Chapter 4

Current Conditions of Hazardous Waste Management in Romania

4. Current Conditions of Hazardous Waste Management in Romania

This chapter provides detailed information on the current conditions concerning some aspects of hazardous waste management in Romania. The chapter comprises of the following sections:

4.1 Hazardous Waste Treatment and Disposal

4.2 Soil Contaminated Sites

Detailed information on other aspects of hazardous waste management in Romania is shown in Volume 3 and Volume 2 Chapter 6. Detailed information concerning administrative and legislative aspects of the hazardous waste management in Romania is shown in Volume 3 Chapter 3.

4.1 Hazardous Waste Treatment and Disposal

4.1.1 General Situation

Not all hazardous waste generation can be avoided, similarly it is not practicable to reuse, recover, recycle or utilise all unavoidable hazardous wastes. There will always be a need for environmentally sound hazardous waste treatment and disposal. In order to be managed effectively it is first necessary to correctly identify and segregate hazardous wastes.

Enterprises in Romania; are often failing to identify some hazardous wastes (either deliberately, because of unwillingness to pay for proper management or lack of available options for proper management, or unwittingly), secondly, some non-hazardous wastes are being incorrectly categorised as hazardous wastes.

Some hazardous wastes are however being identified and segregated and many of these are being “stored” pending later management. The term “storage” implies a future intention to do something with the material stored, but in Romania the term storage is used interchangeably with the term “disposal”. Most “stores” are in reality waste dumps.

ICIM have estimated that approximately 500,000 tons of hazardous industrial wastes were accumulated and stored within various companies by the end of 2000. In theory this is temporary storage pending utilisation, recovery, recycling, treatment or final disposal/landfill. However, it is noted that such “temporary” storage clearly lasts more than two years in some cases, essentially changing the local storage area into an unprotected landfill, located on companies’ sites.

The most commonly used storage methods are: bulk storage, storage in metallic containers and storage in basins/settling tanks. Storage conditions are often very poor and containment often poor - some metal containers observed holding wastes have almost completely rusted away.

Hazardous waste treatment or disposal may be undertaken at source (i.e. the location where the waste is generated), at other locations by the companies which generated the waste or by third parties. Hazardous waste management at source and by the waste generators is variable in Romania, management of organic wastes from the oil sector and organic chemicals sector has in the past been fairly good, and in some cases

still is.

4.1.2 Treatment and Disposal at Source

In common with many countries with transitional economies, many of Romania's industries have old, out-dated, inefficient processes and equipment. This is particularly true of waste treatment and disposal systems where these exist.

Many factories have in the past have had physical/chemical treatment systems and incineration systems which, due to economic pressures, have been allowed to fall into disrepair and have become inoperative as a result. Similarly, due to the general decline some factories have opted not to use their existing treatment facilities and also discharge wastes untreated or are stockpiling the wastes. Whilst this is a fairly general problem there are some examples of good practice too.

It is not uncommon for enterprises to compensate for lack of adequate wastewater treatment to rely on massive dilution of hazardous wastes to meet discharge consent concentrations.

According to data held by ICIM, in 1999 there were 846 industrial waste landfill sites in Romania; ICIM 2002 data indicates there are currently 687 industrial waste landfills. Landfill accounts for >80% of final disposal for industrial waste. It should be noted that in certain landfills for urban waste industrial waste is also disposed; some belonging to the category of hazardous waste, a fact that represents a serious infringement of the norms regarding the management of such waste. Many of the 'landfills' for industrial waste deposits are basic with little or no special provisions for containment of waste, leachate control or final cover; also, there are a large number of landfills for mining spoils (203) and settling ponds / catch pits (189) (Table 4.1.1a). Table 4.1.1b shows landfills by hazard category.

Table 4.1.1a Industrial Landfills by Categories

	Mining Waste Landfills	Catch pits and ponds	Drying beds	Landfills for slag and ashes	Simple deposits	Underground deposits	Other
Number	203	189	55	77	107	45	11
Occupied surface (ha)	5409	1608	50	3102	129	2	47

Source: EPR

Only 30% of the landfills for industrial waste have authorisation to operate. The remainder operate without such authorisation. 34% of landfills for industrial waste are located within built-up areas, 60% are outside settlements and 6% are located near waters.

Table 4.1.1b Industrial Landfills by Hazard Categories

	Inert	Non-hazardous	Hazardous	Not Specified
Number	103	351	147	86
Occupied surface (ha)	4500	4428	749	669

Source: ICIM 2002 Survey Data

Although the vast majority of industrial waste landfills are unsuitable for hazardous wastes, many probably receive a certain amount of hazardous wastes due to poor segregation of waste at source.

The majority of industrial waste landfills (about 76%) occupy relatively small areas (up to 5 ha). At least 50 industrial waste landfills do not have any investment for environmental protection. Some landfills have one or more special features (eg lining, drainage for leachate, perimeter ditches, monitoring boreholes), but very few have all the necessary features to comply with the conditions for the environmental protection. None meet full EU engineering or operational standards. In addition, fly tipping is common.

According to UNECE Environmental Report For Romania 2001, there are 83 land disposal sites specifically for hazardous wastes, with a total area of about 450 ha, located in 30 counties. 75% of these sites accept more than 10 tons of hazardous waste per day.

Only 10% of the landfills for hazardous waste are authorised by the environmental protection authorities. Most hazardous waste is deposited in landfill sites (60%), or stored (20%) at the industrial facility where the waste was generated, although some larger waste storage areas have been established on the sites of obsolete production plant where the ground was already contaminated.

Waste treatment in Romania is well behind Western practices. Table 4.1.2a derived from the ICIM 2002 Survey data (for which the information is provided by the local EPIs) identifies the types of different treatment reported for the industrial and agricultural wastes. The 2002 survey collected data based on the EU Treatment and Disposal Codes which are very ‘generic’ and shows that 72% of wastes are code E4 (discharged to land surface”. The 1999 survey (Table 4.1.2b) had shown that the predominant treatment methods were dehydration (eg filter press, drying beds), and mechanical means. It should be noted that treatment plants, where they do exist have often been allowed to fall into disrepair and many are non-functional. Also many facilities are extremely basic with no means of mixing contents to ensure adequate treatment, no fixed pipework systems or storage tanks for reagents, no means of taking adequate samples and so on.

Some enterprises have no access to sewer discharge systems and rely on tanker collection of wastewaters for disposal to sewage treatment works. Indeed during our industrial visits we found one enterprise that was sending inorganic electroplating wastes to a nearby company for incineration due to lack of suitable third party treatment systems.

Table 4.1.2a Types of Industrial and Agricultural Waste Treatment and Disposal Methods in 2002 for Purposes of Sale or for Final Disposal

RECYCLING OPERATIONS for hazardous waste (2002)	Code	%
recovery and regeneration of solvents	R1	0.025
recycling and recovery of organic waste	R2	0.033
recycling and recovery of metallic waste	R3	3.3
recycling and recovery of other inorganic waste	R4	1.149
regeneration of acids and bases	R5	0.463
recycling of materials used for pollutants collection	R6	0.227
recycling of catalysts	R7	0.002
refining of used oils	R8	0.584
use as combustible material or other mean for energy production	R9	0.941
use in agriculture, composting, other biological operations	R10	0.02
other non-mentioned use of waste	R11	0.438
waste exchange between operators	R12	3.113
temporary storage	R13	1.355
non-specified		0.12
TOTAL		**11.77**

DISPOSAL OPERATIONS for hazardous waste (2002)	Code	%
disposal on soil and in subsoil	E1	5.246
waste treatment in contact with soil	E2	0.013
underground injection	E3	0
discharge on surfaces	E4	71.945
disposal on special landfills	E5	3.186
discharge in waters	E6	0.492
discharge in sea	E7	0
biological treatment	E8	0.408
physico-chemical treatment	E9	2.28
incineration on soil	E10	0.003
incineration on sea	E11	0
permanent storage	E12	3.706
mixing	E13	0.004
reconditioning	E14	0.001
temporary storage	E15	0.868
non-specified		0.079
TOTAL		**88.23**

Source: ICIM

Table 4.1.2b Types of Industrial and Agricultural Waste Treatment Methods in 1999 for Purposes of Sale or for Final Disposal

Total	Mechanical	Chemical	Mechanical - chemical	Biological	De-hydration	Thermal	Other
5.2 MT	2.3	0.17	0.39	0.14	1.5	0.24	0.4
%	12	3.3	7.5	2.7	28.8	4.6	7.7

Source: ICIM

Several enterprises have dedicated hazardous waste incinerators; these are listed

in Table 4.1.3 these are generally used for management of the respective enterprise's own wastes although some do accept wastes from third parties.

4.1.3 Third Party Treatment and Disposal (General)

A country in transition like Romania generally does not have many hazardous waste contractors (companies which collect, transport, treat and/or dispose of hazardous wastes), however, there are a small number of hazardous waste management contractors. Note that hazardous waste recycling contractors have been covered separately (see Chapter 4.2).

There are a large number of waste collectors in Romania but these are only collecting municipal wastes. Some industrial wastes find their way into this collection stream but this is unofficial and claimed to be small volume.

These collection contractors generally do not operate the landfill sites; these are generally developed and operated by municipalities although private sector landfill operations are becoming more common. Industries largely transport their own wastes to municipal landfills or operate their own landfills / dumps – these activities were covered by the waste generation sources survey activities

4.1.4 Third Party Treatment and Disposal (Organic Wastes)

There are two very small commercially operated incinerators (ProAirClean and Mondeco), see Table 4.1.4 and two enterprises take wastes from third parties to burn alongside their own wastes generated (Arpechim and Uzina Produse Speciale – Fagaras). The small sizes of the ProAirClean and Mondeco incinerators are such that they are unlikely to be of strategic importance. The other two incinerators may have some spare capacity but again are unlikely to have great strategic importance.

Once again, many of these are low-technology devices and some have been poorly maintained resulting in some being unusable.

In addition, Romania has an established cement industry with several rotary cement kilns suitable for modification for utilisation of hazardous wastes. Two of the cement companies, Lafarge Romcim and HolCim have rotary cement kilns and are particularly keen to process hazardous waste as a supplementary fuel. At present, neither of these accept significant volumes of hazardous waste due to certain barriers which are include lack of willingness to pay.

Sotem Romania SRL is a company formed recently by Civa (USA) and HolCim which has an organic waste blending facility at the HolCim Campulung cement plant (see Figure 4.1.1). Sotem has put considerable efforts into developing the market for cement kiln incineration and has met with limited success. Sotem's facility at Campulung has the capability of processing a wide variety of organic wastes including liquids, sludges and solids and supplies blended waste as a fuel to the HolCim cement kiln. Figure 4.1.2 shows the blended waste feed system at the cement kiln. Locations of the major cement kilns are shown in Figure 4.1.3.

Figure 4.1.1 Sotem Organic Waste Blending Facility

Table 4.1.3 Incinerators on Industrial Enterprises Own Sites in Romania

Organisation	Type of Incinerator	Gas Cleaning System	Wastes Processed	Capacity T/yr (Total)	Capacity (Currently Used)	Operating (Yes/No)	Likely to meet EU Standards (Yes/No)
Arpechim, Pitesti [1]	3 Incinerators for process emissions 1 liquids incinerator		Acrylonotiriles (process emissions) Electroplating wastes!	80 cu.m / hr unknown	Unknown unknown	 Yes	 Unknown
Oltchim, Rm. Valcea	Fixed hearth liquid waste incinerator [2]	Acid gas absorber (for recovery of HCl)		18,000	18,000		Possible
Petrobrazi	3 Fixed hearth liquid incinerators 1 Rotary Kiln			5,000 16,500	?	No [3] No	No No
Petrom, Bucharest	Fixed hearth, dual combustion chamber.	Caustic soda scrubber.	Oil wastes.			No (awaiting authorisation)	No
Uzina Produse Speciale – Fagaras [1]	1 unknown type	unknown	Explosives (own and 3rd party)	unknown	65 tonnes (2001)	Yes	Unknown
S.C. Kober SRL	Unknown type	unknown	Paints/varnishes	unknown	unknown	Yes	Unknown

1 Process third party wastes as well as their own wastes

2 Oltchim want to add solids handling capability.

3 PetroBrazi claim that at least one is operating but this is considered unlikely to be the case.

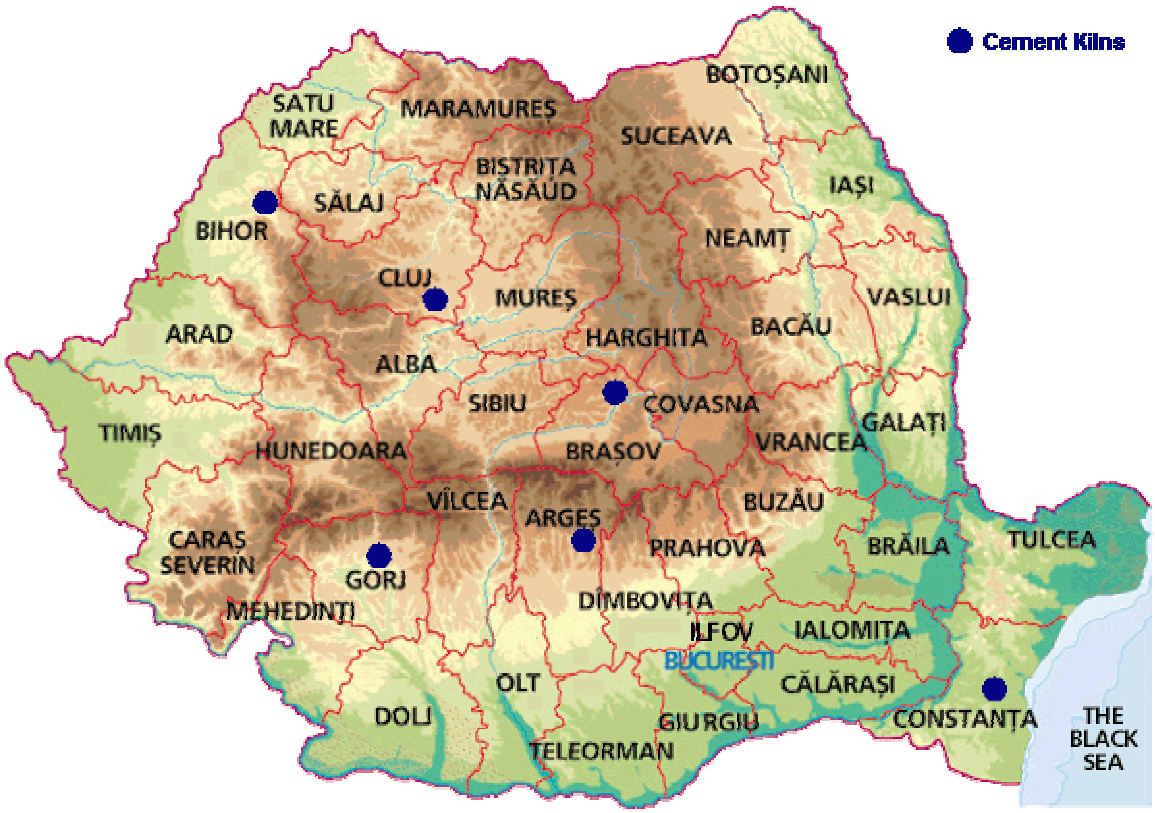
Table 4.1.4 Merchant Incinerators Currently Existing in Romania

Organisation	Type of Incinerator	Gas Cleaning System	Wastes Processed	Capacity T/yr (Total)	Capacity (Currently Used)	Operating (Yes/No)	Likely to meet EU Standards (Yes/No)
Mondeco, Suceava	Fixed hearth (2 units)	Gravity settling of heavy particulate only	Clinical wastes	40 kg/hr 10 kg/hr	40 kg/hr (2^{nd} unit inoperative)	Yes	No
Pro-Air Clean, Timisoara	Fixed hearth, dual combustion chamber.	Activated carbon, alkali scrubber / filter	Clinical and other hazardous wastes	1,200	1,200 [1]	Yes	Possible

1 In 2001 only operated 39 days but since February 2002 operating full time.

Figure 4.1.2 Blended Waste Feed System at Cement Kiln

Figure 4.1.3 Locations of Major Cement Kilns



The cement kiln operations do not currently fully meet European standards with respect to level of automation and continuous monitoring but Sotem/HolCim have a programme of improvements underway which will result in a system that will largely comply with EU standards.

Refineries generating large volumes of organic wastes need to treat and or dispose of these wastes and have a need for access to incineration plant. They could be potential investors in incineration, indeed some refineries have developed incinerators but several have been allowed to fall into disrepair and are unusable. Refurbishment / replacement could be extremely expensive, and whilst refurbished / new incinerators on refineries could process third party wastes, cement kiln incineration is likely to be more cost effective.

The situation then in Romania is slightly unusual in that facilities for the proper management of inorganic wastes are more lacking than facilities for proper thermal treatment. The strategy needs to take this into account.

4.1.5 Third Party Treatment and Disposal (Inorganic Wastes)

The survey work undertaken by the project team did not identify any third party contractors operating physical / chemical treatment services for management of hazardous wastes. This is a very significant omission and is resulting in certain hazardous wastes being stockpiled pending the emergence of such a service.

It is understood that one facility may exist in Timisoara but the local EPI were unaware of it and its existence cannot be confirmed.

4.1.6 Third Party Treatment and Disposal (Landfill)

As already indicated, in Romania, the terms ‘storage’, ‘landfill’ and ‘land disposal’ are often used interchangeably, as there has been tendency to label many wastes as materials being stored for future reuse, whether or not this is ever likely to be feasible.

4.2 Soil-Contaminated Sites

4.2.1 Definition

(1) Background

Management of soil-contaminated sites is one of the important issues that need consideration within a Master Plan for the management of hazardous waste substances. The experience in other industrial countries has shown that pollution caused by past industrial activities is generally quite significant and particularly difficult to mitigate or eradicate. Soil and groundwater contamination, which is the core problem of soil-contaminated sites, generates the risk of chronic long time exposure to hazardous substances through water consumption and land use, resulting in possible health damages and ecological damages. The difficulty of identifying contamination and risks (past activities, uncertainties of risks), the irreversibility of contamination, the difficulty of restoring conditions or to make risk level acceptable (high cost, finding of financial sources and responsibilities) are all challenging issues of soil-contaminated sites management.

(2) Definition

Contaminated site is the term currently used in EU countries to designate any kind of land area contaminated or potentially contaminated by present or historical hazardous waste pollution sources. Hazardous waste sites, abandoned hazardous sites, hazardous waste inactive sites, waste dump sites, old industrial facilities, contaminated land, derelict land, and others, are all examples of designation of soil-contaminated sites. Pollution sources of contaminated sites are mainly old industrial sites, waste dump sites, underground storage sites, and spill of toxic substances on ground.

There is no definition of soil-contaminated sites in Romania, excepted for specific targets like for example the municipal waste landfills. The regulation for landfilling of waste (Decision 162) provides a legal definition of what is a soil-contaminated site in this field: any landfill site having not received permit. Since environmental laws in Romania do not provide a legal definition of contaminated sites, it is proposed, within the scope of the study of the Master Plan, to include in soil-contaminated sites 4 categories of contamination sources, provided that they may be related to past or present activities:

- Landfill site, including dumps or lagoons
- Storage of hazardous waste
- Accidental spill: Past leakage or recent / present spill.
- Factories out of operation after closure (abandoned factories)

The hazaradous waste deposits and storage sites are the main categories of concern for the purpose of the master plan for management of hazardous waste in Romania. However, broadening the definition to include other categories of contaminated sites fits with the current definition and does not affect the implications for management issues. The JICA study team has used these 4 categories of contaminated sites for the questionnaire survey described in Volume 3. The hazardous waste substances of concern are assumed to be those defined by the Romanian legislation.

(3) Presentation of Current Situation

The current situation, which is a review of the physical conditions about soil-contaminated sites in Romania, has been evaluated according to 3 main kinds of data sources, which are:

- Existing inventories of water pollution sources in Romania;
- Questionnaire surveys sent to local EPIs;
- Field surveys (case studies).

4.2.2 Contamination Sources

(1) Inventory of Pollution Sources

There is no complete integrated inventory of soil-contaminated sites in Romania. Several specific inventories of pollution sources have been done almost without consideration of soil and groundwater issues. These inventories, which are explained below, can be characterised as follows:

- generally focusing on surface water pollution and have been initiated in the context of the Danube river protection convention;
- prepared under various jurisdictions presently or formerly covered by the ministry in charge of environment;
- information on present contamination which is mostly caused by present activities or by present management of old waste deposit sites, which makes the information partly but not completely relevant for the understanding of soil-contaminated sites.

The inventory works of landfill and waste storage sites, water hot spots and accident risk spots have been performed within the scope of the Danube Environmental Programme as supporting programs for long term planning and achievement of the objectives of the Danube river protection convention. As one of the contracting parties of the convention, Romania government must take appropriate measures for the prevention or reduction of trans-boundary impacts of water pollution, and for a sustainable and equitable use of water resources as well as the conservation of ecological resources. Although groundwater explicitly belongs to the water protection system of concern, it seems that it was given low priority in the Romanian inventories.

A first action of the Danube Environmental Programme was the preparation of an emission inventory of municipal and industrial waste water discharge point sources in 1995. Results are available on the Internet site of the MWEP (hot spots list). Later in 2000, the International Commission for the Protection of the Danube River (ICPDR) decided to prepare in 2000 the Inventory of Potential Accident Risk Spots in the Danube River Basin, as the first step towards the prevention of accidents in the Danube River Basin (Accident Emergency Prevention Warning System). These risk spots are evaluated based on water-endangering potential with criteria equivalent to those used in the EU Seveso II directive and the UN/ECE Industrial Accidents Convention.

Table 4.2.1 summarises the categories of pollution sources that are mostly taken into consideration in the inventories. Present activity means that site under concern is in operation or management activity. Past activity means no operation or no management. The PCBs inventory is not included because it refers to materials inventory instead of sites inventory. Respective inventories are described in sections below.

(2) Inventory of ICIM Waste Department (landfills)

The waste department of ICIM manages a regular inventory of operating waste landfill sites, within the larger scope of industrial waste generation reporting which was

started in 1993. The inventory is done through a questionnaire sent to the waste generators and collected back by EPI offices. The JICA field survey has shown that main soil-contaminated sites records kept by local EPI agencies are basically those of the waste landfills of the ICIM inventory.

According to the ICIM inventory, there are 951 industrial landfills operating in Romania, with no or low level of environmental protection, and existing potential risk of contamination of soil and groundwater. One third of these landfills are located within town limits and 6% close to a river. The ICIM inventory has recorded 83 industrial landfills for hazardous waste for 1999, covering a total ground area of about 450 ha. The largest number of industrial hazardous waste landfills are located in the following districts: Prahova (7 landfills), Alba, Arges and Vaslui (6 landfills each) and Timis (5 landfills).

Table 4.2.1 Summary of Contamination Sources in Existing Inventories

	Past activity sites				Present activity sites			
ICIM waste department (landfills)							x	
ICIM water department (water hot spots)					x	x	x	
ICIM water department (accident risk spots)					x	x	x	
Apele Romane (accident risk spots)					x	x	x	
Ministry of agriculture and sylviculture (pesticides)		x	x			x		

1. Factory; 2. Storage of hazardous waste; 3. Landfill / dump / lagoon; 4. Accidental spill.

(3) Inventory of ICIM Water Department (Water Hot Spots)

Soil and water degradation hot spots have been inventoried by ICIM in 1995. These hot spots have been determined according to several factors of degradation. Few hot spots like those of Copsa Mica, Baia Mare and Zlatna are directly determined by heavy metal contamination of soil. The surface and underground water related hot spots have been identified for 80 places but include many categories of contamination sources of an industrial, urban or agricultural nature. The list of water hot spots related to industrial pollution sources contains only 49 sites. Among these 49 sites, 26 were reported in the 1st EPI questionnaire, and 4 have been visited during the field survey.

(4) Inventory of ICIM Water Department (Accident Risk Spots)

The water department of ICIM has recently done an inventory of major potential accident risk spots in the Danube tributaries of Romania. This inventory has identified 28 risk spots, which are major contamination sources of surface water of significance at the level of the whole Danube river basin. These risk spots have been selected from a first list of 544 pollution sources including mainly industrial deposits, but also in principle old military sites, agricultural landfills, old mining tails, and contamination zone from old accidents. This inventory specifies the distance to surface water bodies, category of waste

and general ranking of environmental risk.

(5) Inventory of Apele Romane (Accident Risk Spots)

Water basin agencies have developed a system of inventory of contamination sources for surface water, with the objective of planning monitoring control activities and preparing accidental emergency plans at water basin levels. The list of contamination sources is registered in the water management plans prepared by the water basin agencies. The total number of contamination sources identified in latest reports amounts to about 1500 units for Romania. Contamination sources include not only industrial plants but also urban wastewater treatment plants.

Each contamination source receives a ranking priority score from highest to lowest priority. Ranking is established according to criteria, which are: Dilution, effluent quality, impact magnitude, risk of accidental pollution, environmental risk, and continuity and level of pollution. The scoring system is partly subjective but tries to be as integrated as possible. Oil and toxic substances are scored in the effluent quality item. Environmental risk includes several sub-items like: Biological diversity, eutrophication, oxygen demand decrease, sediments contamination, health risk, drinking water, agriculture, persistence of toxics, and others. The JICA study team has not evaluated the practical application and method for such scoring and ranking. Ranking scores of sites are in a range between a maximum of 360 and a minimum of 12.

(6) Inventory of Ministry of Agriculture and Sylviculture (Pesticides)

The Ministry of Agriculture and Sylviculture has identified and started action for the identification and eradication of obsolete pesticide storage or dumping sites. The inventory in this field has established the number of storage sites to 709 points, with around 1350 tons of solid and 550 tons of liquid waste pesticides. Main areas in terms of quantities of obsolete pesticides stored are the NE, NW and south counties. Counties with more than 100 tons are:

- In south west, Satu Mare and Bihor;
- In NE, Iasi and Vaslui;
- In south, Teleorman.

4.2.3 Soil and Groundwater

(1) Background

Groundwater is together with soil the primary receptor of hazardous substances discharged by old soil-contaminated sites. The risk level of exposure to contaminants is strongly determined by the conditions of use of groundwater resources and natural conditions of vulnerability of aquifers to surface contaminants.

It is important to know the location and distribution of groundwater resources and physical conditions of groundwater in order to get an idea of risk potential in case of contamination. Groundwater quality is also a good indicator of soil contamination potential.

(2) Groundwater Resources

Only 25 to 30% of centralised municipal water supply in Romania is from deep groundwater resources. The most important groundwater resources are in the Danube basin (about 32%) and the Siret basin (about 11%). Arges, Olt, Ialomita, and Mures river basins have also significant groundwater resources. In the total quantity of water withdrawal for all uses (municipal, agriculture and industry), groundwater represents only 13%. This rate is very low if compared with most western Europe countries (for example Denmark 99%, the Netherlands 68%, France 60%, of municipal supplies). However, it is estimated that individual water supply from shallow wells is still important in terms of population concerned. According to Apele Romane, only about 19% of rural municipalities have water from centralised water supply system, which shows a high dependency on shallow groundwater mostly in rural areas. More detailed data on the geographical distribution of groundwater intake in river basins could not be collected in spite of requests to the MWEP for access to the Apele Romane reports.

(3) Vulnerability Areas (ICIM)

ICIM is going to complete a study of groundwater vulnerability started in 1992. This study has been conducted within the scope of the program of prevention of transboundary accidental pollution in the Danube river basin. The object of study is the evaluation of environmental vulnerability of phreatic aquifers at country level. The output is a set of maps covering each of the 14 river basins of Romania. Vulnerability maps include also the areas for groundwater resources potential according to available volumes. The study has actually covered 12 river basins. The Siret and Danube downstream area remain to be done.

Groundwater vulnerability is defined according to 3 basic classes which are high, medium and low, according to hydro-geological conditions. Each vulnerability class is subdivided into 2 sub-categories that are, from highest to lowest vulnerability ranking:

- A1. Absence of natural protection layer
- A2. Natural protection with layers less than 3m thick
- B1. Thickness of layer 3 to 5m but infiltration from river bank
- B2. Same as B1 but infiltration through the soil
- C1. Protection by clay layers of 5 to 10m thick
- C2. Same as C1 more than 10m thick

(4) Vulnerability Areas (INMH)

The National Institute of Meteorology and Hydrology (INMH) works in collaboration with Apele Romane based on the surveillance network of groundwater: 1225 measurement points for phreatic water and 600 points for deep groundwater. One of the important outputs of INMH has been the mapping of drinking phreatic water quality conditions. It concluded that 68% of measurements of groundwater resources covered by the 1225 measurement points are not complying with potability criteria (mostly due to nitrates). This statement does not include contamination by hazardous substances. There are however 2 points of relevance for the soil-contaminated sites concern in the INMH

study: the geographical distribution of pressures on groundwater resources, and the indication of most vulnerable groundwater areas. The latter is however the object of the ICIM study.

(5) Groundwater Contaminated Areas

The JICA study team has requested from the MWEP the groundwater quality data recorded in the annual reports of Apele Romane, in order to make a statement of groundwater contaminated areas in Romania. Unfortunately, these reports have not been provided. It seems that there is no evaluation of the groundwater-contaminated areas in Romania. According to the State of Environment report of Romania, the following groundwater areas are considered contaminated by industrial pollution sources:

- Prahova-Teleajen area with contamination by petroleum products and phenol;
- Tg.Mures, Arad, Craiova, Rm.Valcea and Roznov areas with contamination by heavy metals;
- Victoria, Fagaras, Codlea, Isalnita, and Craiova areas (pollution not specified).

The oil and gas sector is certainly the best known on a case by case basis for its environmental impacts on soil and groundwater, mainly caused by leaks from pipelines. The common estimate of 50,000ha of land area contaminated by petroleum products is provided, with contamination of groundwater resources. The Authorities also consider the mining sector as a potential cause of groundwater and surface water contamination by heavy metals.

(6) Soil-Contaminated Areas

As in the case of groundwater, it seems that there is no evaluation of the soil-contaminated areas in Romania, and data are available on a case by case basis from environmental audit reports. As explained in 4.2.2, there is however a good national coverage surveillance network of soil quality, which is managed by the Research Institute for Soil Science and Agrochemistry.

This organisation published the results of a soil quality monitoring program in Romania in 2000. The study estimates that 200,000 ha are excessively polluted. The investigation has concluded from a certain level sampling that most extended soil pollution from industrial sources are caused by the following pollutants:

- Heavy metals and sulphur oxides (mainly Alba, Maramures, Sibiu);
- Fluorine compounds;
- Air emissions (SO_x, NO_x, NH_3, HCl);
- Blowing of materials in dumps;
- Organochlorinated insecticides (DDT and HCH).

The national State of Environment report shows that about 900,000 ha of soil are contaminated by heavy metals (Cu, Pb, Zn, Cd) and sulphur dioxide, with the typical examples of Baia Mare, Zlatna, and Copsa Mica. Of this area, the so-called excessive

pollution area amounts to 200,000 ha. High levels of soil pollution are reported for Targu Mures, Turnu Magurele, Tulcea, and Zlatna. Pollution by oil and salt water from oil exploitation is considered to concern an area of about 50,000 ha. These data seem to refer to 1992 and later to 1997, with same findings in both cases. They have been used in several reports (OECD, UNECE), but there is no information available about the investigations made and method of evaluation of these data.