Guvernul României

Uniunea Europeană

Asistență Tehnică pentru Pregătirea Proiectului în Domeniul Apei Potabile şi Apei Uzate, România

Judeţele Prahova, Buzău, Neamţ, Iaşi şi Bacău

Europe Aid 123050 / D / SV / RO /
Măsura ISPA 2005/RO/16/P/PA/001-2

STUDIU DE FEZABILITATE JUDEŢUL BACĂU

VERSIUNE FINALĂ

VOLUM I/2 - RAPOARTE

ILF
CONSULTING ENGINEERS

Hydro Ingenieure
Planungsgesellschaft für Siedlungswasserwirtschaft mbH
Beratende Ingenieure

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CHAPTER 6

INDUSTRIAL WASTEWATER DISCHARGES

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6.1 Introduction

Industrial wastewater discharged into public sewers can be an important part of the organic and inorganic loads of wastewater treatment plants and needs to be considered in their design and operation.

Uncontrolled discharges of industrial wastewater can have a **negative impact on wastewater collection systems** such as:

- Structural damage to the sewer system by corrosion caused by acids and caustic substances;

  Acids and caustic substances can cause considerable damage to a wastewater collection system, especially on concrete sewers where the cement will be washed out when coming into contact with acids. This will affect the structural stability of the pipes and manholes up to the point where the structures can collapse. Often this kind of damage can be discovered in the first sections of sewers downstream the inflow point of such discharges. The same applies to the biological sulfur corrosion which occurs when there are extreme anaerobic conditions in the sewer due to high organic loads.
- Blockages or negative effect on the hydraulic capacity of the sewers by sedimentation;

  Some manufacturing processes are linked with the production of materials which have the potential of causing blockages in a wastewater collection network. This can cause higher operational efforts such as flushing of the sewers or even permanent damage caused by hardened sediments.
- Formation of scum layers by fat, grease, etc;
- Formation of explosive mixtures in contact with air.

Furthermore, uncontrolled discharges of industrial wastewater can also have a **negative impact on the wastewater treatment plant** such as:

- Breakdown of the purification process in the WWTP resulting from toxic discharges;
  The purification process in wastewater treatment plants depends mainly on biological activity such as organic-carbon digestive removal, nitrification, denitrification, enhanced biological P-removal, etc. Hazardous toxic discharges can cause a disturbance or even a breakdown of these processes. Nitrification, an important step in achieving the required nitrogen removal, is particularly sensitive to toxic discharges. Once the activated sludge has been infected, it takes a relative long time for recovery.
- Formation of bulking sludge in the biological stage of the WWTP caused by high organic loads;
  Organic matter can cause bulking sludge, which has a negative impact on the settling conditions of the activated sludge in the secondary clarification. This again,

will negatively influence the effluent concentrations. In the worst case, activated sludge will not settle in the secondary clarifiers but will leave the system via the overflow weirs and will flow into the receiving waters.

- Negative influence on the quality of the sewage sludge to be disposed.
  The quality of the sludge to be disposed of depends to a great extent on the wastewater which has been treated. Wastewater discharges with high heavy metal and toxic substance concentrations can significantly influence the sludge quality such that sludge recycling for agricultural and other purposes is not possible.

It is necessary to have specific knowledge of the industrial wastewater discharges in order to protect the facilities from their impacts.

6.2 Objectives

According to the Terms of Reference, Chapter 4.2.8.a, a *Report on Industrial Wastewater Discharges* shall be provided. This report is to describe the following aspects:

- background,
- investigations of discharges,
- wastewater pre-treatment plants,
- impact evaluation of the industrial wastewater discharges on the WWTP influent,
- proposal for monitoring and management of industrial wastewater discharges, and
- conclusions and recommendations.

The Report on Industrial Wastewater Discharges will be the basis for the *Action Plan to Control Industrial Wastewater Discharges*. The Action Plan will:

- describe appropriate measures for reducing and controlling the industrial wastewater discharges,
- identify short and medium-term actions, and
- point out responsibilities under consideration of the intended time schedule for the implementation of new wastewater treatment plants or the rehabilitation of existing wastewater treatment plants.

This Chapter of the Feasibility Study is the *Report on Industrial Wastewater Discharge* and also contains the *Action Plan to Control Industrial Wastewater Discharges*.

6.3 Legal Regulation on Industrial Wastewater

6.3.1 Compilation of relevant EU directives and Romanian regulations

The following EU Directives and Romanian Laws are relevant for industrial wastewater:

EU Directives:

EU Directive **91/271/EEC** concerning urban wastewater treatment and which is the basis for Romanian Standards NTPA-001/2002 and NTPA-002/2002

EU Directive **80/778/EEC** concerning drinking water and as subsequently amended by Directive **98/83/EC**

EU Directive **80/68/EEC** on the protection of groundwater, amended by EU Directive **91/692/EU**, they were repealed and to be replaced with EU Directive **2000/60/EC**, which goes into effect on December 21, 2013

EU Directive **79/869/EEC** concerning monitoring and sampling surface waters

EU Directive **75/440/EEC** concerning the quality of surface water used for drinking water

EU Directive **76/464/EEC** concerning pollution caused by the discharge of certain substances into the environment

This directive identifies significant parameters which are enumerated in its "List 1" attachment of Maximum Admissible Concentrations (MAC). The later EU Directive **83/513/EEC** adds Cd and Hg to this list. These two directives have since been modified by a series of further EU Directives.

EU Directive **2000/60/EC** establishes a framework for community action in the field of water policy, amended by EU Directives **2008/32/EC**, **2008/105/EC** and **2009/31/EG**

EU Directive **75/442/EEC** concerning "waste" and as subsequently amended by various Commission Decisions, the last being **96/350/EC**

EU Directive **86/278/EEC** concerning the disposal of sewage sludge

EU Directive **85/337/EEC** concerning the need for "Environmental Impact Assessments"

EU Directive **96/61/EC** concerning "Integrated Pollution Prevention Control"

Romanian Regulations:

Law 107/1996 Water Law

Law 310/2006 amended Law 107/1996

Law 112/2006 amended and completed Law 107/1996

Law 241/2006 on water and wastewater servicies

Government Decision 188/2002 approving the standards NTPA-001, NTPA-002 and NTPA-011 on the requirements for wastewater discharge into aquatic environments

Government Decision 352/2005 amended and completed GD 188/2002

NTPA-001/2002 technical norm concerning pollutant loading limits of industrial and urban wastewater when discharging into natural receiving water bodies

NTPA 002/2002 technical norm concerning conditions for wastewater discharge into municipal sewerage networks and directly into wastewater treatment plants

NTPA 011/2002 technical norm concerning collection, treatment and discharge of urban wastewater

Government Decision 472/2000 on the protection of water resources quality

Government Emergency Ordinance 195/2005 regarding environmental protection

Government Emergency Ordinance 107/2002 concerning the establishment of National Water Administration "Apele Române" (Annex 5, Art. 6)

Other Romanian legislation in the field of environmental protection:

- **Government Decision 1076/2004** on the regulation for environmental valuations for planning and programming
- **Ministry of the Environment and Water Management Order 661/2006** on the approval of standards over the technical documentation and responsibilities in issuing water management permits and licenses
- **Government Decision 573/2002** on the approval of the regulation for commercial authorizations
- **Order 184/1997** on the regulation for the environmental balance
- **Government Emergency Ordinance 78/2000** on the toxic waste regime and approved by **Law 426/2001**
- **Government Emergency Ordinance 16/2001** on the managing of recyclable industrial waste, republished 2002 with further modifications
- **Ministry of Industry Order 1621/1995** on the authorization of the economic agents that perform activities concerning waste
- **Government Emergency Ordinance 243/2000** on the protection of the atmosphere and by **Law 655/2001**
- **Order 506/1996** on the approval of the Regulation Procedure for the Export-Import of substances, products, and equipments subscribed in the Montreal Protocol regarding substances that harm the ozone layer
- **Government Decision 568/2001** on the technical requirements to limit emissions of volatile organic compounds from the storage, loading, unloading and distribution of petrol at terminals and the gas stations, modified and completed by **Government Decision 893/2005**
- **Law 360/2003** on the regulation of dangerous chemical substances and compounds

Government Emergency Ordinance 195/2005 establishes in Article 2 the strategic principles of

- integration of environmental requirements into policies of other sectors,
- precaution in decision making,
- preventive action,
- retention of pollution at the source,
- polluter-pays,
- conservation of biodiversity and ecosystems specific to the sustainable use of natural resources,
- public information and participation in the decision making process as well as access to the judicial system regarding environmental issues, and
- development of international collaboration for environmental protection.

6.3.2 Limits for indirect dischargers (NTPA 002/2002)

The NTPA 002/2002 contains quality standards for the wastewater to be discharged into municipal sewerage networks and in wastewater treatment plants. It contains a list of chemical and biological-chemical parameters of wastewater (see Table 6-1) which must not be exceeded when discharged into municipal wastewater collection systems. Furthermore, other substances are listed which must not be discharged into the municipal sewerage networks, independent of the chemical and biological-chemical parameters, such as oil, fat.

In Article 10 and 11, the framework for the contract between the water user and the operator of the wastewater system is defined, such as the stipulation of maximum loads and concentrations, the check-points for wastewater quality control and the analysis frequency.

No.	Parameter	Limit Value
1	Temperature	40° C
2	pH	6.5 - 8.5
3	Total Suspended Solids	350 mg/l
4	BOD_5	300 mg O_2/l
5	COD_{Cr}	500 mg O_2/l
6	NH_4^+	30 mg/l
7	P_{total}	5 mg/l
8	Cyanide (CN^-)	1 mg/l
9	S^{2-}	1 mg/l
10	SO_3^{2-}	2 mg/l
11	SO_4^{2-}	600 mg/l
12	Phenol (C_6H_5OH)	30 mg/l

No.	Parameter	Limit Value
13	Substances extractable with organic solvents	30 mg/l
14	Biodegradable synthetic detergents	25 mg/l
15	Pb^{2+}	0.5 mg/l
16	Cd^{2+}	0.3 mg/l
17	Cr_{total} (Cr^{3+} + Cr^{6+})	1.5 mg/l
18	Cr^{6+}	0.2 mg/l
19	Cu^{2+}	0.2 mg/l
20	Ni^{2+}	1 mg/l
21	Zn^{2+}	1 mg/l
22	Mn_{total}	2 mg/l
23	Cl_2	0.5 mg/l

Table 6-1: Discharge limits for indirect dischargers (NTPA-002/2002)

GD 472/2000 sets the fines which the dischargers must pay if they do not meet the NTPA-002 limits. The level of these fines, however, does not represent the present social costs associated with contaminated discharges.

6.3.3 Polluter-Pays-Principle

The principle's goal is that the polluter pays the full costs of the pollution it causes. It is an economic and not a juridical principle. The polluter-pays-principle has been recognized as a general principle of international environmental law since 1990[1]. The principle does not mean to punish the polluter, but to establish the necessary economic conditions such that all the environmental costs associated with the operation of a polluter will be considered, leading to sustainable development.

As it is evident, the principle aims at stopping the waste of natural resources and the cost-free use of the environment. The implementation of the polluter-pays-principle results in better environmental conditions by creating incentives for industries to decrease their pollution **loads**. This does not imply decreasing the volume of discharged wastewater but it refers to the total pollution load discharged.

According to international experience, a set of conditions should be met for the polluter-pays-principle to be implemented successfully (including public support):

- clear description of the pollution sources,
- accurate measurements of the pollution loads,
- fairness and good cooperation among all involved parties, and
- implementation of a strong institutional framework.

[1] Economic Instruments for Environmental Protection, OECD, Paris, 1989, Environmental Policy: How to Apply Economic Instruments, OECD, Paris, 1991

The implementation and continued development of the polluter-pays-principle will be an important task of the overall project and it is included in the measures compiled and scheduled in the "Action Plan" (Chapter 6.9).

6.3.4 Prevention and control of accidental pollution

According to Water Law 107/1996, Article 23, Paragraph (2) and NTPA-002/2002, Article 11f, the users of water and other linked facilities are obliged to prepare and implement, if necessary, their own plans for the prevention and control of accidental pollution which might occur as a result of their activities.

According to the same Article, Paragraph (3) of Law 107/1996, the preparation of the plans for the prevision and control of accidental pollution is to be carried out in accordance with a frame-work-methodology established by the Ministry of Waters, Forests and Environmental Protection, which was issued by **Order 278/1997**. Romania shares several cross-border river basins up and downstream with Hungary, Moldova, Ukraine and Serbia. Cross-border water pollution by accidents is also a significant issue.

The preparation of a plan to prevent and control accidental pollution under consideration of the special local conditions will be one of several actions to be carried out by the regional operator in cooperation with the industrial dischargers. This measure is considered in the "Action Plan" (Chapter 6.9).

6.4 Approach and Methodology

An unique aspect of the preparation of this study was the lack of a Regional Operating Company (ROC) during its preparation. This necessitated working with each individual wastewater system operator in the County and, to a degree, with individual villages and communities which are to be incorporated into larger agglomerations. Consequently, the quality of information varies greatly from agglomeration to agglomeration. A ROC which is necessary for CF grants was formed just as this study was being completed.

According to the ToR an inventory of industrial wastewater shall be prepared for industries discharging into the municipal sewage networks. In order to get an overview of the industrial activities with special emphasis on industrial wastewater, a database was created at first in form of an inventory as requested by the Terms of Reference for Phase 1a – Data Collection / Master Plan and in summary compiled in Chapter 6.5 of this Feasibility Study.

For this purpose, a questionnaire was developed and distributed among the major indirect dischargers (see Annex 9.1). The questionnaire includes general information and information regarding wastewater. The dischargers were asked to give information on the following aspects:

- general organizational structure such as name, address, contact person, fields of activity, toxic/hazardous substances handled,
- information on water consumption and water supply source,
- information on wastewater production, i.e., quantities, type of wastewater, main pollutants,
- information on wastewater pre-treatment and
- information on institutional structure and legal framework.

The information collected with the questionnaires were summarised in the Inventory on Industrial Wastewater which is part of the Feasibility Study. All given data were evaluated and adjusted flows and loads were used in calculating the treatment plant loadings. The Consultant used standards elaborated by the German Association for Water, Wastewater and Waste (DWA) (formerly ATV and DVWW) for the different industries and *Reference Documents (BREF) by the European Commission Joint Research Center,* especially for the impact evaluation of the industrial wastewater on the total wastewater composition.

Additionally, information about the current performance of the wastewater system operators concerning industrial wastewater was requested, such as:

- reports regarding the management of industrial wastewater,
- action plans to control industrial wastewater discharges,
- existing tariff structure,
- existing monitoring programs,
- plans for unforeseen situations (accidental discharges) and

- status and documentation of pre-treatment facilities.

The results are summarised in Chapters 6.6 and 6.9.

In Chapter 6.7 the impact of the industrial wastewater discharges on the influent to the wastewater treatment plants is evaluated. If the field of activity of the various industries is known it is possible to identify potential discharges which might affect the composition of the wastewater to be treated at the municipal wastewater treatment plant.

6.5 Investigations of Industrial Wastewater Discharges

The dischargers into urban wastewater collection systems are normally classified as domestic and commercial/industrial. The commercial/industrial dischargers are referred to in Romania as Economic Agents (EAs). The lists of the EAs for each agglomeration were evaluated to determine the dischargers which may have wastewater characteristics other than domestic and of these a separation was made between "minor" and "major" EA dischargers. The *major* dischargers would be classically classified as industrial dischargers. But the wastewater from many *minor* dischargers can be quite contaminated and could easily (probably) exceed the limit values of the NTPA-002 without pre-treatment.

The following inventory, for the sake of brevity, is only for the *major* dischargers. Nevertheless, the impact of the numerous *minor* dischargers as well as their pre-treatment and monitoring requirements are included in this report and the action plan. Table 6-2 summarizes the 2010 population, population equivalent, total economic agents and industrial dischargers for each agglomeration.

Agglomeration	Connected Population	Connected Additional p.e.	Economic Agents	Minor Dischargers	Major Dischargers
Bacău	143,130	40,000	1,471	178	22
Buhuşi	10,700	6,290	176	17	5
Comăneşti-Moineşti[2]	16,060	3,820	254	37	9
Dărmăneşti	115	0	0	0	0
Târgu Ocna	6,600	1,640	374	n.i.	10

Table 6-2: Connected population and economic agents

The individual industrial indirect dischargers were identified in each agglomeration and their contracts with the wastewater collection system operator were collected. Each *major* discharger has an environmental discharge permit with the local Environmental Protection Agency (Agentia de Protectie a Mediului or APM) which specifies any special safety precautions, discharge limits and whether pre-treatment is required before

[2] The agglomerations Comăneşti and Moineşti have to be merged following the EU specifications for agglomeration definition. Local political disruptions are not a sufficient justification for splitting of agglomerations.

The new name of the merged agglomeration is Comăneşti - Moineşti. Comăneşti still refuses to join the IDA and the ROC thus being ineligible for CFs, whereas the communities Moineşti and Găzărie joined both the IDA and the ROC. As a consequence Moineşti and Găzărie were included in the CF project.

All investment measures, performance indicators, CBA, etc as set out in this FS refer to the communities of Moineşti and Găzări only, not the whole Agglomeration Comăneşti - Moineşti.

discharge into the wastewater collection system. Further, the dischargers have a contract with the local wastewater system operator which regulates what is allowed to be discharged (maximum limit values of specific parameters) and the billing procedure for water supplied and the returned wastewater.

The various discharge requirements and billing procedures were extracted from these contracts. The billing procedures for wastewater and storm water have been summarized along EU lines and noted in the inventory tables with the follows symbols:

Billing Procedure Code:

Wastewater

A - not charged

B - flat rate, independent of volume or load

C - volume discharged based on water supply volumes

D - volume discharged based on measured or estimated discharge

E - load (kg BOD, kg COD, etc) discharged based on measurements

Storm water

F - not charged

G - volume discharged to combined system

H - volume discharged to separate storm water system

6.5.1 Agglomeration Bacău

The Agglomeration Bacău consists of the City of Bacău and parts of the four Communities of Letea Veche, Măgura, Mărgineni and Hemeiuş. Wastewater services have been provided in the City of Bacău by S.C. Compania de Apă Bacău S.A. (CAB). The Community of Letea Veche has not had any wastewater service but a collection system is presently being constructed which will connect into the CAB system. Portions of Măgura and Mărgineni have collections systems which are connected into the CAB system. Hemeiuş has no wastewater services.

There are twenty-two major industrial dischargers in the CAB wastewater system. The CAB defines only EAs with a discharge greater than 500 m^3/month as *major* dischargers.

The present concept for the new ISPA financed Baraţi WTP is to discharge the coagulation-flocculation and filter backwash sludge into the CAB wastewater collection system when it goes into operation in 2011. If this concept is implemented the discharge would be the largest in the County. It would also bring significant problems and costs to the collection system and the WWTP. As described in Chapter 7.11, Proposed Sludge Disposal Strategy, this discharge must not occur, the sludge must be dewatered onsite and transported overland to a landfill. For this reason the Baraţi WTP is not listed here in the discharger inventory.

No.	Discharger	Address	Economic Activity	Discharge Location
1	**S.C. AGRICOLA Internaţional S.A. Departamentul "Abatorul de Păsări"**	Calea Moldovei nr. 230	food processing - slaughter house	Calea Moldovei nr. 230
2	**S.C. AGRICOLA Internaţional S.A. Departamentul "Avicola"**	Calea Moldovei nr. 53-55	agriculture, forest and fishery - chicken production	Calea Moldovei nr. 53-55
3	**S.C. AGRICOLA Internaţional S.A. Departamentul "F.N.C."**	Calea Republicii nr. 283	agriculture, forest and fishery - animal feed	intersection of Calea Moldovei and str. Metalurgiei
4	**S.C. EUROPROD S.A. Bacău racordul 1, 2, 3**	Calea Moineşti nr. 16	food processing - meat processing	Calea Moineşti nr. 16
5	**S.C. AEROSTAR S.A.**	str. Condorilor nr. 9	other - aerospace industry	str. Condorilor nr. 9
6	**S.C. ALMERA International S.R.L.**	str. Tolstoi nr. 67	food processing - dairy	n.i.
7	**S.C. ARENA CITY CENTER S.R.L.**	str. Stefan cel Mare nr. 28	other - commercial centre	str. Stefan cel Mare nr. 28
8	**S.C. BILLA ROMÂNIA S.R.L. unitatea 804**	str. Stefan cel Mare nr. 28 A	other - commercial centre	str. Stefan cel Mare nr. 28 A
9	**S.C. BILLA ROMÂNIA S.R.L. unitatea 805**	str. Mioritei nr. 27	other - commercial centre	str. Mioritei nr. 27
10	**S.C. COMAT BACĂU S.A.**	str. Constantin Muşat nr. 1	other - warehouse	intersection of str. Constantin Muşat and str. Constanţei
11	**S.C. CONAGRA S.A. Bacău**	Calea Moineşti nr. 16	food processing - meat processing	Calea Moineşti nr. 16
12	**S.C. PAMBAC S.A. Bacău**	Calea Moineşti nr. 14.	food processing - bread manufacturing	13 discharge locations in the City
13	**S.C. ROMBET S.A. Bacău**	str. Izvoare nr. 98	construction - concrete plant and asphalt mixtures	str. Izvoare nr. 98
14	**S.C. SALBAC DRY SALAMI S.A.**	str. Abatorului nr. 5	food processing - slaughter house and meat processing	str. Abatorului nr. 5
15	**S.C. SELGROS CASH & CARRY S.R.L.**	str. Prelungirea Bradului nr. 135 B	other - commercial centre	str. Prelungirea Bradului nr. 135 B
16	**S.N.T.C.F.-R.T.F.C. IAŞI EXPLOATARE LOCOMOTIVE (racord 1)**	Calea Moineşti nr. 1	transport - railway	Calea Moineşti nr. 1

No.	Discharger	Address	Economic Activity	Discharge Location
17	**S.N.T.C.F.-R.T.F.C. IAŞI REVIZIE VAGOANE CĂLĂTORI (racord 2)**	str. Gheorghe Donici nr. 2	transport - repair and maintenance of railway carriages	n.i.
18	**S.N.T.C.F.-R.T.F.C. IAŞI REVIZIE VAGOANE CĂLĂTORI REVIZIE VAGOANE CĂLĂTORI (racord 3)**	str. Gheorghe Donici nr. 2	transport - repair and maintenance of railway carriages	n.i.
19	**S.C. SONOMA S.R.L.**	str. Tazlăului nr. 7	textile - clothing	str. Aprodu Purice
20	**SPITALUL DE PNEUMOFTIZIOLOGIE BACĂU**	str. Oituz nr. 72	other - hospital	str. Oituz nr. 72
21	**SPITALUL JUDEŢEAN DE URGENŢĂ BACĂU**	str. Spiru Haret nr. 2-4	other - hospital	Calea Maraşeti
22	**S.C. SUBEX S.A.**	str. Milcov nr. 3-4	metallurgic - fastener manufacture	str. Milcov nr. 3-4

Table 6-3: Indirect Discharger Inventory - 1 - Agglomeration Bacău

No.	Discharger	Operator Contract			APM Permit	
		No. / Discharge Limits	Date	Billing Procedure	No.	Date
1	**S.C. AGRICOLA Internaţional S.A. Departamentul "Abatorul de Păsări"**	135 [1]	26.05.2009	C, G	46	29.12.2006
2	**S.C. AGRICOLA Internaţional S.A. Departamentul "Avicola"**	135 [1]	26.05.2009	B, G	4	09.02.2007
3	**S.C. AGRICOLA Internaţional S.A. Departamentul "F.N.C."**	135 [1]	26.05.2009	C, F	372	05.10.2007
4	**S.C. EUROPROD S.A. Bacău racordul 1, 2, 3**	1583 [1]	09.07.2009	C, G	357	23.10.2008
5	**S.C. AEROSTAR S.A.**	139 [1]	01.01.2010	C, G	3 Integrated Authorization 25	01.01.2005 07.08.2006
6	**S.C. ALMERA International S.R.L.**	186 [1]	03.11.2009	C, G	227	16.06.2007
7	**S.C. ARENA CITY CENTER S.R.L.**	1568 [1]	09.07.2009	C, G	358	23.10.2008
8	**S.C. BILLA ROMÂNIA S.R.L. unitatea 804**	1162 [1]	15.06.2009	C, G	19	18.01.2008
9	**S.C. BILLA ROMÂNIA S.R.L. unitatea 805**	1162 [1]	15.06.2009	C, G	3	08.01.2009
10	**S.C. COMAT BACĂU S.A.**	494 [1]	21.06.2010	C, G	92	24.06.2010
11	**S.C. CONAGRA S.A. Bacău**	1029 [1]	05.06.2009	n.i.	94	24.06.2010

No.	Discharger	Operator Contract			APM Permit	
		No. / Discharge Limits	Date	Billing Procedure	No.	Date
12	S.C. PAMBAC S.A. Bacău	132 [1]	26.05.2009	C, G	120 209 268 33 34 35 72	25.05.2006 11.08.2006 24.10.2005 24.01.2007 24.01.2007 24.01.2007 20.02.2007
13	S.C. ROMBET S.A. Bacău	532 [1]	10.03.2010	C, G	491	18.12.2007
14	S.C. SALBAC DRY SALAMI S.A.	1586 [1]	09.07.2009	C, G	93	24.06.2010
15	S.C. SELGROS CASH & CARRY S.R.L.	590 [1]	01.06.2009	C, F	127	16.04.2007
16	S.N.T.C.F.-R.T.F.C. IAŞI EXPOATARE LOCOMOTIVE (racord 1)	659 [1]	05.10.2009	B, F	166	14.05.2007
17	S.N.T.C.F.-R.T.F.C. IAŞI REVIZIE VAGOANE CĂLĂTORI (racord 2)	659 [1]	05.10.2009	B, F	69	16.02.2007
18	S.N.T.C.F.-R.T.F.C. IAŞI REVIZIE VAGOANE CALATORI (racord 3)	659 [1]	04.2006	B, F	68	16.02.2007
19	S.C. SONOMA S.R.L.	662 [1]	05.2008	C, G	413	31.10.2007
20	SPITALUL DE PNEUMOFTIZIOLOGIE BACĂU	143 [1]	28.05.2009	C, G	177	19.06.2009
21	SPITALUL JUDETEAN DE URGENTA BACĂU	138 [1]	26.06.2009	B, G	270	12.07.2007
22	S.C. SUBEX S.A.	137 [1]	26.06.2009	C, G	251 Integrated Authorization 15	03.10.2006 05.06.2006

[1] NTPA-002/2002 discharge limits   n.i. = no information

Table 6-4: Indirect Discharger Inventory - 2 - Agglomeration Bacău

No.	Discharger	Pre-Treatment	Monitoring Results	Questionnaire
1	S.C. AGRICOLA International S.A. Departamentul "Abatorul de Pasari"	M + B, chlorination, sludge dewatering	CAB [1] 2005-2009 SM [2] 2006-2009	2009
2	S.C. AGRICOLA Internaţional S.A. Departamentul "Avicola"	none	CAB 2005-2009 SM 2006-2009	2009
3	S.C. AGRICOLA Internaţional S.A. Departamentul "F.N.C."	3-stage sedimentation	CAB 2005-2009 SM 2006-2009	2009
4	S.C. EUROPROD S.A. Bacău racordul 1, 2, 3	pre-treatment	CAB 2005-2009 SM 2006-2009	2009
5	S.C. AEROSTAR S.A.	pre-treatment, oil separation	CAB 2005-2009 SM 2006-2009	2009

No.	Discharger	Pre-Treatment	Monitoring Results	Questionnaire
6	**S.C. ALMERA International S.R.L.**	oil separation	CAB 2005-2009 SM 2006-2009	2009
7	**S.C. ARENA CITY CENTER S.R.L.**	n.i.	CAB 2008-2009 SM 2008-2009	2009
8	**S.C. BILLA ROMÂNIA S.R.L. unitatea 804**	fat and hydrocarbon separation	CAB 2006-2009 SM 2007-2009	2009
9	**S.C. BILLA ROMÂNIA S.R.L. unitatea 805**	fat and hydrocarbon separation	CAB 2008-2009 SM 2008-2009	2009
10	**S.C. COMAT BACĂU S.A.**	none	CAB 2005-2009 SM 2007-2009	2009
11	**S.C. CONAGRA S.A. Bacău**	M + B, sludge dewatering	CAB 2005-2009 SM 2006-2009	2009
12	**S.C. PAMBAC S.A. Bacău**	none	CAB 2005-2009 SM 2006-2009	2009
13	**S.C. ROMBET S.A. Bacău**	sedimentation	CAB 2007-2009	2009
14	**S.C. SALBAC DRY SALAMI S.A.**	floatation, filtration	CAB 2005-2009 SM 2008-2009 but do not have	2009
15	**S.C. SELGROS CASH & CARRY S.R.L.**	fat separation	CAB 2006-2009 SM 2008-2009	2009
16	**S.N.T.C.F.-R.T.F.C. IAŞI EXPOATARE LOCOMOTIVE (racord 1)**	sedimentation, oil separation	CAB 2006-2009 SM 2009	2009
17	**S.N.T.C.F.-R.T.F.C. IAŞI REVIZIE VAGOANE CALATORI (racord 2)**	none	CAB 2007-2009 SM 2007-2009	2009
18	**S.N.T.C.F.-R.T.F.C. IAŞI REVIZIE VAGOANE CALATORI (racord 3)**	sedimentation	CAB 2007-2009 SM 2007-2009	2009
19	**S.C. SONOMA S.R.L.**	none	CAB 2008-2009 SM 2008-2009	2009
20	**SPITALUL DE PNEUMOFTIZIOLOGIE BACĂU**	chlorination	CAB 2005-2009 SM 2006-2009	2009
21	**SPITALUL JUDETEAN DE URGENTA BACĂU**	chlorination	CAB 2005-2009	2009
22	**S.C. SUBEX S.A.**	neutralization	CAB 2005-2008 SM 2006-2009	2009

[1] S.C. Compania de Apă Bacău S.A monitoring program
[2] Self-monitoring activities

Table 6-5: Indirect Discharger Inventory - 3 - Agglomeration Bacău

6.5.2 Agglomeration Buhuşi

There are five *major* dischargers in the Buhuşi Agglomeration.

No.	Discharger	Address	Economic Activity	Discharge Location
1	**S.C. PESCADO GRUP S.R.L.**	str. Chebac nr. 59 Buhuşi	food processing - fish processing	str. Chelbac
2	**S.C. AVITA S.R.L.**	str. Chebac nr. 114 Buhuşi	food processing – juice bottling	str. Chebac nr. 114
3	**S.C. MONDOTEX S.R.L.**	str. Alexandur Ioan Cuza 116	textile – blanket production	str. Alexandur Ioan Cuza 116
4	**SPITALUL ORĂŞENESC BUHUŞI**	str. Voioagă nr. 3 Buhuşi	other - hospital	str. Voioagă
5	**OMV PETROM S.A.**	str. Libertăţii nr. 76 Buhuşi	chemical and petrochemical - gas station	str. Libertăţii

Table 6-6: Indirect Discharger Inventory - 1 - Agglomeration Buhuşi

No.	Discharger	Operator Contract			APM Permit	
		No. / Discharge Limits	Date	Billing Procedure	No.	Date
1	**S.C. PESCADO GRUP S.R.L.**	6052 [1]	15.11.2007	C, G	325	09.09.2008
2	**S.C. AVITA S.R.L.**	none		A, F	38	30.01.2008
3	**S.C. MONODORTEX S.R.L.**	1471 [1]	2007	n.i.	309	18.11.2005
4	**SPITALUL ORĂŞENESC BUHUŞI**	5 [1]	14.01.2010	C, G	169	16.06.2009
5	**OMV PETROM S.A.**	3704 [1]	01.03.2007	C, G	193	07.07.2008

1 - NTPA-002/2002 discharge limits n.g. = not given n.i. = no information

Table 6-7: Indirect Discharger Inventory - 2 - Agglomeration Buhuşi

No.	Discharger	Pre-treatment	Monitoring Results	Questionnaire
1	**S.C. PESCADO GRUP S.R.L.**	homogenization, floatation, fat separation and filtration	APM 8 parameters	2009
2	**S.C. AVITA S.R.L.**	n.i.	none	
3	**S.C. MONODORTEX S.R.L.**	sedimentation	APM 5 parameters	
4	**SPITALUL ORĂŞENESC BUHUŞI**	sedimentation, hydrocarbon separation and chlorination	APM 7 parameters	2009
5	**OMV PETROM S.A.**	oil separation	APM 6 parameters	2009

Table 6-8: Indirect Discharger Inventory - 3 - Agglomeration Buhuşi

6.5.3 Agglomeration Comăneşti - Moineşti

There are eight *major* dischargers in the Moineşti portion of the Comăneşti - Moineşti Agglomeration.

No.	Discharger	Address	Economic Activity	Discharge Location
1	**S.C. AUTO - CAR S.R.L.**	str. Muntelui, nr. 65 Moineşti	other - carwash	str. Atelierelor
2	**S.C. DOBCRIS S.R.L.**	str. Cpt. Zăgănescu nr. 7 E Moineşti	other - carwash	str. Cpt. Zăgănescu nr. 7 E
3	**S.C. DYPETY S.R.L.**	str. Alboteşti nr. 1 Moineşti	other - automotive workshop	str. Alboteşti nr. 1
4	**S.C. RAD AUTO S.R.L.**	str. Cpt. Zăgănescu, nr. 2 , Moineşti	other - automotive workshop	str. Cpt. Zăgănescu
5	**SPITALUL MUNICIPAL DE URGENŢĂ MOINEŞTI**	str. Zorilor nr. 1 Moineşti	other - hospital	str. Zorilor nr. 1
6	**SPITALUL MUNICIPAL MOINEŞTI – secţia Boli Infecţioase şi Pneumoftiziologie**	str. T. Vladimirescu Moineşti	other - hospital	str. T. Vladimirescu
7	**MALP DR. COTIRLET MIHAELA**	str. Zorilor, bloc.1 bis, ap.4 Moineşti	other - hospital assistance and ambulance	str. T. Vladimirescu
8	**VITARA COM**	str. Atelierelor nr. 132 Moineşti	other - automotive workshop	str. Atelierelor nr. 132
9	**OMV PETROM S.A. – DEPOZIT ALBOTEŞTI**	str. Alboteşti Moineşti	chemical and petrochemical - mineral oil storage depot	to be connected

Table 6-9: Indirect Discharger Inventory - 1 - Agglomeration Comăneşti - Moineşti

No.	Discharger	Operator Contract			APM Permit	
		No. / Discharge Limits	Date	Billing Procedure	No.	Date
1	**S.C. AUTO - CAR S.R.L.**	317 [1]	22.07.2008	C, F	233	18.06.2007
2	**S.C. DOBCRIS S.R.L.**	294 [1]	21.07.2008	C, F	255	25.07.2008
3	**S.C. DYPETY S.R.L.**	272 [1]	17.07.2008	C, G	27	10.02.2006 rev. 24.04.2007
4	**S.C. RAD AUTO S.R.L.**	252 [1]	16.07.2008	C, F	502	20.12.2007
5	**SPITALUL MUNICIPAL DE URGENŢĂ MOINEŞTI**	124 [1]	30.06.2008	C, G	228	15.06.2007
6	**SPITALUL MUNICIPAL MOINEŞTI – secţia Boli Infecţioase şi Pneumoftiziologie**	124 [1]	30.06.2008	C, F	248	25.06.2007
7	**MALP DR. COTIRLET MIHAELA**	201 [1]	10.07.2008	C, F	364	13.12.2006

No.	Discharger	Operator Contract			APM Permit	
		No. / Discharge Limits	Date	Billing Procedure	No.	Date
8	**VITARA COM**	183 [1]	09.07.2008	C, F	198	04.08.2006
9	**OMV PETROM S.A. – DEPOZIT ALBOTEŞTI**	12 [1]	08.05.2008	n.i.	n.i.	

Table 6-10: Indirect Discharger Inventory - 2 - Agglomeration Comăneşti - Moineşti

No.	Discharger	Pre-Treatment	Monitoring Results	Questionnaire
1	**S.C. AUTO - CAR S.R.L.**	sedimentation oil separation	APM 6 parameters	2009
2	**S.C. DOCRIS S.R.L.**	sedimentation hydrocarbon separation	APM 8 parameters	2009
3	**S.C. DYPETY S.R.L.**	suspension clarifier	APM 6 parameters	2009
4	**S.C. RAD AUTO S.R.L.**	hydrocarbons separation	APM 6 parameters	2009
5	**SPITALUL MUNICIPAL DE URGENŢĂ MOINEŞTI**	sodium hypochlorite dosage	APM 9 parameters	2009
6	**SPITALUL MUNICIPAL MOINEŞTI – secţia Boli Infecţioase şi Pneumoftiziologie**	sodium hypochlorite dosage	APM 9 parameters	2009
7	**MALP DR. COTIRLET MIHAELA**	n.i.	APM 10 parameters	
8	**VITARA COM**	oil separation	APM 6 parameters	
9	**OMV PETROM S.A. – DEPOZIT ALBOTEŞTI**	oil separation	n.i.	2010

Table 6-11: Indirect Discharger Inventory - 3 - Agglomeration Comăneşti - Moineşti

6.5.4 Agglomeration Dărmăneşti

There are no industrial dischargers in the Dărmăneşti Agglomeration.

6.5.5 Agglomeration Târgu Ocna

There are ten known *major* dischargers in the Târgu Ocna Agglomeration.

No.	Discharger	Address	Economic Activity	Discharge Location
1	**S.C. OMV PETROM S.A. - suc Bacău**	str. C. Negri nr. 187 Târgu Ocna	n.i.	n.i.
2	**DISTIVIN S.R.L.**	str. C. Negri nr. 197 Târgu Ocna	food processing – wine and alcohol production	str. C. Negri nr. 197
3	**HELIOPOLIS PRES SERV S.R.L.**	n.i.	n.i.	n.i.

No.	Discharger	Address	Economic Activity	Discharge Location
4	**IDEAL AUTO SERVICE**	n.i.	n.i.	n.i.
5	**LUKOIL ROMÂNIA S.R.L.**	n.i.	n.i.	n.i.
6	**MĂGURA S.A. Târgu Ocna**	n.i.	n.i.	n.i.
7	**NEUTRA S.R.L.**	n.i.	n.i.	n.i.
8	**PANIMON**	n.i.	n.i.	n.i.
9	**REWE (ROMÂNIA) Penny Market**	n.i.	n.i.	n.i.
10	**SPITAL PENITENCIAR Târgu Onca**	str. Crizantemelor nr. 9 Târgu Ocna	other -. hospital	str. Crizantemelor nr. 9

Table 6-12: Indirect Discharger Inventory - 1 - Agglomeration Târgu Ocna

No.	Discharger	Operator Contract			APM Permit	
		No. / Discharge Limits	Date	Billing Procedure	No.	Date
1	**S.C. OMV PETROM S.A. - suc Bacău**	n.i.		n.i.	161	29.06.2005
2	**DISTIVIN S.R.L.**	310266 [1]	01.02.2007	C, G	305	01.11.2006
3	**HELIOPOLIS PRES SERV S.R.L.**	n.i.		n.i.	127	08.05.2008
4	**IDEAL AUTO SERVICE**	n.i.		n.i.	41	29.01.2007
5	**LUKOIL ROMÂNIA S.R.L.**	n.i.		n.i.	261	17.09,2009
6	**MĂGURA S.A. Târgu Ocna**	n.i.		n.i.	61	15.02.2007
7	**NEUTRA S.R.L.**	n.i.		n.i.	126	18.05.2005
8	**PANIMON**	n.i.		n.i.	5	08.01.2008
9	**REWE (ROMÂNIA) Penny Market**	n.i.		n.i.	66	17.03.2009
10	**SPITAL PENITENCIAR Târgu Onca**	310264 [1]	01.02.2007	C, G	none	

[1] Contract specific limits, basically NTPA-001/2002 discharge limits n.i. = no information

Table 6-13: Indirect Discharger Inventory - 2 - Agglomeration Târgu Ocna

No.	Discharger	Pre-Treatment	Monitoring Results	Questionnaire
1	**S.C. OMV PETROM S.A. - suc Bacău**	none	APM 6 parameters	none
2	**DISTIVIN S.R.L.**	sedimentation	APM 9 parameters	2010
3	**HELIOPOLIS PRES SERV S.R.L.**	sedimentation	APM 6 parameters	none
4	**IDEAL AUTO SERVICE**	hydrocarbon separation	APM 6 parameters	none
5	**LUKOIL ROMÂNIA S.R.L.**	hydrocarbon separation	APM 6 parameters	none

No.	Discharger	Pre-Treatment	Monitoring Results	Questionnaire
6	**MĂGURA S.A. Târgu Ocna**	fat separation	APM 6 parameters	none
7	**NEUTRA S.R.L.**	none	APM 6 parameters	none
8	**PANIMON**	none	APM 6 parameters	none
9	**REWE (ROMÂNIA) Penny Market**	oil / grease separation	APM 6 parameters	none
10	**SPITAL PENITENCIAR Târgu Onca**	none	n.i.	2010

Table 6-14: Indirect Discharger Inventory - 3 - Agglomeration Târgu Ocna

6.6 Current Performance of Service Operator with Regard to Control of Industrial Wastewater Discharge

6.6.1 General

To date all regulation of industrial dischargers has been done by the local operators:

Agglomeration	Operator
Bacău	S.C. Compania de Apă Bacău S.A
Buhuşi	Consiliul Local Buhuşi Direcţia de Gospodărie Comunală
Comăneşti - Moineşti	S.C. Apa Prim S.R.L. Moineşti
Dărmăneşti	Municipiului Dărmăneşti Serviciul Public de Gospodărie Comunală Dărmăneşti
Târgu Ocna	Primaria Târgu Ocna Serviciul Public de Gospodarie Comunala

All the communal organizations in Bacău County experienced an economic shock after the Revolution in 1989 with an extreme decrease in income. This resulted in a neglect in all wastewater service activities and is responsible to a large degree in the dilapidated condition of the wastewater collection and treatment facilities. Accordingly, the management of the industrial dischargers has been similarly neglected.

Not all cities were equally affected by this process; so similarly, the industrial wastewater management varies greatly within the County. The performance in each agglomeration is outlined below. It must, however, be noted that, with the creation of the new countywide ROC, Compania Regionala de Apă Bacău, the level of wastewater service and industrial wastewater management will be brought up to an equal and acceptable level in the whole County.

6.6.2 Agglomeration Bacău

Wastewater service in the Bacău agglomeration is at a high level due to the largely retained economic activities in and around the City of Bacău. The CAB has a functioning industrial wastewater management system and has a relatively good inventory of their industrial dischargers. The *major* dischargers are monitored regularly, albeit not a complete NTPA-002 monitoring. The CAB laboratory facilities analyse on a regular basis water quality samples for the WWTP influent and effluent and the *major* industrial discharges. The laboratory-staff consists of two chemists, a biologist and seven laboratory assistants. The tests which can be performed at the CAB laboratory are

Temperature	$S^{2-} + H_2S$
pH	SO_4^{2-}

25

TSS	Substances extractable with organic solvents
BOD_5	Biodegradable synthetic detergents
COD_{Cr}	Cl^-
NH_4-N	sludge moisture and DS content
Kjeldahl-N	sludge volatile solids
P_{total}	sludge mineral content

The CAB has a complete contract with its EAs which covers the normal management of the industrial dischargers. The discharge limits for the EAs are the legally valid NTPA-002 limits. Service fees for wastewater are billed monthly based on delivered potable water for most EAs. For some EAs they are based on a calculated lump sum value. Storm water fees are calculated from impermeable area and monthly precipitation for the *major* dischargers. Fines for NTPA-002 limit violations are invoiced on a monthly basis.

6.6.3 Agglomeration Buhuşi

Wastewater service in the Buhuşi agglomeration is at low level due to the nearly complete collapse of the economic activities in and around the City of Buhuşi. There is no functioning industrial wastewater management system. The dischargers are not monitored. The City has laboratory facilities which can analyse only the most primitive water quality samples for the WWTP influent and effluent. The laboratory-staff consists of one laboratory assistant. The tests which can be performed at the laboratory are

Temeperature	BOD_5
pH	COD_{Mn}
TSS	$S^{2-} + H_2S$

Buhuşi has a relatively complete contract with its EAs which does not have any special conditions for the management of the industrial dischargers. The discharge limits for the EAs are the legally valid NTPA-002 limits. Service fees for wastewater are billed monthly based on delivered potable water for most EAs, for some EAs they are based on a calculated lump sum value. Storm water fees are calculated from impermeable area and average annual precipitation for the *major* dischargers. As there is no monitoring, no fines are invoiced for exceeding the NTPA-002 discharge limits.

6.6.4 Agglomeration Comăneşti - Moineşti

Wastewater service in the Moineşti portion of the agglomeration is at a moderate level for Romanian conditions. Economic activities in and around the City of Moineşti are down appreciably from earlier times. Apa Prim effectively does not have a functioning industrial wastewater management system. The dischargers have been monitored on an irregular basis. In the past these monitoring analyses were carried out but their laboratory but most recently Apa Prim has utilized their rights under the NTPA-002 and have had the dischargers carried out the monitoring at their costs. The Apa Prim laboratory facilities analyse on a regular basis water quality samples for the WWTP influent and effluent. The laboratory-staff consists of one chemist and a laboratory assistant. The tests which can be performed at the laboratory are

Temeperature	COD_{Cr}
pH	NH_4-N
TSS	NO_3-N
TDS	$S^{2-} + H_2S$
BOD_5	Substances extractable with organic solvents

Apa Prim has a relatively complete contract with its EAs which does not have any special conditions for the management of the industrial dischargers. The discharge limits for the EAs are the legally valid NTPA-002 limits. Service fees for wastewater are billed monthly based on delivered potable water for most EAs, for some EAs they are based on a calculated lump sum value. Storm water fees are calculated from impermeable area and average annual precipitation for the *major* EAs which discharge into the wastewater collection system. As there is no regular monitoring program, fines are not invoiced for exceeding the NTPA-002 discharge limits.

6.6.5 Agglomeration Dărmăneşti

Dărmăneşti has no management or monitoring of EAs as the wastewater system is nearly non-existent.

6.6.6 Agglomeration Târgu Ocna

Wastewater service in the Târgu Ocna agglomeration is at low level due to the nearly complete collapse of the economic activities in and around the City of Târgu Ocna. There is no functioning industrial wastewater management system. The dischargers are not monitored. The City has laboratory facilities which can analyse only the most primitive water quality samples for the WWTP influent and effluent. The laboratory-staff consists of two laboratory assistants. The tests which can be performed at the laboratory are

Temeperature	NO_3-N
pH	$S^{2-} + H_2S$
TSS	BOD_5
TDS	COD_{Cr}
NH_4-N	Biodegradable synthetic detergents
NO_2-N	Phenol

Târgu Ocna has a relatively complete contract with its EAs which does not have any special conditions for the management of the industrial dischargers. The discharge limits for the EAs given in the contracts are basically the NTPA-001 limits for WWTPs, which are completely unrealistic limits and have never been enforced. Service fees for wastewater are billed monthly based on delivered potable water for most EAs. For some EAs they are based on a calculated lump sum value. Storm water fees are calculated from impermeable area and average annual precipitation for the *major* dischargers. As there is no monitoring, no fines are invoiced for exceeding the contract discharge limits.

No.	Performance Indicators	Unit	TOTAL / AVERAGE		Agglomeration Bacău		Agglomeration Buhuşi		Agglomeration Comăneşti - Moineşti		Agglomeration Dărmăneşti		Agglomeration Târgu Ocna	
			Before Project	After Project	Before Project	After Project	Before Project	After Project	Before Project	After Project	Before Project	After Project	Before Project	After Project
3.5.1	Total number of industrial units in agglomeration	no.	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
3.5.2	Number of industrial units NOT connected to the wastewater system	no.	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
3.5.3	Number of industrial units connected to the wastewater system	no.	46	46	22	22	9	9	5	5	0	0	10	10
3.5.3.1	Number of connected industrial units with pre-treatment facilities	no.	34	34	16	16	8	8	4	4	0	0	6	6
3.5.3.2	Percent of connected industrial units with pre-treatment (compliant with EC/RO regulations)	% of 3.5.3	74	74	73	73	89	89	80	80	0	0	60	60
3.5.4	Pollution load generated by industrial units	1000 kg BOD/d	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
3.5.4.1	Percent of industrial pollution load reduced by pre-treatment (3.5.4./3.4.1.2)	% of 3.4.1.2	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
3.5.5	Number of industrial units discharging dangerous substances into the aquatic environment	no.	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data

Table 6-15: Performance Indicators for industrial dischargers

6.7 Impact Evaluation of Industrial Wastewater Discharges

The impact evaluation of the industrial wastewater discharges on the influent of the municipal wastewater treatment plant is structured as follows:

- Existing and future municipal wastewater treatment facilities

  In order to evaluate the potential impacts of industrial wastewater discharges, the specific type and configuration of the municipal wastewater treatment facility has to be considered. Most of the existing wastewater treatment plants will be rehabilitated and extended in future. The existing and future situation of the wastewater treatment plants is described in Chapter 5.

- Potential risks for the wastewater collection system and WWTP

  The evaluation of the greatest potential risks to the collection system and WWTP operation from the industries before and after pre-treatment is installed. If the field of activity of the various industries is known, it is possible to identify potential discharges which might affect the composition of the wastewater to be treated at the municipal wastewater treatment plant.

As described above, industrial wastewater can affect the efficiency of the biological processes of a municipal wastewater treatment plant which can affect the quality of the receiving waters. Relevant industries in Bacău County are (see Chapter 6.5)

- food, drink and milk (FDM),
- textile,
- metal processing (incl. armament and ammunition), and
- other industries and commercial activities.

6.7.1 Food, drink and milk industries (FDM)

The FDM sector produces both finished products destined for consumption and intermediate products destined for further processing. It is diverse compared to many other industrial sectors. This diversity can be seen in terms of the size and nature of companies, the wide range of raw materials, products and processes and the numerous combinations of each as well as the production of homogenised global products and numerous specialized or traditional products on national and even regional scales. In Bacău County companies for meat processing, beer production, wine production and food production can be found (see Chapter 6.5).

The most significant environmental issues associated with FDM installations are water consumption and contamination, energy consumption, and waste minimisation.

Most of the water which is not used as an ingredient ultimately appears in the wastewater stream. Typically, untreated FDM waste water is high in both COD and BOD. Levels can be 10 – 100 times higher than in domestic wastewater. The SS concentration varies from negligible to as high as 120,000 mg/l. Untreated wastewater from some sectors, e.g., meat, fish, dairy and vegetable oil production, contains high concentrations of fat, oil and grease. High levels of phosphorus can also occur, particularly where large quantities of phosphoric acid are used in the process, e.g., for vegetable oil de-gumming or in cleaning.

The driving forces which result in improved environmental performance are changing. For example, traditionally maximising the utilisation of materials has had the consequence of reducing waste. An approach more directly associated with protection of the environment is now emerging, although this challenges the sector, e.g., with respect to reducing water and energy consumption and the use of packaging, while still maintaining hygiene standards. All of the processes used in the sector cannot be described in detail in this document, but it covers a very wide range from the whole sector */FDM-Industries, Reference Document (BREF), European Commission Joint Research Center, 08/2008/.*

Water consumption is one of the key environmental issues for the FDM sector. Water has many different uses, e.g.,

- for cooling and cleaning,
- as a raw material, especially for the beverage industry,
- as process water, e.g., for washing raw materials, intermediates and products,
- for cooking, dissolving and transporting,
- as auxiliary water, e.g. for the production of vapour and vacuum, and
- as sanitary water.

The quality of water needed depends on the specific use.

Although the FDM sector is an extremely diverse sector, certain sources of wastewater are common to many of its sectors */FDM-Industries, Reference Document (BREF), European Commission Joint Research Center, 08/2008/.* These include:

- washing of the raw material,
- steeping of raw material,
- water used for transporting or fluming raw material or waste,
- cleaning of installations, process lines, equipment and process areas,
- cleaning of product containers,
- blow-down from steam boilers,
- once-through cooling water or bleed from closed-circuit cooling water systems,
- backwash from regeneration of the WWTP,
- freezer defrost water, and
- storm water runoff.

In general, wastewater from the food industry is a good addition to municipal wastewater, as municipal wastewater often lacks the organic matter required for the nutrient removal process.

Nevertheless, wastewater from the food industry can become a risk for the biological wastewater treatment process when being discharged uncontrolled into the municipal wastewater system. This happens, for example, when a production line is shut down due to a change in the production or due to an interruption at the weekend or for holidays. Every time a production line for food or beverage is shut down, the facilities are cleaned. This is closely connected with the short generation of wastewater with a high organic concentration.

In such cases, the oxygen demand on the municipal wastewater treatment plant can exceed the maximum installed capacity of the aeration system. In addition, the short-term loading of organic matter can cause bulking sludge which has a negative impact on the sedimentation conditions of the activated sludge in the secondary clarification. This again will have a negative influence on the effluent concentrations.

Furthermore, industrial wastewater of food and beverage production or processing companies can contain high grease concentrations. Due to this aspect special attention should be given to the existence and the state of the grease separators of such companies.

The comparatively high concentrations of organic matter can also cause biological sulphur corrosion due to the creation of anaerobic conditions in the sewers. This can be detected easily by the state of the first sewer sections downstream of the discharger.

Even if the overall impact of organic loads the municipal wastewater composition can be positive, it is usually advisable to have a mixing and equalization tank to avoid peak loads as described above.

6.7.2 Textile industry

The main environmental concern in the textile industry is the amount of water discharged and the chemical load it carries. Other important issues are energy consumption, air emissions, solid wastes and odours, all of which can be a significant nuisance at certain facilities.

Among these, water is the most important concern. The textile industry uses water as the principal medium for removing impurities, applying dyes and finishing agents, and for the generation of steam. Losses to the product are negligible; therefore, apart from a minor amount of water which is evaporated during drying, the bulk is discharged as aqueous effluent. The main concern is the amount of water discharged and the chemical load it carries.

A number of chemicals which may be used in the textile process are worth specifically mentioning because of their potentially significant negative impacts on the environment */Textiles-Industry, Reference Document (BREF), European Commission Joint Research Center, 07/2003/*. These are:

- Alkyl phenol ethoxylates (detergents, wetting agents, levelling agents, etc): their metabolites (octyl- and nonyl phenols) are highly toxic to aquatic life and are reported to disturb the reproduction of aquatic species by disrupting the endocrine system (octyl and nonylphenol are on the list of "Priority Substances" targeted for priority action under the Water Framework Directive 2000/60/EC and nonylphenol, in particular, is identified as a "Priority Hazardous Substance");
- Polybrominated diphenyl ethers and chlorinated paraffins (flame retardants) halogenated;
- Phenols and benzenes (reagents in the production of flame retardant-mothproofing agents based on permethrin and cyfluthrin (carpet sector) and other biocides;
- Sequestering agents such as EDTA and DTPA and NTA: these are capable of forming very stable complexes with metals (EDTA and DTPA are also poorly bioeliminable);
- Chlorine and chlorine-releasing compounds such as sodium hypochlorite (bleaching agent) and sodium dichloroisocyanurate (wool anti-felting agent): these are capable of reacting with organic compounds to form adsorbable organic halogens (AOX);
- Metal-containing compounds such as potassium dichromate;
- Substances with carcinogenic potential, such as a number of aromatic amines, formed by cleavage of some azo dyes, or vinylcyclohexene and 1,3-butadiene, which can be present in polymer dispersions due to an incomplete reaction during polymerisation; and
- Carriers such as trichlorobenzene, o-phenylphenol, etc.

Wastewater of the textile industry usually contains acids and brines from the various chemical washing processes, organic matter, nitrogen and phosphorous compounds and dyestuffs. The dyestuffs are usually not biological degradable as they are produced to remain in the textile products even at high temperatures and after washing. Furthermore, the wastewater produced in the textile industry can have a high temperature.

The wastewater amounts and wastewater loads can be reduced by

- optimisation of the washing and cleaning processes,
- recycling of wash-water with low contamination,
- separate treatment of different wastewater flows, and
- evaporation of highly concentrated wastewater.

Wastewater treatment follows at least three different strategies: central treatment in a biological wastewater treatment plant on site, central treatment off site in a municipal wastewater treatment plant or decentralised treatment on site (or off site) of selected, segregated single wastewater streams.

All three strategies are BAT options when properly applied to the actual wastewater situation */Textiles-Industry, Reference Document (BREF), European Commission Joint*

Research Center, 07/2003/. Well-accepted general principles for wastewater management and treatment include:

- Characterising the different wastewater streams arising from the process;
- Segregating the effluents at source according to their contaminant type and load, before mixing with other streams. This ensures that a treatment facility receives only those pollutants it can cope with. Moreover, it enables the application of recycling or re-use options for the effluent;
- Allocating contaminated wastewater streams to the most appropriate treatment;
- Avoiding the introduction of wastewater components into biological treatment systems when they could cause malfunction of such a system; and
- Treating waste streams containing a significant non-biodegradable fraction by appropriate techniques before, or instead of, a final biological treatment.

According to this approach, two techniques are determined for the treatment of wastewater from the textile finishing and carpet industry. First the treatment of wastewater in an activated sludge system at low food-to-micro organisms ratio, under the prerequisite that concentrated streams containing non-biodegradable compounds are pre-treated separately, and secondly pre-treatment of highly-loaded (COD>5000 mg/l) selected and segregated single wastewater streams containing non-biodegradable compounds by chemical oxidation.

6.7.3 Metal processing

The composition of wastewater being produced in the frame of metal processing can have a wide variation depending on the special kind of production or processing. Wastewater is produced during the following steps:

- mechanical or chemical cleaning of metals,
- mechanical or chemical processing of metals,
- chemical and electrical spreading metal coatings onto materials,
- chemical and electrical removing of metal coatings from materials,
- converting metal surfaces e.g. anodising, and
- production of electronic semi-conductors.

The wastewater generation is usually related to the treatment of products in aqueous solutions and in baths, whereby losses of the ingredients occur, such as acids, leaches and industrial detergent additives.

Acids and leaches can cause considerable damage to sewer systems, especially on concrete sewers, where the cement will be washed out when coming into contact with acids. This again will affect the structural stability of the pipes and manholes up to a point where the structure can collapse. Typical indications of regular acid influence are washed-out concrete structures, especially on the first sewers sections downstream of the responsible dischargers.

The wastewater amounts can be reduced by optimization of the service lives of the various baths, backing of the ingredients of the various baths by careful transport of the products, splash protection, etc and/or recycling of wash-water with low contamination.

The wastewater of such industrial dischargers must be monitored in terms of heavy metal concentrations due to the potential risk to sludge quality.

6.7.4 Other industries and commercial activities

Above, only the major industries identified in the County have been addressed. Of course there are other industries or companies discharging into the municipal wastewater systems which can significantly affect the composition of the wastewater, such as:

- butchers and slaughter houses, discharge of blood and other organic residues, further, discharges from poultry production and processing can also contain high concentrations of the serious pathogen salmonella,
- hospitals, discharge of serious pathogens and chemicals from x-ray activities,
- pharmaceutical industry, discharge of concentrated effluents and chemicals,
- dentists, discharge of mercury (amalgam),
- photo shops, discharge of chemicals related to the production of photos,
- automotive workshops, discharge of oil and grease due to improper operation of separators,
- restaurants, discharge of fat and grease due improper operation of separators, and
- agriculture, discharge of animal wastes, silage leachates, fertilizers and pesticides.

These facilities must be taken into consideration as well when managing industrial wastewater discharges.

6.8 Monitoring of Industrial Discharges

The different tasks in connection with industrial wastewater are assigned to various organizations.

Apele Române (*Romanian Waters*) (SGA): Apele Române is the institution responsible for issuing environmental permits for all direct and indirect dischargers and defining the operating conditions to prevent accidental pollution. Sampling of wastewater discharged directly to receiving waters is performed by Apele Române.

Agenţia de Protecţie a Mediului (*Environment Protection Agency*) (APM): The APM issues environmental permits for industries and defines the operating conditions to prevent accidental pollution.

Garda de Mediu (*Environment Guard*) (GM): The GM controls and inspects industries and identifies violations of legal provisions. The GM informs and collaborates with the police and/or gendarmerie in gathering the facts which, according to the environmental legislation, represent infractions.

To date the individual operators of each wastewater system were responsible for the monitoring of their industrial dischargers. This activity will now be taken over the newly formed **Compania Regionala de Apă Bacău (*Regional Water Company Bacău*) (CRAB)** (the Regional Operating Company) (**ROC**). The past fragmentation of responsibility in the County has resulted in an extremely varying quality of monitoring activities, from very good in the City of Bacău by the CAB to other cities with no monitoring at all.

Industrial Discharges: The dischargers are responsible to monitor their discharges and to operate their production processes and pre-treatment facilities in a fashion such that they meet the requirements of their APM permits, the NTPA-002/2002 discharge limits, and their wastewater system operator contracts. Unfortunately, very few wastewater system operators in Romanian require the dischargers to maintain ongoing monitoring of their wastewater as provided for in NTPA-002/2002.

Industrial discharges, treatment plant influents and effluents, and treatment plant sludge must be monitored according to several different Romanian regulations. There are, however, discrepancies in monitored parameters and monitoring frequencies which need to be eliminated. This is particularly true when implementing the EU and Romanian goal of using sludge from the WWTPs in agriculture. Here, a harmonization will be necessary between the

- NTPA-002/2002,
- 3rd EU Draft Directive on the use of sludge in agriculture,
- MO 344/2004, and
- GD 472/2000.

This point is covered below in Chapter 6.10 Conclusions and Recommendations. The reader is referred to this section for a detailed discussion of this topic of monitoring regulation harmonization.

The primary responsibility for monitoring the indirect dischargers lies with the wastewater system operator. In the past this was each city or community operator in the County. They were responsible to see that the discharge limits of NTPA-002/2002 are observed and, if not, to collect the appropriate fines. The APM is responsible to see that the operators/ROC are/is carrying out their/its monitoring activities correctly. Apele Române is only responsible to monitor the direct discharges to the receiving waters, including the WWTPs of the ROC. The Environmental Guard has no direct monitoring responsibilities.

None of the operators in Bacău County has self-monitoring requirements in their contracts with the EAs and at present only the CAB has a regular program of their own in place. This is a very large deficit in the management of the industrial dischargers in Bacău County which must now be rectified by the new ROC.

Annex 9.2 depicts the monitoring program of the CAB. Here it will be noted that only 9 of the 23 NTPA-002 limit parameters are being monitored. The Moineşti operator, S.C. Apa Prim S.R.L., has carried out intermittently monitoring of their most significant dischargers. Buhuşi and Târgu Ocna have no programs in place, while Dărmăneşti has no industrial dischargers at present.

The local Bacău APM office provided information on the pre-treatment and self-monitoring requirements of the discharge permits. Annex 9.3 depicts the self-monitoring requirements of the dischargers. Here it is clearly to be seen that the parameters to be analysed are fewer than the limits in the NTPA-002. Only two dischargers are required to monitor heavy metals and one of these dischargers, only one metal, Zn^{2+}. None were required to monitor the important heavy metal lead.

The present monitoring programs of the various operators represent a very significant deficit in the industrial wastewater management in the County. It is now imperative that the new ROC setup a functioning County wide monitoring program. Not only would a thorough monitoring of industrial discharges lead to a better operation of the ROC's WWTPs, but it would also, in the short and medium-term, provide a significant increase in income to the ROC from the discharge limit violations.

The operators also have not taken advantage of their legal right to require the dischargers to do self-monitoring of their discharges through certified, independent laboratories. An effective management of the industrial discharges in the County can only be achieved by either modifying the contracts with the dischargers so that they carry out a quality controlled self-monitoring or the new ROC must equip itself to do complete NTPA-002 monitoring.

The effluent of the EA *minor* dischargers must also be monitored. They do not represent a large hazard to the WWTP operations. They can, however, still have a very significant impact on the total treatment plant loading and the quality of the sludge produced by the WWTPs. Experience with certain types of these dischargers has shown that if uncontrolled their discharge can greatly exceed the NTPA-002 limits. For this reason, a program must also be implemented to monitor and control (required pre-treatment) the effluent from those EA *minor* dischargers which produce not just sanitary wastewater.

6.9 Action Plan to Manage Industrial Discharges

The effective management of the waste loads from industrial discharges requires the coordination of many actors: the ROC, administration, field operation and laboratory personnel; the dischargers; and the regulatory agencies. The following action plan sets out to coordinate all the various responsibilities and activities.

The Compania Regionala de Apă Bacău is presently in the process of being setup and at the moment has no organizational structure. The activities listed here are intended to assist in this process in relation to industrial dischargers which are connected to their various wastewater systems.

6.9.1 Short-Term Activities

All activities are to be completed and in operation before the completion of the CF facilities in 2015.

<u>ROC Administration</u>

1. Setup inside the ROC organization a single department for **all issues** relating to industrial wastewater discharges, specifically,

- assignment of contracts with new industrial clients,
- adjustment of existing contracts, (this is particularly necessary as in the past each individual operator has had its own contract form and they are noticeably deficient in places)
- supervision and enforcement of contractually defined responsibilities of the dischargers, e.g., self-monitoring, maintenance and operation of pre-treatment facilities,
- consultations with the industrial clients on measures for the avoidance or reduction of wastewater,
- contact person for the industrial clients for information on emergency situations or operational problems related to the wastewater discharges, a requirement of NTPA-002, Article 11e, and
- contact person for the ROC's operational personnel of the wastewater treatment plants in case of unusual load situations or in case of operational problems of the treatment plants.

2. Submit to all the *major* and *minor* dischargers the Questionnaire for completion. The information returned is to be included in the Indirect Discharger Inventory data base described below.

3. Modify contracts with the *major* dischargers to require them to complete annually a questionnaire regarding the EA's activities, wastewater production and pre-treatment before discharging into the ROC's wastewater collection systems.

4. Modify contracts with *major* and *minor* dischargers to do self-monitoring of their effluent by certified, independent laboratories;

- *minor dischargers:*
  - complete NTPA-002/2002 analyses every two months,
  - if after one year without exceeding the discharge limits, then the NTPA-002 analyses twice a year,
  - install facilities so flow rate can be determined with each monitoring sample (point measurements), a requirement of NTPA-002/2002, Chapter IV, Article 11d;
- *major dischargers:*
  - add AOX and PBCs to the discharge quality limit parameters,
  - complete NTPA-002, AOX and PBC analyses every month,
  - if after one year without exceeding these discharge limits, then the complete analyses every two months,
  - install facilities for continuous monitoring of discharge flow rate, a requirement of NTPA-002/2002, Chapter IV, Article 11d.

The dischargers are to be required to present the results of their self-monitoring (quantity and quality) in a timely fashion, if not the contracts will specify appropriate fines.

5. Modify contracts with the

- food processing, hotel and restaurant (high BOD_5, extractables and S^{2-} in discharges),
- gas station and car wash (high COD and extractables in discharges),
- work shop and other heavy machinery (high COD and extractables in discharges) and
- chemical cleaners and wash salons (high extractables, BOD_5, COD and detergents in discharges)

dischargers that they install fat / grease / oil traps, a requirement of NTPA-002/2002, Chapter III, Article 5-1e. The contracts should also specify

- the traps are to be cleaned at intervals which do not exceed their design capacity,
- the dischargers are to provide regularly the ROC with documentation of when and how much sludge was removed from the traps, and
- if the traps are not cleaned according to their capacity or the documentation is not presented in a timely fashion, then appropriate fines are specified.

6. Modify contracts with all hospitals and medical and veterinary units to require them to install pre-treatment facilities to achieve a disinfection / sterilization of their wastewater, a requirement of NTPA-002/2002, Chapter III, Article 6-1.

7. Modify contracts of industrial food processors which rise, slaughter and/or package poultry, animal or fish products to require them to install pre-treatment facilities to achieve disinfection / sterilization of their wastewater (this is necessary to eliminate the inflow of salmonella to the WWTPs).

8. If continued violations of the NTPA-002/2002 discharge limits occur, modify contracts of dischargers to require them to install or to up-grade pre-treatment facilities.

9. Modify contracts of the *major* dischargers to incorporate the provision to develop accidental pollution plan.

10. Setup a bookkeeping procedure to provide annual cost data **by agglomeration** of the costs broken down by

- administration (overhead) allocated to wastewater collection and treatment (total annual),
- wastewater collection (total annual and €/m^3 transported to the WWTPs), and
- wastewater treatment (total annual and €/kg-BOD_5)

which includes **operational** and **capital recovery** (amortization) costs.

11. Setup a new fee schedule for EA dischargers which embodies the actual ongoing wastewater collection and wastewater treatment costs of their agglomeration (Polluter-Pay-Principle) based on the **actual** volume of wastewater (to cover allocated total collection system costs) and the **actual** waste load discharged (to cover allocated total wastewater treatment costs), ***not calculated values as presently done***.

<u>ROC Operations</u>

1. Setup an Indirect (*major* and *minor*) Discharger Inventory data base for the County;

- data base design and programming for data storage, processing, retrieval and reporting,
- collection of presently incomplete information,
- continuous updating of the inventory (e.g., annual questionnaires of the dischargers), and
- regular reporting of the inventory (at least annual reports but also possibly in Internet).

2. Setup a parallel and connected Monitoring Program data base;

- data base design and programming for data storage, processing, retrieval and reporting of

- industrial discharges' self-monitoring, ROC monitoring and possibly also the APM's self-monitoring and Apele Române's monitoring results,
- WWTP inflow / outflow quantity and quality, in combined wastewater collection systems also combined overflows (quantity and quality) to receiving waters,
- sludge production and quality data,

- continuous updating of the monitoring results, and
- regular reporting of the monitoring programs with summary results of the discharged and treated wastewater (at least annual reports but also possibly in Internet).

New dedicated personnel will be necessary for the setting up and maintenance of the two data bases

3. Setup of own monitoring of the EA dischargers in all agglomerations according to the MO 31/2006 Manual with the analysis of the parameters

Temperature	NH_4^+ or NH_4-N
pH	PO_4^{3-} or P_{total}
BOD_5	Detergents
COD_{Cr}	Cr_{total}
TSS	Zn^{2+}
Extractables	Fe_{total}
S^{2-}	TDS
N_{total}	Q

as a check of the dischargers' self-monitoring. If discharger self-monitoring is not implemented then laboratory facilities must be setup to carry out the complete NTPA-002 limit parameter analyses on a regular basis for all the industrial dischargers.

Presently there are few laboratories in Romania which are capable of carrying out all the analyses prescribed in the NTPA-002. In order to reduce the level of effort and costs as well as guaranteeing the quality of the monitoring, it is recommended that the ROC set up a laboratory which is capable of carrying out all of the NTPA-002 analyses. In this way they could provide complete local laboratory services to their dischargers.

4. Carry out an initial detailed investigation of all existing pre-treatment facilities to determine

- process functions and facilities,
- condition of facilities, and
- operational procedures.

This information is then to be provided to the ROC's Indirect Discharger Inventory for storage and reporting.

5. Setup a monitoring program to measure storm water overflows (volume and quality) in the combined wastewater collection systems.

6. Setup a continuing complete WWTP operation monitoring program according to NTPA-001/2002 and NTPA-011/2002.

7. Setup a continuing complete sludge monitoring program appropriate for agricultural reuse of sludge according to MO 344/2004.

This will also need new dedicated personnel for sampling and laboratory analyses

Industrial Dischargers

1. Retain a certified, independent laboratory to carry out self-monitoring of their discharge.

2. Install and maintain discharge flow measurement facilities.

3. Install pre-treatment fat / grease / oil traps (food processing, hotels and restaurants, gas stations and car washes, etc) with appropriate maintenance and documentation.

4. Install and maintain pre-treatment disinfection / sterilization facilities (hospitals, medical and veterinary units, and poultry, meat and fish industries).

5. If required because of continued violation of the NTPA-002/2002 limits, install or up-grade pre-treatment facilities.

6. All dischargers with pre-treatment facilities, keep a complete logbook of the operation and maintenance of the pre-treatment facility which is open to ROC for inspection.

6.9.2 Middle-Term and Continuing Activities

ROC Administration

1. Calculate and set fines on a monthly basis for the *major* and *minor* EA dischargers with the data coming from the new data bank and monitoring program.

2. Modify contracts with dischargers to incorporate provisions for the proper storage and treatment of storm water with the payment of appropriate fees if the ROC Operations' investigations of the generated storm water indicate a pollution hazard.

ROC Operations

1. Regular monitoring of the dischargers' logbook and conditions of their pre-treatment facilities. This information is then to be provided to the ROC's Indirect Discharger Inventory for storage, evaluation and reporting.

2. Prepare recommendations for improvements to and operating procedures of the pre-treatment facilities.

3. Investigate if storm water control facilities are necessary, and, if so, prepare plans for the appropriate storage, treatment and operation.

4. Prepare in cooperation with the *major* dischargers a plan to prevent and control accidental pollution in accordance with the frame-work-methodology of MO 278/1997. The gas stations and electrical transformer facilities from the *minor* dischargers must be also included in this planning.

Industrial Dischargers

1. Implement the prevention and control of accidental pollution plan.

2. Implement the storm water control plan.

6.10 Conclusions and Recommendations

A number of conclusions and recommendations have resulted out of this investigation of industrial wastewater discharge in Bacău County. The conclusions can be summarized as follows:

Conclusions

ROC Administration

1. Significant new organization is necessary in the ROC administration regarding industrial dischargers.

2. Important changes are needed in bookkeeping procedures.

3. Significant changes must be made in the discharger contracts.

ROC Operations

1. There is no organized discharge monitoring on a County wide basis. The only organized monitoring of *major* dischargers in place is in the City of Bacău. None of the dischargers are being fully monitored according to the Romanian Standard NTPA-002/2002. Also, the corresponding discharge volumes and time varying flow rates are not being measured. The existing monitoring procedures are resulting in:

    a. a lack of knowledge of the true quality of water influent to the WWTPs, especially with regard to heavy metals and organic toxins,

    b. without the corresponding constituent concentrations and wastewater flow rates, the appropriate discharge loading rates cannot be determined and, therefore, the correct discharge fees cannot be determined,

    c. appropriate fines are not being collected from the dischargers, and

   d. the wastewater system operators are not exercising their authority to have the industries to retain certified, independent laboratories to monitor their discharges.

2. True (complete) wastewater collection and treatment costs are not known.
3. Without the waste loading of the individual dischargers and the complete costs of wastewater collection and treatment, the true cost of services provided to the dischargers is not being levied, that is, effectively the **Polluter-Pays-Principle is not enforce** in the County.

Dischargers

Presently four major dischargers in the County have pre-treatment WWTPs, thirty have some pre-treatment facilities like neutralization, fat / grease / oil separation or sedimentation. The requirement of fat / grease / oil traps for all food processing, hotel, restaurant, gas station and carwash, workshop and other heavy industry dischargers will mean that a number of dischargers will have to install these facilities. In a similar fashion, the hospitals and certain food processors will have to install disinfection facilities for their discharges. When a complete NTPA-002 monitoring program is in place for two years, other dischargers may also have to install various types of pre-treatment. These facilities will significantly reduce the BOD_5, COD, S^{2-} and oil and grease loadings to the WWTPs.

Romanian Government

A harmonization of various Romanian regulations is needed. While outside the scope of this study, these modifications will result in an improved effectiveness of the proposed Action Plan. These changes in the Romanian regulations will improve the sludge disposal procedures and will enable an effective management of the indirect industrial dischargers for proper WWTP operation and to provide for sludge produced which can be used in agriculture, land reclamation and reforestation. The needed modifications of the Romanian legislation and regulations are as follows:

1. The Romanian regulations which bear on the use of urban sludge in agriculture must be brought into coordination with each other and with the EU Draft Directive. Table 6-16 depicts a comparison between the various regulations and their regulated pollution parameters. The Romanian MO 344/2004, NTPA-002/2002 and GD 472/2000 must be modified so that the respective pollution parameters are the same in each regulation. As a minimum, NTPA-002 must be modified to include for dischargers all the limit parameters in the MO 344 with an appropriate modification of the fines in GD 472.

   Without this modification of NTPA-002 the operator of a wastewater system has no method of removing these pollutants from their urban sludge making it unusable in agriculture which is anchored in national Romanian regulations. That is to say, the operator has at present no or very limited legal mechanism for requiring the discharger to reduce and eliminate these substances from his wastewater.

EU Draft Directive	MO 344	NTPA-002	GD 472
Mn_{total}	Mn_{total}	-	Mn^{2+}
Hg_{total}	Hg_{total}	-	Hg^{2+}
Co_{total}	Co_{total}	-	Co^{2+}
AOX	AOX	-	-
PAH	PAH	-	PAH
PCB	PCB	-	-
PCDD/F	-	-	-
LAS	-	-	-
DEHD	-	-	-
NPE	-	-	

Table 6-16: Comparison of limit and penalty parameters

2. Government Decision 472/2000 must be modified to increase penalties for non-compliance of NTPA-002/2002 limit quality-parameters.

   GD 472 is from 2000 and does not reflect the present day social costs of the excessive pollutants. It is often that an industrial discharger will not operate a pre-treatment facility required in their APM environmental discharge permit because it is more economical to pay NTPA-002 penalty fines. Also, GD 472 does not reflect the social (increased direct) costs of the WWTP operation or of the disposal of polluted sludge.

3. Government Decision 472/2000 should be modified to allow the operator of a wastewater collection system include in their contracts with the industrial dischargers higher penalties than the standard penalties.

   Such a provision would allow the operator to coordinate the discharge limits and penalties of the industrial dischargers to manage better the wastewater quality in his system.

4. Government Decision 472/2000 must be expanded or new legislation is needed to allow the operator of a wastewater collection system to give monetary penalties for non-compliance of APM environmental discharge permits.

   The present authority to terminate contracts, to issue Cease and Desist Orders, is not an effective tool for enforcing the discharge permits. Such actions usually force the closure of the economic activities which results in significant social costs to the total society (e.g., loss of jobs and tax income). Fines place bearable economic incentives on the operators/owners of the delinquent discharger to modify their actions.

The performance indicators for industrial wastewater discharge are given in Table 6-15.

Recommendations

The Action Plan contains the recommendations resulting from this study.

CHAPTER 7

Sludge Disposal Strategy

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7 SLUDGE DISPOSAL STRATEGY

7.1 Introduction

Sewage sludge is the residue material of the wastewater treatment process. There are three different types of sewage sludge – domestic, urban and industrial sludge. Domestic sewage sludge is the residue sludge from wastewater treatment plants where only domestic households are connected. Industrial sludge is the residue of the industrial wastewater treatment process. Urban sludge is the residue of municipal wastewater treatment plants which are used for the treatment of domestic and industrial wastewater. This study is only concerned with urban and domestic sludge because industrial sludge is not a residue of municipal wastewater treatment plants.

There are three main alternatives for the disposal of sewage sludge existing: land application, combustion and depositing. Unfortunately, none of these options can be considered as a perfect solution. Each one has its advantages and disadvantages, which can differ significantly under local conditions. The difference is the emphasis between benefits and hazards in the determination of the best alternative. There is no unique best European practice and the discussion over this issue is quite overheated.

The European policy is already clear on at least one alternative. It is foreseeable that the deposition of sludge will be discouraged in Europe in the future, even if there are still many countries where land filling is the major sludge-disposal route. Nevertheless, European legislation clearly states that utilization should always be preferred. It does not matter if the sludge is used as a material for land application or energy production through fermentation and/or combustion.

There are several possibilities for the land use of sludge. The sludge can have beneficial effects in agriculture, forestry and land reclamation. Favourable for these purposes is the organic content of the sewage sludge. If synergies with the municipal solid waste management exist, it can be advantageous to compost the sludge. Nevertheless, the benefits of the application of sludge on land have met more and more reservations in the last few years. The reasons for these doubts are the pollutants which are carried in the sludge, like heavy metals or xenobiotics.

When sludge is combusted, it is possible to utilize its energetic value. The relatively high calorific value of sludge is of interest. Dried urban sludge (90 % DS) can have a calorific value of 13.5 GJ/t. This value is only valid when the sludge has not been digested. After digestion sludge reaches values of only 10.5 GJ/t, likewise for 90 % DS[1]. These values

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[1] Arlt, A. 2003. Analytical comparison of the production of supplementary fuels from biogenic wastes – on the examples municipal sewage sludge, bio waste and green waste (in German: *Systemanalytischer Vergleich zur Herstellung von Ersatzbrennstoffen aus biogenen Abfällen, am Beispiel von kommunalem Klärschlamm, Bioabfall und Grünabfall*), Ph.D. Dissertation, Helmholtz-Forschungszentrum, Karlsruhe, Germany

are comparable to poor brown coals. Hence, dried sludge can be used to substitute fossil fuels in cement factories, coal power plants or similar large combustion units. Here again, the pollutants in the sludge are adverse in this alternative. Extensive flue gas treatment facilities are required for the direct combustion of sewage sludge, thereby the cost-effectiveness is reduced.

To sum up, it is necessary to carry out an impartial economic and environmental option analysis to develop a sludge-disposal strategy. It is necessary not only to consider the ***costs*** of the alternative. The ***environmental compatibility*** and ***disposal security*** must be equally considered to achieve a ***sustainable solution*** for the operator and the society.

7.2 Objectives

It is foreseeable Bacău County will be a beneficiary of the European Union Cohesion Fund. The wastewater treatment of the County will make significant steps forward with the help of these funds. Several new wastewater treatment plants will be installed and the connection rate of the population will increase significantly. This will lead to a major increase in the urban sludge being generated.

It is also evident the present sludge-disposal practice in the County does not comply with the regulations and the current legislative developments of the European Union and Romania. At the moment there is a very unclear situation for the operators of the existing wastewater treatment plants. The impressions received after several site visits of wastewater treatment plants in the County indicate clearly that the existing sludge management and disposal situation needs major changes.

It is mandatory for the preparation of a sustainable sludge-disposal strategy that the proposed solution compiles with the following three requirements:

- ***Disposal Security***: The major demand on the future sludge-disposal strategy is to find a solution that secures a safe disposal of the whole sludge arising in the next thirty years. Therefore, numerous aspects need to be considered like the possible developments in the legislation or public opinion. It is also important to choose well-established technologies with high process security.
- ***Environmental Security***: The second major requirement is the possible environmental impact of the chosen disposal path. Since the population is paying more and more attention to environmental issues, only those disposal routes should be considered where possible negative environmental impacts can be minimized.
- ***Affordability***: The third demand is an appropriate cost-effectiveness of the chosen solution. The affordability of the future disposal procedure should be obvious.

The main purpose of this report is to find an approach for the further sludge disposal. This could be a single option. A mixture of options could as well be the result which would lead to a larger degree of flexibility. This is very important for the disposal security since sludge disposal is highly influenced by hardly predicable external effects like public opinion and/or legislation. Therefore, a presentation is made of several state-of-the-art approaches for sludge disposal. An evaluation for each of these is performed to assess the suitability under present conditions in the County. A review is made of the concerned regulations to illustrate the influences of current legislation. The selection of possible disposal routes is based on an assessment of current sludge disposal practice in Europe. Out of this analysis, a recommended strategy is put forward to shape the future sludge disposal in the County. The implementation of this disposal strategy is staged to find short, medium and long-term solutions.

7.3 Approach and Methodology

The main output of this sludge-disposal strategy is the prioritization of several disposal alternatives. The main steps are a review of the current European and Romanian legislation (Chapter 7.4), the present disposal practice (Chapter 7.5) and the sludge quantities and qualities (Chapter 7.6). It is necessary to assess the current situation and to prepare a future projection for the evaluation of quantities and qualities. The main focus will be on the forecast, since the data on the existing situation are not sufficient for an appropriate evaluation.

The presentation of the general disposal alternatives will include a general assessment of the environmental impacts (Chapter 7.7). Subsequently, an evaluation of local conditions is presented to provide a County capacity determination of the general alternatives (Chapter 7.8).

Chapter 7.9 summarizes sludge-disposal costs which have to be expected for the various alternatives. Since no organized sludge disposal exists yet in Romania, most of the costs have been developed on the basis of western European data.

A strategy is presented in Chapter 7.10 depicting the various short, middle and long-term activities making possible a sustainable sludge-management procedure for the County.

Subsequent are the final conclusions and recommendations (Chapter 7.12). Here the consequences of the sludge management are summarized in various performance indicators.

7.4 Legislative Framework

Numerous directives regulate the disposal of urban sludge. Most of the European and Romania directives concerning the environment need to be considered when developing a sustainable sludge-disposal strategy.

It should be mentioned that minor adjustments in legislation could induce significant changes in sludge-disposal procedures. The whole feasibility of a disposal strategy can be in danger due to minor legislative changes. The directives are usually the product of public and political opinion. These are usually nearly always unpredictable. This means it is not possible to foresee the exact future development of relevant directives.

There already have been several major amendments which revolutionized the sludge disposal market in the past. For example, sludge disposal at sea is forbidden after the release of the European Urban Wastewater Framework Directive (91/271/EEC). The next radical change in the disposal market was the commencement of the European Landfill Directive (99/31/EC). Thus, it is nearly forbidden in numerous member states of the European Union to dispose urban sludge in landfills. Consequently, operators are currently searching for alternative disposal routes in a large part of Europe. Changes are also expected in the legislation concerning the agricultural reuse of urban sludge. The draft of the future sludge directive already calls for much stricter limit values for the pollutants contained in sludge. The developments in the field of legislation need to be followed carefully.

Normally, the methodology of the environmental legislation in Europe is that the European Union defines several targets. These are obligatory for all the member states. They are usually forced to define national laws to achieve these targets. The implementation, however, is usually different between each of the member states.

Since the Romanian and the European legislation are obligatory in defining the sludge-disposal strategy, it is important to evaluate both of them. The most significant directives are given below.

European Directive on waste (2006/12/EC)

This directive is also called the Waste Framework Directive. Here the major principles of waste management are stated and since urban sludge is declared as waste, these must be followed with sludge. The basic principle is always the avoidance of waste as the first priority. When it is not possible to avoid the generation of a waste, the material should be recycled. This can be done by reuse or recovery of secondary raw materials. Recycling is possible by using the waste as a source of energy.

There is no specific implementation of this directive existing in Romania at this point of time. The governing law on waste is the **Romanian Law 426/2001**, but there the same targets are formulated.

European Directive on landfill of waste (1999/31/EC)

This directive is also referred to as the Landfill Directive. Here major constraints are given for depositing urban sludge in municipal solid waste landfills. The directive formulates targets for a significant minimization of organic wastes in landfills. It only allows the deposition of wastes that have been treated. The term treatment means an elimination of its hazardous nature and a volume reduction of the waste. The deposition of liquid waste has been prohibited as well.

In Romania, the **Government Decision 162/2002** on waste deposition originally implemented this European Directive. GD 162/2002 was later repealed by **Government Decision 349/2005**. This new Government Decision lays down the procedures regarding the reception of wastes into landfills, the procedures for checking and monitoring during landfill operation, as well as the procedures for the closing landfills which are not in compliance with the EC Directive requirements. It also lays down the sum of contraventions and fines which are to be paid in case of non-observance of the compulsory norms.

Additionally, the **Ministry of Environment and Water Management Order 757/2004 (Technical Norm for Waste Disposal)** exists. Here the capacity of a landfill which can be used for "sludge" is limited to a maximum 1:10 ratio to urban household solid wastes, without defining what "sludge" is or if the ratio is by volume, wet weight or dry weight.

European Council Directive of the protection of the environment when sludge is used in agriculture (86/278/EEC)

This directive is of major significance when the spreading of sludge on agricultural lands is considered as an outlet. The given limit values for heavy metal pollutants in sludge and soil need special consideration. The directive defines, as well, which farmlands are allowed to use sludge. In addition, rules are given for monitoring procedures.

The corresponding directive in Romania is the **Ministries of Environment and Water Management and Agriculture, Forestry and Rural Development Order 344/2004**. It should be noted that limit values and restrictions in this Romanian Ministerial Order are much stricter than the European Directive. This is caused by the fact that the European Directive is to be rewritten in the next few years. The Romanian law is implemented, to a large degree, on basis of the **Third Draft of the European Sludge Directive** from 2000.

European Council Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)

This directive is usually referred to as the Nitrates Directive. Here the maximum amounts of nutrients are given which are allowed to be applied to agricultural lands. This directive concerns, therefore, the agricultural reuse of urban sludge since it limits the allowed amount of nitrogen in sludge which can be spread.

The **Government Decision 964/2000** implements without major changes this directive into Romanian law.

European Council Directive concerning urban wastewater treatment (91/271/EEC)

This directive is also called the Urban Wastewater Framework Directive. The disposal of sludge is forbidden at sea. It also declares recycling as the target for sludge disposal.

This directive is implemented without large changes into Romanian law with the normative **NTPA-011/2002**.

European Directive on incineration of waste (2000/76/EC)

This directive becomes important when sludge is considered for incineration. Rules are given here for the emission, the residue management and the monitoring of incineration plants. The directive includes all types of combustion plants which use waste as additional fuel.

The **Government Decision 268/2005** implements without major changes this directive into Romanian law.

Other concerned legislation

- European Directive on the quality of water intended for the human consumption (**98/83/EC**)
- European Directive for establishing a framework for community action in the field of water policy (**2000/60/EC**)
- European Directive on implementation of a European Pollutant Emission Register (EPER) according to Article 15 of Council Directive 96/61/EC concerning integrated pollution prevention and control (IPPC) (**2000/479/EC**)
- European Directive amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community with respect to the Kyoto Protocol's project mechanisms (**2004/101/EC**)
- Romanian **Government Decision 472/2000** on protection of water resources quality
- Romanian **Law 645/2002** on integrated pollution prevention and control
- Romanian **Ministry of Water, Forestry and Environmental Protection Order 756/1997** on the evaluation of environmental pollution

7.5 Current Sludge Disposal

Twelve urban wastewater treatment plants currently exist in Bacău County. Those located in Bauău City, Buhuşi, Moineşti, Comăneşti, Dărmăneşti, Slanic Maldova, Târgu Ocna, Oneşti, Faraoani and Răcăciuni (Table 7-1) are functioning. The data given here are from an APM 2007 questionnaire; the information reported is from the WWTP operators, often very incomplete and cannot be verified.

WWTP	Current Sludge Treatment	Final Disposal	Current Production (t DS/a)
Bacău City	anaerobic digestion mech. dewatering	sludge lagoon	15,858
Buhuşi	Imhoff tanks drying beds	drying beds	390
Moineşti	Imhoff tanks drying beds	drying beds	507

WWTP	Current Sludge Treatment	Final Disposal	Current Production (t DS/a)
Comăneşti	aerobic stabilization drying beds	drying beds	105
Dărmăneşti	unknown	unknown	unknown
Slănic Maldova	drying beds	drying beds	2
Târgu Ocna	Imhoff tanks drying beds	non-compliant landfill	4
Oneşti	Imhoff tanks	sludge lagoon	692
Căiuţi	not functioning	none	none
Faraoani	drying beds	unknown	<< 1
Răcăciuni	unknown	non-compliant landfill	0.05
Podu Turcului	not functioning	none	none

Table 7-1: Existing WWTPs in Bacău County with urban sludge

There is also a large regional WTP in Caraboaia treating surface water from the Uz River which produces a significant amount of sludge, in 2007 1,627 t DS/a. This sludge is similar to urban sludge but with less organic content and always has a significant amount of heavy metals. This sludge is not dewatered and is discharged directly as a liquid into the neighboring Mascas Creek.

There is presently a large amount of sludge in lagoons, Bacău and Oneşti, and drying beds, Buhuşi, Moineşti, Comăneşti and Slănic Maldova, which has accumulated over time and will have to be disposed of in the future. The sludge in the lagoons presents particular problems. The sludge from Oneşti is polluted with hazardous substances and metals while the Bacău sludge surely contains salmonella bacteria.

It is obvious by regarding the current sludge disposal that a new solution needs to be found for Bacău County as well as finding a disposal route for the backlog in previously generated sludge. This study, however, covers only the management of the sludge which will generated by the Cohesion Fund facilities. Two major WWTPs in the County, which are not ROC facilities, will produce significant sludge and their sludge disposal is not included in this study, Oneşti and Comăneşti.

7.6 Sludge Volume and Sludge Quality

7.6.1 Quantity of the Sludge

The amount of the sludge arising is of major importance when choosing the right disposal alternative. The problem is that at this stage of the project it is difficult to predict these values. Table 7-1 shows an annual sludge production of 1,100 t DS. It can be expected that the annual sludge production will increase significantly with an increasing connection rate.

Based on the WWTP design and corresponding sludge treatment, the following values for specific sludge production have been used:

- WWTP without primary settling tanks and simultaneous aerobic stabilization (WWTP ≤ 50,000 p.e.): 70 g DS/p.e./d
- WWTP with primary settling tanks and anaerobic sludge digestion (WWTP > 50,000 p.e.): 49 g DS/p.e./d

The above mentioned treatment processes include tertiary treatment. According to the Accession Treaty of Romania to the European Union all the agglomerations with more than 10,000 p.e. must have a tertiary treatment phase when they discharge into sensitive areas. The Romanian government has declared the whole Country as sensitive area, thus all treatment plants which exceed 10,000 p.e. need to be equipped with tertiary treatment.

The basis for the sludge prediction is the forecast for the connected population equivalents.

A detailed forecast of sludge production from the CF WWTPs for each agglomeration is presented in Annex 10.1 and a summary overview is given in the following table.

Parameter	Unit	2010	2013	2015	2018	2021	2024	2030	2037
Bacău									
Total urban sludge weight (35 % DS)	t/y	9,033	10,236	12,106	12,062	12,007	11,937	11,770	11,542
Moineşti									
Total urban sludge weight (35 % DS)	t/y	1,414	1,692	2,012	2,003	1,993	1,980	1,950	1,909
Buhuşi									
Total urban sludge weight (35 % DS)	t/y	1,209	1,571	1,907	1,900	1,892	1,881	1,856	1,823
Darmaneşti									
Total urban sludge weight (35 % DS)	t/y	8	1,056	1,396	1,392	1,387	1,381	1,366	1,347
Târgu Ocna									
Total urban sludge weight (35 % DS)	t/y	586	809	996	992	987	980	965	944
Total Urban WW Sludge									
Total urban sludge weight (35 % DS)	t/y	12,250	15,363	18,418	18,350	18,265	18,159	17,906	17,565

Table 7-2: Forecast of urban sludge production per agglomeration

A detailed forecast of WTP sludge production for each treatment plant is presented in Annex 10.2 and a summary overview is given in the following table.

Parameter	Unit	2010	2013	2015	2018	2021	2024	2030	2037
Caraboaia WTP - CF Facility									
Total sludge weight (35 % DS)	t Wet Sludge		2,056	2,918	3,315	3,592	3,791	3,886	3,942
Baraţi WTP - Non-CF Facility									
Total sludge weight (35 % DS)	t Wet Sludge		2,870	3,457	3,562	3,664	3,763	3,869	3,957
Total WTP sludge weight	**t Wet Sludge**		**4,926**	**6,375**	**6,877**	**7,256**	**7,554**	**7,755**	**7,900**

Table 7-3: Forecast of WTP sludge production

7.6.2 Quality of the Sludge

Several disposal alternatives are very demanding on the sludge quality; the heavy metal, organic toxin and moisture content are particularly important. The prediction of the quality is equally important as it is with the quantity of sludge. Up to now there are only sludge analyses for two existing WWTPs in the County. The results are given in Table 7-5.

Parameter	MO 344/2004 mg/kg DS	WWTP Bacău mg/kg DS				WWTP Buhuşi mg/kg DS	WTP Caraboaia mg/kg DS
		2006			2010	2010	2010
		minimum	average	maximum			average
Cadmium	10	0.4	4.4	8.3	2.4	nd [3]	1.9
Copper	500	14	87	140	114	60	79
Nickel	100	13	29	40	63.5	nd	53.8
Lead	300	< 13	30	46	51.6	nd	< 0.1
Zinc	2000	75	609	1000	586	1657	113
Mercury	5	0.23	0.6	1.0	0.8	ns	ns
Chromium	500	15	91	190	22.4	nd	< 0.08
Cobalt	50	ns [2]	ns	ns	4.62	ns	ns
Arsenic	10	< 4	5.5	8.3	4.6	ns	ns
Molybdenum	ng [1]	ns	ns	ns	ns	ns	ns
Selenium	ng	ns	ns	ns	ns	ns	ns
Iron	ng	ns	ns	ns	ns	ns	8,605
Manganese	ng	ns	ns	ns	ns	ns	ns
AOX	500	1.7	9.7	24	ns	ns	ns
LAS	ng	ns	ns	ns	ns	ns	ns
DEHP	ng	ns	ns	ns	ns	ns	ns

Parameter	MO 344/2004 mg/kg DS	WWTP Bacău mg/kg DS				WWTP Buhuşi mg/kg DS	WTP Caraboaia mg/kg DS
NPE	ng	ns	ns	ns	ns	ns	ns
PAH	5	0.82	3.25	7.7	3.94	ns	ns
PCB	0.8	< 0.033	0.26	< 0.61	0.005	ns	ns
PCDD/F (dioxins)	ng	ns	ns	ns	ns	ns	ns

[1] not given
[2] not sampled
[3] not detected

Table 7-4: Sampled urban sludge quality – Bacău County

It can be seen here that nearly all of the samples have heavy metal contents below the MO 344/2004 indicating the sludge most likely could be utilized in agriculture, land reclamation and reforestation. However, it should be noted that the metal concentrations have been increasing in Bacău over the last three years which may be an indication of possible problems in the future.

7.6.3 Management of residues from WWTPs

The following tables compile the information about management of residues from WWTPs.

	Daily volume (m^3)	*Polluting load (kg BOD/d)*	*Processing / Disposal*
Grease	2.67	Grease from aerated grit and grease chamber will be pumped into anaerobic digestion. No additional pollution load for the treatment process.	Grease from aerated grit and grease chamber will be pumped into sludge treatment facilities.
Sand	2	The pollution load coming from sand, separated in the grit chamber is insignificant and has no effect on the WWTP	After the grit chamber sand is processed with a sand classifier, dropped into containers and disposed of at solid waste landfills.
Residues from sewer cleaning	4.61	The load is insignificant and included in Design Load	Residues from sewer cleaning are discharged into WWTP inflow, separated at the aerated grit and grease chamber and processed like sand above.
Sludge collected from septic tanks expected to be treated in the WWTP	66	481	Sludge from sceptic tanks is discharged to the WWTP inflow (reception area), and afterwards processed with the raw water inflow to the WWTP.

Table 7-5: WWTP Residues – Agglomeration Bacau

	Daily volume (m^3)	*Polluting load (kg BOD/d)*	*Processing / Disposal*
Grease	0.5	Grease from aerated grit and grease chamber will be pumped into gravity sludge thickeners of containers. No additional pollution load for the treatment process.	Grease from aerated grit and grease chamber will be pumped into sludge treatment facilities.
Sand	0.3	The pollution load coming from sand, separated in the grit chamber is insignificant and has no effect on the WWTP's	After the grit chamber sand is processed with a sand classifier, dropped into containers and disposed of at solid waste landfills.
Residues from sewer cleaning	0.61	The load is insignificant and included in Design Load	Residues from sewer cleaning are discharged into WWTP inflow, separated at the aerated grit and grease chamber and processed like sand above.
Sludge collected from septic tanks expected to be treated in the WWTP	8.77	64	Sludge from sceptic tanks is discharged to the WWTP inflow (reception area), and afterwards processed with the raw water inflow to the WWTP.

Table 7-6: WWTP Residues – Agglomeration Moinesti

	Daily volume (m^3)	*Polluting load (kg BOD/d)*	*Processing / Disposal*
Grease	0.24	Grease from aerated grit and grease chamber will be pumped into gravity sludge thickeners of containers. No additional pollution load for the treatment process.	Grease from aerated grit and grease chamber will be pumped into sludge treatment facilities.
Sand	0.2	The pollution load coming from sand, separated in the grit chamber is insignificant and has no effect on the WWTP..	After the grit chamber sand is processed with a sand classifier, dropped into containers and disposed of at solid waste landfills.
Residues from sewer cleaning	0.41	The load is insignificant and included in Design Load	Residues from sewer cleaning are discharged into WWTP inflow, separated at the aerated grit and grease chamber and processed like sand above.
Sludge collected from septic tanks expected to be treated in the WWTP	5.9	43	Sludge from sceptic tanks is discharged to the WWTP inflow (reception area), and afterwards processed with the raw water inflow to the WWTP.

Table 7-7: WWTP Residues – Agglomeration Darmanesti

	Daily volume (m^3)	*Polluting load (kg BOD/d)*	*Processing / Disposal*
Grease	0.18	Grease from aerated grit and grease chamber will be pumped into gravity sludge thickeners of containers. No additional pollution load for the treatment process.	Grease from aerated grit and grease chamber will be pumped into sludge treatment facilities.
Sand	0.1	The pollution load coming from sand, separated in the grit chamber is insignificant and has no effect on the WWTP..	After the grit chamber sand is processed with a sand classifier, dropped into containers and disposed of at solid waste landfills.
Residues from sewer cleaning	0.31	The load is insignificant and included in Design Load	Residues from sewer cleaning are discharged into WWTP inflow, separated at the aerated grit and grease chamber and processed like sand above.
Sludge collected from septic tanks expected to be treated in the WWTP	4.36	32	Sludge from sceptic tanks is discharged to the WWTP inflow (reception area), and afterwards processed with the raw water inflow to the WWTP.

Table 7-8: WWTP Residues – Agglomeration Targu Ocna

7.7 Strategic Sludge Disposal Alternatives

In this chapter the several disposal alternatives will be presented. Only commonly used options will be discussed. After this presentation, several alternatives will be chosen which seem practicable under the County specific background. These will then be further assessed with a cost analysis.

7.7.1 Agricultural Reuse

Fertilizer

Urban sludge can carry significant amounts of nitrogen and phosphorus. These elements are the most important nutrients for the plant growth. For this reason agriculture is often considered the logical disposal path for sludge. There are several problems, however, related with the form of these elements and how they are released from the sludge in a soil environment.

Plants can only obtain nitrogen from the soil in dissolved mineral forms, mainly as the nitrate ion (NO_3^-) and to a smaller degree as ammonium (NH_4^+). Organic forms of nitrogen are not available to plants from the soil in spite of the nearly religious belief of portions of the society to that effect. Both nitrate and ammonium are highly soluble and will not precipitate as solids in a soil environment. Small amounts of ammonium can be fixed by cation exchange to the soil clay particles but the availability of these limited fixation sites is in competition with the heavy metals present or being added to the soil.

The modern WWTPs being built with the EU Cohesion Funds include nutrient removal from the treated wastewater. As a result the sludge produced contains effectively no dissolved mineral forms of nitrogen, or for that matter phosphate. The remaining nitrogen is in the form of organic nitrogen. Nitrate is released from these very stable organic compounds through the chain of the hydrolyzation (organic nitrogen to ammonium) - nitrification (ammonium to nitrite and then to nitrate) processes. These processes are very directly temperature dependent, during colder periods they come to an effective standstill in the soil. When sludge is applied to soils the release of nitrate can only achieve a significant level when the soil is warm, that is, late summer and fall.

Plants have their maximum nitrogen uptake requirement at the time of their maximum biomass accumulation rate, the late spring and early summer. This is a time when the release of mineral nitrogen from sludge at a very low and insignificant level. In other words, sludge provides very little nitrogen available for agricultural plant growth. Most all of the released nitrogen is simply washed out of the soil profile or converted to N_2 gas through denitrification during the winter months. Some authorities are optimistically of the opinion dewatered sludge can replace 15 to 30 % of the nitrogen nutrients on a short-term basis in comparison to mineral fertilizer[2] for the same amount of nitrogen nutrients for plant growth. That is to say, 70 to 85 % of the nitrogen in sludge is lost to plant growth and is simply discharged to the environment. On a long-term basis, the result could be a bit better. Others feel, however, there is effectively no nutrient advantage to the application of urban sludge to agricultural soils.

The amount of phosphate (PO_4^{3-}) in urban sludge also gives the appearance of being significant for plant growth. The importance of this nutrient is especially interesting with the background of the strongly limited global phosphorous deposits. Here again, however, the availability for plants is limited since phosphate is either bound during the wastewater treatment process as chemical precipitants (chemical phosphate removal) or in organic compounds (biological phosphate removal). Phosphate binds itself in various insoluble organic forms and also forms chemical precipitants with metals. Phosphate is very difficult to mobilize for plant growth considering the characteristics of urban sludge.

Soil Amendment

Without a doubt an important possible uses of urban sludge is its organic matter and the organic carbon as a soil amendment in agriculture, reforestation and land reclamation. In heavy soils with a significant clay contents the sludge organic matter can form flocks with clay particles improving root penetration, soil drainage and aeration, simultaneously increasing the soil moisture holding capacity.

Heavy Metals and Organic Toxins

A bit more complex is the discussion about the environmental impact of the pollutants in the sludge. The influence of heavy metals in sludge has been widely discussed in the past. Heavy metals are concentrated in the urban sludge during the wastewater treatment process. Cadmium and Selenium are an especially significant pollutant because of their high mobility in the soil. Many, however, see the environmental hazard posed by heavy metals reduced by using the limit values given by the European Commission and the Romanian Government standards for the sludge use and disposal.

Metals are bound in the soil by two physical-chemistry processes. Every soil has a maximum storage (retention) capacity for metals. When this limit is reached applied heavy metals will simply move on through the soil column into the groundwater and out into the surface receiving waters. In general, one can say, as the soil pH increases the soil retention of metals increases and as it decreases so does the storage capacity. In the apposed direction, increasing pH decreases the availability of the metals to the plants. It must always be considered when applying sludge to soils that any sudden decrease of pH, for whatever reason, will result in a surge release of metals into the environment.

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[2] Galler, J. 2007. Nitrogen. Cycle - Fertilizing - Environment (in German: *Stickstoff. Kreislauf - Düngung - Umwelt*), Landwirtschaftskammer, Betriebsentwicklung und Umwelt, Salzburg, Austria

Plants have not only their well known nutrient requirements of nitrogen, phosphorus and potassium but also the so called trace elements (micro-nutrients) which include some of the heavy metals often found in sludge. Without these trace elements the plants cannot utilize the other nutrients but, however, their uptake requirements for these elements are quite small. Further, the same elements which are micro-nutrients in slightly higher concentrations function as toxins for plants and, as well, for the higher organisms in the food chain. Selenium is a very good example here.

Sludge also contains concentrations of toxic organic compounds such as AOX, PAHs, PCBs, dioxin, medical residuals and pesticides. The impact of these comparatively stable, highly toxic and carcinogenic compounds on the soil environment is still unknown as is their plant uptake and movement further on into the food chain.

As a matter of fact, recent studies of medical residuals have shown they are very resistant to breakdown in WWTPs and in the soil. They build up in the soil and are taken up by plants. In this way, they are reintroduced into the food chain which presents a very significant potential environmental hazard[3].

Tables 7-5 to 7-9 compare the various aspects of the limits for the use of sludge in agriculture. Depicted here are the limits of the Romanian Ministerial Order 344/2004, EU Directive 86/278/EEC, the EU Third Draft Directive on the use of sludge in agriculture, and the Romanian Ministerial Order 756/1997 which defines the maximum environmentally acceptable concentrations of pollutants in soils. Here it should be noted that the maximum limit concentrations of heavy metals in soils resulting from urban sludge applications (MO 344/2004) are for all concerned metals higher than the *maximum acknowledged limit* of Ministerial Order 756/1997 for natural soils. Also of significance are the average loads given in MO 344/2004. They are more than an order of magnitude higher than the plant uptake of the metals[4]. If these loadings are followed it is only a matter of time before the maximum holding capacity of the soil for metals will be reached. In other words, ***sludge application in agriculture is not a sustainable use!***

Urban sludge can, nevertheless, be used without any reservations for onetime applications such as for land reclamation or reforestation if the restrictions of the Ministerial Order 344/2004 are followed.

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[3] Winkle, M. 2009. "Pharmaceutical residuals in urine and potential risks related to usage as fertilizer in agriculture", Ph.D. Dissertation, Hamburger Berichte zur Siedlungswasserwirtschaft 67, TU Hamburg-Harburg, electronic version: http//doku.b.tu-harburg.de/volltexte/2009/557

[4] The trace elements with the highest plant uptakes are Cu and Zn. The maximum uptake (dependent on crop, soil, weather, etc) for these elements lies around 0.5 kg/ha/a, an order of magnitude lower than the average loadings given in Ministerial Order 344/2004.

Parameter	MO 344/2004 mg/kg DS [1]	EU Directive 86/278/EEC mg/kg DS [1]	EU Draft Directive		
			short term mg/kg DS [1]	middle term (about 2015) mg/kg DS [1]	long term (about 2025) mg/kg DS [1]
Cadmium	10	20 - 40	10	5	2
Copper	500	1000 - 1750	1000	800	600
Nickel	100	300 - 400	300	200	100
Lead	300	750 - 1200	750	500	200
Zinc	2000	2500 - 4000	2500	2000	1500
Mercury	5	16 - 25	10	5	2
Chromium	500	ng [2]	1000	800	600
Cobalt	50	ng	ng	ng	ng
Arsenic	10	ng	ng	ng	ng
Molybdenum	ng	ng	ng	ng	ng
Selenium	ng	ng	ng	ng	ng
Iron	ng	ng	ng	ng	ng
Manganese	ng	ng	ng	ng	ng
AOX	500	ng	500	ng	ng
LAS	ng	ng	2600	ng	ng
DEHP	ng	ng	100	ng	ng
NPE	ng	ng	50	ng	ng
PAH	5	ng	6	ng	ng
PCB	0.8	ng	0.8	ng	ng
PCDD/F (dioxins)	ng	ng	100 [3]	ng	ng

[1] maximum constituent concentration for the sludge applied
[2] not given
[3] ng TE/kg DS

Table 7-9: Concentration limits of sludge intended for agricultural use

Parameter	Trace Element/ Toxicity	MO 344/2004 6.5 < pH mg/kg DS [1]	EU Directive 86/278/EEC 6 < pH < 7 mg/kg DS [1]	EU Draft Directive 5 ≤ pH < 6 mg/kg DS [1]	EU Draft Directive 6 ≤ pH < 7 mg/kg DS [1]	EU Draft Directive 7 ≤ pH mg/kg DS [1]
Cadmium	no / high	3	1 - 3	0.5	1	1.5
Copper	yes / yes	100	50 - 140	20	50	100
Nickel	yes / yes	50	30 - 75	15	50	70
Lead	yes /yes	50	50 - 300	70	70	100
Zinc	yes /yes	300	150 - 300	60	150	200
Mercury	no / extreme	1	1 - 1.5	0.1	0.5	1
Chromium	yes / extreme	100	ng [2]	30	60	100
Cobalt	yes / low	ng	ng	ng	ng	ng
Arsenic	yes / yes	ng	ng	ng	ng	ng
Molybdenum	yes / yes	ng	ng	ng	ng	ng
Selenium	yes / extreme	ng	ng	ng	ng	ng
Iron	yes / none	ng	ng	ng	ng	ng
Manganese	yes / none	ng	ng	ng	ng	ng
AOX	no / yes	ng	ng	ng	ng	ng
LAS	no / yes	ng	ng	ng	ng	ng
DEHP	no / yes	ng	ng	ng	ng	ng
NPE	no / yes	ng	ng	ng	ng	ng
PAH	no / yes	ng	ng	ng	ng	ng
PCB	no / yes	ng	ng	ng	ng	ng
PCDD/F (dioxins)	no / extreme	ng	ng	ng	ng	ng

[1] maximum constituent concentration of the soil
[2] not given

Table 7-10: Concentration limits of agricultural soils receiving sludge

Parameter	MO 344/2004	EU Directive 86/278/EEC	EU Draft Directive		
			short term	middle term (about 2015)	long term (about 2025)
	kg/ha/a [1]	kg/ha/a [1]	kg/ha/a [1]	kg/ha/a [1]	kg/ha/a [1]
Cadmium	0.15	0.15	0.03	0.015	0.006
Copper	12	12	3	2.4	1.8
Nickel	3	3	0.9	0.6	0.3
Lead	15	15	2.25	1.5	0.6
Zinc	30	30	7.5	6	4.5
Mercury	0.1	0.1	0.03	0.015	0.006
Chromium	12	ng [2]	3	2.4	1.8
Cobalt	ng	ng	ng	ng	ng
Arsenic	ng	ng	ng	ng	ng
Molybdenum	ng	ng	ng	ng	ng
Selenium	ng	ng	ng	ng	ng
Iron	ng	ng	ng	ng	ng
Manganese	ng	ng	ng	ng	ng
AOX	ng	ng	ng	ng	ng
LAS	ng	ng	ng	ng	ng
DEHP	ng	ng	ng	ng	ng
NPE	ng	ng	ng	ng	ng
PAH	ng	ng	ng	ng	ng
PCB	ng	ng	ng	ng	ng
PCDD/F (dioxins)	ng	ng	ng	ng	ng

[1] maximum annual loading limit, based on a ten year average
[2] not given

Table 7-11: Loading limits of agricultural soils receiving sludge

Parameter	MO 344/2004 maximum soil mg/kg DS	MO 756/1997		
		Maximum acknowledged limit mg/kg DS	alert threshold [1] mg/kg DS	intervention threshold [1] mg/kg DS
Cadmium	3	1	3	5
Copper	100	20	100	200
Nickel	50	20	75	150
Lead	50	20	50	100
Zinc	300	100	300	600
Mercury	1	0.1	1	2
Chromium	100	30	100	300
Cobalt	ng [2]	15	30	50
Arsenic	ng	5	15	25
Molybdenum	ng	2	5	15
Selenium	ng	1	3	10
Iron	ng	ng	ng	ng
Manganese	ng	900	1500	2500
AOX	ng	< 0.5	25	50
LAS	ng	ng	ng	ng
DEHP	ng	ng	ng	ng
NPE	ng	ng	ng	ng
PAH	ng	< 0.1	7.5	15
PCB	ng	< 0.01	0.25	1
PCDD/F (dioxins)	ng	< 0.0001	0.0001	0.0001

[1] limit for sensitive terrains
[2] not given

Table 7-12: Contamination limits of soils

7.7.2 Land Reclamation

Urban sludge can be a useful material for land reclamation measures. It is the high organic content which is of interest. The sludge organic material can be utilized in reclamation measures. Important is the effect of sludge organic matter on the soil structure. The possible fields of application are numerous. Sludge was used in the past for revitalizing old quarries, mine tailings and brown-lands. Sludge has also shown its ability to stop erosion and desertification in several cases and to establish vegetation on landfill covers. Large amounts of sewage sludge can be of disposed these ways. A typical application rate is 125 t DS/ha.

It is possible to dispose large amounts of sludge in Romania by land reclamation. There will be a need in closing old municipal solid waste landfill sites in the coming years. There are numerous landfills operated now which are not compliant with the current European and Romanian regulations. These will have to be closed in the near future. Sewage sludge can be used as a soil conditioner for the re-cultivation of the cover. It is possible with this approach to dispose of large amounts of sludge in an environmentally safe manner.

In urban areas sludge can be utilized to reclaim brown-lands to convert them into green areas. There exist in Romania huge tracks of land with abandoned industrial facilities which can be reclaimed into parks and other green areas for improving the urban quality of life. The task of the post industrial cleanup of the old production sites has long been on the agenda in other parts of Europe but still needs to be initiated in the Romanian society.

A larger potential for the use of sludge is reclamation measures on agriculturally depleted soils through over farming. Especially in Wallachia and Moldavia there are large areas which are subject to erosion due to soil structure damage and nutrients depletion or salinisation[5, 6]. Sludge could be used in these areas to re-establish vegetation to stop desertification and erosion.

Land reclamation activities in Romania are regulated by **Law 138/2004**. The general provisions of the law define its area of application to be soil conservation to capitalize on agriculture and forestry but also to improve damaged lands. The activities for land reclamation laid down in the law include, among other things, land forming and improvement of soil structure through the use of soil amendments (e.g. sludge). An Administration of Land Reclamation has been setup to implement the law and it is to

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[5] Dumitru, M. and I. Munteanu. 2002. "State of art of land degradation and desertification in Romania - The strategy to mitigate them", Research Institute for Soil Science & Agrochemistry, Bucharest, Romania, available on Internet, Annex 10.9

[6] Canarache, A. 2002. "Soil degradation processes in the area with desertification risk in Romania", Research Institute for Soil Science & Agrochemistry, Bucharest, Romania, available on Internet, Annex 10.9

prepare regularly a national program for land reclamation which includes local participation.

It will be very difficult to guarantee a continuous sludge disposal with this alternative. Each land reclamation measure must be approved by several competent authorities. It is also usually necessary to make a special design of the measure and to run application field trials. There are also many different decision makers associated with the sites, all of which need to be convinced of the advantages of land reclamation and the use of sludge, like the final user of the site, the environmental protection agency, the site operator and the local authorities.

The use of sewage sludge in land reclamation is advantageous since it has benefits to the society by making degraded land useable for urban and rural uses and stopping further degradation and desertification. Furthermore, this alternative can be regarded as a low-cost option since no major investments are needed. There are some practical problems associated with the non-continuous demand for sludge in reclamation activities.

7.7.3 Composting

Sludge composting is considered another approach for recycling sludge. This technique stabilizes the sludge with an aerobic degradation of the organic matter. It does not matter if the sludge has been digested before or not. The result of the composting process is a soil conditioner for agriculture, land reclamation or similar markets, since it is rich in organic carbon. For this reason, the process might be considered as recycling. It is, however, not a final disposal route.

The compost must find a use (outlet) which has to be guaranteed by the contractor (composting facility) if it is to be considered a sludge-disposal alternative.

The efficiency of composting depends on a rapid microorganism growth in the material. A high sludge water content is, therefore, very unfavourable. This problem is faced in the practice by mixing the sludge with highly fermentable organic wastes with suitable water contents. It is also important to establish a certain carbon to nitrogen ratio in the mixture. For example, green, agricultural, wood processing or separated municipal solid waste can be used as such a bulking agent. The material mixed is usually defined by requirements of the outlet of the composted material.

If agriculture is considered as the outlet of the compost, the content of pollutants can become problematic. The risk of pathogenic problems can be considered as satisfactory low because of the high temperature level during the degradation processes. Nevertheless, the heavy metal content is often very critical since these pollutants are concentrated in the compost. The same directives and regulations are valid for the agricultural outlet as with the direct application of sludge.

The significant investment and operational costs are also problematic with composting. A large area for the fermentation process must be provided. The area necessary can be reduced by the installation of bioreactors. These plants are equipped with a forced aeration and a mechanical turning system to control and accelerate the processes. However, these facilities have high operational costs. Ordinary composting plants need much simpler turning equipment. They should be preferred when the space is available.

The most important issue for the suitability of composting is finding an appropriate outlet for the composted material. The problem is that often the sludge could just as well be applied directly on the same lands, thus making the composting process unnecessary. Composting and the direct application of sludge share the same disadvantage of heavy metal and organic toxin pollution. The pollutant content can become even higher by composting when the wrong bulking agent has been chosen. Nevertheless, the bulking agents can represent a positive aspect for this alternative. The cost effectiveness can be re-established when there are problems in disposing appropriate waste types like green waste or separated municipal solid waste. However, this does not seem to be the case in Romania. An appropriate waste separation needs to be in place, and a system which separates organic waste is neither present nor planned.

Nevertheless, composting could be an alternative for a portion of the sludge in Bacău County. The existing experience and the numerous possible applications speak for this alternative. The major drawback is there seems to be a general lack willingness to pay for the compost material.

7.7.4 Forestry

It is possible to reuse the sludge in forestry. The utilization procedure is similar to the agricultural application of sludge. The current legislation on agricultural application of sewage sludge does not consider the use in forestry. This is expected to be changed by release of the next European Sludge Directive. According to the Third Draft of this Directive, it is only allowed to use sludge on new plantings of harvested areas and reforestation projects. If forestry is included the next European Sludge Directive, it is very likely that the same requirements will be valid as in agricultural reuse, therefore making all the concentration and loading limits the same.

Law 46/2008, the Forestry Code, directs and controls all forestry activities in Romania. Previously forest covered 70 % of present day territory of Romania; today it is only 27 %. The Forest Code sets out the goal of increasing the forest areas of the Country. Forest management features stipulated by the Forestry Code include:

- ROMSILVA (Regia Nationala a Padurilor) has the authority to buy low productivity lands or accept donations from owners for reforestation, and to manage public low productivity lands; and
- Plant material and technical assistance costs necessary for the reforestation of low productivity lands is funded by the state budget.

In other words, the Forestry Code provides the framework for reforestation activities which could use urban sludge as a soil conditioner.

7.7.5 Direct Combustion

Since the farmers and food producers are more and more concerned about pollutants in urban sludge, other alternatives like thermal treatment are increasingly used for disposing sludge. The relatively high calorific value of sludge is of interest. Dried urban sludge (90 % DS) can have a calorific value of 13.8 GJ/t. This value is only valid when the sludge has not been digested. After digestion sludge reaches values of only 10.5 GJ/t, likewise for 90 % DS. These values are comparable to wood (<15 GJ/t) and poor brown coals (<20 GJ/t). Hence, dried sludge can be used to substitute fossil fuels in cement factories, coal power plants or similar large combustion units.

Sludge can be incinerated with a self-sufficiently combustion energy when it has an appropriate dry matter content. Digested sludge needs a dry matter content of 45 to 55 % to burn autonomously and undigested sludge a dry matter content of 35 %. These values can usually be reached by drying the sludge with the waste heat of the incinerator.

The mineral pollutants need to be taken into account, as well, in the incineration of urban sludge since they remain in the residues of the combustion process. Therefore, modern flue-gas treatment technologies must be utilized. A large part of the heavy metals is bound to the ashes. The ash must be treated as a hazardous waste. The mobility of these pollutants in the ash is low, however. The toxic organic compounds found in urban sludge are effectively destroyed in a proper incineration. Nevertheless, the public acceptance of waste incineration is not very high.

<u>Incineration</u>

Incineration of sludge involves converting sludge into an inert material by combustion of the organic matter at temperatures above 850℃. Thi s can be performed in designated incinerators or in municipal solid-waste incinerators. Through the incineration it is possible to capture a portion of the calorific value of the sewage sludge. According to the European policy, this disposal alternative is less favourable than recycling, but it is still a priority over depositing the material in a landfill. There are also several similar approaches like vitrification or gasification. These processes are not yet economically practicable and remain too expensive. Today incineration is considered a major future disposal route for sludge in Europe. Since direct sludge spreading in agriculture and deposition in landfills is subject to more and more regulatory obstructions, the percentage of sludge incinerated is continuously increasing, especially in Western Europe.

There are several different technical approaches to incineration. It is possible to incinerate sludge together with or without municipal solid waste. The incineration together with municipal solid waste can be neglected since there is no incinerator existing or planned in the County. When the sludge is incinerated in a designated sludge incinerator, the state-of-the-art technology is the fluidized bed system. Here a bed of sand is brought to a high temperature which is held in suspension with combustibles by an injection of hot air in a vertical furnace. The sludge is introduced inside or above the bed of sand. A temperature of 850℃ must be maintai ned during the combustion process to ensure a complete burnout of the flue gas. These incinerators are in general equipped with a heat recovery system to pre-dry the sludge. During the combustion process steam can be produced, which can be used as energy for operating rotary disk dryers. Sludge with a dry matter content of 20 to 25 % can be introduced into an incineration plant when the energy is optimally recovered.

Regardless of the chosen technology, the incineration of urban sludge should be considered as the least desirable option from an economic point of view, unless there are free capacities in a municipal solid waste incinerator. The investment costs for an incineration plant are high. There are many regulatory constraints against the combustion alternative, but also the management of the off-gas treatment of residues and ashes. These not only affect the investment costs but also the operational costs are significant. Further, highly qualified staff is required to run an incineration plant. This increases the running costs significantly and, respectively, the disposal fee. A feasibility study for the construction of a municipal solid-waste incinerator was made in Prahova County. There the consultants calculated a disposal fee of at least 80 €/t waste. This means around 125 €/t DS, when sewage sludge with a dry matter content of 65 % is incinerated. The costs for a designated sludge incinerator are expected to be even slightly higher.

Incineration is mainly restricted by the European Directive 2000/76/EC on incineration of waste. This directive gives limit values for all kind of emissions from these plants. There are several other requirements specified by this Directive, for example, monitoring and that every incineration plant must to be approved by the competent environmental authorities. This involves a very time and cost consuming process. Also unfavourable for a successful approval procedure is a very likely lack of public support. As discussed below, the CO_2 emissions are also a serious drawback to incineration.

A big advantage of the incineration process is that the presence of pollutants in the sludge is not important for the process. In general, the sensitivity to pollutants in the sludge composition is very low. The whole material is converted into ashes. This process is enhanced by a significant volume and mass (through CO_2 emissions) reduction. The disposal of these ashes, however, needs to be clarified. The ashes can be recycled, as well, as fillers in the construction industry. It is even possible to recover phosphorus out of the ashes when the sludge is combusted in a designated incinerator; however this technique is not yet developed to a point for practical applications.

To summarize, it can be said that incineration has several advantages. The main advantage is that the whole process is independent of the sludge contents. This technique is also environmentally safe, the CO_2 emissions aside. Another big advantage is that the whole process is very regulatory safe in comparison to the other sludge disposal routes. There are no major changes expected in the legislation in the near future. High investment and operating costs of incineration are, however, major

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constraints to using this disposal route in Romania in the next few years. Very often, the low public acceptance of these plants is also a large deterrent.

It is obvious considering the current disadvantages; incineration has no future as a sludge disposal strategy in the County. Only major changes in the legislation can change this situation in favour of this disposal route.

Co-Incineration

The approach of co-incineration is similar to direct incineration. Cement factories are often used for co-incineration in some parts of Europe. The sludge is combusted in a cement kiln and the remaining inert material is bound to the cement clinker. Sludge can be regarded as an additional fuel for cement factories. The operators of cement factories can reach a considerable fuel reduction when dried sludge is used. The European Emission Trading Directive **2003/87/EC** considers biomass fuels, including sewage sludge, as greenhouse gas neutral. Considering this fact, cement factories can reduce their greenhouse gas emissions by using sludge. Their operators are, therefore, interested in using urban sludge as an additional fuel.

According to the regulations of the European Directive **2000/76/EC** on incineration of waste, the combustion plant is subject to the requirements on emissions and obligations of this directive when using sludge as additional fuel. This implies a need for an environmental approval of the competent authorities. Cement factories particularly are prepared to obtain the permits necessary for the use of sludge as fuel, because the use wastes of other origins is already a well-established practice. In general, cement factory operators should be interested in long-term contracts to reach a supply guaranty, but in practice this is not always the case since sludge is in competition with other types of waste.

Compared to the simple incineration, the sensitivity to sludge composition is even lower by combusting sludge in cement kilns. The amounts of pollutants in the sewage sludge are nearly unimportant. The kiln temperatures are above 1450℃ during the burning process. This temperature guaranties a nearly complete destruction of the pollutants of biological origin. Pollutants like heavy metals become part of the clinker structure.

Cement factories can utilize dewatered and dried sludge, whereas dried sludge has favourable properties for the burning process. The calorific value of sludge is higher when it has not been treated in a digester. The requirements of the sludge treatment should to be agreed upon in advance with the operator of the cement factory to produce an appropriate sludge quality. The cement factory will normally prefer dried sludge, but it can be beneficial to dry the sludge at the factory site. There it can be dried with the waste heat of the kiln. The drying should be cheaper with this procedure than when it is performed at the WWTP site. This possible saving has to be compared, nevertheless, with the higher transport costs of only dewatered sludge cake. If co-incineration in cement factories is chosen as the first priority outlet, a cost-benefit analysis for a drying unit will be necessary.

Not only cement factories can be used for the co-incineration of sludge. Coal power plants have also proven suitable for the co-incineration of sludge in several cases. This is already common practice in Germany and Switzerland. Up to 10 % of the primary energy source can be substituted by sludge in coal power plants. Experience showed that it is particularly advantageous to use co-incinerating of sludge in lignite power plants because they are able to incinerate dewatered sludge. Only dried sludge can be incinerated in mineral coal plants and the waste heat is very often not sufficient to dry the sludge. Mineral coal plants are, however, not present in Romania. About 17 % of the national energy was produced with brown coal (lignite) power plants in 2000. It can be expected that the percentage has been decreasing recently because several of these plants were significant polluters. Other types of power plants are substituting them for this reason.

New bio-fuel power-plants can also burn sludge with the other fuel materials. Plants of this type are being built in Romania which burn scrap wood as their fuel[7]. As the wood must also be dried before combustion, the co-incineration with sludge is of no problem what so ever.

Theoretically, it should be possible to incinerate sludge also during the process of producing asphalt mixtures. Several attempts have been made in Germany to assess the suitability of these plants. Dried sludge can be used for the heating of the rotary drier. The experience from Germany has shown, however, that several procedural constraints prevent this alternative from being effective and economical. A larger storage basin for the sludge would be necessary since asphalt production is usually seasonal.

7.7.6 Bio-Gas Production

Urban sludge can be mixed with other organic wastes and used to produce bio-gas (methane). This fermentation process has been optimized by the company Scandinavian Biogas to such an extent that it is now an economic source of energy. This company picks up the sludge at its source (WWTP) and transports it to their production unit. Here it is usually mixed with kitchen or food processing wastes before fermentation. The operator of these bio-gas units need long-term delivery contracts with the sludge producers and charge nothing for their “disposal service”. Heavy metals are not a problem; the bio-gas producer only needs to know in advance what the metal content is. The remaining material (there is a 12 to 1 reduction in volume) from the fermentation is disposed of by the bio-gas company, often as a soil conditioner product.

Commercial bio-gas production is not an ultimate urban sludge disposal procedure in itself. Nevertheless, when used in conjunction with land filling or as a soil amendment, i.e., land reclamation or reforestation, it provides a very significant reduction in the sludge to be disposed, a 92 % reduction in sludge volume.

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[7] For example at Pângărați in Neamț County

It would take five to six years to implement bio-gas production in Romania after negotiating agreements between the WWTP operators and the production firm. This long lead time is a consequence of the necessary permit approval process in Romania.

7.7.7 Land Filling

The depositing of sludge in municipal landfills is currently common practice in Romania. Presently, however, the European Union highly encourages their member states to replace this disposal route. The member states of the European Union should avoid depositing all kinds of organic material in landfills according to the European Landfill Directive 99/31/EC. The demanded massive reduction of organic wastes in landfills can only be achieved by avoiding the deposition of sludge. The requirements on the construction of landfills have been increasing significantly in the past years and this will cause a major increase in the entrance fees. The capacity of this alternative is also limited. The Romanian Ministerial Order 757/2004 allows the landfill operator to deposit "sludge" at a ratio of 1:10 with urban solid wastes. The exact interpretation of this rule is presently not clarified. For instance, no differentiation is made between urban sludge from WWTPs with a high organic content and the sludge from other sources like the coagulation-flocculation sludge from drinking water treatment plants with nearly only mineral content; or further whether the ratio is defined by weight or volume. If the ratio is for weight, is it to be interpreted as dry weight of urban sludge or the wet weight.

Several requirements for the treatment of sludge need to be taken into account when depositing it in landfills. In general, the use of digesters is beneficial. By digesting the sewage sludge, the organic content of the material can be reduced. The stabilization of the material needs to be done in any case to avoid bringing infectious material to the landfill. The sludge should be dewatered to a high level to reduce the disposal costs. Here a close examination of sludge drying can be worthwhile. The investment in drying facilities could be economically meaningful in case of massive increases in the entrance fees.

In any case, the Romanian Technical Norms on Waste Landfilling (the Annex to MO 757/2004) specifies that sludge must be dewatered to at least 35 % DS. It can be achieved by additional mechanical dewatering in the WWTP, e.g., recessed-plate filter presses or diaphragm filter presses with $FeCl_3$ and polymer conditioning, or by post treatment plant processes such as solar drying or mixing with calcium oxide (lime dosing). The process used is dependent on factors such as local accessibility of space and materials and the transport distance to the landfill site. Mechanical dewatering with recessed-plate filter presses proved to be the most economical in the County (see the option analysis given in Annex 10.10).

Sludge can be mixed with recycled demolition materials or limestone to provide the daily cover at a solid waste disposal site. Here the sludge must have at least a 21 % DS content, 25 % DS is desirable. Sludge of 35 % DS can also be used directly as the daily cover. This use of sludge as a landfill construction material is not considered as part of the 10 % organic material limit, but this interpretation of the Romanian regulations might be reversed.

To sum up, it can be said the deposal of sludge in landfills should be avoided as much as possible. It can only be considered as a temporary solution to absorb start up problems in establishing other disposal routes. Land filling can be used as well to cover emergency situations like exceeded pollutant limit values or capacity problems at storage facilities. The Romanian authorities also expect an analysis showing the inapplicability of the remaining disposal options before considering sludge disposal in landfills.

7.7.8 Greenhouse Emissions

Urban sludge is basically a detritus material containing organic carbon and nitrogen. When it is oxidized it produces CO_2, around 1.2 t-CO_2/t-sludge DS. The reduction of CO_2 emissions to minimize the greenhouse effect is presently the highest EU environmental goal. The chosen sludge-disposal path must also consider this important environmental impact.

The deposition of urban sludge in solid-waste landfills results in a very slow release of CO_2 to the atmosphere. Depending on the landfill closure procedure, these emissions can be measured in decades and centuries.

The use of sludge in agriculture, land reclamation and/or reforestation results in a one to ten year short to middle-term emission of CO_2.

Simple incineration results in an immediate release of the CO_2 from the sludge organic matter.

Co-incineration of sludge replaces other fossil fuels as a source of energy. The European Emission Trading Directive 2003/87/EC considers biomass fuels, including sewage sludge, as greenhouse neutral. Therefore, co-incineration as a sludge disposal path is the most environmental of all the available alternatives.

The evaluation of sludge disposal paths must also consider the CO_2 emissions generated (and for that matter, the energy consumed) in transporting the sludge to its disposal site.

Another important greenhouse gas produced in the soil is nitrous oxide (N_2O)[8]. It has a 310 times more impact per unit weight than CO_2. Nitrous oxide is produced naturally in soils through the microbial processes of nitrification and denitrification. Nitrous oxide is gaseous intermediate product in the reaction sequence of denitrification, which leaks for microbial cells into the soil and then into the atmosphere. Nitrous oxide is also produced during nitrification, although by a less well-understood mechanism. In other words, the use of sludge in agriculture, and to a lesser degree in land reclamation and reforestation, will also result in the increased release of the more potent greenhouse gas nitrous oxide.

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[8] U.S. Environmental Protection Agency. 2009. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, Washington DC 20460, USA

7.8 Available Capacities for Sludge Disposal

All the possible sludge outlets in the County are described in this Chapter. Several disposal routes are available in Bacău such as agriculture, reforestation and land reclamation with the direct use of sludge or with compost, co-incineration, bio-gas production and land filling. There are no designated incinerators existing for the sludge incineration.

7.8.1 Agriculture

The agricultural use of urban sludge is the preferred outlet by the regulatory agencies in Bacău County. The whole County has a high agricultural footprint. There are large amounts of possible farmland to be used. The crop structure of these lands is presented in Table 7-10. These values are taken from the webpage of the National Institute for Statistics, and they represent the crop structure and dimensions of the farmland in 2007. It can be assumed these values have not changed significantly. In total there are 120,000 ha of farmed agricultural lands in the County. Not all of this area can be used for the spreading of sludge. The Ministerial Order 344/2004 regulates the suitability of these lands. The main criteria are crop types, surface slope, soil pH, texture and cationic exchange capacity.

A grouping of the agricultural lands suitable for sludge application according the crop types is done in Table 7-10. The crops marked as not suitable are not allowed in general for sludge application because the sludge pollutants are expected to end up directly in the human food chain. The remaining crop types can be used. This still corresponds to a total area of around 107,000 ha.

Crop Structure in Bacău County Crop Type	Agricultural Lands [ha]	Suitability for Sludge
Maize	83,657	yes
Wheat and rye	13,823	yes
Barley	2,131	yes
Other grains	2,399	yes
Sunflower	4,443	yes
Other oil plants	1,230	yes
Potatoes	5,363	no
Legumes	6,427	no
Sugar Beets	642	no

Table 7-13: Crop structure of agricultural lands in Bacău County

No information is available on the suitability of agricultural areas by soil characteristics and topography. MO 344/2004 specifies that the Research Institute for Soil Science and Agrochemistry (Institutul de Cercetări pentru Pedologie şi Agrochimie), or ICPA, and the Soil Science and Agrochemestry Offices (Oficii de Studii Pedologice şi Agrochimice), or OSPA, are (and only organizations authorized) to carry out these needed special soil science studies to identify the land suitable for the use of urban sludge. This is a very binding legal constraint in the preparation of a sludge disposal plan which incorporates the agricultural use of urban sludge. In the intervening six years since 2004 the Bacău County OSPA office has not completed the legally prescribed special soil science reports (MO 344/2004, Chapter III, §5.b).

MO 344/2004 also specifies that the Ministry of Agriculture, Forests and Rural Development is to provide the funds for the determination of the lands suitable for the application of sludge.[9] Apparently from our communications with OSPA these funds have not yet been made available.

In order to expedite future field trials of the agricultural use of sludge, the ROC in Buzău County contracted with ICPA to carry out the soil studies required by MO 344/2004 on an

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[9] Excerpt from MO 344/2004:

"CHAPTER III: Obligations and responsibilities attached to competent authorities

In order to achieve the objectives of these technical norms, the central competent authorities have the following obligations:

. . .

3. Ministry of Agriculture, Forests and Rural Development

a) Ensures the funds required to endow and authorize the laboratories of Research Institute for Soil Science and Agro-chemistry (ICPA) and Soil Science and Agro-chemistry Offices (OSPA) for soil, sludge and plants analyses according to the Order of the Minister of Water and Environmental Protection No. 370/2003, concerning the activities and authorization system for environmental laboratories, published in the Official Gazette of Romania, Part I, No. 756/20 of October 2003;

b) Ensures the funds required for ICPA and OPSA to conduct special soil science reports in order to identify the land suitable for sewage sludge and follow the evolution of cultures in these sites;

c) Ensures the financing for monitoring activity (soil, water and plants) after sludge application on agricultural land;

4. Research Institute for Soil Science and Agro-chemistry (ICPA)

a) Ensures the organization of monitoring activity (soil, water and plants) after sludge application in agricultural lands, based on the financing sources received from the Ministry of Environment and Water Management;

b) Conducts surveys in order to establish the behaviour of other pollutants from sewage sludge in the soil-plant-water system and set the load limit of the these pollutants;

5. Soil Science and Agro-chemistry Offices (OSPA)

a) Elaborate recommendations on the public information and of potential factors implied;

b) Elaborate soil science studies for agricultural land to which sewage sludge can be applied and follow the evolution of cultures on these lands;

. . ."

88 ha area. This study which began in October 2009 was completed in March 2010 and cost 140 €/ha.

The European practice has shown that the heavy metal and organic toxin content is not the limiting value when estimating the farmland needed for sludge disposal. Usually the nitrogen application rate (EU Directive 91/676/EEC and GD 964/2000) is limiting. The Romanian legislation only allows the spreading of 170 kg total nitrogen on agricultural fields per year. Since it is not possible at this time to predict nitrogen values of the sludge to be produced by the CF WWTPs in the County, experience values must be used.

A typical application rate for urban sludge in agriculture is 10 t DS/ha. With this sludge application rate, the MO 344/2004 maximum constituent concentrations and the middle-term (about 2018) maximum average loadings given in the EU Third Draft Directive result in minimum application interval of once in ten years. This application rate represents an annual disposal capacity of 120,000 t DS when only considering the cropping structure. If the local authorities are required to finance the special soil science studies to identify the land suitable for the use of urban sludge, based on the contract with ICPA (Annex 10.2) this would represent an investment of 17 million Euros to study all the potentially usable cropping lands in the County. This would obviously make the agricultural use of sludge a very expensive alternative.

Not only are the limiting effects of soil characteristics and topography presently not known, but also the acceptability of sludge applications by the agricultural community. Nevertheless, areas of non-foodstuff crops could also be used for sludge disposal. The non-foodstuff crops include items such as fibre, vegetable oil for biodiesel, starch (maize) for ethanol and wood pellets for decentralized and centralized energy production.

To summarize: First, the agricultural reuse of urban sludge is not sustainable. Further, this disposal route could only be implemented in the long-term as it will take years to carry out the necessary detailed soil studies to determine which areas can be used as well the field trials to demonstrate the applicability of the use of sludge in agriculture.

7.8.2 Forestry

Advanced deforestation has occurred in the semiarid and dry sub humid zones in Romania[6, 7]. These climatic zones predominate in Bacău County which indicates a large potential for reforestation. These man-induced deforested ecosystems are of little economic or environmental value and often subject to erosion, landslides and other degradation processes. Reforestation is not the replanting of harvested forest areas. It involves planting areas which historically were forests but through human activities have been denuded of trees and natural vegetation for long periods of time. Reforestation is predominately possible in the vicinities of the Moninești, Dămănești und Târgu Ocna WWTPs. If provisions of the EU Third Draft Directive dealing with the use of sludge in forest areas are put into effect then the same preconditions will exist as with the agricultural use of sludge.

There are presently over 268,000 ha of recognized silviculture forests in Bacău County, 171,000 ha public forests and 97,000 ha private forests. At present about 600 ha are harvested and replanted a year as well as another 180 ha are reforested annually. This would indicate an under exploitation of this valuable renewable resource in the County. With a typical application rate for urban sludge of 10 t DS/ha, this represents alone about 7,800 t DS/a which can be utilized in silviculture considering only the present yearly replanted and reforested areas.

Experience in other counties in Romania has shown that large tracts of potential areas for reforestation belong to the local councils. The determination of the specific candidate areas for reforestation must be made by the Bacău Forest Directorate of the National Forest Authority, the local councils and possibly OSPA.

7.8.3 Composting

Yet no composting facility exists in the County at present. Facilities, however, have been proposed for urban green wastes in Oneşti. It is not clear at this time whether sludge can also composted at this site.

It is foreseen to establish a composting facility on the ROC premises (i.e. Bacau City), operated by a private contractor (uni-recycling). The ROC concluded an agreement in principle with the company securing the taking over and composting of non-dangerous WWTP sludge up to quantities as defined in the agreement. The agreement in principle is attached as annex to the FS.

7.8.4 Land Reclamation Measures

There are large areas in Bacău County which are affected by anthropogenic induced terrain deformations (largely land slippage and landslides) and water errosion[6, 7] (see Annex 10.9). Diagram 1 from Dumitru and Minteanu (2002)[6] depicts the areas in Bacău County with the human induced degradation while Diagram 2 depicts the areas where moderate to strong erosion is occurring. Here the use of urban sludge could be a valuable soil amendment to reclaim these lands. The expected areas should be large enough to dispose of the sludge arising for many years. The total County sludge produced annually can be disposed on less than 50 ha/a if the standard land reclamation application rate of 125 t DS/ha is utilized (for 2015: 5,860 t DS / 125 t DS/ha).

According to the APM (see Annex 10.11) there are 73 (103) potentially contaminated sites in the County which should be reclaimed, 67 (75) of them are on OMV Petrom's property, 5 (7) are municipal solid waste landfill sites and a number of various industrial sites. Preliminary investigations on a portion of these contaminated sites have been completed and submitted to the APM Bacău for restoration consideration. These sites also represent a large potential for the use of urban sludge.

The temporary closure of landfills can be accomplished with a sludge application rate of around 1,000 t DS/ha. Using sludge of 20 % DS results in a layer thickness of 0.4 to 0.5 m which reduces with time to approximately 0.3 m (mainly by evapotranspiration). An amount of 2,000 t DS/a (from 2011 till 2014) has been considered in the short-term disposal strategy for the temporary closure of the 8 ha Bacău City Nicolae Bălcescu non-compliant landfill.

Estimates of degraded lands in Bacău County have been made by the APM[10]. They are presented in the following table. Here sludge can be very effectively used to reclaim or improve these lands.

Soil Degradation		Affected Area [ha]
Salinization and Alkalinity		
	low	1,620
	medium	1,380
Acidification		
	low	25,060
	medium	53,190
	high	4,040
	very high	910
Nutrient Depletion		
	Humus (organic matter)	
	low	20,050
	medium	53,760
	high	179,080
	very high	47,400
	excessive	7,880
	Total Nitrogen	
	low	12,610
	medium	224,390
	high	83,550
	Mobile Phosphorus	
	low	55,700

[10] Raport anual priviud Starea Mediului pe anul 2008, Annex SOL (*Annual Report on the Status of the Environment in 2008, Annex SOL)*, Agenția Național Protecție a Mediului

Soil Degradation	Affected Area [ha]
medium	92,590
high	95,700
very high	61,140

Table 7-14: Areas of affected soils for potential land reclamation in Bacău County

Sludge can also be very useful in reclaiming degraded lands resulting from mining operations; such as reclaiming spoil areas from open-pit mines or tailings from deep mines. Bacău County has had mining operations in the past where sludge might be used in land reclamation. First and foremost are the coal mining areas around Asău, Comăneşti and Dărmăneşti. Apparently there was also mineral mining around Tescani / Bereşti-Tazlău. Little information is presently available on these past mining operations. This alternative use of sludge in reclaiming mining areas must be investigated in future studies (see Annex 10.11).

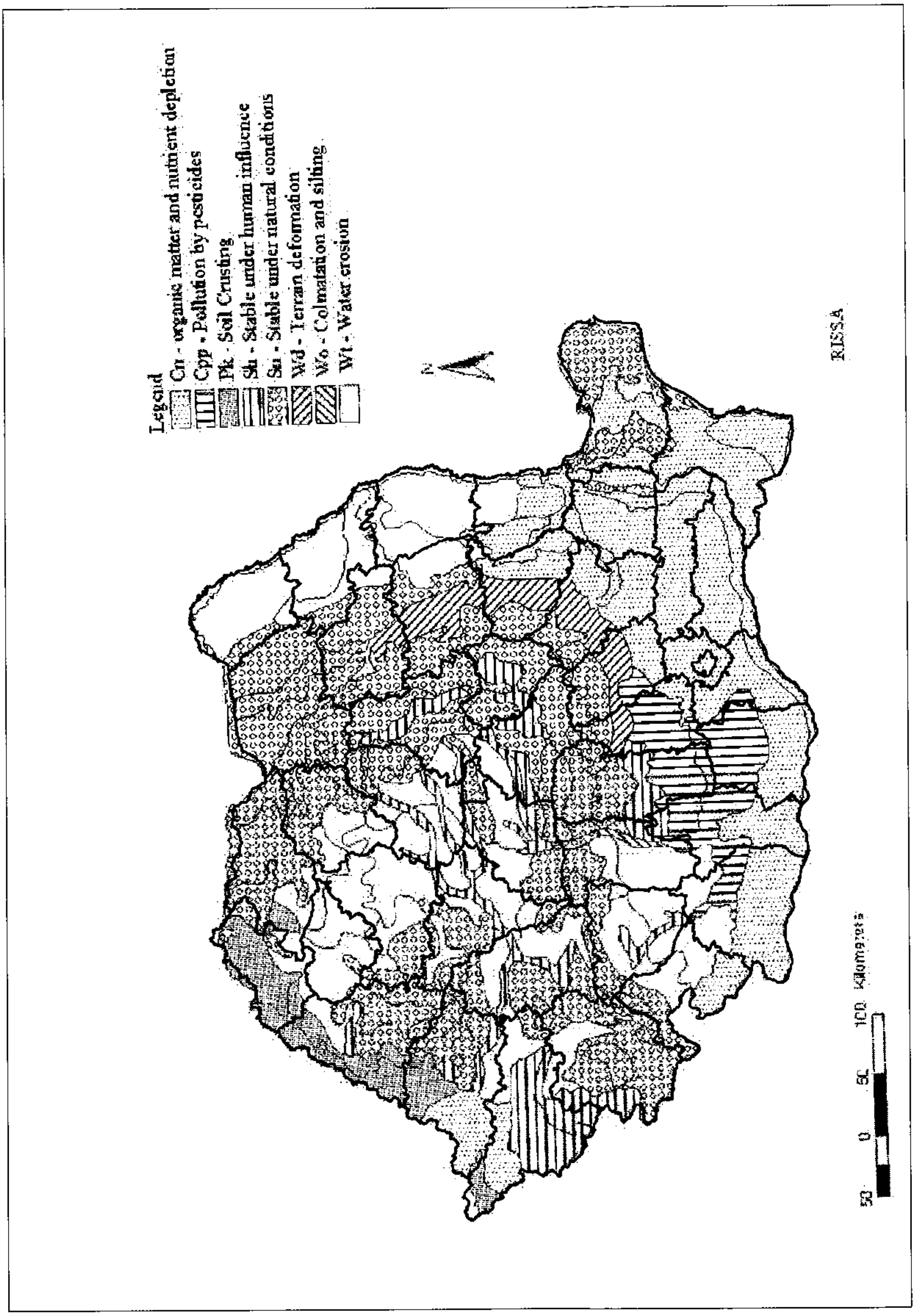

Diagram 7-1: Anthropogenic induced soil degradation (dominant type) in Romania

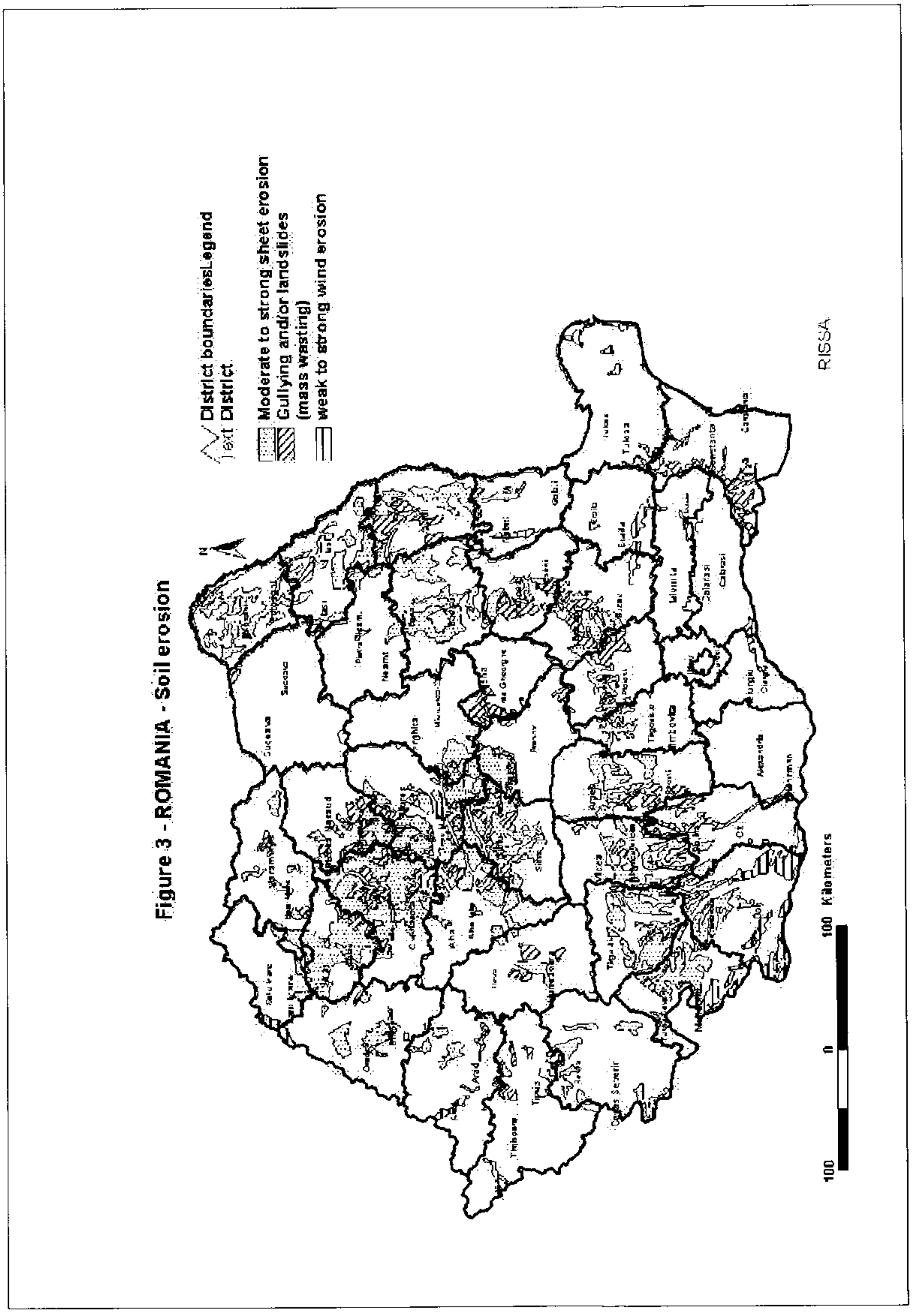

Diagram 7-2: Soil Erosion in Romania

7.8.5 Co-Incineration

The only presently existing large co-incineration plants in the surroundings of the County are cement factories. Several discussions have been made with the operators of these plants. The thematic of using sludge met in general with a high interest on the side of the operators. The fact of saving greenhouse gas emissions and energy were usually considered as positive.

The incineration of waste from other sources in cement factories is already a common practice. This means that the use of sludge is already possible at several locations since the operators already hold the necessary permits. At the moment, however, it is only possible to incinerate dried sludge. Investments need to be made to allow the delivery of dewatered sludge. An implementation period of at least two years must be taken into consideration for this disposal route.

The operators of the cement factories listed below replied positively to incinerating urban sludge and are suitably located for Bacău County.

WWTP	Lafarge Ciment		Carpatcement	
	Hoghiz	Medgidia	Fieni	Bicaz
Bacău	220	364	261	88
Buhuşi	232	392	276	61
Moineşti	190	378	231	134
Dărmăneşti	209	458	232	147
Târgu Ocna	167	355	208	175

Table 7-15: Distances between WWTPs and cement factories (km)

Lafarge Ciment

Lafarge Ciment Romania is operating two cement factories in Romania close to Bacău County. One is in Hoghiz, Braşov County and the other one is in Medgidia, Constanța County. According to the operator (see Annex 10.3), it should be possible to incinerate sludge in both of the factories. Both have the necessary permits and both are already incinerating other types of waste. Theoretically, 20,000 t DS could be incinerated at each of the kilns per annum. The cement factory in Hoghiz is equipped with one kiln and the factory in Medgidia is equipped with two kilns.

The plant in Medgidia already has the appropriate facilities for incinerating dried sludge. There are presently only facilities for combusting solid waste in Hoghiz. Therefore, an investment must be made at this site if dried sludge is to be incinerated. It is also imaginable for Lafarge Ciment to accept dewatered sludge at their plants. It should be possible to construct at the site of the cement factory a sludge drier, which is able to dry the sludge with the waste heat from the cement kiln. The investment costs would have to be allocated to an entrance fee at the cement factory. Unfortunately, it was not possible to make an estimate of a range of entrance fees at this stage in the planning process.

The distances from the WWTPs to the cement factories are long (see Table 7-10). This not only increased disposal costs but is also environmentally disadvantageous for the measure because of the carbon dioxide emissions associated with the transport. A delivery of the sludge by train is also possible according to the operator, and this would mitigate somewhat the distance aspects of environmental impact.

Carpatcement

Carpatcement operates three cement factories in Romania. Two of these are in the range of Bacău County. These factories are located in Fieni, Dâmbovița County and Bicaz, Neamț County. According to Carpatcement, it should be possible in general to incinerate sludge at both of the plants (see Annex 10.3). The operator has already experience with incinerating other types of waste and has the required permits. The operator has not determined the possible capacity for sludge incineration. It should, however, be approximately 10,000 t DS per year and cement factory of Carpatcement.

Carpatcement has already negotiated a pre-contract with the ROC in Neamț County (see Annex 10.4) to co-incinerate all of the County's urban sludge at their Bicaz factory. The particular sludge characteristic limits specified in the pre-contract are:

- energetic value ≥ 11 GJ/t
- Cl < 2 % DS
- Hg < 2 mg/kg DS
- S < 3 % DS
- P_2O_5 < 8 % DS
- moisture content ≤ 10 % DS

Also of great importance, according to the pre-contract, Carpatcement will not charge an entrance fee for the co-incineration. They do not want to dry the sludge at Bicaz facility: the ROC must dewater and dry the sludge before delivery.

As shown in Table 7-12, the distances from all the agglomerations of Bacău County to the cement factory of Carpatcement in Bicaz are considerably shorter than the distances to the Hoghiz cement factory operated by Lafarge. It can be assumed that the entrance fee will be zero for all factories as in Bicaz.

In any case, the capacities of either the Lafarge (Hoghiz) or the Carpatcement (Bicaz) factories are theoretically large enough to take the total County production of sludge.

7.8.6 Sanitary Landfills

A compliant IWMS landfill for Bacău County is planned for south of Bacău on Chimiei Street which will have a lifetime of 20 years, 2011-2030. This site will have a total capacity of 200.000 t/y.

On the short term (2011 – 2014) only landfilling is available as reliable disposal option. Available capacities are limited and specifically on the short term.

The limited sludge disposal capacity of Chimei Landfill represents a major bottleneck in Bacau County disposal strategy. Yet it is still possible to substantiate the feasibility of the short term disposal strategy which suggests 100 % landfill disposal by applying the lower range of specific sludge production of the table below.

The justification to apply lower specific sludge production rates for the short term strategy is as follows:

- The FS design data are peak values for the design of the sludge treatment facilities like digesters, dewatering machines, storage capacities etc.. For the layout of these facilities the maximum capacity is required.
- Sludge disposal is related to average yearly production rates. Furthermore literature presents a range of specific sludge production for WWTP (see table below). The FS design data are at the upper range of values. For sludge disposal it is justifiable to apply the lower values (43 g DS/cap/d for anaerobic digestion and 62 g DS/cap/d for simultaneous aerobic stabilization).
- This argumentation is supported by the fact that the current specific pollution loads for BOD_5 etc. (g BOD_5/cap/d) only match 85 – 90 % of the standard design values. Consequently the specific sludge production must be lower.
- Additionally, the design sludge volumes from WTPs completely result from eliminated turbidity of the raw water intakes which are design values (max. values of the past years).
- Sludge production is not referring to peak loads, but annual average values. Hence it is reasonable to apply lower values for the WTP sludge production when estimating the required disposal capacities. In the short term strategy 80% of the peak loads are used (which is still on the save side).

The following table compiles literature data on sludge production and FS design data as presented in Chapter 7.6.1.

Sludge Production	**Similtaneous Aerobic Stabilization with Chemical Precipitation**	**Anaerobic Stabilization with Chemical Precipitation**
	g DS/cap/d	**g DS/cap/d**
Literature Data	62 - 70	43 - 50
FS Design Data (as presented in Chapter 7.6.1)	70	49
Data used for confimation of Chimei Landfill sludge disposal capacity	62	43

Table 7-16: Literature vs. Design Sludge Production for WWTPs

Chimei landfill will be developed in cells 1 – 3, for the short term sludge disposal, cell 1 refers. The available and consumed sludge disposal capacities are summarized in the following table.

Chimei Landfill Cells		cell 1			
Year		2011	2012	2013	2014
Sludge capacity per year (35 % DS)	t/y	20,599	19,210	19,146	19,253
Total sludge capacity per cell (35 % DS)	t	78,208			
Consumed sludge capacity per year and cell, WWTP and WTP sludge (35 % DS)	t/y	18,488	19,210	19,146	19,253
Total sludge capacity consumed per cell (35 % DS)	t	76,097			

Table 7-17: Sludge Capacity Chimei Landfill, cell 1

Chimei Landfill Cells		cell 2								
Year		2015	2016	2017	2018	2019	2020	2021	2022	2023
Sludge capacity per year (35 % DS)	t/y	19,364	17,278	17,396	17,518	17,466	17,585	17,722	17,864	18,011
Total sludge capacity per cell (35 % DS)	t	160,204								
Consumed sludge capacity per year and cell, WWTP and WTP sludge (35 % DS)	t/y	19,364	17,278	17,396	17,518	17,466	17,585	7,256	7,370	7,483
Total sludge capacity consumed per cell (35 % DS)	t	128,716								

Table 7-18: Sludge Capacity Chimei Landfill, cell 2

Above tables verify that Chimiei landfill capacities are sufficient for the proposed disposal concept.

7.9 Sludge Treatment and Dewatering Facilities

Detailed sludge treatment procedures at all WWTPs can be found in Chapter 10.2.2. The following summarizes the technical facilities for sludge treatment, dewatering and storage of the WWTP in each priority agglomeration.

7.9.1 Bacău WWTP

- **Secondary Sludge:** Secondary sludge will be pumped to the mechanical sludge dewatering station where a final DS content of 6 % is achieved. From there the secondary sludge will be pumped to the anaerobic digesters.

- **Anaerobic Digesters:** The raw sludge (primary + secondary sludge) will be digested in a set of 5 digesters (approx. 1,500 m^3 each). Total retention time is approximately 20 days.
- **Biogas Utilization:** Biogas generated in the anaerobic digesters is stored in a tank (approx. 1.000 m^3) and used in a cogeneration unit for the production of electrical and thermal energy.
- **Sludge Dewatering:** The digested sludge is dewatered in sludge dewatering machines to a final DS content of approximately 35 %.
- **Sludge Storage Area:** The sludge storage area is 6,750 m^2 which is sufficient for a 6 months storage capacity.

Sludge dumping height:			1.00	m
Sludge storage volume:	6,750 m^2 x 1.00 m	=	6,750	m^3

7.9.2 Buhuşi WWTP

- **Secondary Sludge:** Secondary sludge will be discharged to the secondary sludge gravity thickener where a final DS content of approximately 2 – 3 % is achieved. From there the primary sludge is pumped to the sludge dewatering machines.
- **Sludge Dewatering:** The stabilized sludge is dewatered in sludge dewatering machines (recessed plate filter presses) to a final DS content of approximately 35 %.
- **Sludge Storage Area:** The sludge storage area is 2,200 m^2 which is sufficient for a 6 months storage capacity.

Sludge dumping height:			1.00	m
Sludge storage volume:	2,200 m^2 x 1.00 m	=	2,200	m^3

7.9.3 Moineşti North WWTP

- **Secondary Sludge:** Secondary sludge will be discharged to the secondary sludge gravity thickener where a final DS content of approximately 2 – 3 % is achieved. From there the primary sludge is pumped to the sludge dewatering machines.
- **Sludge Dewatering:** The stabilized sludge is dewatered in sludge dewatering machines (recessed plate filter presses) to a final DS content of approximately 35 %. The sludge from WWTP Moineşti-South will be transported to Moineşti-North and dewatered at Moineşti-North.
- **Sludge Storage Area:** The sludge storage area is 2,000 m^2 which is sufficient for a 6 months storage capacity.

Sludge dumping height:			1.00	m
Sludge storage volume:	2,000 m^2 x 1.00 m	=	2,000	m^3

7.9.4 Moineşti South WWTP

- **Secondary Sludge:** Secondary sludge will be discharged to the secondary sludge gravity thickener where a final DS content of approximately 2 – 3 % is achieved. From there the sludge is transported to the WWTP Moineşti-North.
- **Sludge Dewatering:** The sludge will be transported to WWTP Moineşti-North where it is dewatered to a DS of 35 %.
- **Sludge Storage Area:** No sludge storage area is required.

7.9.5 Dărmăneşti WWTP

- **Secondary Sludge:** Secondary sludge will be discharged to the secondary sludge gravity thickener where a final DS content of approximately 2 – 3 % is achieved. From there the primary sludge is pumped to the sludge dewatering machines.
- **Sludge Dewatering:** The stabilized sludge is dewatered in sludge dewatering machines (recessed plate filter presses) to a final DS content of approximately 35 %.
- **Sludge Storage Area:** The sludge storage area is 1,350 m^2 which is sufficient for a 6 months storage capacity.

Sludge dumping height:			1.00	m
Sludge storage volume:	1,350 m^2 x 1.00 m	=	1,350	m^3

7.9.6 Târgu Ocna WWTP

- **Secondary Sludge:** Secondary sludge will be discharged to the secondary sludge gravity thickener where a final DS content of approximately 2 – 3 % is achieved. From there the primary sludge is pumped to the sludge dewatering machines.
- **Sludge Dewatering:** The stabilized sludge is dewatered in sludge dewatering machines (recessed plate filter presses) to a final DS content of approximately 35 %.
- **Sludge Storage Area:** The sludge storage area is 1,050 m^2 which is sufficient for a 6 months storage capacity.

Sludge dumping height:			1.00	m
Sludge storage volume:	1,050 m^2 x 1.00 m	=	1,050	m^3

7.10 Sludge Disposal Costs

The estimation of possible sludge disposal costs has been made for five of the six in the County practicable sludge disposal alternatives: agricultural, reforestation, land reclamation, co-incineration and land filling. The projection of exact costs is quite uncertain since there is only experience with land filling. The remaining alternatives can only be estimated on experience values from other European countries. Problematic also is the disunity of the costs for each plant because of the impact of several influences like the size of the plant and/or the distance to the outlet. In addition, the final disposal fee depends to a large extend on the negotiations between the operators of the treatment plants and the outlet. Therefore, only cost ranges are possible. Nevertheless, average costs in the County need to be selected for the cost-benefit calculations. A common sludge treatment goal is needed to maintain comparability in the estimation of sludge disposal costs. A sludge dewatering at the WWTPs has been used for all of the alternatives with a 35 % dry solids content to 2020 and thereafter 20 % DS.

Several literature values for the disposal of urban sludge are given in the following tables. The wide range of values is easy to observe. The comparability of these costs to Romania is uncertain. The costs for investment goods are only 4 % lower in comparison to the EU according to the statistics of Eurostat, but the costs for construction works are 46 % lower. The biggest difference is located in the labour costs. Here the average costs are 80 % below the European average[11]. This means that the costs in general will be lower in Romania than the European average. It can be assumed that they are on the lower boundaries of the cost ranges.

The following table shows basis cost structures for sludge disposal in Western Europe.

Process Step	Unit Costs	Comments
	Euro/t DS	
Transport		
Truck, wet sludge	100 – 260	5 - 20 km
Truck, dewatered sludge	20 – 50	5 - 20 km
Truck, dewatered sludge	30 – 60	20 - 50 km
Truck, dewatered sludge	35 – 115	more than 50 km
Sludge Drying		
Fixed plant, 90 % DS	320 – 405	
Mobile plant, 90 % DS	460	
Agricultural Sludge Disposal / Recultivation (without transport)		
Agriculture, wet sludge	145 – 350	
Agriculture, dewatered sludge	85 – 205	
Recultivation, dewatered sludge	85 – 205	
Incineration (without transport)		
Mono-incineration, dewatered sludge	145 – 405	
Mono-incineration, dried sludge	40 – 70	
Co-incineration lignite power plant	115 – 375	
Co-incineration in cement factories	260	

Table 7-19: Cost structures in sludge disposal

Typical costs for sludge disposal are shown in the following table.

[11] ec.europa.eu/eurostat, accessed on January 13, 2009

Disposal Route	DS Content	Disposal Cost	Average DS Content	Disposal Cost
	%	Euro/t Wet Sludge	%	Euro/t DS
Agriculture, wet	4 - 5	8 - 12	4.5	178 - 267
Agriculture, regional	25 - 45	25 - 30	25	100 - 120
Agriculture, national	25 - 45	33 - 45	25	132 - 180
Land reclamation	25 - 45	30 - 45	25	120 - 180
Co-incineration lignite power plant	25 - 45	50 - 75	25	200 - 300
Separate incineration	25 - 45	80 - 120	25	320 - 480
Co-incineration cement factory	> 85	90 - 100	90	100 - 111

Table 7-20: Typical disposal cost ranges incl. transport costs

The MO 344/2004, MO 756/1997 and the EU Third Draft Directive define the necessary monitoring when sludge is used in agriculture. It should be noted Romania presently has maximum concentration and monitoring requirements which are higher than those historically applied in Western Europe. Detailed cost estimates of the required sampling programs for the industrial dischargers, WWTP sludge and soil analyses of the land receiving the sludge have given total monitoring costs of 40 to 110 €/t DS for the County. These costs are not born alone by the WWTP operators but the costs of soil analyses are to be paid for by OSPA[10]. The industrial discharger monitoring costs should also be carried by the dischargers. The costs given below, however, represent the total costs for this sludge-disposal route.

The values given in the above mentioned tables on agricultural reuse have a large range. This is probably related to legislative constraints and the resulting costs. In many parts of Europe the soil analyses need to be carried out by the operators. A payment into a compensation fund needs to be made in other countries for the case of damages caused by sludge pollutants. Administrative duties remain with the operator such as the preparation of sludge analyses, the identification of appropriate lands, the preparation of up-to-date records on lands used, sludge quantities and qualities, crop types and spreading times. In addition to this, the spreading needs to be organized and carried out by the operator of the WWTP. Therefore, it may be necessary for the operators to invest in equipment or to contract this with outside firms. Investments in storage equipment will also be necessary for the times when sludge cannot be spread on fields.

The costs which occur by spreading the sludge in land reclamation and forestry measures should be in the same range as for agriculture. Here the administrative expenses and the costs of continued soil monitoring drop out of the costs but transport distances may be higher than in agricultural reuse. Field trials need to be carried out which prove the suitability of the sludge for reclamation and reforestation measures. Additionally, the owners of the degraded lands need to be encouraged to reclaim these areas with the help of urban sludge. Still the costs should be lower than in the agricultural use of sludge.

The structure of the costs is less complex for the co-incineration in cement factories. The only costs which occur besides the transportation are the costs of drying and the entrance fee at the cement factory. A zero entrance fee has been chosen as the value for the cost estimation. Based on the pre-contract between Capatcement and the Neamț County ROC, no entrance fee has been calculated for the Bicaz and Fieni cement factories, while an entrance fee of 100 €/t DS has been chosen for the cost estimation for the Hoghiz and Medgidia factories. The entrance fee, nevertheless, is only the minor part of the cost arising from co-incineration. The main cost occurs in the drying of the sewage sludge. The literature gives a range of costs for the drying of sludge between 300 and 800 €/t DS. The costs should be lower as most of the existing wastewater treatment plants have drying beds which could be easily transformed into more effective solar drying facilities. As a result, 200 € per ton dry matter has been estimated for the drying.

Entrance fees for co-incineration at a biomass-power plant cannot be estimated at present. Here there is no European experience to fall back on. These costs will simply have to be negotiated during the execution of Sludge Disposal Strategy.

The entrance fee at the compliant County solid waste landfill at Chimiei Street will be 12 €/t for urban sludge at 35 % DS; this results in an entrance fee of 34 €/t DS. Dewatering the sludge to 35 % DS at the WWTPs was assumed to be achieved by using recessed-plate filter presses or diaphragm filter presses with polymer and $FeCl_3$ conditioning. The cost of the conditioning chemicals has been considered in the consumable costs of the WWTPs.

An assessment has been made of the transportation costs. The unit transport cost per ton dry matter decreases with higher transport distances as the loading and unloading costs become less significant. A summary result of the assessment is shown in the following figure.

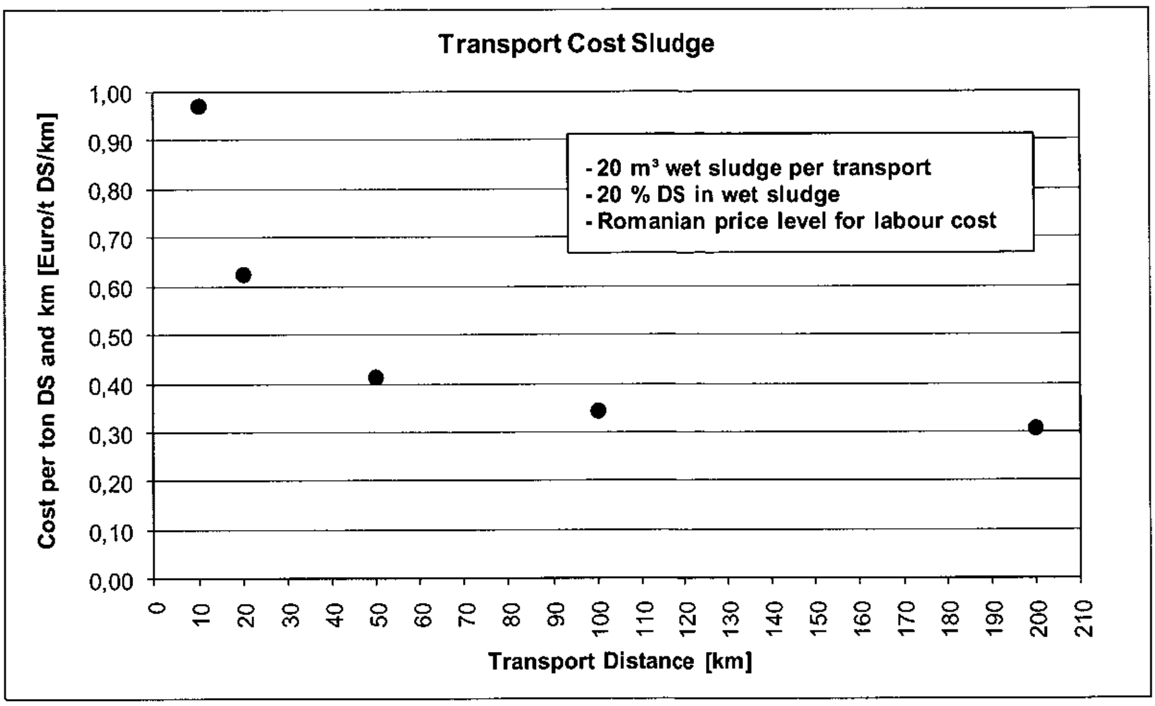

Diagram 7-3: Cost for sludge transport

The following tables provide estimates of the disposal costs for each WWTP in the County and possible disposal route. The calculations are based on present information. It has been assumed that appropriate lands exist for agriculture, reforestation and land reclamation. Co-incineration is assumed to occur at the Bicaz cement factory with 90 % DS dried sludge while the landfill alternative for the County's sludge is for it to go to the central Chimiei Street landfill site. The agricultural reuse of sludge does not include the costs to determine which lands satisfy the requirements of MO 344/2004. The Application Costs for agriculture, reforestation and land reclamation include spreading and working the sludge into the soil as required in MO 344/2004. Too little information is available to estimate the costs of bio-gas production in spite of its appearance of being a very cost effective use of sludge.

It can be seen below that according to present knowledge reforestation and land reclamation appear to be the most cost-effective sludge reuse disposal routes. The environmental social costs have not been included in any of the alternatives. Holistically, one can say these will be the highest with agricultural reuse and the lowest with co-incineration. It must be clearly understood that only the costs for land filling are based on Romanian conditions. All other costs are estimated with significant uncertainties.

Disposal Route	**Drying €/t DS**	**Transport €/t DS**	**Laboratory Analyses €/t DS**	**Entrance Fee €/t DS**	**Application Costs €/t DS**	**Total Costs €/t DS**
Agriculture	0	9	75	0	40	124
Reforestation	0	11	60	0	40	111
Land Reclamation	0	11	60	0	40	111
Composting	0	4	0	37	0	41
Co-Incineration	200	5	0	0	0	205
Land Filling	0	4	0	37	0	41

Table 7-21: Sludge disposal costs – Bacău WWTP

Disposal Route	Drying €/t DS	Transport €/t DS	Laboratory Analyses €/t DS	Entrance Fee €/t DS	Application Costs €/t DS	Total Costs €/t DS
Agriculture	0	9	75	0	40	124
Reforestation	0	11	60	0	40	111
Land Reclamation	0	11	60	0	40	111
Composting	0	8	0	37	0	45
Co-Incineration	200	4	0	0	0	204
Land Filling	0	8	0	37	0	45

Table 7-22: Sludge disposal costs – Buhuşi WWTP

Disposal Route	Drying €/t DS	Transport €/t DS	Laboratory Analyses €/t DS	Entrance Fee €/t DS	Application Costs €/t DS	Total Costs €/t DS
Agriculture	0	21	75	0	40	136
Reforestation	0	9	60	0	40	109
Land Reclamation	0	9	60	0	40	109
Composting	0	11	0	37	0	48
Co-Incineration	200	7	0	0	0	207
Land Filling	0	11	0	37	0	48

Table 7-23: Sludge disposal costs – Moineşti WWTPs

Disposal Route	Drying €/t DS	Transport €/t DS	Laboratory Analyses €/t DS	Entrance Fee €/t DS	Application Costs €/t DS	Total Costs €/t DS
Agriculture	0	24	75	0	40	139
Reforestation	0	9	60	0	40	109
Land Reclamation	0	9	60	0	40	109
Composting	0	13	0	37	0	50
Co-Incineration	200	8	0	0	0	208
Land Filling	0	13	0	37	0	50

Table 7-24: Sludge disposal costs – Dărmăneşti WWTP

Disposal Route	Drying €/t DS	Transport €/t DS	Laboratory Analyses €/t DS	Entrance Fee €/t DS	Application Costs €/t DS	Total Costs €/t DS
Agriculture	0	24	75	0	40	139
Reforestation	0	9	60	0	40	109
Land Reclamation	0	9	60	0	40	109
Composting	0	12	0	37	0	50
Co-Incineration	200	9	0	0	0	209
Land Filling	0	12	0	37	0	50

Table 7-25: Sludge disposal costs – Târgu Ocna WWTP

Disposal Route	Drying €/t DS	Transport €/t DS	Laboratory Analyses €/t DS	Entrance Fee €/t DS	Application Costs €/t DS	Total Costs €/t DS
Land Filling	0	13	0	37	0	50

Table 7-26: Sludge disposal costs – Caraboaia WTP

Disposal Route	Drying €/t DS	Transport €/t DS	Laboratory Analyses €/t DS	Entrance Fee €/t DS	Application Costs €/t DS	Total Costs €/t DS
Land Filling	0	5	0	37	0	42

Table 7-27: Sludge disposal costs – Barați WTP

In conclusion it can be said that the transport costs for all alternatives are relatively accurate as are the land filling entrance fees. The costs for laboratory analyses are based on semi-accurate adjustments of costs for Romania. No entrance fee has been calculated for the Bicaz cement factory based on the pre-contract between Carpatcement and the Neamț County ROC. The application costs for landfill closure, agriculture, reforestation and land reclamation are quite uncertain estimates based on western European experience. To summarize, the difference in costs for sludge reuse in agriculture, reforestation and land reclamation are not significantly different considering the uncertainty in the cost estimates. Land filling is the cheapest disposal route in spite of undesirability by the MoEF and the EU. Co-incineration is more expensive than the other alternatives, be it environmentally the best solution.

7.11 Proposed Sludge Disposal Strategy

A strategy is not a plan or procedure. A strategy is a set of planning and analysis activities and decision making procedures one uses to arrive at the disposal goals set. The goals or objectives of the sludge disposal in Bacău County, as stated in Chapter 7.2 above, are

- disposal security,
- environmental security and
- affordability.

The strategy can be divided into short, middle and long-term activities and for each time horizon there are different disposal routes which can be implemented according to the status of the strategy activities. As also described above, there are several possible disposal routes in the County.

The basis for the developed sludge disposal strategy, with confirmed, selected and provisionally selected disposal paths, are the projected of sludge production, the planned sludge dewatering facilities and the legal directives of the EU and Romania as well as the information from ROC and various governmental organizations (OSPA, ROMSILVA, APM) about the possible disposal paths for urban sludge.

The Romanian legal constraints and the lack of detailed information preclude all disposal paths except landfill closure, land filling and co-incineration at this time. It will take a number of years to carry out the necessary field studies and trials necessary for the "natural" disposal paths (agriculture, land reclamation and reforestation) to be implemented and at the same time there are presently very rapid developments occurring in the feasibility of the "technical" disposal paths (e.g., bio-gas and ethanol production, phosphate recovery).

For this reason, the immediate disposal paths to be utilized in the short-term will be land filling. Co-incineration falls out of consideration in light of its high investment and operational costs. A commitment at this time to co-incineration would preclude other disposal paths in the future. The strategy laid out here provides a roadmap to develop an economically and environmentally optimal disposal procedure with the necessary robustness to provide operation security under unexpected operational and economic variations.

In the short-term sludge from the Bacău WWTP will be going to the Chimiei Street compliant landfill. In the middle-term only land filling is feasible. The provisionally selected disposal paths for the long-term are:

- land reclamation – 25 %
- reforestation – 25 %
- co-incineration – 50 %

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