill contribution is less than 4 Mg per year, which would require a timeperiod of more than 1.800 years in order to complete the elimination of the Chromium remaining in the dumpsite at current contamination and treatment situation.

Table 20_Comparison of existing and treated Chromium

Quantity of Cr^{+6} on the landfill in Mg	Quantity of Cr^{+6} in the soil and factory	Cr^{+6} removed on WWTP in Mg	% removed	Time needed to remove complete Cr^{+6} in years
7.388	**1.280**	**5,24**	**≤ 1%**	**~ 1800**

As showed the impact of this hotspot will remain very long. Even under the worst case preposition that only 10% of contaminated flow is under control and that other 90% is just disappeared in the environment with out cleaning, impact will remain for centuries.

Geomorphology and hydrologic conditions of the dumpsite are quite unfavorable, so that the access of water to the dumpsite is relatively easy. Most relevant information about this is the pending level of the monthly pumped drainage water from the landfill. Based on

[15] Additionally with the possible natural washing out process with ground water which isn't controlled by introduced barrier.

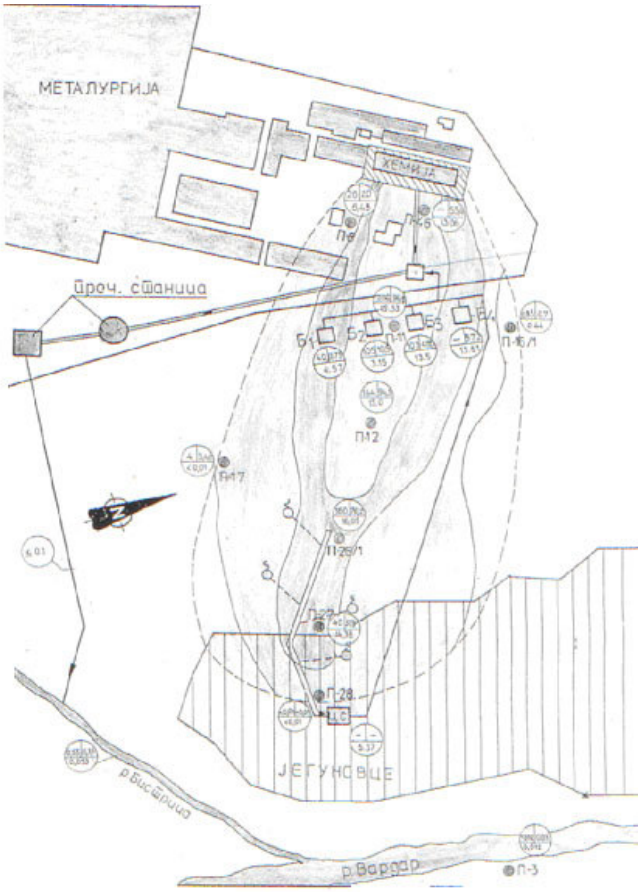
[16] Source: Silmak Annual Report

the existing data, under the preposition that total drainage water were pumped to the WWTP, minimum quantities are about few hundred cubic meters (290 m3/month in August 2005 and 504 in March 2004) and maximum of about few thousands (5004 m3/moth in April 2005 and 5116 in Marc 2007). This is valid argument that connection between the rainfall and drainage water quantities, as well between the participation and concentration of Chromium in the pumped water probably exist.

Because of the fact that the Jegunovce village are using drinking water from the public water supply system risk on health could be estimated as LOW.

The risk on the environment is still open, particularly to the public water supply system of Skopje, so that risk could be estimated at least as MODERATE.

Figure 29_Pollution simulation around the production facility



8.4 Surface Water Impacts

In 1982, the plant began monitoring soil and groundwater. Data confirmed that surface water and the upper secondary aquifer on the plant location had been contaminated by chromium. Because of the hydrological conditions the ground water in the village Jegunovce was contaminated too. This contamination is caused by improper handling of material containing chromium salts because in the first years of production sludge was dumped, uncontrolled in the plant area. The leaching water from the dumpsite was evident too. Obviously it was technically (or maybe economically) to difficulty to remove the source of the pollution (as well from the factory as from the dumpsite), so that decision was undertaken to treat of contaminated ground water from the upper secondary aquifer from the plant location and the leaching water from the landfill. Based on the investigations, water pumping barrier to prohibit the polluted potable water flow to the village direction was constructed (pumping of potable water to the WWTP by 4 wells). To clean up the potable water from the village the pumping of polluted water from the village was organized too. The leaching waters from the landfill were collected by drainage pipes and pumped directly to WWTP. A concrete pipe was installed to allow a small creek (Muzga Spring) to run under the dump site (3-5 l/s)[17]. This pipe was broken allowing the creek water to absorb Cr^{6+} contamination. In 2003 this pipe was repaired.

Mentioned program for site ground water remediation by pump and treatment technology, started in 1990. The ground water from Jegunovce area, plant ground water and dumpsite ground water are pumped to WWTP and treated with Sodium hydrosulphite (NaHSO3) to reduce Cr6+ to Cr3+. The WWTP is running very efficiently. The inlet concentration of about 50 mg/l of Cr6+ is reduced to **0,01 mg/l of Cr6+ what is in compliance with national and international standards**. By this process chromium is not being removed completely from the water, but rather converted from hexavalent chromium – Cr (VI), to trivalent chromium – Cr (III). The treated water is then discharged into the Bistrica River, which drains to the Vardar. Bearing in mind, that not all Chromium is captured by the drainage system, especiall the Vardar river, close to the leakaging dumpsite is still impacted above the permitted surface water levels for Chromium (10µg/l). The exact amount of impacting (polluting) Chromium is hardly to define, but can be estimated with 50% of the pollution potential. Through this fact SILMAK hotspots belong to the pollution sources with trans-boundary impact.

Based on this data it can be assumed, that before the operation of the treatment plant has been a high concentration of Chromium VI, leacking from the site been emitted into the Vardar River. Current is surfacewater moderated impacted. The risk of a pollution is high, while due to the exemplary treatment by Silmak the impact can be stated currently is LOW to MODERATE.

8.5 Impact on air

Winddirection are towards north, while the residential areas are located in the south of the dumpsite. Due to the fact, that neither in the facility, nor on the landfill are Chromium components in a hughe amount uncovered, the impact due to windtransmission can be estimated as low.

Due to the fact, that neither in the facility, nor on the landfill are Chromium components in a hughe amount uncovered, the impact due to windtransmission can be estimated as LOW.

[17] This pipe was broken allowing the creek water to absorb Cr^{6+} contamination. In 2003 this pipe was repaired.

8.6 Health Impacts

See chapter Qualitative Health Impact Assessment, heading number 6.1, page number 54.

In the Silmak case is the impact on health is definitely lower because due to the fact, tat the government acted in an early stage and prevented a direct impact on human health and transmission due to secondary migration paths.

Health impact of Chromium is widely described in the Volume 00_A - Qualitative Health Impact Assessment.

8.7 Hazardous risk assessment

Hazardous risk assessment of pure substances (Chromium VI) is estimated as very high, as it is given in tables in the appendix for Chromium. Fortunately, in the particular case, because of the concentrated pumping and treatment activities and that the substance is not directly or indirectly impacting human health the risk for the environment and health is under control and could be estimated as MODERATE.

9 REMEDIATION TECHNIQUE

9.1 Specification of source of site contamination

In Jegunovce are 3 types of environmentally completely different remediation problems, that means:

- **Dumpsites with Chromium VI** – 882.175 m³ total disposal material, which is equal to 2.029.000 Mg, while 296.260 Mg are consits of Chromium sludge with an Chromium amount of 7.388 Mg of Chromium VI. A remediation under current activities would need a life span of more than 1.800 years. The Chromium contaminated groundwater on the eastern part of the site is captured by a drainag system and pumped to the waste water treatment plant, located within the production facility of Silmak. The load of Chromium out of this waste water stream is up to 100 mg/l. Cr VI is reduced to Cr III. A The costs for the treatment are covered by the MoEPP.
- **Surrounding area of the production facility** – the load of Chromium could be reduced from 50 to 12 mg/l within the groundwater. This Chromium compounds have been spilled into the soil and flushed during the years into the groundwater due to inpropper handling of Bichromates during the former operation and storage. The goal is it to achieve a limit of smaller 1mg/l,which will take several years.
- **Groundwater stream onto the direction of Jegunovce village** – similar facts than described above are faced on soil and in the groundwater onto the direction of the populated area of Jegunovce. A project has been designed to capture groundwater, which is chromium contaminated. In addition have the water supply be changed to an central one, which shall guarantee a high drinking water quality. Recent investigations conducted by the national insitute of public health indicated a level of Chromium in the village Jegunovce below the permitted level.

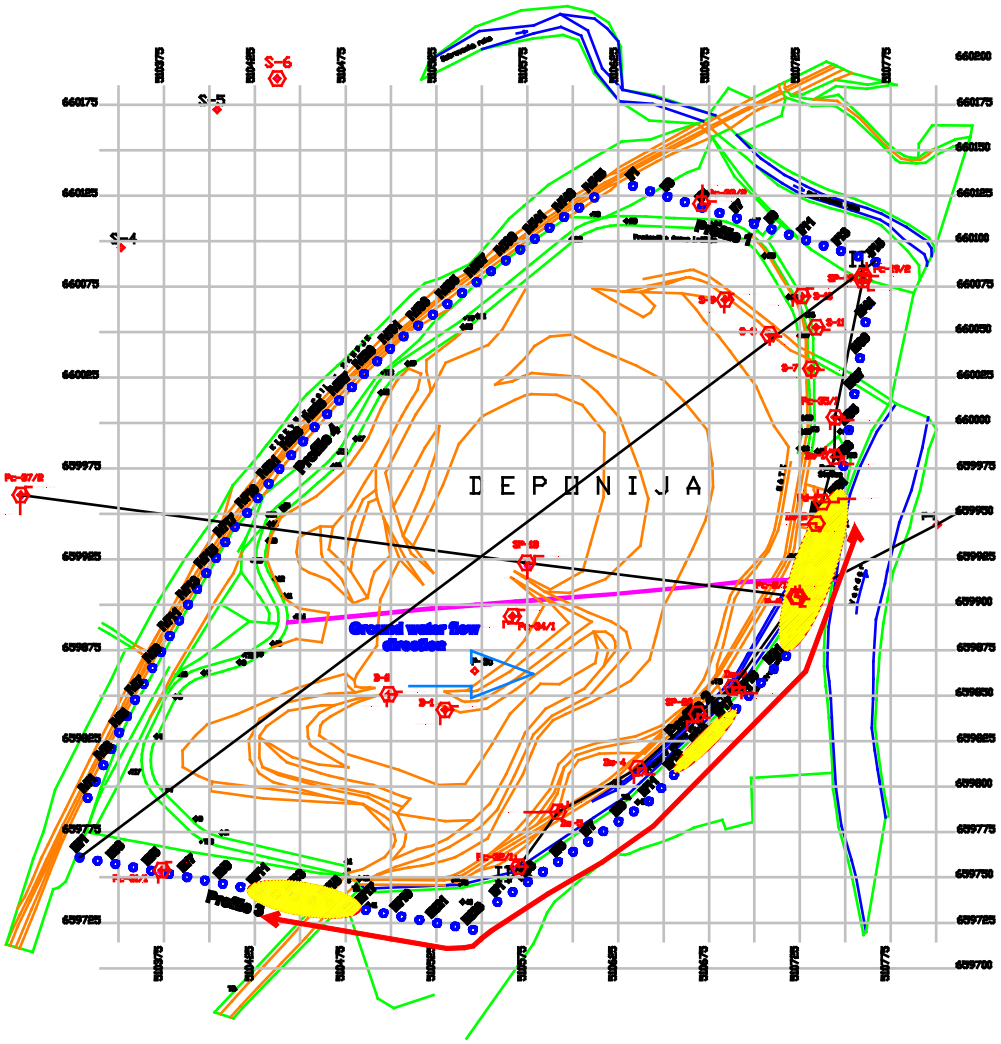
All those activities have been based on studies of the institute Cerni and investigations conducted by UNEP and several Cards programs. The locations of the capture drainage system are chosen right. The measures have shown proper result and can be stated as successful.

Taken the long life time of required treatment into consideration, can those measures been seen as emergency activities and shall be transformed into development measures with a reasonable treatment and remediation time span.

The mainpullution is caused by the dumpsite, while the project will focuse on this facility and will below address methods for remediation.

The pollution dispersion is indicated due to geotechnical investigation – see next figure. Composition of the waste is known due to an assessment of the former process, material and waste stream.

Figure 30_Dilution of Pollution in soil and groundwater - Chromium

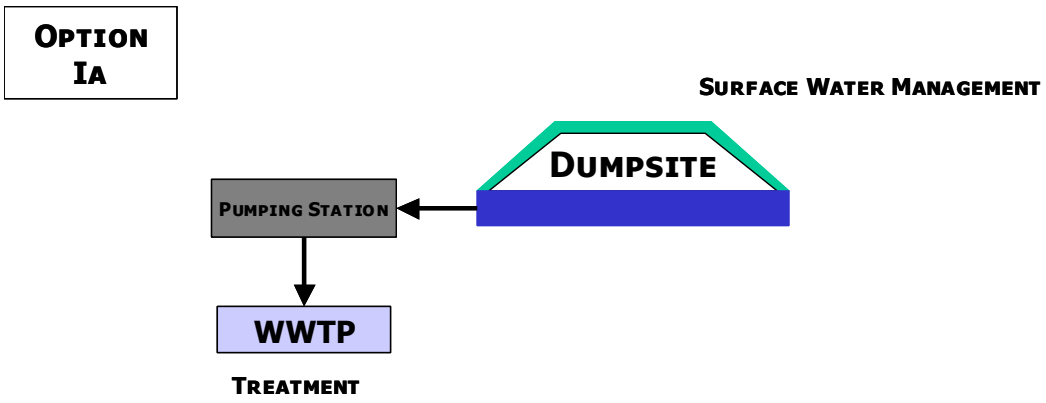


9.2 Selected alternatives for Chromium dumpsite remediation

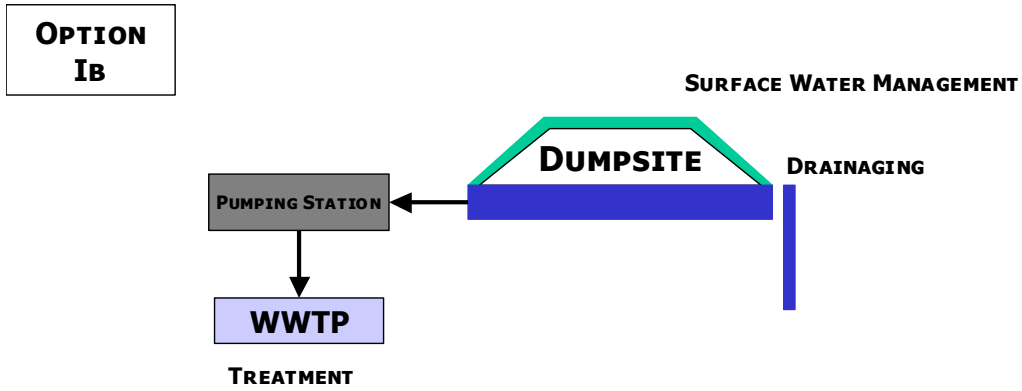
Independent from the selected remediation technique on the long-term time permitted levels in soil and groundwater, according the existing standards (given in Annex) have to be reached.

From the environmental view of point, for the remediation of HCH dumpsites there are following possibilities:

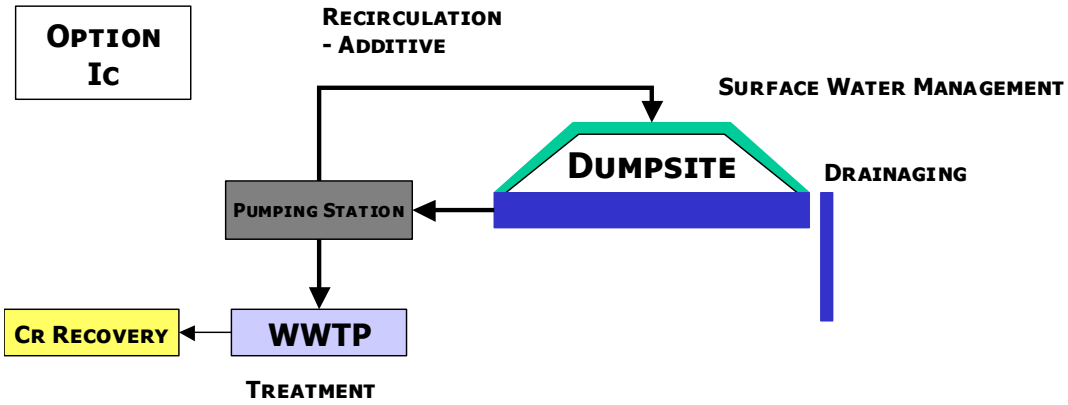
- **No activities** [0]– no activities will undertake. Impact on environment will remain but with slow decreasing trend. The problem will remain for decades and the location will remain a hot spot (for ever). No other use of the location will be possible. Perception of population in Skopje and in closer neighborhood will remain negative due to a potential impact on the Rasce spring.
- **In situ [1]– phytoremediation** with weed is the most appropriate method expecially for tanneries, with surface contamination. Due to the fact, that the dumpsite has an average height of 23 m, the roots of the reed will only reach a depth of maximum 1 meter. Weed can be used as additional measure in case of capping and recultivation to ensure a reduction of the fist layers and to avoid a surface contamination due to secondary migration paths.
- **In Situ [Ia]** – Sacrophage – Surface Water Management in combination with treatment of groundwater on the WWTP and groundwatermanagement. The investment is limited by covering the whole site with clay (2x25cm) and with 0,5m topsoil layer. The polluted groundwater will be treated on the existing facility till a international accepted level has been achieved. A 10 years treatment period is required.



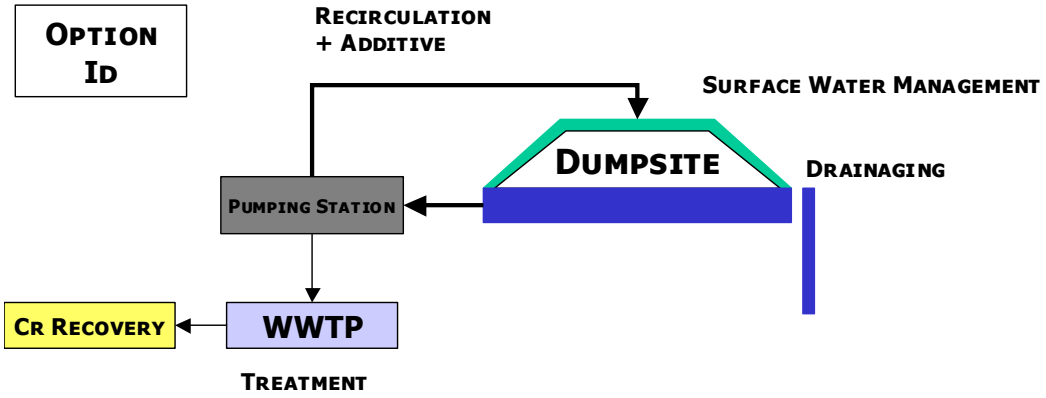
- **In Situ [Ib]**– Sacrophage – Surface Water Management in combination with treatment of groundwater on the WWTP and groundwatermanagement. The investment is limited by covering the whole site with clay (2x25cm) and with 0,5m topsoil layer. On the western part of the area has a drainage to be installed in order to avoid groundwater contact to the bottomlayer of the dumpsite. The drainage has to be 554m long, minimum 10 meter deep (381 maSl) and consisting of 4 drainage liners. The groundwater can be treated on the existing WWTP plant until international permitted levels have been achieved. The commercialization of extracted Chromium is not prior due to the low efficiency. A 5 years treatment period is required.



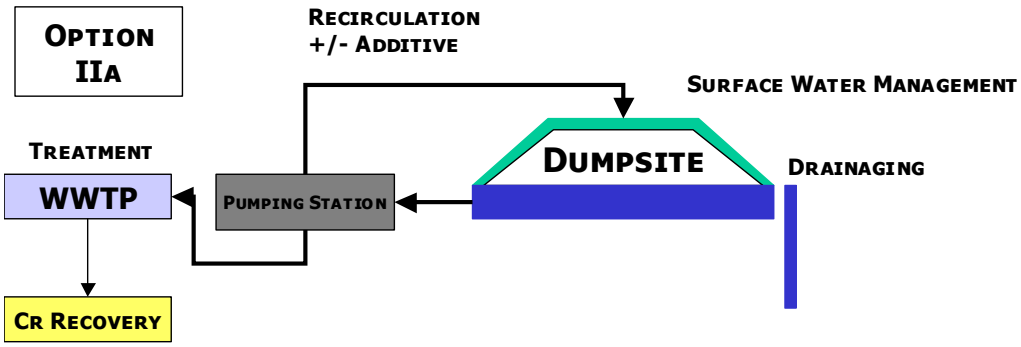
- **In Situ [IC]**– Surface Water Management in combination with treatment of groundwater on the WWTP and groundwatermanagement. The investment is limited by covering the whole site with clay (2x25cm) and with 0,5m topsoil layer. On the western part of the area has a drainage to be installed in order to avoid groundwater contact to the bottomlayer of the dumpsite. The drainage has to be 554m long, minimum 10 meter deep (381 maSl) and consisting of 4 drainage liners. Groundwater will be recirculated in order to achieve faster dilution potential under controlled conditions. The reinfiltration unit is installed under the capping layer. Remaining pollution will be pumped to the WWTP until international permitted levels have been achieved. Additives (agents) are not in use. The commercialization of extracted Chromium is not prior due to the low efficiency. A 10 years treatment period is required.
-



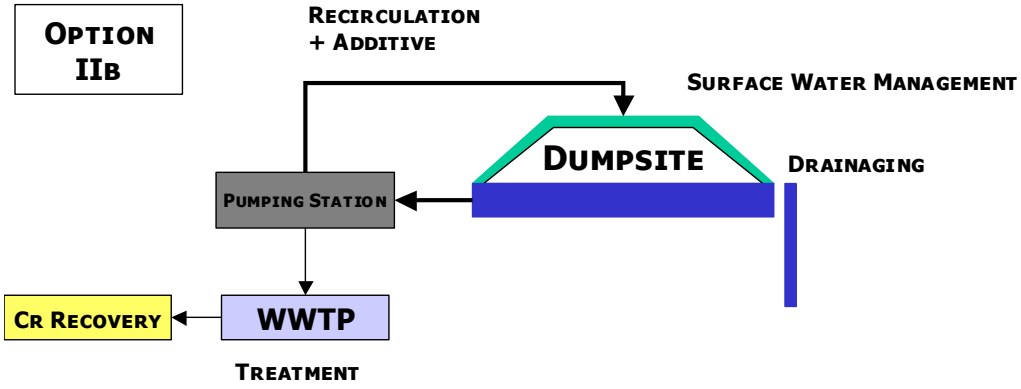
- **In Situ [Id]**– Surface Water Management in combination with treatment of groundwater on the WWTP and groundwatermanagement. The investment is limited by covering the whole site with clay (2x25cm) and with 0,5m topsoil layer. On the western part of the area has a drainage to be installed in order to avoid groundwater contact to the bottomlayer of the dumpsite. The drainage has to be 554m long, minimum 10 meter deep (381 maSl) and consisting of 4 drainage liners. Groundwater will be recirculated in order to achieve faster dilution potential under controlled conditions. The reinfiltration unit is installed under the capping layer. Remaining pollution will be pumped to the WWTP until international permitted levels have been achieved. Additives (agents) are in use to achieve a faster imobilisation of Chromium due to the reduction from CrVI to Cr III on site within the dumpsite body. The commercialization of extracted Chromium (3,67 Mg/year) is not prior due to the low efficiency. A 5 years treatment period is required.



- **In Situ [IIa]**– Surface Water Management in combination with treatment of groundwater on and Chromium extraction plant (WWTP) and groundwatermanagement. The investment requires a mobile process plant and covering of the whole site with clay (2x25cm) and with 0,5m topsoil layer. On the western part of the area has a drainage to be installed in order to avoid groundwater contact to the bottomlayer of the dumpsite. The drainage has to be 554m long, minimum 10 meter deep (381 maSl) and consisting of 4 drainage liners. Groundwater will be recirculated in order to achieve faster dilution potential under controlled conditions and an enrichment of Chromium in the groundwater which will be immediately on site treated. The reinfiltration unit is installed under the capping layer. Remaining pollution will be pumped to the WWTP until international permitted levels have been achieved. Additives (agents) are not in use. The commercialization of extracted Chromium is taken into consideration and can achieve under this circumstances an output of 50 Mg/year. A 7 years treatment period is required.



- **In Situ [IIb]**– Surface Water Management in combination with treatment of groundwater on the existing WWTP plant and groundwatermanagement. The investment requires a mobile process plant and covering of the whole site with clay (2x25cm) and with 0,5m topsoil layer. On the western part of the area has a drainage to be installed in order to avoid groundwater contact to the bottomlayer of the dumpsite. The drainage has to be 554m long, minimum 10 meter deep (381 maSl) and consisting of 4 drainage liners. Groundwater will be recirculated in order to achieve faster contact with the additives (agents) under controlled conditions and to immobilize the Chromium in the dumpsite due to the reduction of CrVI into CrIII. Remaining pollution will be pumped to the WWTP until international permitted levels have been achieved. The commercialization of extracted Chromium is not taken into consideration . A 5 years treatment period is required.



- **On site - Flushing [IIIa]** – by using the mobility and solubility of Cr VI, excavation and and onsite treatment through soil flushing (washing) is introduced. The activities are mainly on site and decontaminated material will be disposed back onto the existing dumpsite. Equipment for exacavation and soilflusing has to be installed and high fluctuation on lab tests and monitoring has to be followed. A extraction of 500 Mg Chromium per year can be achieved, which is technical possible, but financially not feasible due to a low Chromium stock price. Groundwater can be treated within the same process. A 5 years treatment period is required.
- **Off site - Flushing [IIIb]** – by using the mobility and solubility of Cr VI, excavation and and off site treatment through soil flushing (washing) is introduced. The activities are mainly close to the existing WWTP and decontaminated material will be disposed back onto the existing dumpsite. Additional equipment for exacavation and soilflusing has to be installed and high fluctuation on lab tests and monitoring has to be followed. A extraction of 500 Mg Chromium per year can be achieved, which is technical possible, but financially not feasible due to a low Chromium stock price. Groundwater can be treated within the same process. A 5 years treatment period is required.
- **Excavation and off site disposal [IV]-** excavation and safe transport required. Due to the circumstance, that in Macedonia no landfill of hazard disposal are in operation, the case of Silmak might be a perfect start up to take those options of preparation of abandoned sites into consideration. (e.g. Lojane tailing dam for final disposal and capping). Disadvantag of this method is the high transport fluctuation which would be required for the transport of 2.029.000 Mg and the additional cover and capping cost on the final disposal facility.

9.2.1 Environmental Ranking of various proposed methods for remediation of Chromium based contamination

In the evaluation of different options (even not realistic one), environmental impact was evaluated according the international practice (see e.g. EPA USA) and enlarged in the broader content of sustainability. Evaluation was done only in the relation to present location and Macedonian availability. General environmental relevant information's, different sustainable impacts and rough ranking of possibilities for different technical options are given in next table.

From the environmental point of view different, almost equal options are possible. From sustainable one (possible use of location for other purposes, sensibility of public, technical possibilities of Macedonian economy and practice), the best practice is excavation and final treatment (on or outside the location) or disposal (outside the location).

Table 21_Environmental Comparison of various potential alternatives

		In Situ				On site			Ex Situ	Off Site
	No activities	**GW Treatment + capping - drainage**	**GW Treatement + capping + drainage**	**GW Recirculation capping + drainage**	**GW Recirculation capping + drainage + agents**	**GW Accumulation capping + drainage**	**GW Immobilisation capping + drainage**	**On Site Flusing capping + drainage**	**Off stie flushing capping + drainage**	**Excavation and off site disposal**
Hazard	H[18]	M	L	M	L	M	M	M	M	M
Risk	H	M	L	L	L	M	M	M	M	M
Environmental impact – FINAL	H	M	L	L	L	M	L	M	M	M
Environmental impact – during the remediation	H	M	L	M	L	L	M	M	M	M
• **on air**	H	L	L	L	L	L	L	M	M	M
• **on water**	H	M	M	M	M	M	M	M	M	M
• **on soil**	L	M	M	M	M	L	M	M	M	M
Time needed to complete solve the problem	H	L	L	L	M	L	L	L	M	M
Monitoring needs – time and frequency	H	L	L	L	L	L	L	L	L	L
Best practice – world wide use of the technology – Development status	H	M	L	M	M	L	L	L	M	M
Technical and technology assistance needed - Macedonia is self-sufficient	L	L	L	L	L	L	L	H	H	L
Sustainability - Potential use of location	H	H	L	L	L	L	L	L	L	L
Sensibility of the public (Acceptance)	H	M	L	L	L	L	L	L	L	L
SCOR	11/0/2 **21**	1/8/4 45	0/2/11 61	0/5/8 55	0/4/9 57	0/4/9 57	1/3/9 55	1/7/5 47	1/9/3 43	0/9/4 **47**
Ranked	**7**	5	1	3	2	2	**3**	**4**	**6**	**4**

9.2.2 Chriteria of Chromium dumpsite remediation technique

As it was mentioned before, from the environmental view of point different, almost equal options are possible. From sustainable one (possible use of location for other purposes,

18 H - HIGH – Always means most unfavourable or worse alternative/solution/costs (scored as 1) ; M – MODERATE – something between H and L (scored as 3); L – LOW - Always means most favourable or best alternative/solution/costs (scored as 5)

sensibility of public, technical possibilities of Macedonian economy and practice), the best practice is excavation and final treatment (on or outside the location) or disposal (outside the location).

Before the final decision basic data about the dump site (volume, quantities, shape, monitoring data) shall be carefully recorded. Treatment should be performed based on main project design approved by authorities.

Treatment technology should be practice only with the equipment with all needed environmental protection measures, whereby the emission standards particularly on air must be fulfilled. Before the introduction of any treatment technology, operator must submit relevant evidence about the compliance to the environmental standards. If requested trough the technology, monitoring of emissions should be installed.

Main pollution during any on or outs site treatment process will probably occur during the excavation so that adequate measures need to be implemented as e.g.:

- For the excavation appropriate project must be prepared
- Whole process should recorded
- Open (excavation) dump area should be keep a small as possible
- Intrusion of water should be prohibited and eventually entered one should be treated
- In case of high Chromium odor emissions excavation must be done under shelter and in “under pressure atmosphere” with gas cleaning (absorption, burning and washing)
- Chance finds of hazardous waste or other interested materials should be recorded, temporary safe storage and safe dispose
- Adequate monitoring of underground water and soil should be introduce
- The excavation should be executed until the virgin unpolluted soil will be remain
- Final geodetic measurements should be done

9.2.3 Management plan for selected alternative

Mitigation Activities - include it in decision-making process on construction or reconstruction, and during Conceptual Design Draft

Table 22_Mitigation and Environmental Management Plan

Phase	Issues – Activities	Mitigation measure and possible impact	Responsibility	Costs	Comment
Preliminary estimation of the site	Monitoring data Geodetic data Others	NON	Operator	Cover by operator	Data should be recorded present situation
	Checking of odor emissions by preliminary excavation	Impact on proposed measures	Operator		
	Project design		Checking of proposed measures by Authority		
Excavation		Sheltered excavation if needed	Operator		
		Small open spaces Control of water intrusion	Operator		
	Chance finds of hazardous waste	Temporary storage and safe disposal	Operator and Authority		
Transport (if any)	Loading and transporting	Closed lories or big bag In case of higher odor emissions close containers	Operator		
Treatment (if any)	According the selected treatment technique				
Final work	Monitoring of soil Geodetic data		Authority		Recording of final stage of the activities

9.2.4 Monitoring

Monitoring schemes according selected remediation activity and relevant existing legislation Development of a monitoring plan (Monitoring Activities- during construction and use**)** including cost structure (monitoring action plan)

Table 23_Monitoring Plan

Phase	**What** **- parameter is to be monitored?**	**Where** ***is the parameter to be monitored?***	**How** ***is the parameter to be monitored/ type of monitoring equipment?***	**When** ***is the parameter to be monitored- frequency of measurement or continuous?***	**Who** **Responsibility and Reporting**	**How much** **Costs** **Investment /** **Operational**
Preliminary estimation of the site	Chromium Odor emission	Soil and underground water pollution -Close to dump site Organoleptic	Taking the samples and out site analysis	Before the work will start	Operator to Authority	NO/According the market price
Excavation	Chromium	Soil and underground water pollution	Taking the samples and out site analysis	During the excavation on regular basis	Operator	
Transport (if any)	NO monitoring needs					
Treatment (if any)	According the selected treatment technique					
Final work	Chromium	State of the virgin soil pollution	Taking the samples and out site analysis		Authority	

9.3 Conclusion

For the remediation of Chromium contaminated sites have following options been ranked from the environmental assessment as most appropriate for further financial and economical evaluation:

Groundwater treatment on WWTP + capping + drainage – 1

Groundwater recirculation + agents / accumulation + capping + drainage – 2

Groundwater recirculaiton / Imobilisation + capping + drainage – 3

On site flushing / Excavation and off site disposal – 4

Groundwater treatment on WWTP + capping – drainage – 5

Off site fluhing - 6

10 Economical-Financial Evaluation on Silmak Chromium dumpsite

10.1 Site specific Economical Evaluation

10.2 Objective

>>Designing an ecological end-use as an integral component of the remediation system will realize more pronounced benefits from the remediation process, and in no way is intended to jeopardizeor compromise the selected remediation goals and objectives. Incorporation of ecological enhancements can benefit multiple stakeholders, such as regulatory agencies, the regulated community (industry), local communities, and the general public[19]*<<*

10.3 Possible solutions

10.3.1 No activities [Option 0]

One option is taking no activites into consideration. There are no positive effects from this option. The removal and remediation of the area is not taken into consideration.

10.3.2 Green Area [Option 1]

This opportunity should include growing different kind of trees, bushes and all floras that can be suitable for the area.

The remediation (covering and greening) by profiling, but none removal of the material is required.

10.3.3 Sanitary Landfill [Option 2]

The neighboring municipalities of Jegunovce (where Silmak is placed) are Zelino and Tearce. The total number of population in these municipalities is 54.071 or 12.000 households. According to the available space the potential volume of the dump site is 745.600m3 which mean that this dump site can serve 160.000 (much more than the three mentioned one) inhabitants for 20 years. The removal of the material is required.

10.3.4 Extend present dispoal opportunity for Silmak [Option 3]

Part from the total dump site Silmak factory is using as their dump site and they have IPPC plan for this area. If Silmak is planning to extend this area than part from the hot-spot can be used for that purposes. The remediation by profiling is needed, but not removal of the material is requred.

10.3.5 Industrial Land Use [Option 4]

The Silmak dump site is placed close to the high way (distance of 10 km) and close to the railway Skopje - Tetovo. The Skopje airport is 57 km from Jegunovce. All these

[19] Source: "Planning and Promoting of Ecological Re Use of Remediated Sites " prepared by Interstate Technology and Regulatory Council ITRC#

connections are very favorable for all kind of manufacturing businesses. For this option the removal of the material is needed.

10.4 Evaluation of Options

All of these five former mentioned options are valued according to the certain indicators which are presented in the table number 1, presented bellow.

In this table with the sign minus "-" is marked if the presented option does not have any positive effect on the presented indicator and with plus "+" if there are influence of the option to the certain indicator.

Table 24_Ranking different opportunities (+ and -)

indicator	Option 0 No Activities	Option 1 Green Area	Option 2 Sanitary Landfill	Option 3 Extend present sump site of Silmak	Option 5 Industrial land use
Development of the region	-	-	+	+	+
Wider development impact	-	-	+	-	+
Direct Revenue Generator	-	-	+	-	+
Low start up-costs	-	+	-	+	+
Return of Investment	-	-	+	-	+
Social impact	-	-	+	-	+
Technological impact	-	-	-	-	+
Positive environmental impact	-	+	+	+	-
Capacity to manage		+	+	+	+
Sustainability	-	+	+	+	+
TOTAL	**-**	**4**	**8**	**5**	**9**
Ranking	**5**	**3**	**2**	**4**	**1**

Influence of the different options to the indicators is presented through numbers from 0 which mean without any influence to 5 which means high influence.

Table 25_Ranking different opportunities (from 0 to 5)

indicator	Option 0 No Activities	Option 1 Green Area	Option 2 Sanitary Landfill	Option 3 Extend present sump site of Silmak	Option 5 Industrial land use
Development of the region	0	2	5	3	5
Wider development impact	0	1	5	3	4
Direct Revenue Generator	0	0	5	2	4
Low start up-costs	0	4	3	5	4
Return of Investment	0	1	5	2	5
Social impact	0	2	4	2	5
Technological impact	0	1	4	2	5
Positive environmental impact	0	5	5	4	3
Capacity to manage	0	5	5	4	4
Sustainability	0	4	5	4	4
TOTAL	**0**	**26**	**46**	**31**	**38**
Ranking	**5**	**4**	**1**	**3**	**2**

10.4.1 Conclusion of previous ranking:

The most economic feasible option according to positive influence to different indicators is sanitary landfill for 3 municipalities. This option has wider development impact and very important environmental impact. Also it is sustainable for a longer period of time as it was described in Table 26. The standard life time for sanitary landfill is minimum 15 years.

10.5 Sanitary landfill for 3 municipalities

10.5.1 Description and evaluation

In the table bellow are all positive and negative aspects are mentinoned using remediate land as a Sanitary Landfill. This opportunity, as all others have its positive and negative sides which should be taken into consideration for all future steps.

Table 26_SWOT of Sanitary Landfill

Strengths +	Weaknesses -
✓ Organized waste disposal ✓ Landfill for wider region ✓ Better control over the waste storage ✓ Position – not close to the residential area ✓ Strategically fulfillment of the EU approximation of the landfill directive ✓ Fulfillment of waste management plan (NWMP II/2006) → municipal waste ✓ Enforcement of legislation (Wastemanagment and regionalisation related legislation) ✓ Removal of significant and long term pollutant	❖ Removal of material is required ❖ Capacity to manage the dump site ❖ Capacity to meet interests of different municipalities ❖ Sensitivity of Jegunovce and of Skopje inhabitants
Opportunities +	**Threats -**
✓ Experience for future organization of regional used landfills ✓ Future use of the area ✓ Long-term approach (>20years)	❖ Political misuse ❖ Political disagreement ❖ Potential inadequate management ❖ Development of inadequate technology due to budget constrains ❖ Inappropriate operaton might lead to pollution of Rasce spring

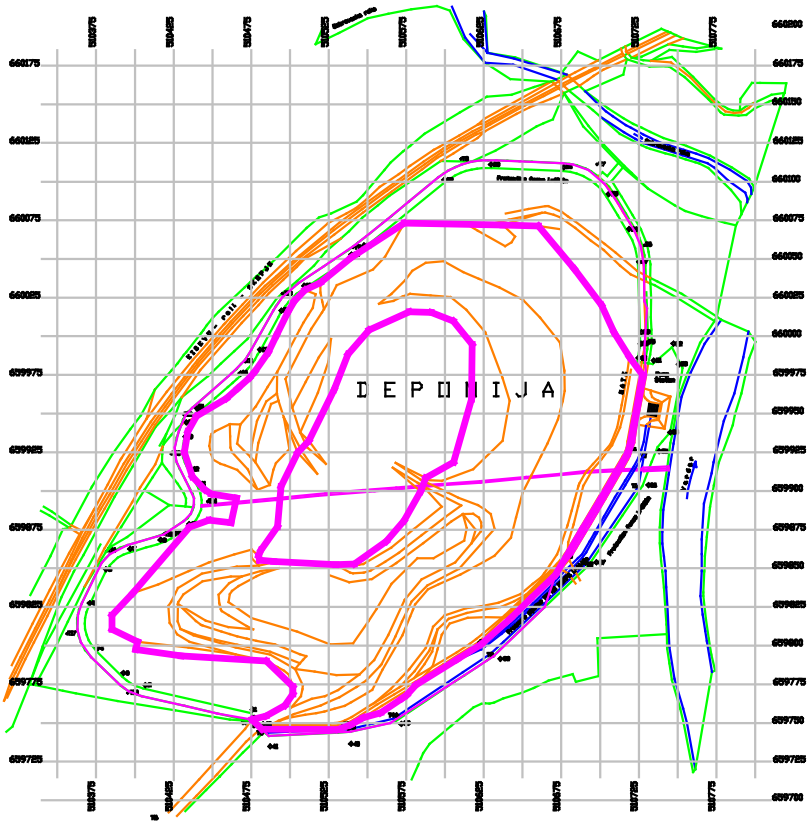
10.5.2 Legal Base of "regional landfill"

Article 80 of the Law on Waste Management (Off. Gazette no 6/2004; 68/2004; 71/2004) regulates the conditions for establishing a landfill. This article , under paragraph (8), clearly states that the Minister managing the body of the public administration responsible for environmental affairs may request, as a condition to the issuance of permit for establishment of a landfill, that the founder join other municipalities to the contract provided, if doing so, it contributes to more economic and improved waste management, in accordance with the Waste Management Plan of the Republic of Macedonia.

10.6 Investments required for the set up of a regional landfill

The following map present the possible area to be used for the implementation of a sanitary landfill.

Figure 31_Dumpsite – landfill area



It is necessary to plan the following funds for the establishment of the landfill from 6,5 ha:

Table 27_Listing of costs for sanitary landfill

Description	Unit	Amount in Euro
Installation Costs for 6,54 ha	Euro	3.065.000
Operating Costs	Euro/year	150.000
Closing – Down Costs	Euro	1.500.000

Description of the map:

Pink Lines – Contours of the outer an inner boundary of the proposed landfill with an surface of 6,54 ha.

10.7 Financial Evaluation of various treatment Methods

SILMAK - Financial Evaluation of various Alternatives										
		Insitu				On Site			Exsitu	Off Site
	Units	Groundwater Treatment on WWTP with final capping without drainage	Groundwater Treatment on WWTP with final capping and drainage	Groundwater recirculation with final capping and drainage	Groundwater recirculation with agents - final capping and drainage	Groundwater Accumulation - Capping and drainaing	Immobilisation - Capping and drainaging	On site flushing	Off Site flushing	Excavation and off site disposal - Lojane
Environmental Ranking										
Method		Ia	Ib	IC	Id	IIa	IIb	IIIa	IIIb	IV
Total Amount of Slag	Mg	2.028.999	2.029.000	2.028.999	2.029.000	2.029.000	2.029.000	2.029.000	2.029.000	2.029.000
Excavation	Mg	507.250	507.250	507.250	507.250	507.250	507.250	2.029.000	2.029.000	2.029.000
Transport Distance	km	0	0	0	0	0	0	0	4	100
Truckloads for Slag Transport	pcs	0	0	0	0	0	0	135.267	135.267	135.267
Waggon Loads for Slag	pcs	0	0	0	0	0	0	50.725	50.725	50.725
Treatment Surface	sqm	41.150	41.150	41.150	41.150	41.150	41.150	68.500	68.501	68.000
Capping material (0,5m)	m³	20.575	20.575	20.575	20.575	20.575	20.575	34.250	34.251	34.000
Topsoil material (0,5m)	m³	20.575	20.575	20.575	20.575	20.575	20.575	34.250	34.251	68.000
Transport Cover Material	m³	41.150	41.150	41.150	41.150	41.150	41.150	68.500	68.501	102.000
Truckloads	m³	2.743	2.743	2.743	2.743	2.743	2.743	4.567	4.567	6.800
Drainage ditch	m	0	554	554	554	554	554	0	0	
Water pumping activity	m³/year	37.843	37.843	37.843	37.843	70.000	70.000	37.843	37.843	70.000
specific treatment costs	Euro/Mg	1,24	1,24	0,50	1,70	0,50	1,70	3,50	3,50	1,24
Depreciation Period / Lifespan	years	10	5	10	5	7	5	5	5	5
Piecometers	pcs	0	0	0	0	0	0	0	0	0
Monitoring	amount	18	18	18	18	18	18	18	18	18
Processtechnology Investment	Euro	0	0	80.000	80.000	120.000	120.000	218.000	218.000	0
Depreciation	Euro/year	0	0	8.000	16.000	17.143	24.000	43.600	43.600	0
Profiling and Excavation	Euro	710.150	710.150	710.150	710.150	710.150	710.150	2.840.600	2.840.600	2.840.600
Drainage construction costs	Euro	0	193.900	193.900	193.900	193.900	193.900	0	0	0
Transport costs Slag (Truck)	Euro	0	0	0	0	0	0	0	703.388	17.584.710
Transport costs Slag (Train)	Euro	0	0	0	0	0	0	0	12.681.250	12.681.250
Treatment costs	Euro	469.253	234.627	189.215	321.666	245.000	595.000	7.265.739	7.265.739	434.000
Capping material costs	Euro	154.313	154.313	154.313	154.313	154.313	154.313	256.875	256.879	391.000
Material Transport costs	Euro	192.033	192.033	192.033	192.033	192.033	192.033	319.667	319.671	2.856.000
Profiling and compacting	Euro	82.300	82.300	82.300	82.300	82.300	82.300	137.000	137.002	272.000
Other Costs										
Public Awareness	Euro	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000

Drilling of Piecometers	**Euro**	0	0	0	0	0	0	0	0	0
Monitoring	**Euro**	30.600	30.600	30.600	30.600	30.600	30.600	30.600	30.600	30.600
Investment	**Euro**	0	0	80.000	80.000	120.000	120.000	218.000	218.000	0
Total Operational Costs	**Euro**	1.648.649	1.607.922	1.642.510	1.774.961	1.738.296	2.088.296	11.078.480	11.781.879	19.515.450
Supervision	**Euro**	49.459	48.238	49.275	53.249	52.149	62.649	332.354	353.456	585.464
Capitalisation of Invest	**Euro**	0	0	16.821	8.776	2.100	2.100	3.815	3.815	0
Total Costs	**Euro**	**1.698.108**	**1.656.160**	**1.708.607**	**1.836.986**	**1.792.545**	**2.153.045**	**11.414.650**	**12.139.150**	**20.100.914**
specific costs	**Euro/m³**	**448,72**	**218,82**	**451,50**	**242,71**	**179,25**	**153,79**	**5,63**	**5,98**	**10**
Output Chromium	**Mg**	**0,00**	**0,00**	**3,67**	**3,67**	**36,68**	**0,00**	**500,00**	**500,00**	**0**
Potential Income Chromium	**Euro**	**0**	**0**	**46.217**	**23.108**	**323.518**	**0**	**3.150.000**	**3.150.000**	**0**
Total Income	**Euro**	**0**	**0**	**46.217**	**23.108**	**323.518**	**0**	**3.150.000**	**3.150.000**	**0**
specific income	**Euro/m³**	**0,000**	**0,000**	**0,023**	**0,011**	**0,159**	**0,000**	**1,552**	**1,552**	**0**
specific turn over	**Euro/Mg**	**-448,72**	**-218,82**	**-451,48**	**-242,70**	**-179,10**	**-153,79**	**-4,07**	**-4,43**	**-10**
Financial Ranking		**2**	**1**	**3**	**5**	**4**	**6**	**7**	**8**	**9**

10.7.1 Financial Evaluation of Silmak Chromium dump site remediation alternatives

Those treatment methods, which have been evaluated as environmental accepted and ranked from 1 till 9 have been taken further into consideration for the financial evaluation. An amount of 2.029.000 Mg is primary base for calculation. Transportation has been calculated once with trucks (1,30 Euro/km above a distance of 30km, below 25 Euro/load) and once with wagons (250 Euro/wagon), while a critical distance of 100 km has been taken into consideration (above 100 km by train, below by truck). The costs for public awareness and a two year monitoring program have been handles like fix costs due to the fact, that independent from the chosen alternative, those costs will be raised.

The options Ia and Ib are comparing the capping with and without constructing a drainage to decrease the groundwaterlevel, while the operation costs without drainaging will remain for a double as long lifespan compared with the treatment method including drainaging. A recovery of Chromium has not taken into consideration. Investment in process technology are not raising. The existing infrastructure will be used. The operation costs (extracting of chromium) have been calculated with 1,24 Euro per treated m³ of waste water (5,24 Mg/year --> 70% of Chromium from the dumpsite). Base for the treatment cost calculation is the study of HPC[20], while yearly costs of 124.000 Euro have been taken into consideration.

Another options are based on the reduction of Chromium in the groundwater due to recirculation and immobilisation,while a Chromiumoutput of 3,67 Mg was base for calculation. Investments for an improved process of 80.000 Euro are required in order to achieve the installation of recirculation measures of polluted groundwater onto and into

[20] Harres Pickel Consult GmbH – GIUGLARIS039 – Obnova-EAR-SK – EU FWC, Lot6 Environment "Protection of Soil, Ground- and Surfacewater from chromium pollution in the area of Jegunovce"

the dumpsite body. Option Ic has a double long lifespan than option Id, which is reflected in the operation costs. In addition has option Ic increased treatment costs due to the fact, that no agents will be used.

In order to achieve an higher Chromium output for possible sales, the options Iia and Iib are based on the enrichment of Chromium in the groundwater, which reduces the lifespan, increases the chromium output and the pumping capacity up to double. While Iia is focused on the higher output, is Iib reflecting the possibility of a faster immobilisation rate, without being focused on the extraction of Chromium.

Soilflushing, once on site and once off site are based on the removal of the material and extracting Chromium of 500 Mg/year. The onsite flushing does not show significant lower costs, so that it is much more recommended to treat off site and use current facility (WWTP) for the extraction of Chromium. The life span is calculated worst case with 5 years. The specific treatment costs are almost double high than the compareable options show.

Final option is the off site disposal (eg. Lojane) and the removal of all material on site. No Chromium can be extracted and the costs for the disposal on another site (capping, covering) have been taken into consideration. This demonstrates the most expensive option, but would allow to follow the econonomical suggestion of using the location for the development of a sanitary landfill.

The most feasible option is Iib, which is based on the cappoing and drainaging of the site and requires a 5 years further treatment in order to decrease the pollution to an international accepted level.

Best available option is the combination of capping (surface water management), drainaging (groundwater control) and 5 years further treatment of polluted waters up to an international accepted level.

Ranking:	
Treatment on WWTP, capping, drainaging	-1
Treatment on WWTP, capping – without drainaging	-2
Groundwater recirculation, capping, drainaging	-3
Groundwater accumulation, capping, drainaging, Chromium recovery	-4
Groundwater recirculation, immobilisation, capping, drainaging	-5
Imobilisation, capping and drainaging	-6
Excavation and on site flushing, Chromium recovery	-7
Excavation and off site flushing, Chromium recovery	-8
Exacavation and off site disposal	-9

10.8 Comparison of the Economical with Financial and Environmental Evaluation on Silmak

The final proposed opportunity as the best from the economical point of view required complete removal of the material, while this option has been evaulated from the financial and from the environmental point of view as not feasible. The total costs for excavation and transport of the material off site (eg. Lojane) will require and finacial input of 20.100.914 Euro, as stated in the financial evaluaton sheet

The best financial solution is the conbination of capping, installation of a drainge system and common treatment of the underground water in the existing WWTP facility for a period of 5 years which will create costs of total 1.656.160 Euro. An extraction of flocculated Chromium and commercialisation is not taken into consideration due to the fact, that a break even can be achieved at an amount of 65 Mg per year, while current are only 5,24 Mg extracted.

From the economical point of view is a possible negative impact of the current water supply system for Skopje and the appropriate water provision almost not calculatable, but would definitely exceed all mentioned costs of the proposed alternatives.

10.9 Future Economical Benefits

Implementing the proposed alternative of remediation combinations (capping, drainage, treatmetn), will lead into prevention of environmental negative impacts with possible positve economical aspects can be stated as following

- Establishment of new technology – with the latest generations of equipment the productivity is reaching higher and higher standards. We should not exclude the possibility to reuse the soil with chromium and take away the residuals of chromium after identification of possible technical appropriate and economcial feasible technology.
- Price of chromium – if the price of chromium in world market incrases to a 20 times higher value than the current one, chromium extraction and commercialisation would lead to financial benefit. At this point it is not economically feasible to sell it due to its low price Euro 1.260 / Mg. The breake even point is impossible to achieve with the present capacity and stock prices.

The economical evaluation of the environmental and financial ranked treatment alternatives alow the recommendation of a combination of treatment by the current operated WWTP for a period of 5 years, surface water management by capping and closure measurements and groundwatermanagment by constructing a drainage system in the western part of the dumpsite. The proposed removal and developing of a sanitary landfill upto 160.000 PE and a lifespan of 20 years is economical most appropriate, but does not compete with the financial obstacles at current stage. The financial input for the proposed measurements are 1.656.160 Euro. A recovery and commercialisaton of Chromium requires a higher stock price than the current one or more efficient treatment technology due to the fact, that all chromium is dispersed within 2.029.000 Mg of slag and sluge waste.

11 Attachments

11.1 Legal frame

11.1.1 Terms of Reference for Legal, Institutional and Technical Expert

Beneficiary country

The former Yugoslav Republic of Macedonia

Contracting authority

Ministry of ……..

11.1.2 Team staff:

- Foreign Institutional Expert- 4 months within 9
- Local Legal Expert- 6 months within 9
- Local Institutional Expert- 3 months within 9
- Local Technical Expert- 3 months within 9

11.1.3 Position: Legal Expert

The legal gap analysis made within the project identified crucial gaps in missing hotspots" terminology, unclear environmental liability, no guidelines and solutions for "hotspots" remediation, set up of an earmarked environmental trust fund. Therefore the obligations and responsibilities for the Legal Expert Position will include: amending existing laws in the area of environment, more particularly the Law on Environment, Law on Waste Management, Draft Law on Hazardous Waste. Not only law amendments are needed, but also drafting new legislation, for example Law on soil protection, Law on establishment of trust funds, Rulebook on Remediation of "hotspots", Rulebooks on monitoring, Rulebook on protection from pollution from priority substances. The issue of environmental liability is not clear, therefore the legal expert will need to recommend how this question will be solved, whether the state is responsible, and for how long or the new owner. The Legal Expert will need to cooperate closely with Institutional, as well as with an technical expert, when drafting the changes of the laws or drafting new laws. The cooperation with the Institutional expert will be considerable especially in the area of the funding mechanisms. The technical expert will be needed to provide inputs when drafting the laws and especially the rulebooks which will be in form of technical guidelines (monitoring, remediation, soil protection). The legal expert will have to write progress reports, as well as inception and final reports.

The Legal expert should have: a degree in law (preferably environmental law group), professional experience of minimum 10 years in law related fields, drafting of legislation; making of analysis. The legal expert also should have a knowledge of the national legislation (especially in environment and finance, because most of the changes required are in those fields), intensive knowledge of local (national) legal structure and related stakeholders, as well as institutional set up knowledge. Cards program and procedure experience would be considered an asset. He/she should be familiar especially with the Hotspots issue, environmental liability, funding mechanisms. Regarding the language skills, proficiency in oral and written English is required.

The general requirements for such an expert include analytical capability to deal with legislation; good interpersonal skills; team player; presentation skills; able to follow rules of confidentiality and independent and free from conflicts of interest in the responsibilities accorded to them; skilled in Microsoft Office (Word, Excel, PowerPoint);

The terms of engagement for the Legal Expert will be 6 within 9 months (132 working days), starting from xxxx 2008. The main beneficiary will be the Ministry of Environment and Physical Planning, and the contractor will be the EAR (European Agency for Reconstruction).

11.1.4 Position: Institutional Expert

The responsibilities of the Institutional Expert will be making proposals and solutions for the existing institutional gaps; develop a regional or national funding mechanism for hot spot remediation activities, and cooperate with the legal expert regarding legal matters for the needed funding mechanism. He will describe responsibilities, interlinks between various institutions, evaluate the various budget sources in accordance with national and international institutional, legal and economical principals such as polluter or risk related fees. Development of an institutional strategy for the implementation of further remediation works, and establishment of an implementation body, as well as describing responsibilities of such a body. The Institutional Expert will have to help the legal expert in drafting legislation, as well as preparation of a presentation workshop, together with the legal expert.

The Institutional Expert should have a degree in social or natural science, professional experience of minimum 10 years in environmental management and related activities; knowledge in international funding facilitation and institutional set ups (international networking); relevant knowledge of national legislation related to Public Information and international related conventions (Aarhus Convention), and be familiar with the legislation on funding mechanisms. Cards program and procedure experience will be considered as an asset. Proficiency in oral and written English is required as well as knowledge of Microsoft Office (Word, Excel, PowerPoint);The general requirements are analytical capability to deal with environmental assessment; able to follow rules of confidentiality and independent and free from conflicts of interest in the responsibilities accorded to them; performing of field and office work; good interpersonal skills; The terms of engagement will be 3 months (66 working days), starting from xxxx 2008. The main beneficiary will be the Ministry of Environment and Physical Planning, and the contractor will be the EAR (European Agency for Reconstruction).

11.1.5 Position: Technical Expert

A technical expert will closely cooperate with the legal and institutional expert, in execution of the technical and legal parts. The required expertise will mainly be technical, but some environmental law expertise will also be needed. The responsibilities of the Technical Expert will include supporting the legal expert in drafting legislation in the environmental area by providing technical input during the entire project. He should contribute in the preparation of the new legislation that is recommended to be adopted (Law on soil protection, Rulebook for remediation of “hotspots” as well as the drafting of the changes of the legislation that need to be done. Also the technical expert will participate in writing the reports (Inception, Progress, and Final). The qualifications required for the technical expert are the following: a degree in life science, engineering, minimum 10 years of working experience in the relevant environmental area (Waste, Water, Air, IPPC), knowledge of the situation of the country regarding the “hotspots” matter, as well as knowledge of the waste sector, water sector, air sector. Preferable is to have some knowledge of the environmental legislation, as the tasks will be changes in the environmental legislation. Cards program and procedure experience will be

considered as an asset. Proficiency in oral and written English is required as well as knowledge of Microsoft Office (Word, Excel, PowerPoint);The general requirements are analytical capability to deal with environmental assessment; able to follow rules of confidentiality and independent and free from conflicts of interest in the responsibilities accorded to them; performing of field and office work; good interpersonal skills; The terms of engagement will be 3 months (66 working days), starting from xxxx 2007 within a period of 3 months. The main beneficiary will be the Ministry of Environment and Physical Planning, and the contractor will be the EAR (European Agency for Reconstruction).

11.1.6 Position: Foreign Institutional Expert

The overall objective of the Foreign Institutional Expert will be to coach and support the project team in their legal and institutional needs. The Expert will support the local institutional expert in the proposals and solutions for the existing institutional gaps; in developing the regional or national funding mechanism for hot spot remediation activities, support the legal expert regarding legal matters for the needed funding mechanism. He will help in the development of an institutional strategy for the implementation of further remediation works, and the establishment of an implementation body. He will have to report to the project team and develop a final report. The expert shall have: a degree in social or natural science, professional experience of minimum 10 years in environmental management and related activities in a country that has passed successfully the transitional development process (experience throughout the transitional period, and after); knowledge in international funding facilitation and institutional set ups. The foreign Expert should possess relevant knowledge of national legislation related to Public Information and international related conventions (Aarhus Convention), as well as relevant knowledge in relevant European Directives and International Standards and Legislations. He should also be proficient in oral and written English, and have analytical capability to deal with environmental assessment; good communication skills, excellent knowledge of Microsoft Office (Word, Excel, PowerPoint);

The foreign Expert will be based in Skopje (Project Office), The period of activity will be 4 months within 9.

11.1.7 Office Accommodation

Office accommodation of a reasonable standard and of approximately 10 square metres for each expert working on the contract is to be provided by the beneficiary. This will include basic furnishings and communication lines (at least two fixed telephone lines with hand-sets and the technical possibility for the consultant to establish high speed internet access) as well as electricity, air conditioning, heating, water and general cleaning and maintenance. The consultant's experts will be located in the same building or as near as possible to the MEPP core functions to be supported under this contract.

The beneficiary will also provide desktop computers, printers, a fax machine and a photocopier for use by the consultants. These will remain the property of the beneficiary. However, the suitability and reliability of these machines cannot be guaranteed, and all associated operating and maintenance costs will be borne by the contractor and included within fee rates. Any additional equipment (for example laptop computers) will also be provided by the consultant at no cost to the project (i.e. included within fee rates).

11.1.8 Facilities to be provided by the beneficiary

The Consultant is responsible for organizing the project office space provided by the beneficiary and for providing any additional furnishings and equipment needed to provide an appropriate working environment for all members of the Consultant's staff funded under this contract, and to allow Working Groups of up to ten people to meet and operate as necessary. The Consultant will ensure that all members of its team in fYR Macedonia

are equipped with adequate computing, document processing and dedicated electronic mail facilities and other means required to perform the tasks requested under these ToR.

The consultant will moreover ensure the mobility of all his/her staff for all work related purposes. In particular he/she shall ensure that there is sufficient administrative, secretarial and interpreting provision to enable experts to concentrate on their primary responsibilities.

The cost of all of these inputs must be included in the fee rates. In particular, the Consultant shall make available, within the fee rates of its experts, the necessary resources for:

- . office equipment,
- . backstopping services at headquarters;

11.1.9 Equipment

No equipment is either to be purchased on behalf of the beneficiary country as part of this service contract or transferred to the beneficiary country at the end of this contract. Any equipment related to this contract, which is to be acquired by the beneficiary country, must be purchased by means of a separate supply tender procedure.

11.1.10 Reporting requirements

All reports shall be written in UK English, and, where necessary, working documents and reports should be translated into the local language(s) as described below. Standard reporting formats to be used are attached to this ToR.

The Consultant shall prepare and submit the following reports:

An Inception Report shall be submitted 2 months after the commencement date of the project The report shall clearly define the aims, objectives and methodology of the contract; set out a detailed work plan for the provision of each activity, area of expertise and list of deliverables; identify the experts and local personnel required, the management of the project and any possible commitments required from the beneficiary etc. The inception report shall show all activities pertaining to results and outputs in a cart highlighting milestones. The report will list and comment on any developments (legal, institutional, other donor activities etc.) that have taken place since these ToR were drafted and which might have an impact on project design and relevance of activities to be developed under it. The use of locally available moderators familiar with this methodology is strongly recommended. The inception report will feature an extended executive summary in English and Macedonian language providing decision makers with sufficiently detailed information to understand concept and implications and form an opinion. The main report will not exceed 25 pages of text.

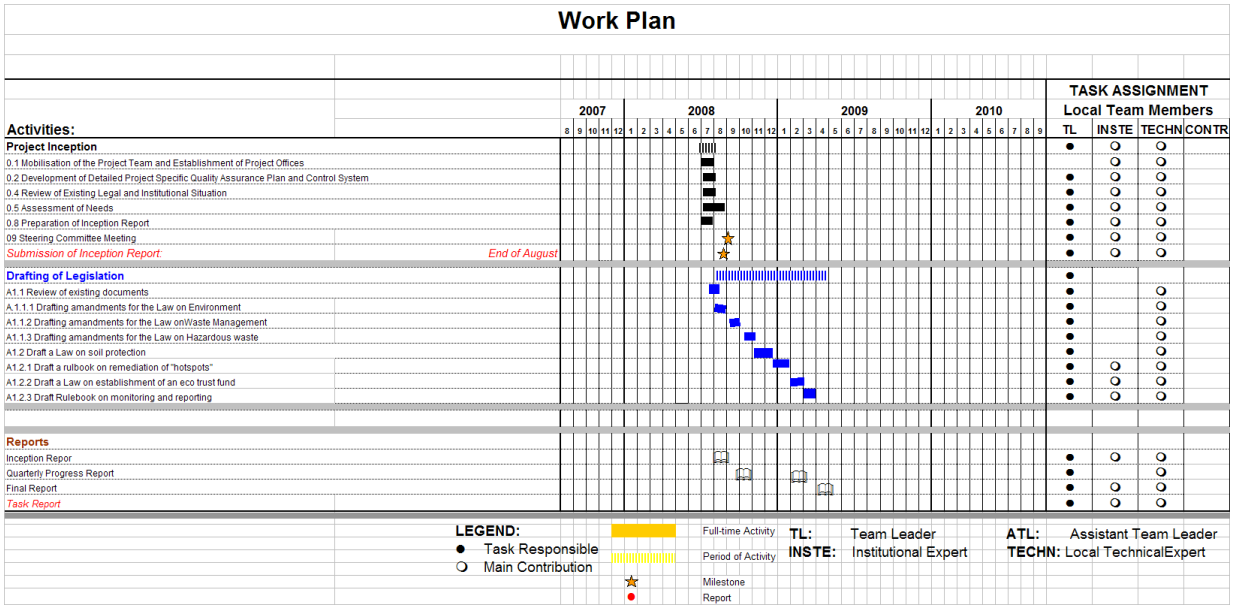
Quarterly Progress Reports shall be submitted within two weeks after the end of each three-month period. The first Quarterly Progress Report shall be delivered at the end of the third month after the inception period. Quarterly progress reports will feature an extended executive summary in English and Macedonian, highlighting project progress against each output, key activities undertaken, obstacles hampering project progress and proposed solutions, consumption of contract inputs and essentials of the work plan for the following quarter, including recommendations and requests (ToRs, Specifications and Tender Dossiers). The Quarterly Progress Report will also identify relevant progress and general developments in the sector in general and in the specific thematic areas covered by this contract (legislative, institutional, activities of other donors, private sector initiatives and others of interest) and, as far as these developments affect contract implementation and/or validity, of its objectives and outputs.

The Final Report will contain prioritised follow up proposals to the activities developed under this contract for funding consideration under the project. They will contain a description of all documents prepared under the contract (reports, proceedings from conferences, minutes of relevant meetings, findings from workshops), all previously approved reports, documents and other on CD-ROM. The main reports shall not exceed 50 pages. The exact table of contents of the draft final and final report is subject to approval by the contracting authority. The draft final and final report shall contain an extended executive summary in English and Macedonian language(s).

The Draft Final Report is due one month before the end of the contract. The Final Report will be delivered within one month after the completion of the contract. The Final Report shall be provided on CD - ROM as well. The Final Report must be accompanied by the final invoice and an audit certificate (as defined in Article 30 of the General Conditions and in accordance with the template in Annex VI of the contract) confirming the final certified value of the contract.

The reports shall be submitted to the MEPP National Project Co-ordinator (for the beneficiary) and the EAR Project Manager (for the contracting authority). Approval of all reports rests solely with the EAR Project Manager. The beneficiary shall communicate his observations on all reports to the consultant and to the Contracting Authority within 15 calendar days of receipt of the report in question. The Project Manager when requesting amendments to the report, and prior to its approval shall take these into account.

11.1.11 Action Plan



11.2 Institutional

11.2.1 Action Plan for setting up the Remediation Fund

Action	Implementing Institution	Time frame	Resources required
Definition of Terms of References for local and international assistance (experts)	MOEPP; Donor	2007	Local / international expert
Tendering and recruiting national and international experts	Donor	2007	Procurement officer
Revision of legislation regarding environmental liabilities for past pollution.	MoEPP, MoE	2007	6 man-months of local and int. experts
Introduction of economic instruments (sources of funding for the Remediation Fund).	MoEPP, MoF	2007	6 man-months of local and int. experts
Introduction of cleanup standards and recommended guidelines.	MoEPP, MoA	2007	man-months of local and int. experts
Drafting and adoption the Law on establishing the Remediation Fund.	MoEPP	2007	2 man-month of local and int. experts
Establishment of the Fund's Management Board and Technical Committee.	MoEPP	2008	N/A
Recruitment/appointment of the General Director, Financial Director and Technical Director.	MoEPP	2008	N/A
Hiring and training of staff.	Fund's Director	2008	N/A
Development of operating procedures for the Fund.	Fund	2008	Fund's staff, int. experts
Setting up data base of contaminated sites	Fund	2008-2009	Fund's staff, Information Centre of Environment
Development of prioritisation methodology (risk assessment based)	Fund	2008	Fund's staff, int. experts
Preparation of draft investment strategy, work programme, and business plan.	Fund	2008-2009	Fund's staff
Establishment of the Fund' website.	Fund	2009	Fund's staff
Preparation of the first annual operating programme.	Fund	2009	Fund's staff

11.2.2 Terms of Reference for Short Term Consultant for Public Awareness Campaign (PAC)

11.2.2.1 Background

"Development and support of Implementation of a public information system in regard to Remediation Plans with Financial Requirements for Elimination of Industrial Hotspots"

The overall objective of the project is to support the remediation of industrial hotspots on a environmentally and financially sustainable manner for an improved life quality of the population of the former Yugoslav Republic of Macedonia.

11.2.2.2 Scope of the Work

This ToR describes the work that should be done by the mentor during implementation of separate activities within the PA Campaign on remediation activities at SILMAK.

It is expected that Mentor will help SILMAK, Municipality and local NGOs in preparation and realization of particular activities focused on PA rising.

11.2.2.3 Beneficiary

Main beneficiary is the potential impacted population

Duties and Responsibilities:

1. To continue with the training of local NGOs and municipal staff for preparing applications for certain PA raising activities related to the proposals in the Report on Public Awareness
2. Building the link between various intuitions (focal point) and responsible for information dissemination
3. Support of the MoEPP and Municipality of Jegunovce to define certain PA activities, staff-, budget and time scheduling (Action Plan)
4. Support the local stakeholders (NGOs, Local Self Government, schools etc.) in realization of the activities
5. Identification of Indicators
6. To prepare a questionnaire and to initiate a yearly public satisfaction study within the project area in close cooperation with independent survey staff
7. Evaluation of the survey results and using it as a planning tool for further activities
8. Preparation of various presentation
9. To be present on the place of realisation of the activities
10. To make evaluation of realisation of the separate activities and to deliver the evaluated reports to the MoEPP
11. Activity-, indicator-, project result-, and cost control (supervisory function)

11.2.2.4 Output:

- List of Indicators
- To deliver 6-month progress reports and forecast planning with specific activities to MOEPP
- Information Dissemination plan followed

- Yearly satisfaction study and form of representation
- Consultant should submit detail report on previous realized activities in accordance with Terms. Special attention should be paid on problems appeared and achievements from realized activities. The reports should contain results, proposals for follow up activities, constrains and needs and requirements
- The reports and supporting material shall be prepared and submitted to MOEPP in Macedonian (and English if required)

11.2.2.5 Required Expert Input:

- National expert and/or consultant company, no more than 180 working days in a period of one year and 100 in the second year
- Consultant should travel in the region in order to conduct meetings with relevant stakeholders (NGOs, village communities, schools etc.) and to provide specific training and directions for realization of activities.
- Consultant should closely cooperate with SILMAK, relevant Ministries and impacted local authorities to specify certain activity, time, budget, and staff input scheduling

11.2.2.6 Qualifications:

- University degree in the fields relevant to the project;
- Minimum 5 years of relevant experience in developing of institutional schemes
- Strong communication and interpersonal skills;
- Prior experience in working with local governments and NGO's;
- Previous experience in developing and realization of PAC;
- Team management and moderator skills;

11.2.3 Fact Sheet – Municpality of Jegunovce

Basic data about Municipality of Jegunovce important for organization of PAC

Jegunovce is one of the larger villages in the **Polog** Valley. It is located about 15 km northeast of the Macedonian city of Tetovo. It is the center of the Jegunovce Municipality.

The municipality borders Serbia in the north, City of Skopje in the southeast, Tearce municipality in the west, Želino municipality in the south and Tetovo municipality in the southwest.

Ethnic groups in the municipality (according to 2002 census)

- Macedonians = 5,963
- Albanians = 4,642
- Serbs = 109
- others

Demographic of Jegunovce municipality

Census year	Population
1994	7,013
2002	7,227

Inhabited places in Jegunovce Municipality

Villages: Belovište, Vratnica, Žilče, Jažince, Jegunovce, Kopance, Orašje, Podbrege, Preljubište, Raotince, Ratae, Rogačevo, Siričino, Staro Selo, Tudence, Šemševo.

Municipality area: 176,93 km²

Total Population: 10,790 PE

Population density: 60,98 PE/km²

11.2.4 Sample Plan for Public Participation

Subject	Example
What is the basic activity?	Public participation in the EIA procedure concerning the proposed clean up of the XXXX site
Objectives: what effect has to be obtained?	• Notifying the public about the project and the possible decisions • Notifying the public about the ways in which it may participate in the procedure and about the authority competent for making a decision • Notifying the public about the course of the public participation procedure • Enabling the public to submit comments and recommendations • Examining the submitted comments and recommendations during the project's evaluation before issuing the decision
Dates of initiating and finalizing the procedure	• Initiation: date • Notification of the public: date • Press release: date • Distributing the leaflets: date • Visiting the site: date • Meeting interested parties: date • Administrative trial with the public participation: date • Analysing the documentation and comments submitted by the public: date • Making the decision • Finalisation: date
Results and activities What are the expected results? What activities have to be concluded?	• Plan of public participation • Notifying the public • Press release • Leaflet directed to the public • Members of public visit the site • Interested parties visit the site • Meeting with the members of public • Seminar for the interested parties

	• EIA report • Assessment of EIA report • Decision made • Note on the outcome of the public participation procedure
Responsibilities of the team and resources needed	• Xx hours project manager • Xx hours cleanup expert • Xx hours for journalism • Xx hours for technical editor • Xx hours for inspector • Xx hours for facilitator
Financial resources needed	

11.3 References

11.3.1 References – Legal Frame

[1]… National Waste Management Plan (NWMP)

[2]… National Environmental Action Plan II (NEAP II)

[3]… Law on Waste Management (Off. Gazette no. 6/2004);

[4]… Law on Environment (Off. Gazette no. 53/05 and 81/05);

[5]… Law on Privatisation (Off. Gazette no. 37/96; 25/99; 81/99; 49/2000; 6/2002; 74/05);

[6]… The draft Law on Hazardous Waste (which is being produced in the CARDS 2004 Programme, and was provided by them).

[7]… Law on Ambient air Quality (Off. Gazette no. 67/2004);

[8]… Draft Law on Waters

[9]… Law on Budgets (Official Gazette of the Republic of Macedonia no. 79/93; 3/94; 71/96; 46/2000;11/2001, 93/2001; 46/2002; 24/2003; 85/2003 and 96/2004 and Decision of the Constitutional Court no. 180/98 (Official Gazette of the Republic of Macedonia no. 15/99)

[10]… Decree on the criteria and manner for B IPPC permit (Off. Gazette no. 04/2006); Decree on the level of charges for A IPPC permit (Off. Gazette no. 04/2006);

[11]… IPPC Ordinance - A permits (Off. Gazette no. 4/06);

[12]… IPPC Ordinance - Adjustment permits (Off. Gazette no. 04/2006);

[13]… IPPC Ordinance - B permits (Off. Gazette no. 4/06);

[14]… Rulebook on the form and content of the application form, and the content of the permit for collecting and transporting urban and other types of non-hazardous waste as well as on the minimum technical requirements for performing the economic activity of collecting and transporting urban and other types of non-hazardous waste (Off. Gazette no. 23/2007);

[15]… Rulebook on the format and the content of the Journal for records keeping on the waste handling, the format and the content of the forms for the annual report on waste handling by legal entities and natural persons and the format and the content of the annual report on waste handling by the mayor (Off. Gazette no. 7/2006);

[16]… Rulebook on the functioning methods and conditions of the integrated waste disposal network (Off. Gazette no. 29/2007);

[17]… List of Waste Types (Off. Gazette no. 100/05);

[18]… Waste Framework Directive;

[19]… Landfill Directive;

[20]… Directive for PCB's and PCT's;

[21]… Hazardous Waste Directive;

[22]… IPPC Directive.

[23]… Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal

11.3.2 References – health risk assessment

[24]… Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Chromium. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1998

[25]… American Conference of Governmental Industrial Hygienists (ACGIH). 1999 TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices. Cincinnati, OH. 1999.

[26]… California Environmental Protection Agency (CalEPA). Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Draft for Public Comment. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1997.

[27]… California Environmental Protection Agency (CalEPA). Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II. Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment, Berkeley, CA. 1999.

[28]… Occupational Safety and Health Administration

[29]… Environmental Protection Agency. Guideline for exposure assessment, Washington, 1992

[30]… http://www.health.gov.au/internet/wcms/publishing.nsf/Content/ohp-ehra-2004.htm~ohp-ehra 2004-background.htm

[31]… http://reports.eea.europa.eu/GH-07-97-595-EN-C2/en/chapter1h.html

[32]… http://www.who.int/ipcs/publications/ehc/methodology_alphabetical/en/index.html

[33]… http://www.who.int/ipcs/publications/ehc/ehc_numerical/en/index.html

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[36]… National Environmental Action Plan. Government of the Republic of Macedonia, Skopje, 1996

[37]… National Health Environmental Action Plan. Government of the Republic of Macedonia, Skopje, 1999

[38]… National Waste Management Plan 2006-2012. Government of the Republic of Macedonia, Skopje, 2005

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[43]… Republic Institute for Health Protection. Internal data on request, Department for Social Medicine, 2007

[44]… Republic Institute for Health Protection. Internal data on request, Department for Hygiene and Environmental Health, 2007

[45]… State Statistical Office. Statistical Yearbook of the Republic of Macedonia, Skopje, 2000,2001,2002,2003,2004,2005,2006

[46]… The Second National Environmental Action Plan. Government of the Republic of Macedonia, Skopje, 2005

[47]… UN - Environmental Performed Review for FYR of Macedonia, 2002

[48]… UNEP.Post-Conflict Environmental Assessment—FYR of Macedonia, Geneva, 2000.

[49]… UNEP. Feasibility Study for urgent Risk Reduction Measures at hot spots In FYR of Macedonia, Geneva, 2001.

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[52]… WHO. Assessing human risk of chemical: Derivation of guideline values for health based exposure limits. Geneva, Environmental Health Criteria 170, 1994

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11.4 SAMPLES AND RESULTS

11.4.1 Jegunovce - Jugochrome

Chemical analysis have been performed in RIHP on 16th July 2007

	Point 1	Point 2	Point 3	MLP
$Chromium_{tot}$ [mg/lt]	<0,001	<0,001	<0,001	0,05

Sampling points: Village

Point 1- new central drinking water supply system

Point 2- new central drinking water supply system

Point 3- well from household (groundwater)

11.4.2 Analytical results of piecometers in comparison

Parameter	22/3	8	15/2	12/2	26/2	27/1	28	19	19/2	35/1	2\1
	X=4658497,81 Y=7509981,29	X=4658566,72 Y=7510290,83	X=4658533,48 Y=7510326,28	X=4658556,78 Y=7510479,66	X=4658542,86 Y=7510580,76	X=4658534,23 Y=7510772,78	X=4658480,00 Y=7510922,00	X=4660076,21 Y=7510759,27	X=4660078,04 Y=7510759,30	X=4660001 Y=7510743,82	X=4659903,27 Y=7510722,01
ph	6,65	6,05	6,39	6,35	6,51	6,41	6,85	6,09	5,61	6,5	6,38
Temperature	13,1	14,3	11,1	12,8	14,5	14,1	14,5	15,4	13,8	13,5	1,85
EC	268	337	467	618	527	459	380	191	161	283	475
NH4-N	0,15	0,499	0,51	0,223	0,373	0,436	0,58	0,55	0,38	2,2	0,092
O2 (p-p)	6,52	7,88	4,3	10,86	5,56	6,3	0	1,72	2,64	2,82	8,99
Vaporistaion remains	195	652	2170	1929	512	4429	551	1890	155	0	0
Ca	43,44	51,4	55	76,64	104,98	41,99	463	29	26,8	35,5	54,3
Cd	0,0002	0,0004	35	0,0001	0,0001	0,0001	0,00009	2	3	3,3	1
Cr	0,012	3,53	4,53	14,54	1,92	5,91	0,02	0,0009	0,002	0,147	19,6
Cl	11,34	8,82	5,04	6,3	12,6	8,19	6,3	6,3	1,26	0	1,26
Cu	0,003	0,002	6,6	0,001	0,002	0,002	0,0009	2	4	6,3	2
Cn total	0,001	0,0009	2,9	0,0009	0,0009	0,0009	1	0,9	0,9	2,9	0,9
Fe	0,0009	0,004	2,5	0,0009	0,0009	0,005	1,65	4	0,9	14,6	6
Pb	0,002	0,0019	1,9	0,0019	0,0019	0,0019	0,0019	1,9	1,9	1,9	3
Mg	7,93	15,82	12,8	2,73	0,04	14,9	15,8	4	1,73	11,9	2,21
Mn	0,024	0,053	0,011	0,005	0,007	0,008	0,19	0,077	0,013	1,9	0,17
Hg	0,00009	0,00009	0,9	0,00009	0,00009	0,00009	0,00009	0,9	0,9	0,9	0,9
Ni	0,001	0,002	1,7	0,001	0,001	0,001	0,001	3	1	5,5	2
K	1,52	1,24	1,34	1,53	3,71	1,98	1,46	1,92	1,91	2,72	1,98
Na	5,94	34,79	28,2	67,97	44,66	36,23	9	5,1	4,85	0	49
PO4	0,101	0,015	0,009	0,07	0,08	0,22	0,025	0,024	0,015	0,083	0,19
SO4	21,81	37,87	72,8	112,37	111,54	60,5	38,7	14,4	16,9		51
Zn	0,082	0,276	0,022	0,058	0,04	0,086	0,034	1,7	0,58	0,256	0,059
Carbonates as CaCO3	102,24	212,51	191	190,46	229,55	165,4	134,8	95,7	78,2	138	196
TOC											
Total oksidised nitrogen	6,48	5,1	4,9	2,88	3,9	3,46	1,45	2,9	4,1	2,9	1,78
As	0,009	0,009	0	0,009	0,009	0,009	0,009	0,009	0,009	0,18	0,009
Ba	0,053	0,0048	0,086	0,056	0,083	0,066	0,059	0,125	0,105	0,18	0,131
Ba		0,009	0,033	0,009	0,009	0,009	0,009	0,009	0,009	0,018	0,009
F		0,48	0,62	0,471	0,451	0,443	0,433	0,353	0,48	0,54	0,38
Phenol	0,014	0,0009	0,0009	0,0009	0,0009	0,0009	0,0009	0,0009	0,016	0,13	0,0009
P	0,104	0,012	0,008	0,057	0,063	0,226	0,279	0,047	0,029	0,03	0,49
Se	0,009	0,009	0	0,009	0,009	0,009	0,009	0,009	0,009	0	0,009
Ag	0,00039	0,00039	0,39	0,00039	0,0004	0,00039	0,00039	0,39	5	0,39	7
NO2	0,0029	0,0046	0,019	0,0029	0,076	0,0029		9,1	6,4	7	76
NO3	2,7	4,4		2,6	3,9	2,9	0,7	0,8	0,7	0,6	1,7

11.4.3 Analytical results of piecometers in comparison with precipitation and time

Time	Pc-32/1 (mg/l)	SP-20 (mg/l)	Pc-2/1 (mg/l)	P-2 (mg/l)	Pc-35/1 (mg/l)	SP-19 (mg/l)	Pc-19/2 (mg/l)	Pc-31/1 (mg/l)	Pc-33/1 (mg/l)	Pc-34/1 (mg/l)	P-1	P (r
Jan 90	27									11		
Feb 90	28		0,37		0,055					11		
Mrz 90	18									5,3		
Apr 90	41									3,34		
Mai 90	29		0,34		0,03					3,5		
Jun 90	18,88									1,39		
Jul 90	10,02									6,33		
Aug 90	2,99		0,03		0,056			<0.01	<0.01	27,62		
Sep 90	5,35									16,15		
Okt 90	5,1									35,56		
Nov 90	3,09		0,45		0,03					131,41		
Dez 90	3,02									24,51		
Jan 91	27,62									173,5		
Feb 91	17,18		0,35		<0.01					138,4		
Mrz 91	37,38									28,48		
Apr 91												
Mai 91	40,04									135,02		
Jun 91	22,96				0,135					1,112		
Jul 91	17,8									<0.01		
Aug 91	11,83									<0.01		
Sep 91	5,55				0,08					5,44		
Okt 91	2,48									0,036		
Okt 91	7,13									0,08		
Nov 91	22,5		0,22		0,03			<0.01	<0.01	<0.01		
Dez 91	26,37											
Jan 92	24,67									0,05		
Feb 92	18,66				0,47					<0.01		
Mrz 92	19,63											
Apr 92	34,45									13,95		
Mai 92	17,74									<0.01		
Jun 92	20,52											
Jul 92	34,03											
Aug 92	5,51				0,09					0,08		
Sep 92	4,1											
Okt 92	5,99				0,57					0,07		
Nov 92	4,55									0,38		
Dez 92	14,19											
Jan 93	15,07											
Feb 93	19,77				0,14					4,48		
Mrz 93	26,31											
Apr 93	10,27											
Apr 93	5,14				0,18							
Mai 93	5,82											
Jun 93	1,37											
Jul 93	4,1				0,15							
Aug 93	2,4											
Sep 93	8,9				0,24					0,06		
Okt 93	17,63											
Nov 93	23,11											
Dez 93	19											
Jan 94	13,69				0,07							
Feb 94	15,04											
Mrz 94	10,61											
Apr 94	7,45				0,18					0,15		
Mai 94	5,13											
Jun 94	4,44											
Jul 94	6,84											
Aug 94	3,08				0,03					0,07		
Sep 94	3,08											
Okt 94	2,05				0,03					<0.01		
Nov 94	20,54											
Dez 94	8,05											
Jan 95	7,02				0,13					4,28		
Feb 95	6,16											
Mrz 95	5,13		0,12									
Apr 95	4,45		0,43		0,024							
Mai 95	8,21		0,48							1,25		
Jun 95	4,4											
Jul 95	11,64		0,75		0,43					<0.01		
Aug 95	3,42											
Sep 95	15,6		<0.01									
Okt 95	21,4		0,78		0,22					0,14		

Nov 95	30,13		0,72									164,7
Dez 95	52,04		0,8									39,2
Jan 96	68,48		0,75		0,068					<0.01		93,5
Feb 96	41,6		0,82									73,5
Mrz 96	18,83											56,6
Apr 96	6,5		0,68							0,68		48,7
Mai 96	5,13		0,9									17,9
Jun 96	2,56		0,93									7,7
Jul 96	1,62		1,13									29
Aug 96	5,99		0,73		<0.01					<0.01		120,6
Sep 96			1,8									28,7
Okt 96	25,85		0,7		0,04		<0.01			<0.01		68,4
Nov 96	23,97		1,1									96,5
Dez 96	15,4											39
Jan 97	11,98		1,4		0,08					0,17		11
Feb 97	8,21		5,82									23,7
Mrz 97	5,64		1,6									53,2
Apr 97	2,05				0,2					<0.01		26
Mai 97	1,54		1,54									22,9
Jun 97	2,39		11,47									13,4
Jul 97	0,67		8,21		0,13					3,76		38,5
Aug 97	4,71		6,21									2,8
Sep 97	6,16		2,5									148,6
Okt 97	25,68		3,6		0,22		<0.01			<0.01		30,2
Nov 97	17,12		2,8									66,6
Dez 97	21,23		2,4									24,3
Jan 98	15,41		3,1		0,23					<0.01		36,7
Feb 98	17,12		1,4									51,8
Mrz 98	9,76		2,1									44,9
Apr 98	7,02		2		0,2					<0.01		91
Mai 98	5		2									19,2
Jun 98	4,31		2,4									36,4
Jul 98	2,23		2,2		0,09					<0.01		17,7
Aug 98	18,6		2,4									96,2
Sep 98	31,35		2,7									75,1
Okt 98	31,01		2		0,21					<0.01		92,6
Nov 98	34,98		2									44,17
Dez 98	53,24		5,6									
Jan 99	28,43		3,27		0,06					<0.01		
Feb 99	29,29		2,4									
Mrz 99	13,43		6,8									
Apr 99	7,83		4,8		0,01					<0.01		
Mai 99	7,23		2,2									
Jun 99	5,78		3									
Jul 99	3,4		2,8		0,01					<0.01		
Aug 99	3,2											
Sep 99	60,3											
Okt 99	83,66		0,8		0,01		0,08			<0.01		
Nov 99	63,58											
Dez 99	87,87		1,5									
Jan 00	34,46		0,26		0,02					<0.01		
Feb 00	12,06		2,4									
Mrz 00	0,69		2									
Apr 00	5,02		1,7		<0.01					<0.01		
Mai 00	2,4		2,4									
Jun 00	3,44		4,4									
Jul 00	3		2,4		0,04					<0.01		
Aug 00	2,6		2,4									
Sep 00	2,4		2,8									
Okt 00	2		2,4									
Nov 00		11,2	2				0,02					
Dez 00				2,1		0,02	0,1					
Jan-01	8	3,6	1,5	1,1	0,01	<0.01	<0.01			<0.01		
Feb-01	6,4	7,6	0,8	0,7	0,01	<0.01	<0.01			0,28		
Mrz-01		11,6	1,7								0,01	
Apr-01	18,61											
Mai-01				1,1	<0.01	<0.01	<0.01			<0.01		

11.5 Geoelectrical Profiles – Silmak Chromium dumpsite

11.5.1 Profile GE I

Region: **Tetovo**

Location: **Dumpsite Silmak – Jugochrome - Jegunovce**

Method: **Geoelectrical mapping - resistivity**

Arrangement: **Wenner: AM=MN=NB=a=10, 20, 30 m**

Instruments: **Resistivity meter type IC/1B made in Serbia; Geophysical institute - Belgrade**

Azimuth: **107°**

Date: **14.07.2007**

Operator: **Novica Stolic**

Profile GE I:	AM=MN=NB=a=10 m						a=10m; AB/2=15 m					Control measurements			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	(m)	(m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
I/2-3	510647,13	660126,31	-15,00	15,00	1-4	2-3	10	62,83	44,40	9,10	306,56	45,00	9,30	304,03	
I/3-4	510656,67	660123,32	-15,00	25,00	2-5	3-4	10	62,83	43,00	8,60	314,16				
I/4-5	510666,21	660120,32	-15,00	35,00	3-6	4-5	10	62,83	51,00	8,10	395,61				
I/5-6	510675,75	660117,33	-15,00	45,00	4-7	5-6	10	62,83	79,00	12,00	413,64				
I/6-7	510685,29	660114,34	-15,00	55,00	5-8	6-7	10	62,83	50,00	9,10	345,23	51,00	9,15	350,21	
I/7-8	510694,83	660111,34	-15,00	65,00	6-9	7-8	10	62,83	46,00	9,50	304,24				
I/8-9	510704,37	660108,35	-15,00	75,00	7-10	8-9	10	62,83	33,00	6,00	345,58				
I/9-10	510713,92	660105,36	-15,00	85,00	8-11	9-10	10	62,83	31,00	6,25	311,65				
I/10-11	510723,46	660102,36	-15,00	95,00	9-12	10-11	10	62,83	44,00	8,20	337,15	45,00	8,50	332,64	
I/11-12	510733,00	660099,37	-15,00	105,00	10-13	11-12	10	62,83	64,00	12,00	335,10				
I/12-13	510742,54	660096,37	-15,00	115,00	11-14	12-13	10	62,83	56,00	12,80	274,89				
I/13-14	510752,08	660093,38	-15,00	125,00	12-15	13-14	10	62,83	93,00	19,90	293,64				

Profile GE I:	AM=MN=NB=a=20 m						a=20m; AB/2=30 m					Control measurements			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
I/4	510661,44	660121,82	-30,00	30,00	1-7	3-5	20	125,66	19,20	7,70	313,34	20,00	8,00	314,16	
I/5	510670,98	660118,83	-30,00	40,00	2-8	4-6	20	125,66	18,80	7,10	332,74				
I/6	510680,52	660115,83	-30,00	50,00	3-9	5-7	20	125,66	24,50	10,20	301,84				
I/7	510690,06	660112,84	-30,00	60,00	4-10	6-8	20	125,66	31,00	12,50	311,65				
I/8	510699,60	660109,85	-30,00	70,00	5-11	7-9	20	125,66	69,50	30,50	286,35	71,00	31,00	287,81	
I/9	510709,14	660106,85	-30,00	80,00	6-12	8-10	20	125,66	28,50	13,80	259,52				
I/10	510718,69	660103,86	-30,00	90,00	7-13	9-11	20	125,66	64,00	19,60	410,33	65,00	20,00	408,41	
I/11	510728,23	660100,86	-30,00	100,00	8-14	10-12	20	125,66	31,50	12,40	319,23				
I/12	510737,77	660097,87	-30,00	110,00	9-15	11-13	20	125,66	39,30	16,50	299,31				

Profile GE I:	AM=MN=NB=a=30 m						a=30m; AB/2=45 m					Control measurements			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
I/5-6	510675,75	660117,33	-45,00	45,00	1-10	4-7	30	188,50	17,50	11,20	294,53				
I/6-7	510685,29	660114,34	-45,00	55,00	2-11	5-8	30	188,50	14,60	10,00	275,20	15,00	10,50	269,28	
I/7-8	510694,83	660111,34	-45,00	65,00	3-12	6-9	30	188,50	13,20	10,50	236,97				
I/8-9	510704,37	660108,35	-45,00	75,00	4-13	7-10	30	188,50	17,00	11,00	291,31	17,00	11,00	291,31	
I/9-10	510713,92	660105,36	-45,00	85,00	5-14	8-11	30	188,50	71,00	43,50	307,66				
I/10-11	510723,46	660102,36	-45,00	95,00	6-15	9-12	30	188,50	72,00	44,00	308,45				

11.5.2 Profile GE II

Region: **Tetovo**

Location: **Dumpsite Silmak – Jugochrome - Jegunovce**

Method: **Geoelectrical mapping - resistivity**

Arrangement: **Wenner: AM=MN=NB=a=10, 20, 30 m**

Instruments: **Resistivity meter type IC/1B made in Serbia; Geophysical institute - Belgrade**

Azimuth: **57-9°**

Date: **11.07.2007**

Operator: **Novica Stolic**

Profile GE II: AM=MN=NB=a=10 m					a=10m; AB/2=15 m							Control measurements			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	(m)	(m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
II/2-3	510570,91	659744,72	-15,00	15,00	1-4	2-3	10	62,83	32,00	14,80	135,85				
II/3-4	510579,23	659750,26	-15,00	25,00	2-5	3-4	10	62,83	29,00	16,00	113,88				
II/4-5	510587,57	659755,79	-15,00	35,00	3-6	4-5	10	62,83	25,50	17,00	94,25	25,00	17,20	91,33	
II/5-6	510595,89	659761,33	-15,00	45,00	4-7	5-6	10	62,83	28,00	16,00	109,96				
II/6-7	510604,19	659766,90	-15,00	55,00	5-8	6-7	10	62,83	31,00	14,60	133,41				
II/7-8	510612,49	659772,50	-15,00	65,00	6-9	7-8	10	62,83	26,40	12,00	138,23				
II/8-9	510620,81	659778,04	-15,00	75,00	7-10	8-9	10	62,83	21,80	9,70	141,21				
II/9-10	510629,16	659783,53	-15,00	85,00	8-11	9-10	10	62,83	16,00	8,00	125,66				
II/10-11	510637,49	659789,07	-15,00	95,00	9-12	10-11	10	62,83	10,50	6,60	99,96	10,00	6,50	96,66	
II/11-12	510645,08	659795,48	-15,00	105,00	10-13	11-12	10	62,83	22,00	12,00	115,19				
II/12-13	510651,95	659802,75	-15,00	115,00	11-14	12-13	10	62,83	33,00	17,10	121,25				
II/13-14	510658,82	659810,02	-15,00	125,00	12-15	13-14	10	62,83	26,00	19,00	85,98				
II/14-15	510665,68	659817,29	-15,00	135,00	13-16	14-15	10	62,83	20,30	20,90	61,03				
II/15-16	510672,55	659824,56	-15,00	145,00	14-17	15-16	10	62,83	31,00	30,00	64,93				
II/16-17	510679,41	659831,83	-15,00	155,00	15-18	16-17	10	62,83	40,50	40,20	63,30				
II/17-18	510686,28	659839,10	-15,00	165,00	16-19	17-18	10	62,83	36,00	28,00	80,78				
II/18-19	510693,15	659846,37	-15,00	175,00	17-20	18-19	10	62,83	31,00	18,30	106,44	30,00	18,30	103,00	
II/19-20	510700,01	659853,64	-15,00	185,00	18-21	19-20	10	62,83	120,00	65,00	116,00				
II/20-21	510706,88	659860,91	-15,00	195,00	19-22	20-21	10	62,83	210,00	112,00	117,81				
II/21-22	510713,75	659868,18	-15,00	205,00	20-23	21-22	10	62,83	215,00	125,00	108,07				
II/22-23	510719,13	659876,42	-15,00	215,00	21-24	22-23	10	62,83	225,00	134,00	105,50				
II/23-24	510722,73	659885,75	-15,00	225,00	22-25	23-24	10	62,83	240,00	188,00	80,21				
II/24-25	510726,63	659894,96	-15,00	235,00	23-26	24-25	10	62,83	252,00	243,00	65,16				
II/25-26	510730,85	659904,04	-15,00	245,00	24-27	25-26	10	62,83	134,00	134,00	62,83				
II/26-27	510734,76	659913,24	-15,00	255,00	25-28	26-27	10	62,83	18,50	27,70	41,96				
II/27-28	510738,81	659922,83	-15,00	265,00	26-29	27-28	10	62,83	39,00	50,00	49,01				
II/28-29	510741,77	659932,41	-15,00	275,00	27-30	28-29	11	69,12	59,00	75,00	54,37	59,00	74,50	54,74	
II/29-30	510743,38	659941,96	-15,00	285,00	28-31	29-30	12	75,40	66,00	65,00	76,56				
II/30-31	510744,90	659951,84	-15,00	295,00	29-32	30-31	13	81,68	73,00	53,00	112,50	73,00	53,00	112,50	

II/31-32	510746,42	659961,73	-15,00	305,00	30-33	31-32	14	87,96	72,00	40,00	158,34					
II/32-33	510747,93	659971,61	-15,00	315,00	31-34	32-33	15	94,25	75,00	28,50	248,02					
II/33-34	510749,45	659981,49	-15,00	325,00	32-35	33-34	16	100,53	65,00	27,00	242,02					
II/34-35	510750,97	659991,38	-15,00	335,00	33-36	34-35	17	106,81	56,00	25,00	239,26	54,00	24,50	235,43		
II/35-36	510752,49	660001,26	-15,00	345,00	34-37	35-36	18	113,10	55,00	25,50	243,94					
II/36-37	510754,01	660011,15	-15,00	355,00	35-38	36-37	19	119,38	56,00	25,00	267,41					
II/37-38	510755,53	660021,03	-15,00	365,00	36-39	37-38	20	125,66	16,00	9,00	223,40					
II/38-39	510757,04	660030,91	-15,00	375,00	37-40	38-39	21	131,95	19,00	12,50	200,56					
II39-40	510758,56	660040,80	-15,00	385,00	38-41	39-40	22	138,23	45,00	24,00	259,18					
II/40-41	510760,08	660050,68	-15,00	395,00	39-42	40-41	23	144,51	25,00	14,50	249,16					

Profile GE II:	**AM=MN=NB=a=20 m**						**a=20m; AB/2=30 m**					**Control measurements**			
Points	**Y**	**X**	**Z**	**L**	**Elektrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	**Note**
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(ohmm)**	**(mV)**	**(mA)**	**(ohmm)**	
II/5	510591,75	659758,53	-30,00	30,00	2-8	4-6	20	125,66	41,00	42,50	121,23				
II/7	510608,36	659769,68	-30,00	50,00	4-10	6-8	20	125,66	14,50	18,00	101,23	15,00	19,00	99,21	
II/9	510625,00	659780,76	-30,00	70,00	6-12	8-10	20	125,66	37,00	32,50	143,06				
II/11	510641,65	659791,85	-30,00	90,00	8-14	10-12	20	125,66	51,50	53,00	122,11				
II/13	510655,38	659806,39	-30,00	110,00	10-16	12-14	20	125,66	23,60	26,00	114,06				
II/15	510669,12	659820,93	-30,00	130,00	12-18	14-16	20	125,66	14,00	19,00	92,59				
II/17	510682,85	659835,47	-30,00	150,00	14-20	16-18	20	125,66	61,00	101,00	75,90				
II/19	510696,58	659850,01	-30,00	170,00	16-22	18-20	20	125,66	165,00	510,00	40,66				
II/21	510710,31	659864,55	-30,00	190,00	18-24	20-22	20	125,66	40,00	50,00	100,53				
II/23	510721,09	659881,02	-30,00	210,00	20-26	22-24	20	125,66	110,00	102,00	135,52				
II/25	510728,90	659899,43	-30,00	230,00	22-28	24-26	20	125,66	226,00	320,00	88,75	225,00	315,00	89,76	
II/27	510736,71	659917,84	-30,00	250,00	24-30	26-28	20	125,66	176,00	251,00	88,11	176,00	250,00	88,47	
II/29	510742,62	659937,02	-30,00	270,00	26-32	28-30	20	125,66	26,50	35,50	93,81				
II/31	510745,66	659956,78	-30,00	290,00	28-34	30-32	20	125,66	74,00	48,00	193,73				
II/33	510748,69	659976,55	-30,00	310,00	30-36	32-34	20	125,66	43,00	24,40	221,46	43,00	25,00	216,14	
II/35	510751,73	659996,32	-30,00	330,00	32-38	34-36	20	125,66	42,00	25,00	211,12				
II/37	510754,77	660016,09	-30,00	350,00	34-40	36-38	20	125,66	20,00	11,00	228,48				
II/39	510757,80	660035,86	-30,00	370,00	36-42	38-40	20	125,66	19,00	10,50	227,39				
II/41	510760,84	660055,62	-30,00	390,00	38-44	40-42	20	125,66	20,00	13,50	186,17				

Profile GE II:	**AM=MN=NB=a=30 m**						**a=30m; AB/2=45 m**					**Control measurements**			
Points	**Y**	**X**	**Z**	**L**	**Elektrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	**Note**
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(ohmm)**	**(mV)**	**(mA)**	**(ohmm)**	
II/5-6	510595,89	659761,33	-45,00	45,00	1-10	4-7	30	188,50	17,50	28,70	114,94	17,00	27,60	116,10	
II/8-9	510620,81	659778,04	-45,00	75,00	4-13	7-10	30	188,50	25,00	43,50	108,33				
II/11-12	510645,08	659795,48	-45,00	105,00	7-16	10-13	30	188,50	26,00	49,80	98,41				
II/14-15	510665,68	659817,29	-45,00	135,00	10-19	13-16	30	188,50	7,70	18,80	77,20				
II/17-18	510686,28	659839,10	-45,00	165,00	13-22	16-19	30	188,50	56,00	106,00	99,58				
II/20-21	510706,88	659860,91	-45,00	195,00	16-25	19-22	30	188,50	71,00	96,00	139,41	70,00	96,50	136,73	
II/23-24	510722,73	659885,75	-45,00	225,00	19-28	22-25	30	188,50	162,00	272,00	112,27				
II/26-27	510734,76	659913,24	-45,00	255,00	22-31	25-28	30	188,50	56,00	84,50	124,92				
II/29-30	510743,38	659941,96	-45,00	285,00	25-34	28-31	30	188,50	41,00	51,00	151,54				

II/32-33	510747,93	659971,61	-45,00	315,00	28-37	31-34	30	188,50	200,00	120,00	314,16	200,00	120,00	314,16	
II/35-36	510752,49	660001,26	-45,00	345,00	31-40	34-37	30	188,50	212,00	125,00	319,69				

11.5.3 Profile GE III

Region: ***Tetovo***

Location: **Dumpsite Silmak – Jugochrome - Jegunovce**

Method: ***Geoelectrical mapping - resistivity***

Arrangement: ***Wener: AM=MN=NB=a=10, 20, 30 m***

Instruments: ***Resistivitymeter type IC/1B made in Serbia; Geophysical institute - Belgrade***

Azimuth: ***100°***

Date: ***15.07.2007***

Operator: ***Novica Stolic***

Profile GE III:		AM=MN=NB=a=10 m					a=10m; AB/2=15 m					Control measurements			
Points	Y	X	Z	L	Electrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
III/2-3	510343,29	659758,22	-15,00	15,00	1-4	2-3	10	62,83	39,00	10,20	240,24	80,00	20,80	241,66	
III/3-4	510353,13	659756,41	-15,00	25,00	2-5	3-4	10	62,83	102,00	31,00	206,74				
III/4-5	510362,96	659754,60	-15,00	35,00	3-6	4-5	10	62,83	165,00	52,00	199,37				
III/5-6	510372,80	659752,79	-15,00	45,00	4-7	5-6	10	62,83	109,00	32,00	214,02				
III/6-7	510382,63	659750,98	-15,00	55,00	5-8	6-7	10	62,83	53,00	13,20	252,28	101,00	25,00	253,84	
III/7-8	510392,47	659749,18	-15,00	65,00	6-9	7-8	10	62,83	65,00	20,00	204,20				
III/8-9	510402,30	659747,37	-15,00	75,00	7-10	8-9	10	62,83	79,00	29,50	168,26				
III/9-10	510412,14	659745,56	-15,00	85,00	8-11	9-10	10	62,83	57,00	20,00	179,07				
III/10-11	510421,97	659743,75	-15,00	95,00	9-12	10-11	10	62,83	35,50	11,20	199,16				
III/11-12	510431,81	659741,95	-15,00	105,00	10-13	11-12	10	62,83	44,00	16,00	172,79				
III/12-13	510441,64	659740,14	-15,00	115,00	11-14	12-13	10	62,83	55,00	20,50	168,57	54,00	21,00	161,57	
III/13-14	510451,48	659738,33	-15,00	125,00	12-15	13-14	10	62,83	37,00	19,50	119,22				
III/14-15	510461,31	659736,52	-15,00	135,00	13-16	14-15	10	62,83	18,50	17,00	68,38				
III/15-16	510471,15	659734,72	-15,00	145,00	14-17	15-16	10	62,83	21,00	17,50	75,40				
III/16-17	510480,98	659732,91	-15,00	155,00	15-18	16-17	10	62,83	26,00	17,20	94,98				
III/17-18	510490,82	659731,10	-15,00	165,00	16-19	17-18	10	62,83	24,80	13,50	115,42				
III/18-19	510500,65	659729,29	-15,00	175,00	17-20	18-19	10	62,83	23,50	10,10	146,19	24,00	10,50	143,62	
III/19-20	510510,49	659727,49	-15,00	185,00	18-21	19-20	10	62,83	27,00	11,00	154,22				
III/20-21	510520,33	659725,68	-15,00	195,00	19-22	20-21	10	62,83	30,50	11,50	166,64				
III/21-22	510530,16	659723,87	-15,00	205,00	20-23	21-22	10	62,83	29,00	12,00	151,84				

Profile GE III:	AM=MN=NB=a=20 m				a=20m; AB/2=30 m							Control measurements			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
III/4	510358,04	659755,50	-30,00	30,00	1-7	3-5	20	125,66	13,50	7,70	220,32	13,00	7,50	217,82	
III/6	510377,71	659751,89	-30,00	50,00	3-9	5-7	20	125,66	43,00	25,30	213,58				
III/8	510397,38	659748,27	-30,00	70,00	5-11	7-9	20	125,66	14,20	9,30	191,87	14,00	9,00	195,48	
III/10	510417,06	659744,66	-30,00	90,00	7-13	9-11	20	125,66	65,00	40,00	204,20				
III/12	510436,73	659741,04	-30,00	110,00	9-15	11-13	20	125,66	33,00	20,50	202,29				
III/14	510456,40	659737,43	-30,00	130,00	11-17	13-15	20	125,66	8,70	7,70	141,98				
III/16	510476,07	659733,81	-30,00	150,00	13-19	15-17	20	125,66	10,80	8,20	165,51				
III/18	510495,74	659730,20	-30,00	170,00	15-21	17-19	20	125,66	48,00	37,30	161,71	49,00	38,00	162,04	
III/20	510515,41	659726,58	-30,00	190,00	17-23	19-21	20	125,66	28,20	17,50	202,50				

Profile GE III:	AM=MN=NB=a=30 m				a=30m; AB/2=45 m							Control measurements			
Points	Y	X	Z	L	Elektrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
III/5-6	510372,80	659752,79	-45,00	45,00	1-10	4-7	30	188,50	8,90	7,90	212,36				
III/8-9	510402,30	659747,37	-45,00	75,00	4-13	7-10	30	188,50	50,00	39,00	241,66	49,00	38,50	239,90	
III/11-12	510431,81	659741,95	-45,00	105,00	7-16	10-13	30	188,50	18,00	17,00	199,58				
III/14-15	510461,31	659736,52	-45,00	135,00	10-19	13-16	30	188,50	19,50	17,50	210,04				
III/17-18	510490,82	659731,10	-45,00	165,00	13-22	16-19	30	188,50	49,00	48,00	192,42				

11.5.4 Profile GE IV

Region: ***Tetovo***

Location: **Dumpsite Silmak – Jugochrome - Jegunovce**

Method: ***Geoelectrical mapping - resistivity***

Arrangement: ***Wener: AM=MN=NB=a=10, 20, 30 m***

Instruments: ***Resistivitymeter type IC/1B made in Serbia; Geophysical institute - Belgrade***

Azimuth: ***26-55°***

Date: ***12/13.07.2007***

Operator: ***Novica Stolic***

Profile GE IV:		AM=MN=NB=a=10 m					a=10m; AB/2=15 m					Control measurements			
Points	Y	X	Z	L	Electrodes		a	K	dV	I	Ra	dV	I	R	Note
No.	UTM (m)	UTM (m)	(m)	(m)	AB	MN	(m)		(mV)	(mA)	(ohmm)	(mV)	(mA)	(ohmm)	
IV/2-3	510339,49	659807,24	-15,00	15,00	1-4	2-3	10	62,83	47,00	13,10	225,43	46,50	13,00	224,75	
IV/3-4	510343,83	659816,25	-15,00	25,00	2-5	3-4	10	62,83	38,00	11,00	217,06				
IV/4-5	510348,16	659825,26	-15,00	35,00	3-6	4-5	10	62,83	29,00	9,10	200,23				
IV/5-6	510352,50	659834,27	-15,00	45,00	4-7	5-6	10	62,83	32,50	9,80	208,37				
IV/6-7	510356,84	659843,28	-15,00	55,00	5-8	6-7	10	62,83	36,00	9,90	228,48				
IV/7-8	510361,40	659852,17	-15,00	65,00	6-9	7-8	10	62,83	45,00	12,00	235,62				
IV/8-9	510366,19	659860,95	-15,00	75,00	7-10	8-9	10	62,83	55,00	14,90	231,93				
IV/9-10	510370,98	659869,73	-15,00	85,00	8-11	9-10	10	62,83	55,00	14,50	238,33				
IV/10-11	510375,77	659878,51	-15,00	95,00	9-12	10-11	10	62,83	55,00	14,20	243,36	77,00	20,00	241,90	
IV/11-12	510380,78	659887,16	-15,00	105,00	10-13	11-12	10	62,83	45,00	12,00	235,62				
IV/12-13	510385,81	659895,81	-15,00	115,00	11-14	12-13	10	62,83	35,00	9,20	239,03				
IV/13-14	510390,75	659904,51	-15,00	125,00	12-15	13-14	10	62,83	50,00	15,50	202,68				
IV/14-15	510395,76	659913,16	-15,00	135,00	13-16	14-15	10	62,83	65,50	22,00	187,07				
IV/15-16	510400,92	659921,73	-15,00	145,00	14-17	15-16	10	62,83	78,00	26,50	184,94				
IV/16-17	510406,11	659930,28	-15,00	155,00	15-18	16-17	10	62,83	90,00	33,30	169,82				
IV/17-18	510411,29	659938,84	-15,00	165,00	16-19	17-18	10	62,83	87,00	32,00	170,82				
IV/18-19	510417,34	659946,88	-15,00	175,00	17-20	18-19	10	62,83	85,00	31,60	169,01	125,00	48,50	161,94	
IV/19-20	510423,61	659954,78	-15,00	185,00	18-21	19-20	10	62,83	105,00	36,00	183,26				
IV/20-21	510429,52	659962,85	-15,00	195,00	19-22	20-21	10	62,83	126,00	41,20	192,16				
IV/21-22	510435,51	659970,86	-15,00	205,00	20-23	21-22	10	62,83	98,00	32,00	192,42				
IV/22-23	510441,73	659978,69	-15,00	215,00	21-24	22-23	10	62,83	69,00	23,40	185,27				
IV/23-24	510448,27	659986,28	-15,00	225,00	22-25	23-24	10	62,83	60,00	24,00	157,08				
IV/24-25	510454,63	659994,00	-15,00	235,00	23-26	24-25	10	62,83	28,00	9,60	183,26				
IV/25-26	510461,23	660001,52	-15,00	245,00	24-27	25-26	10	62,83	40,00	14,00	179,52				
IV/26-27	510467,99	660008,89	-15,00	255,00	25-28	26-27	10	62,83	52,50	17,80	185,32				
IV/27-28	510474,77	660016,25	-15,00	265,00	26-29	27-28	10	62,83	64,00	20,00	201,06				
IV/28-29	510481,63	660023,53	-15,00	275,00	27-30	28-29	10	62,83	75,50	22,30	212,73				
IV/29-30	510488,61	660030,70	-15,00	285,00	28-31	29-30	10	62,83	50,00	16,00	196,35				
IV/30-31	510495,82	660037,65	-15,00	295,00	29-32	30-31	10	62,83	30,50	7,60	252,15	30,00	7,30	258,21	
IV/31-32	510503,11	660044,52	-15,00	305,00	30-33	31-32	10	62,83	41,00	9,40	274,05				
IV/32-33	510510,82	660050,89	-15,00	315,00	31-34	32-33	10	62,83	51,00	11,40	281,09				

IV/33-34	510518,84	660056,87	-15,00	325,00	32-35	33-34	10	62,83	101,00	25,00	253,84				
IV/34-35	510526,86	660062,84	-15,00	335,00	33-36	34-35	10	62,83	152,00	39,00	244,88	150,00	38,50	244,80	
IV/35-36	510534,88	660068,82	-15,00	345,00	34-37	35-36	10	62,83	109,00	24,00	285,36				
IV/36-37	510542,89	660074,79	-15,00	355,00	35-38	36-37	10	62,83	60,00	10,90	345,86				
IV/37-38	510550,91	660080,77	-15,00	365,00	36-39	37-38	10	62,83	55,00	10,00	345,58				
IV/38-39	510558,93	660086,74	-15,00	375,00	37-40	38-39	10	62,83	50,00	10,00	314,16				
IV39-40	510566,95	660092,72	-15,00	385,00	38-41	39-40	10	62,83	33,00	8,00	259,18				
IV/40-41	510574,97	660098,69	-15,00	395,00	39-42	40-41	10	62,83	16,00	5,15	195,21				
IV/41-42	510582,99	660104,67	-15,00	405,00	40-43	41-42	10	62,83	44,00	11,00	251,33				
IV/42-43	510591,01	660110,65	-15,00	415,00	41-44	42-43	10	62,83	73,00	17,00	269,81	72,00	17,00	266,11	
IV/43-44	510599,18	660116,23	-15,00	425,00	42-45	43-44	10	62,83	71,00	16,50	270,37				

Profile GE IV:		**AM=MN=NB=a=20 m**					**a=20m; AB/2=30 m**					**Control measurements**			
Points	**Y**	**X**	**Z**	**L**	**Electrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	**Note**
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(ohmm)**	**(mV)**	**(mA)**	**(ohmm)**	
IV/4	510345,99	659820,75	-30,00	30,00	1-7	3-5	20	125,66	59,50	30,00	249,23				
IV/6	510354,67	659838,77	-30,00	50,00	3-9	5-7	20	125,66	65,00	31,50	259,31				
IV/8	510363,80	659856,56	-30,00	70,00	5-11	7-9	20	125,66	39,00	19,00	257,94	38,50	18,90	255,98	
IV/10	510373,37	659874,12	-30,00	90,00	7-13	9-11	20	125,66	65,00	30,00	272,27				
IV/12	510383,41	659891,43	-30,00	110,00	9-15	11-13	20	125,66	55,00	30,20	228,86				
IV/14	510393,27	659908,82	-30,00	130,00	11-17	13-15	20	125,66	99,00	69,00	180,30				
IV/16	510403,58	659925,97	-30,00	150,00	13-19	15-17	20	125,66	108,00	69,20	196,12				
IV/18	510413,94	659943,08	-30,00	170,00	15-21	17-19	20	125,66	89,00	67,00	166,93	85,00	65,00	164,33	
IV/20	510426,48	659958,88	-30,00	190,00	17-23	19-21	20	125,66	100,00	68,00	184,80				
IV/22	510438,45	659974,90	-30,00	210,00	19-25	21-23	20	125,66	97,00	73,00	166,98				
IV/24	510451,51	659990,09	-30,00	230,00	21-27	23-25	20	125,66	88,00	60,00	184,31				
IV/26	510464,72	660005,12	-30,00	250,00	23-29	25-27	20	125,66	101,00	75,00	169,23				
IV/28	510478,27	660019,82	-30,00	270,00	25-31	27-29	20	125,66	73,00	43,50	210,88	71,00	43,10	207,01	
IV/30	510492,23	660034,16	-30,00	290,00	27-33	29-31	20	125,66	98,00	58,00	212,33				
IV/32	510506,81	660047,91	-30,00	310,00	29-35	31-33	20	125,66	92,00	38,00	304,24				
IV/34	510522,85	660059,86	-30,00	330,00	31-37	33-35	20	125,66	66,00	28,20	294,11				
IV/36	510538,88	660071,81	-30,00	350,00	33-39	35-37	20	125,66	30,00	12,10	311,56	29,90	12,00	313,11	
IV/38	510554,92	660083,76	-30,00	370,00	35-41	37-39	20	125,66	98,00	33,30	369,82				
IV/40	510570,96	660095,71	-30,00	390,00	37-43	39-41	20	125,66	48,00	22,50	268,08				

Profile GE IV:		**AM=MN=NB=a=30 m**					**a=30m; AB/2=45 m**					**Control measurements**			
Points	**Y**	**X**	**Z**	**L**	**Electrodes**		**a**	**K**	**dV**	**I**	**Ra**	**dV**	**I**	**R**	**Note**
No.	**UTM (m)**	**UTM (m)**	**(m)**	**(m)**	**AB**	**MN**	**(m)**		**(mV)**	**(mA)**	**(ohmm)**	**(mV)**	**(mA)**	**(ohmm)**	
IV/5-6	510352,50	659834,27	-45,00	45,00	1-10	4-7	30	188,50	41,00	32,50	237,79	40,00	32,00	235,62	
IV/8-9	510366,19	659860,95	-45,00	75,00	4-13	7-10	30	188,50	64,00	53,00	227,62				
IV/11-12	510380,78	659887,16	-45,00	105,00	7-16	10-13	30	188,50	59,00	59,00	188,50	62,00	61,00	191,59	
IV/14-15	510395,76	659913,16	-45,00	135,00	10-19	13-16	30	188,50	70,00	61,00	216,31				
IV/17-18	510411,29	659938,84	-45,00	165,00	13-22	16-19	30	188,50	70,00	77,00	171,36				
IV/20-21	510429,52	659962,85	-45,00	195,00	16-25	19-22	30	188,50	87,00	86,00	190,69				
IV/23-24	510448,27	659986,28	-45,00	225,00	19-28	22-25	30	188,50	91,00	88,00	194,92				
IV/26-27	510467,99	660008,89	-45,00	255,00	22-31	25-28	30	188,50	22,00	20,50	202,29				

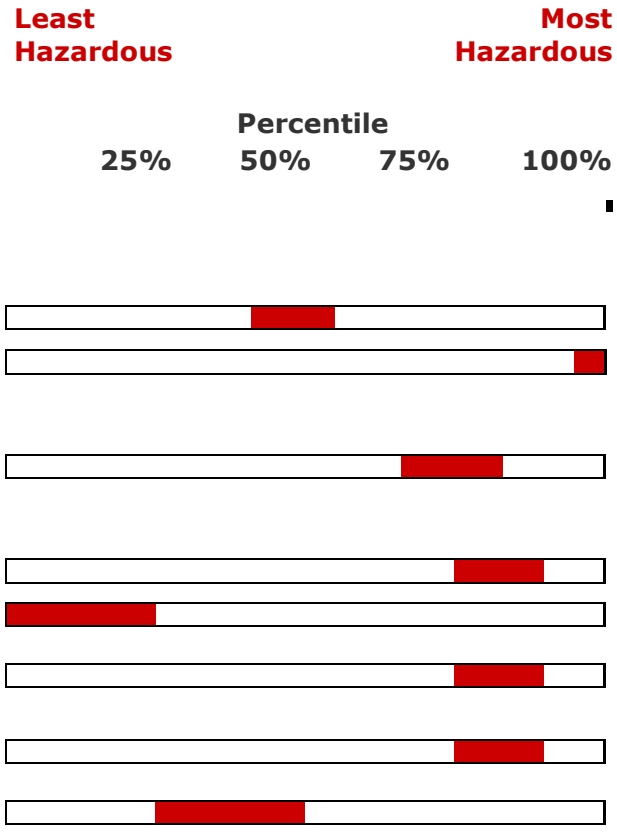
IV/29-30	510488,61	660030,70	-45,00	285,00	25-34	28-31	30	188,50	20,00	18,20	207,14				
IV/32-33	510510,82	660050,89	-45,00	315,00	28-37	31-34	30	188,50	82,00	56,00	276,01	83,00	59,00	265,17	
IV/35-36	510534,88	660068,82	-45,00	345,00	31-40	34-37	30	188,50	52,50	33,00	299,88				
IV/38-39	510558,93	660086,74	-45,00	375,00	34-43	37-40	30	188,50	95,00	49,00	365,45				

11.6 Environmental related annexes

11.6.1 Hazard Ranking of Chromium

More hazardous than most chemicals in 8 out of 11 ranking systems
Ranked as one of the most hazardous compounds (worst 10%) to human health.

Chemical: CHROMIUM
CAS Number: 7440-47-3



11.6.2 Permit level for waters and soil and disposal

Parameter	Surface Water	Groundwater	Drinking Water	Soil (Dutch)	Landfill Directive EU	
					Limit values for non-hazardous wast	
					L/S = 2 l/kg	L/S= 10 l/kg
Cu	µg/l Class I/II 10 Class III/IV50 Class IV > 50	µg/l Class I/II 10	0,1	190	25	50
Hg	µg/l ClassI/II 0.2 ClassIII/IV 1 Class IV > 1	µg/l ClassI/II 0.2	0,001	???	0.05	0.2
Cd	µg/l ClassI/II 0.1 ClassIII/IV 10 ClassIV >10	µg/l ClassI/II 0.1	0,005	12	0.6	1
Cr	µg/l ClassI/II 10 ClassIII/IV 50 ClassIV >50	µg/l ClassI/II 10	Cr(VI) 0,05 Cr(III) 0,10	100	4	10
Pb	µg/l ClassI/II 10 ClassIII/IV 30 ClassIV >30	µg/l ClassI/II 10	0,01	530	5	10
Zn	µg/l ClassI/II 100 ClassIII/IV200 ClassIV >200	µg/l ClassI/II 100	0,1	720	25	50
Ni	µg/l Class I/II 50 ClassIII/IV 100 ClassIV >100	µg/l Class I/II 50	0,01	210	5	10
α-HCH		1		0,003		
γ-HCH		.1		0,00005		
β-HCH		1		0,009		
δ-HCH		.1		0,00006		
Aldrin		.0,003				
Dieldrin		0,001		0,005		
DDE		.0,001		0,01		
DDD		.0,001				
$CHCl_3$		2				
CCl_4		2				
C_2HCl_3		3				
$CHCl_2Br$		2				
C_2Cl_4		2				
$CHBr_3$		2				
Naphtalene		1				
Fenantrene		5				
Acenaphtene		5				
Antracene		5				
Fluorantrene		0,01				
Pyrene		.0,01				
Benz antracene		.0,01				
Krizen		0,01				
Benz(b)fluorantrene		0,01				
Benz(k)fluorantrene		0,01				
Benz(a)pyrene		0,01				
Indeno(1,2,3,cd)pyrene		0,01				
Dibenz(a,h)antracene		0,01				
Benzo(g,h,i)perylene		0,01				

11.6.3 Data needs for treatment technologies for slag and contaminated soil

Technology	Data requirement
Capping	• Extent of contamination • Depth of ground water table • Climate conditions • Waste volume
Solidification/stabilization	• Material concentration • Moisture content • Bulk density • Grain size distribution • Waste volume • Inorganic salt content • Organic content • Debris size and type • Toxicity-TCLP
Soil washing/acid leaching	• Soil type and uniformity • Moisture content • Bulk density • Moisture content • Clay content • Metal concentration/species • pH • Cation exchange capacity • Organic mater content • Waste volume • Mineralogical characteristics • Debris size and type • Toxicity-TCLP[21]
Off-site land disposal	• Soil characterization as dictated by the landfill operator and the governing regulatory agency • Waste volume • Toxicity-TCLP
Reuse/Recycling	• Potential buyer/user • Waste volume/weight • Metal content for acceptance by smelter

21 TCLP-Toxicity Characteristic Leaching Procedure

11.6.4 Required Standards for Capping

The landfill rehabilitation should include the following components.

- Landscaping of slopes and surfaces to a conductive and stable profile
- The completion of the final capping layer system
- The construction of access roads on the Landfill
- The construction of surface water drains
- The supply, installation and maintenance of vegetative covering.

11.6.4.1 Landfill capping system

The capping system should be considered as comprising the respective composite layers between the final level of the waste and the final topsoil cover to be seeded and planted upon completion and closure of the landfill.

It is recommended that the maximum use is to be made of locally available earthen material for this purpose.

- Foundation trimming and profiling of the top slag layer
- Compacted Clay Layer permeability **< 1 x 10^{-8} m. s^{-1}**
- Granular soil drainage Layer
- Sub-soil cover
- Vegetative topsoil layer

No	Layer Zone Top - Down
1	Vegetative topsoil layer
2	Sub – soil cover (optional)
3	Granular soil drainage Layer (optional)
4	Compacted Clay Layer permeability **< 1 x 10^{-7} ms^{-1}**
5	Slag – Waste

11.6.4.2 Foundation trimming and profiling of the top slag layer (gradient 3%)

Trimming and profiling (compacting if necessary) of the top slag layer determine the design and the final shape of the rehabilitated landfill.

11.6.4.3 Compacted Clay layer

- The natural clay liner **(total 500mm thickness)** shall be placed in two layers each 250mm. The upper surface of each layer shall be parallel to the final design of the liner as appropriate. If any layer of the mineral liner will not be covered with a subsequent layer **within 24 hours** of its placement, then measures should be taken to prevent damage to or desiccation of the mineral liner until such time as the cover is placed. The liner constructed on slopes, construction shall take place from the bottom of the slope, upwards.

- All joints between adjacent areas of material placed at different periods shall be benched into by the depth of each layer and overlapped by **at least 500 mm per layer.**
- **The moisture content of the material at the point of deposition shall lie within the range of the OMC, to OMC+5%.The material should be compacted to at least 95% of Standard Proctor maximum dry density.**
- The contracting company shell submit a Method statement detailing the proposed sources and processing of materials and the plant to be employed in its placement and compaction for approval of the owner companies representative consultant.
- Compaction field trials shall be carried out by the contractor under the supervision and to the acceptance of the representative consultant, prior to the acceptance of any material for inclusion in the capping layer..
- The position and level of each test or sampling location on the mineral liner shall be surveyed.

11.6.4.4 Drainage Layer - optional

A 300 mm thick layer of drainage sand or suitable granular material has to be placed to discharge infiltrated storm water to the storm water drainage placed at the outside borders of the landfill.

11.6.4.5 Sub-soil cover

A 750 mm layer of subsoil is required in order to provide further protection for the mineral liner. This protection is required against the possibility of establishment of self sown plants with deep root system and to minimize the impacts of borrowing animals. The layer will also help with the uptake of excessive rainfall on the surface of the Landfill

11.6.4.6 Vegetative Topsoil

The topsoil shall be taken from on-site and off-site stockpiles or borrow pits wherever available. The total thickness of the topsoil shall be a **minimum of 150 mm.**

The topsoil shall have been temporarily stored, placed and handled in a manner so as not adversely affect its vegetation supporting qualities and characteristics.

Topsoil operations shall commence within one week of completion of placement of the underlying subsoil layer.

11.6.4.7 Access Roads and surface water drainage

Access roads shall be designed and installed on the restored cap

11.6.4.8 Surface Drainage ditches

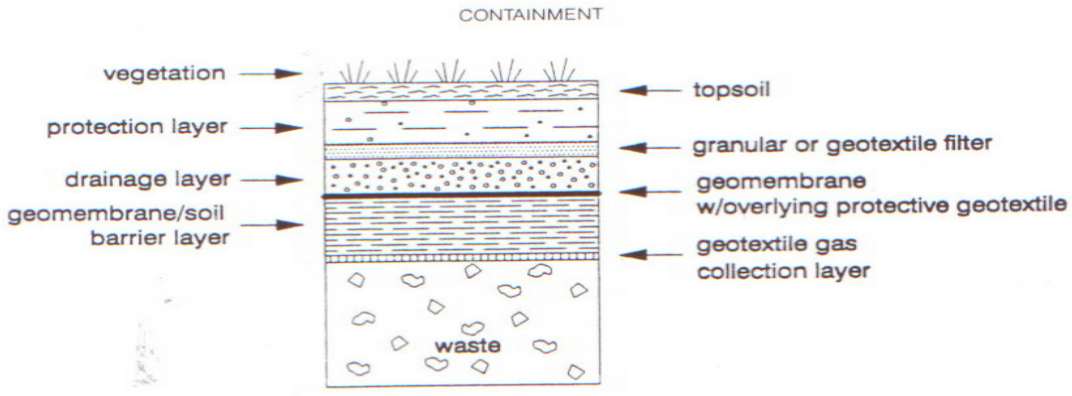
Surface water ditches shall be constructed either side of access roads to **a maximum depth of 600 mm** with a cross sectional area of 0,30 m².

11.6.4.9 Erosion measures

The access roads and surface water drains shall be constructed immediately after the placement of topsoil to ensure that no erosion may occur.

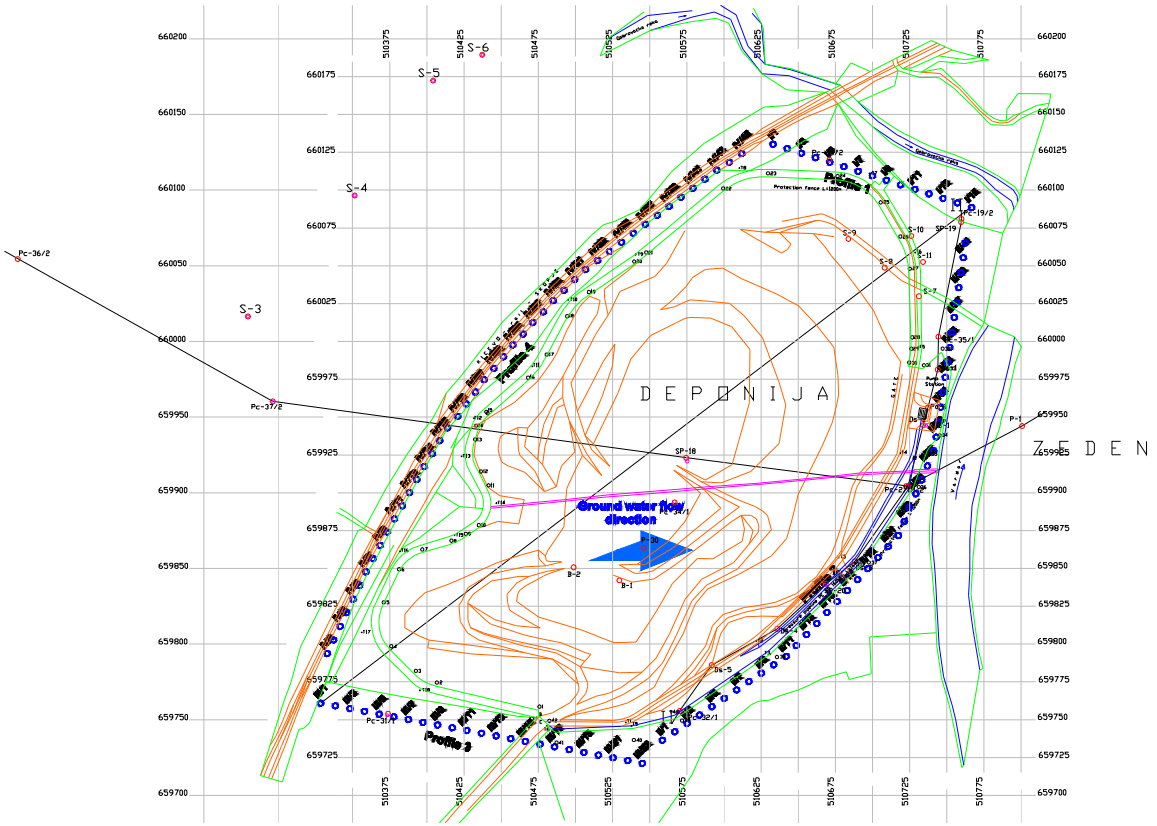
11.6.4.10 Vegetation on Landfill

- Establish an erosion control program to stabilize the soil soon after final capping of the landfill, in order to prevent erosion.
- Determine the soil nutrient status; before or during grass and ground cover trials soil tests
- Should be carried out to determine; ph, major nutrients content (nitrogen, potassium and phosphorus.
- Determine soil bulk density, since cover soil is frequently compacted by Landfill equipment during spreading operations increasing bulk densities, and this could severely restrict plant root growth.
- Modify soil cover is required: The soil over the entire planting area should be modified with lime, fertilizer in accordance with results of soil tests carried out prior to planting. These measures should be incorporated into the **top150mm of soil.**
- Select Landfill-tolerant species: Grass and other ground covers can be selected for planting in the soil cover by evaluating the results of the environmental plots established earlier to determine such Landfill-tolerant species.
- Plant grass and ground covers: It is generally desirable to embed the seed in the soil. Mulches can be used as an alternative to embedding the seed.

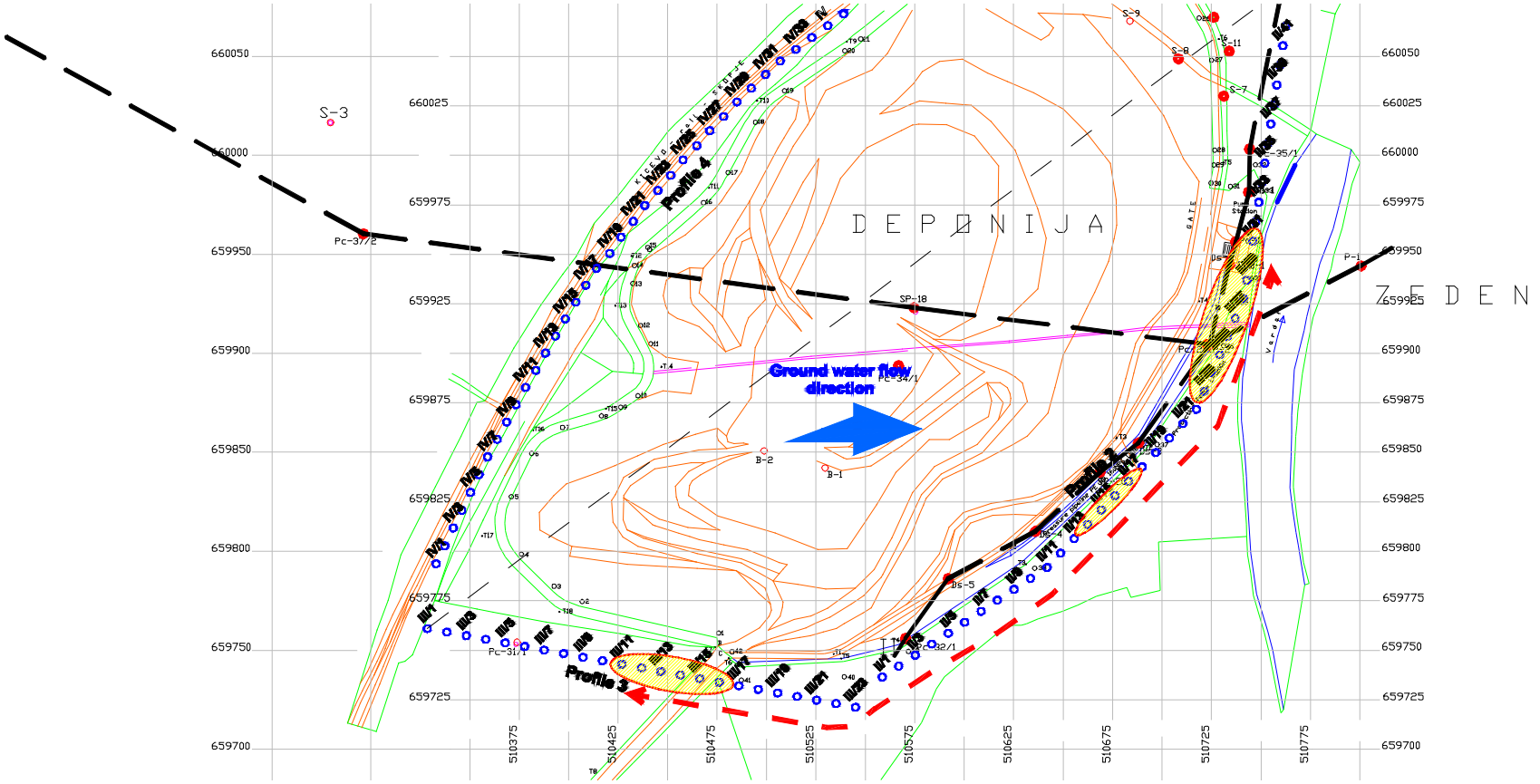


11.7 Maps

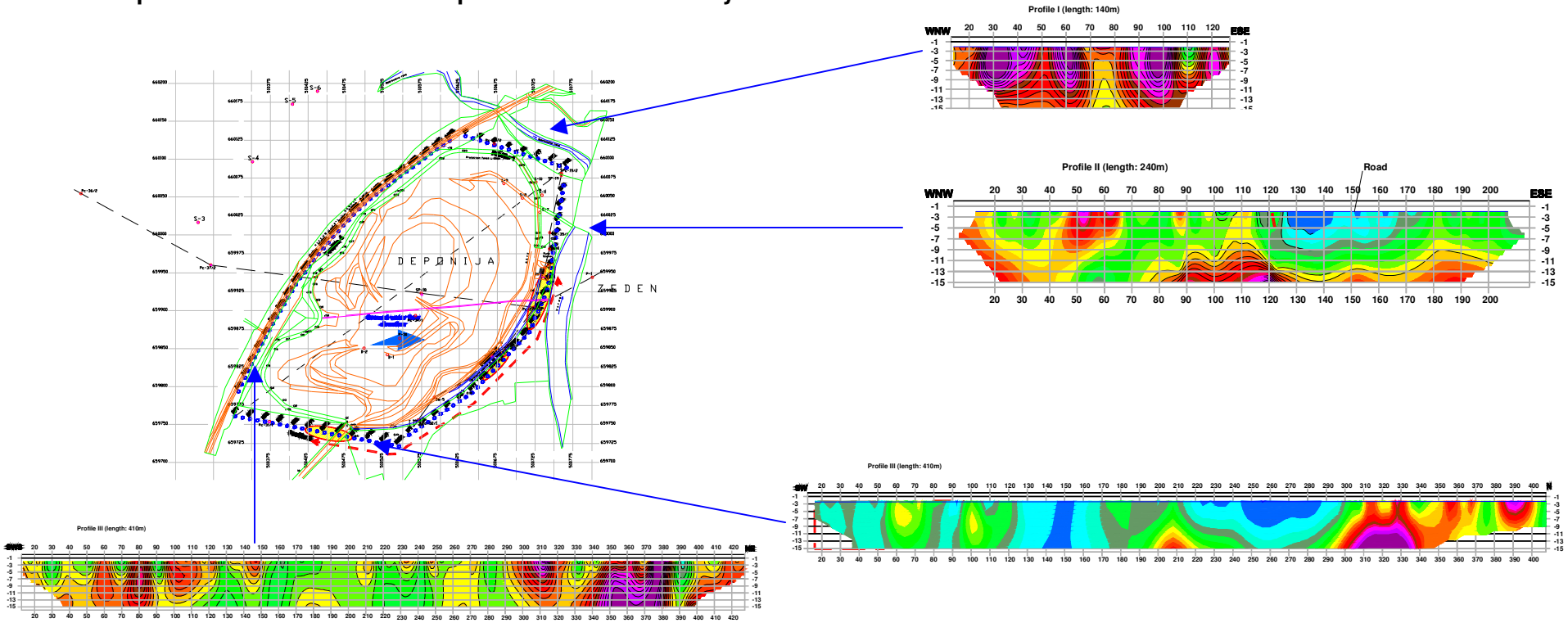
11.7.1 Maps – Silmak Chromium dumpsite – Profiles I till V



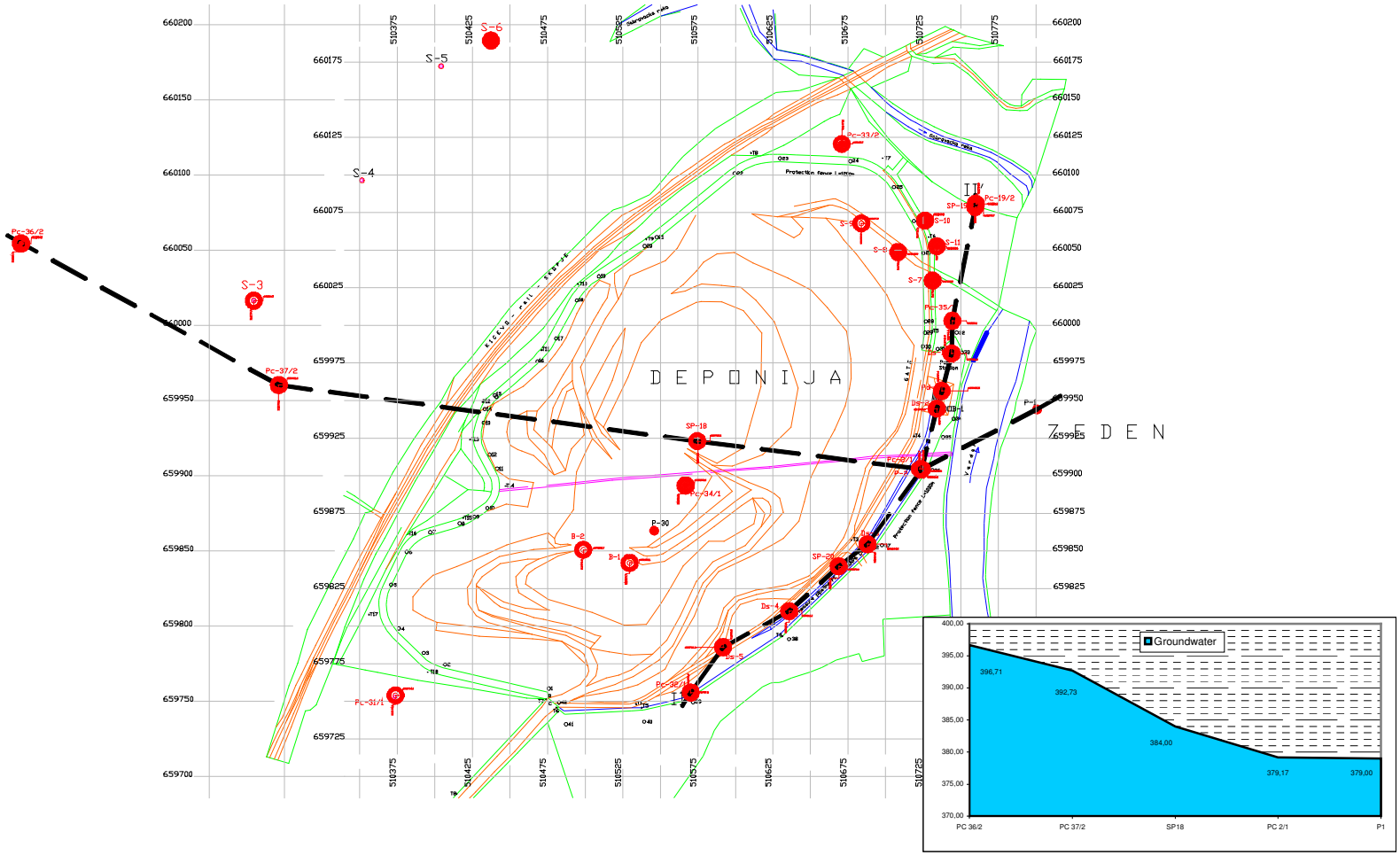
11.7.2 Maps – Silmak Chromium dumpsite – Anomaly Zones



11.7.3 Maps – Silmak Chromium Dumpsite – Vertical Anomaly Zones



11.7.4 Existing core drills and piezometer



11.8 Pictures

11.8.1 Silmak Chromium dumpsite