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PROJECT 2004/RO/16/P/PE/003-1

TECHNICAL ASSISTANCE FOR PROJECT MANAGEMENT AND PROGRAM ASSISTANCE FOR BUCHAREST WWTP

"Finalisation of Glina WWTP, rehabilitation of the main sewer collectors and of Dambovita sewer collector canal (CASETA)"

Volume V: Environmental Impact Assessment (EIA), July 2012

ISPA MEASURE

Bucharest Wastewater Treatment Plant Rehabilitation: Stage 1

NO. 2004/RO/16/P/PE/003

SWECO Halcrow SOGREAH GROUPE ARTELIA

1989147000/WWBPIU - RP-50

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Abbreviations

WWTP	Waste Water Treatment Plant
ISPA	Instrument for Structural Policies for Pre-Accession (EC)
EIA	Environmental Impact Assessment
MoB	Municipality of Bucharest
CFA	Cohesion Fund Application
ANB	Apa Nova Bucharest
MoESD	Ministry of Environment and Sustainable Development
GD	Govermental Decision
CF	Cohesion Fund
COD	Chemical Oxygen Demand
BOD	Biological Oxygen Demand
DS content	Dry solid content
SS	Suspended solids
GCV	Gross Calorific Value
NCV	Net Calorific Value
ESP	Electrostatic precipitator
IE Directive	Directive no 2010/75/EU on industrial emissions
CAPEX	Capital investment expenditure
OPEX	Operating cost expenditure
SOP	Sectoral Operation Programme
ToR	Terms of Reference
VL	Limit values

EIA of the Glina WWTP stage 2 including the sludge incineration and works for Bucharest sewerage system rehabilitation

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EIA of the Glina WWTP stage 2 including the sludge incineration and works for Bucharest sewerage system rehabilitation

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Chapter 1 GENERAL DATA

1.1 Necessity and opportunity of the project

The city of Bucharest, where around 2 millions inhabitants are living, has a combined system to collect domestic, industrial and storm water.

The Bucharest wastewater will be treated within the Glina wastewater treatment plant (Glina WWTP), from where the treated effluent will be discharged into the river Dambovita. Near Budesti the river Dambovita flows into the river Arges, which finally discharge his water into the Danube near Oltenita. The discharge of the Bucharest untreated wastewater was considered the main source of water quality degradation in Dambovita and Arges Rivers and also as one of the major sources of pollution of the Danube River.

To remediate this situation, an ISPA Measure “Bucharest Wastewater Treatment Plant Rehabilitation Stage 1” with a component entitled “Technical Assistance for Project Management and Program Assistance for Bucharest WWTP” – code 2004/RO/16/P/PE/003-1 was promoted. Within the frame of this project, the stage 1 of the Glina WWTP development and the Feasibility Study for the development stage 2 of the same plant was achieved.

This Environmental Impact Assessment study (EIA) refers to the Glina WWTP Stage 2 development, which means:

- Water treatment line no 2
- Final sludge handling and disposal

The EIA study together with the Feasibility Study and other documents elaborated within the frame of the above nominated project will be used for preparing and sustaining the Application for Cohesion funding.

Finalizing the rehabilitation of Glina WWTP is a priority for environment protection, as well as an important objective of public interest.

1.2 The Promoter and Beneficiary of the project

The Beneficiary of the Project is the Municipality of Bucharest (MoB), which is also the Contracting and the Implementing Authority.

1.3 The Consultant of Feasibility Study and Environmental Impact Assessment

The Consultant, preparing the Feasibility Study (FS), the Environmental Impact Assessment (EIA) and later on the Cohesion Fund Application (CFA) is the Joint Venture Sweco

International AB, Halcrow Group Ltd and Sogreah Consultants (SHS JV) with local sub-consultants Halcrow Romania, Romproed S.A. and Sogreah - Enviroassist.

The Environmental Impact Assessment (EIA) was elaborated by the former SC Enviroassist srl, (actual SC Artelia Romania srl) which is registered within the National Register of environmental studies elaborators at the position no.198. The registration Certificate has validity till 13.04.2015.

The Feasibility Study (FS) for Glina WWTP, Stage 2 including Incineration of sludge, as well as FS for Casseta and collectors and the corresponding EIA report will serve for the elaboration of the Cohesion Fund Application (CFA). The Cohesion Fund Application (CFA) will to be submitted end 2011 and its approval is expected to be obtained in 2012.

1.4 Coordination and correlation elements

The Urban Certificate no 166 of 5.10.2011 delivered by the City Hall of Glina commune

The Water authorization no 291/16.12.2011 delivered by the National Authority “Apele Romane” Bucharest contains as conditions:

- the quality parameters for effluent discharge in Dambovita river, as required by the GD 352/2005 – Annex 3 and GD 351/2005 modified by HG 783/2006
- to take corrective measures in case of exceeding the discharge limits
- to actualize, any time when needed, the Plan for preventing and control of accidental pollution; to have intervention materials and means for case of intervention
- to announce immediately in case of accidental pollution of water resources due to exceeding discharge limits and to act for eliminating the pollution causes and for limiting the pollution effects.

The Environmental agreement no 40/7.06.2004 (actualized by the Decision 9/16.06.2010), issued by the EPA Ilfov has indicated the following conditions (reiterated in the Decision 9/16.06.2010) for the project achievement:

- respecting the noise level of 65dB(A) at the site limit
- respecting air quality parameters as required by STAS 12574/1987
- taking measures to avoid soil pollution with oil products or harmful materials
- storage of waste generated from constructions and plant functioning on-side in special arranged places and dispose them by mean of an authorized company
- assure a good sealing of the storage basin for $Fe\ Cl_3$
- respecting the provisions of the Water authorization.

As proof that above conditions have been fulfilled no complaints or penalties are recorded.

The present project is correlated with the Framework Scheme for Management of the Dambovita Hydrographical Basin and do not affect the flowing regime of surface and underground water or any existing or future objectives in the area.

Chapter 2 DESCRIPTION OF THE PROPOSED PROJECT

2.1 General elements

This chapter presents a description of the Glina Wastewater Treatment Plant (WWTP) including its history. The basic design criteria (wastewater flow and pollution load) and those used for the Stage I development (including changed values agreed within Addendum no 3 to the Work Contract no 2004/RO/16/P/PE/003-03) are only shortly presented, while the design concept, parameters and proposed components for the development of Stage II of the Bucharest WWTP are detailed.

The potential impacts and mitigation measures of the option proposed for Stage II are analyzed in another chapter of this report. Also the comparison of the described option with alternative options is presented into a separate chapter, so that to become clear why the first one was considered as the *preferred alternative*.

2.2 Detail on the project location

Location

Both the Stage 2 of the Glina WWTP and the sludge incinerator will be constructed in connection and on the site of the existing WWTP stage 1.

The site of the Glina WWTP stage 1 is located to the south-east of Bucharest, near the Glina village, on the land of the former Glina and Popesti-Leordeni agricultural Farms. This location is on the right bank of the Dambovita River - the receptor of the untreated wastewater of Bucharest.

The WWTP site is bounded to the **north** by the Dambovita River canal and the formerly proposed Bucharest Inland Harbour.

To the **east** the immediate bordering area and the area further away is covered by pastures and other agricultural land.

To the **south,** the slope of a slight hill is separating the WWTP to the Glina Village - the nearest residential area. South-west from the WWTP there is the Solid Waste Dumping Site “Ochiul Boului”.

Towards **west** of the WWTP there are a wholesale store for consumer goods, the former pilot wastewater treatment plant, followed by the PROTAN factory, an animal body processing factory. Four to five km further starts the Bucharest urban area. An industrial area including the Bucharest Thermo-Electric Power Plant is situated in the **north-west** of the WWTP.

Occupied surface

For the Glina WWTP a total surface of 114 ha was reserved including 71.9698 ha, a surface that are the property of the Bucharest Municipality, and 42 ha, a surface subject of the Association contract No.145/11.11.2004, signed by the City Hall of Bucharest and Glina Commune, having as subject the finalizing of Glina WWTP and the construction of the water supply and sewage network of Glina commune.

The surface reserved for the Stage II of the Glina WWTP is around 65 ha. Excepting the area of **8.5 ha** where constructions or installations will be place and **1 ha** occupied by roads, the remaining unoccupied surface will be arranged as green land.

2.3 Specific data on the project

2.3.1 History and actual situation

The major development of infrastructure during the period 1970 – 1980 in Bucharest has included the realignment of the free flowing river Dambovita into a set of artificial lakes and the collection of domestic and industrial wastewaters, storm and groundwater infiltrations by mean of several trunk sewers into a “Casseta”, a large collector running under the new concrete channel for the clean water of Dambovita river.

Refurbishment of the river Dambovita and building of the Casseta was carried out as a unified project with the Glina Wastewater Treatment Plant and the extension of the Dambovita man-made channel to the Arges River.

In order to understand the impact of the possible solutions for Bucharest WWTP it is important to have knowledge about the history of the project because of the following reasons:

Firstly, flows entering Glina WWTP are composed of wastewaters (domestic and industrial) and rainwater discharged into the sewer, as well as infiltrations in it. For the treatment process in the Glina plant the amount of infiltration entering into the wastewater flow is of most importance because of the generated dilution and supplemental hydraulic load.

Secondly, organic load to be treated is depending on the connected population and discharges from industry. Future Bucharest territorial development, as well as the connection of neighboring dwelling areas sewers, will determine variation of flow and load entering the plant.

Finally, the partially constructed structures and the mechanic or electric equipment provided during the first construction phase have obliged the contractor of Line 1 to use some of these existing assets. Line 2 has to complete the treatment process in such a way to assure compliance with the imposed conditions for the whole amount of influent waters.

2.3.2 Sewerage system

The Bucharest sewerage system is unitary conceived, collecting both rainwater and wastewaters within the same system.

Two structural elements define the characteristics of the system:
- the Casseta and the large collectors
- the sewage collection system.

Casseta

The Casseta was built in the years 80's for a "cosmetic" reason, because the old Dambovita River was in fact a large open sewer.

The natural Dambovita River does not really exist on the Bucharest territory, being replaced by a dual system:

- the Casseta and
- an artificial 'river bed' which runs on top of the Casseta, containing clean water delivered over the dam of Morii lake (Morii Lake receives the water of Dambovita river upstream Bucharest).

The Casseta is a channel system running from west to south-east, respectively from Morii Lake down to the Glina WWTP. It is composed of 2 separate sub-casseta-s on the distance from its starting point (Morii Lake) to the city centre (the Courthouse), and 3 sub-casseta-s from that point down to the Glina WWTP.

5 km before the WWTP plant, the Casseta leaves its initial position of beneath the artificial river-lakes and runs further parallel with the channeled river. Finally, the Casseta receives all collectors 4 km before reaching the Glina site, where it discharges the wastewater through a single overflow provided at the chamber for the water line no 2.

Downstream Bucharest and until reaching the confluence with the Arges River, Dambovita River has been transformed into a man-made straight channel, which at the present is carrying an important amount of untreated wastewater from the largest Romanian city straight into the Danube (60 km downstream).

Apa Nova Bucharest (ANB) is the current operator of the water supply and sewerage system in Bucharest and the existing concession contract between ANB and the Municipality of Bucharest (MoB) clearly indicates that ANB will be the future operator of any wastewater and sludge treatment facilities provided for Bucharest.

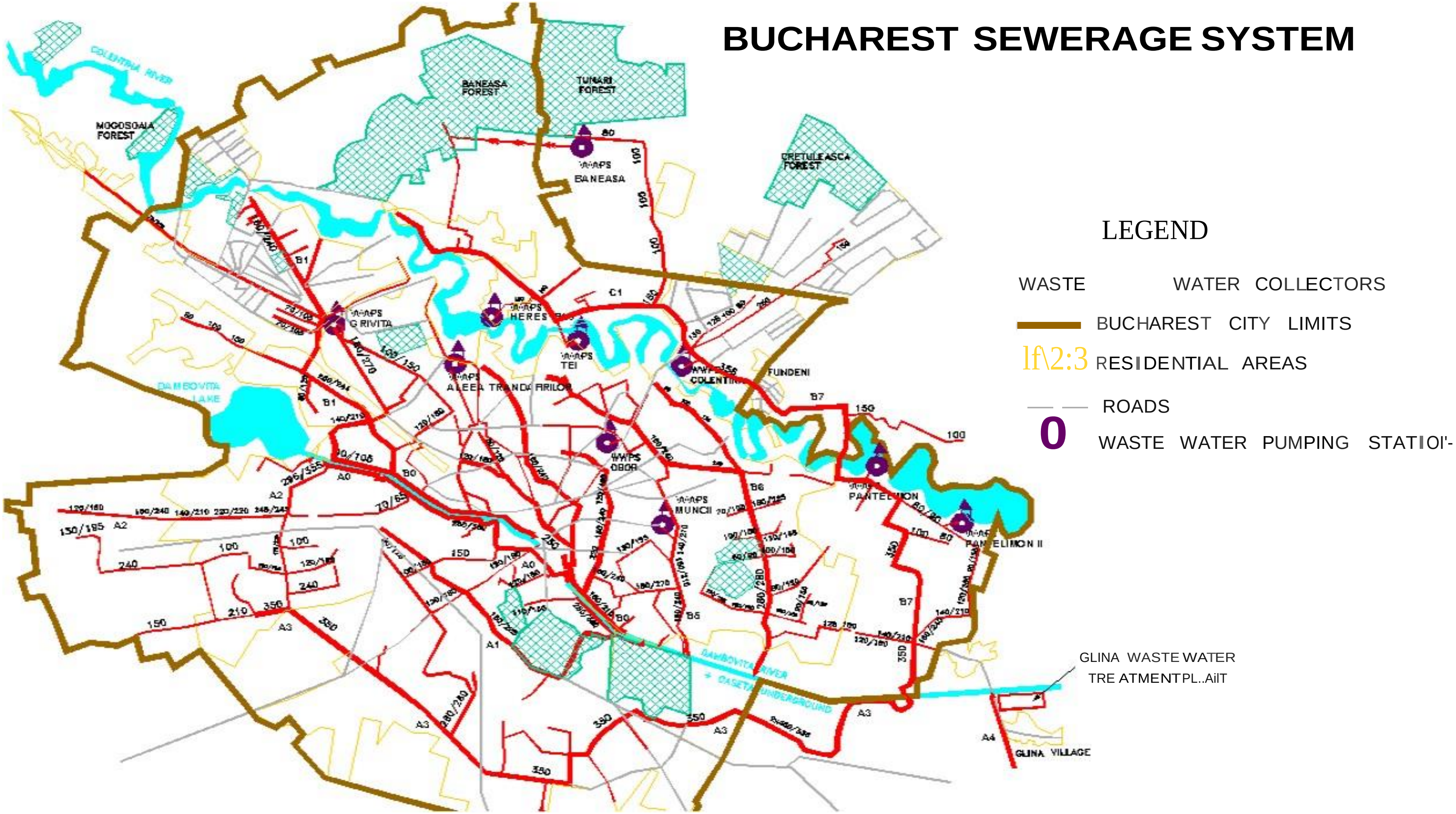


Figure 2.1 Sewerage system and trajectory ofDambovita and Colentina Rivers on Bucharest territory

Collection system (Large collectors)

There are a number of main 12 collectors out of which 2 – are adjacent to the Dambovita river, 3 are on the southern (right) part of the river (A1….A3) and 7 – on the northern (left) part (B1….B7) of the river.

Collectors having the largest areas for collecting sewage waters are A3 (35.9 km^2 and B7 – 35.5 km^2).

The main wastewater collectors of the city initially have discharged into the large collectors **A0 and B0** which run on both sides of the Casseta. Because of the construction of the Metro line no 1 the collector B0, which is on the left side, was fragmented and communicates with the Casseta in several points. The other collector A0 is discharging in the right bank sub-casseta, downstream of the city.

Smaller collectors are discharging wastewaters either into A0 or B0 or directly into the sub-casseta-s, in different sections.

The sewerage system is owned by the Bucharest Municipality, but operated by "Apa Nova Bucharest" – ANB (a subsidiary of Veolia Company).

2.3.3 Design and construction history

The design of Glina WWTP was developed based on pilot plant studies carried out in the years 1970's, on a local trunk sewer which was not representative for the flow and loads currently reaching the plant.

The initial design envisaged a WWTP on the right bank of river Dambovita, next to Glina village, composed of **three treatment lines** containing primary settlement and conventional activated sludge basins. Each treatment line was sized for a 7.5 m^3/s flow to full treatment, with an additional 7.5 m^3/s capacity of mechanical treatment only for storm flow.

The total dry weather flow (DWF) anticipated for full treatment would have been 22.5 m^3/s, with an additional storm flow of 22.5 m^3/s. Sludge treatment was conceived according to these flows and was thought to be carried out by a two-stage anaerobic digestion followed by mechanical dewatering.

Due to budget constraints, Bucharest Municipality finally authorized only **two lines** with the equivalent sludge treatment.

Construction works at Glina site started in **1985** and progressed with difficulty being interrupted many times. Initially, the construction started simultaneously in several plant sections, on both lines and most equipment for these plant sections was supplied before 1989.

Works were resumed in **1991** with efforts directed to commission Line 1 mechanical treatment and ancillary sections.

In **1996** tests revealed considerable problems with the mechanical equipment and works were abandoned again after 3 months of trial operation.

After some attempts of reviewing and updating the initial design that took place in different periods (years 1997/1998, 2000/2001), in 2003 a new feasibility study has proposed a strategy for the completion of Glina WWTP comprising the following components:

1. refurbishment and completion of the **water line 1, based on a 10 m^3/s dry weather flow** for primary and secondary treatment of wastewater, including sludge treatment;

2. design of a **totally new line 2 for another 10 m^3/s flow**, the construction of additional digestion capacity, as well as an incinerator for digested sludge;

3. a **storm water capacity of 60,000 m^3**, with a maximum hydraulic capacity of the plant of 78,000 m3/h; the storm retention basins were thought to function as primary settling tanks till the finalizing of the line no. 2.After the finalizing of the line 2 these basins will receive wastewater only during periods with heavy rains.

The implementation of these components was proposed to be carried out in two phases:

Phase 1 (2006 – 2010) was oriented on the completion and upgrading of the existing water and sludge treatment line 1 (Q=10 m3/s), the demolition and removal from site of all unwanted structures and the inclusion of agreed storm water basins. This phase was funded through the ISPA program.

Phase 2 (2011-2015) was planned for the design and construction of a new water and sludge line of an estimated capacity of 10 m^3/s, adjusted in function of the line 1 performance. A sludge incinerator is included in this phase. This phase was thought to be funded by EU Cohesion Funds and partially from other sources.

The completion and modernizing of the plant implied the following objectives:
- revision of the technology for the whole treatment process in conformity with the European standards;
- provision of efficient equipments adequate to the technology requirements;
- improving of existent assets, in order to integrate them in the revised process;
- provision of measurement and control equipment.

Based on this feasibility study, in **2006** the joint venture **Aktor S.A – Athena S.A** has contracted with Bucharest Municipality the detailed design and construction of Line 1 under the project entitled "*Bucharest wastewater treatment plant rehabilitation – Stage 1*".

According to the plans, the WWTP Stage I was put into operation in summer 2011.

2.4 Design Parameters

2.4.1 Design parameters for Line 1

The Stage I of the Glina WWTP was designed to treat a flow of $10m^3/s$ by mechanical and biological processes based on the wastewater quality parameters presented in Table 2.1:

Table 2.1 Initial design parameters for Glina WWTP Line 1

Parameters	Influent characteristics (Flow = $10m^3/s$)		Effluent characteristics (Flow = $10m^3/s$)	
	Pollutant concentration (mg/l)	Pollutant load (kg/d)	Pollutant concentration (mg/l)	Pollutant load (kg/d)
BOD5	84,98	73,425	25	21,600
COD	187.36	161,877	125	108,000
SS	119.77	103,479	35	30,240
TN	13.14	11,350	10	8,640
TP	2.47	2,137	n/a	n/a

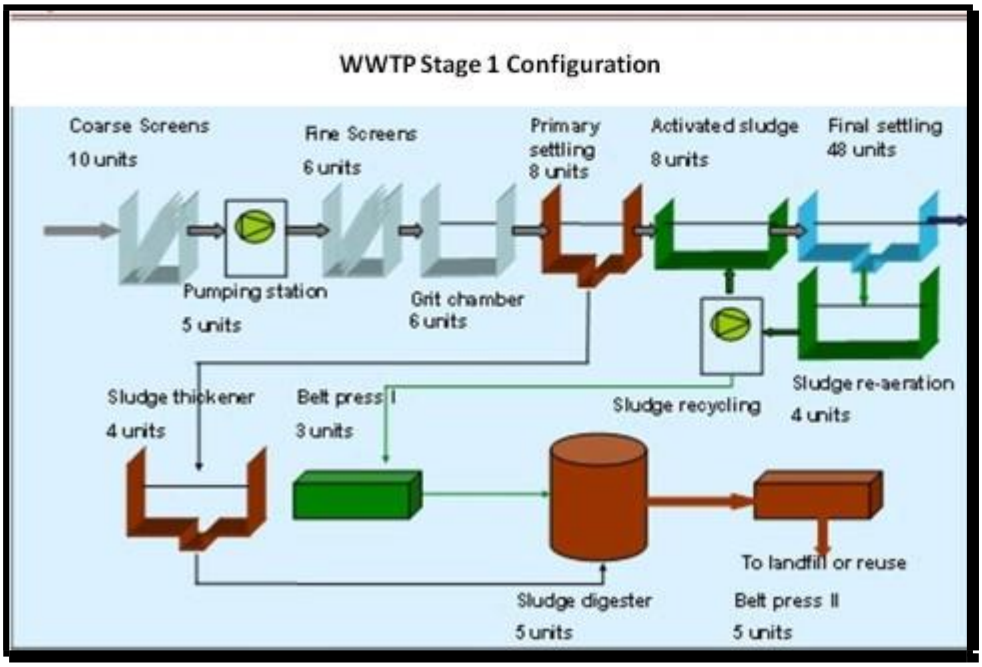


Figure 2.2 Configuration of Glina WWTP Stage I

Wastewater flow and quality data collected in years 2008-2010 have shown changes consisting in lowering of flow and increasing of pollutant concentration except BOD5, that could lead to the noncompliance with conditions for the effluent discharge into the river.

Another supplemental element, important for compliance with the actual provisions for effluent discharge, resulted of the recent Romanian norm for Phosphorus removal down to 1 mg/l (NTPA 011/2002), as a consequence of the fact that the whole territory of Romania was declared a "sensitive area" by the GD 352/21.04.2005.

Within the initial design parameters the WWTP process would be not capable to allow nutrients removal and especially phosphorus, to such a value to respect the imposed limits.

Table 2.2 Wastewater characteristics according to the initial and amended Financing Memorandum

Parameters	Wastewater characteristics of wastewater according to the initial Financing Memorandum (mg/l)	Wastewater characteristics according to the amended Financing Memorandum (mg/l)
BOD5	85	120
COD	181	280
SS	120	210
Total Nitrogen	13.2	24
Total Phosphorus	2.5	4.4

Considering the new established pollutant concentration and the need to comply with the imposed Phosphorus concentration in the discharged effluent, it was agreed that the treatment capacity of the line no I to be reduced and a supplementary treatment for Phosphorus removal to be introduced. As a result, a change of the Glina WWTP Stage 1 design parameters has been agreed as follows:

- the line 1 to treat 10 m^3/s in the primary mechanical phase and only 5 m^3/s in the secondary biological phase, but including Phosphorus removal;
- the remaining 5 m^3/s mechanically treated to be diverted through the emergency by-pass to the river;
- the hydraulic capacity of all biological process units to remain 10 m^3/s.

Referring to the Phosphorus removal process the following new assets have been requested:

- 2 BIO-P basins having a total volume of 22,000 m^3
- 2 pumping stations for sludge return
- 1 facility for Phosphorus additional chemical removal (comprising 1 storage basin for $FeCl_3$, dosing recipients, pumps for dosing and transport reagents).

The sludge treatment process will be completed too, by providing 2+1 centrifuges and a facility for conditioning polymer preparation (reservoirs pump and sludge transporters).

Glina WWTP Stage 1 was commissioned in November 2010. In March 2011, the Contractor started to treat part of the wastewater pumped to the plant in both the primary sedimentation tanks and biological stage, as was the initial intention. The average flow entering the plant was 4.47 m^3/s, instead of 10 m^3/s as was the contractual flow to treat. After the mechanical stage, only 2.18 m^3/s was led into the biological stage. This flow should be compared with the contractual flow, which is 5 m^3/s. These data indicate that the primary sedimentation tanks have been loaded with less than 50% of the contractual flow, while the secondary tanks – with only 20% of the 10 m^3/s flow to be handled.

Below information from just one month operation of Glina WWTP, Stage 1. This month was June 2011, which coincides with the short test period of Trial operation. The plant was not operated according to the original process design and with design flows and loads for a long time because of operation problems.

Table 2.3 a. Performance of Glina WWTP, Stage 1, June 2011

Parameter	Influent WWTP, mg/l	Effluent Primary sedimentation, mg/l	Reduction over Primary sedimentation; %	Effluent WWTP, mg/l	Total treatment efficiency, %
BOD_5	154	101	34	4	98
COD	372	230	38	18	95
TSS	213	100	53	7	97
Tot-N	24	22	9	7,8	67
Tot-P	4,4	3,8	15	0,74	83

For June 2011, the average flow into the plant was 438,834 m^3/d, which is only 5.1 m^3/s. This flow, fully treated in the mechanical treatment stage, should be compared with the contractual flow to treat, which is **10 m^3/s**. After the mechanical stage, the flow or 5.1 m^3/s was led into the biological stage. This flow should be compared with the contractual flow, which is **5 m^3/s**.

The table below shows the loads of pollutants entering the biological stage in June 2011 compared with the loads stated in the FM Addendum from 2010.

Table 2.3 b. Biological stage load in June 2011 compared with loads in FM Addendum

Parameter	Load of the biological stage in June 2011, tonnes/d	Load of the biological stage according to FM Addendum, tonnes/d
BOD_5	44	35
COD	101	81
TSS	44	45
Tot-N	9,5	9,5
Tot-P	1,7	1,6

The Table 2.4 has confirmed that the **loads** of TSS, Tot-N and Tot-P were almost the same as stated in the FM while the **loads** of BOD_5 and COD were considerably higher.

The concentrations registered in the inlet to the plant in June by the Contractor, Aktor & Athena, were higher than the analyzed concentrations in the Caseta at Glina analysed by ANB during 2008-2011. The reason for this is most probably that the pumps, taking the wastewater into the plant, are also bringing a lot of settled debris from the bottom of the Caseta to the plant.

The secondary sedimentation tanks have been loaded to roughly 50% of the **flow** they are designed to handle (that was 10 m^3/s) and this is probably one reason why the effluent quality is very good. However, the low concentration of Tot-N in the effluent is an indication that the biological processes works as intended during design conditions.

Main deficiencies identified during operation of WWTP Stage 1 are presented below. Most of them will be solved by the design and construction of Stage 2.

Table 2.4 Deficiencies identified during operation of WWTP Stage 1

Plant component	**Deficiency**
Odour treatment	Odour treatment was not elaborated in Stage 1.
Grease removal	Grease removal not elaborated in Stage 1.
Inlet pumping station	Inlet pumping station is not working properly.
Flow measurement	Flow measurement after mechanical stage was not installed.
Secondary sedimentation tanks	Distribution of mixed liquor to secondary tanks is difficult to control.
Secondary sedimentation tanks	Effluent weirs in secondary sedimentation tanks is hard to adjust

2.4.2 Design parameters for Line 2

The design parameters of Glina WWTP Line 2 were conditioned by two elements:

- achievement of the treatment of all wastewater generated by Bucharest municipality and the surrounding connected localities
- avoiding the over dimensioning of the plant, meaning over estimated investment and operation costs.

In the light of these conditions, the action of reducing clean water infiltration into the Bucharest sewage - the main contributor of wastewater in the Glina plant influent - is of most importance.

2.4.2.1 Quantitative details on the infiltrations and reduction objectives

The data concerning clean water entering in the Caseta and sewage collectors are based on a vast campaign of measurements carried out by the Apa Nova Bucharest during the years 2009-2010. The campaign purpose was the optimization of the investment for Phase 2 of the Glina WWTP.

Table 2.5 presents the origin of infiltration waters and of other undesired water arriving into the Caseta, together with actions for their reduction and their estimated flows.

The total amount of infiltration and other undesired water into the Caseta is **5.36 m^3/s,** out of which the estimated infiltration flow is **4.66 m^3/s**, while other undesired waters flow - **0.71 m^3/s.**

Table 2.5 Estimated origins of infiltration and other undesired flows (2010)

Action No.	**Origin**	**Nature of undesired water**	**Reason for reduction**	**Action to reduce undesired water**	**Flow m^3/s**
1	Infiltration from water network leakage	Infiltration	To reduce infiltration	Leakage control of water supply network	0.44
2	Drainage from industries	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.11

Action No.	**Origin**	**Nature of undesired water**	**Reason for reduction**	**Action to reduce undesired water**	**Flow m^3/s**
3	Drainage from lakes	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.50
4	Infiltration from Dambovita river	Infiltration	Caseta structural rehabilitation	Waterproofing on 17 km, 60 m width	0.93
5	Infiltration from groundwater (high level of groundwater)	Infiltration	To reduce infiltration	Reinstatement of subway drainage system to lower the ground water table	1.38
6	Infiltration from groundwater (part due to structural sewers conditions)	Infiltration	Network structural rehabilitation	Rehabilitation of 36 km sewers	0.10
7	Metro drainage	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.09
8	Infiltration from Caseta left drain in city centre (10 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	1.26
9	Infiltration from Caseta left drain downstream city centre (7 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	0.27
10	Infiltration from Caseta right drain downstream city centre (7 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	0.27
	Total, infiltration (1, 4, 5, 6, 8, 9, 10)				**4.66**
	Total, other undesired water (2,3,7)				**0.71**
	Grand total (1-10)				**5.36**

Target for reduction of infiltration and other undesired water flows

According to Table 2.5 there are defined **7** contributions to "infiltration" and **3** to "other undesired water" flows. The reason for a certain action may, however, primarily be structural rehabilitation.

Of the **10** proposed actions within Table 2.5
- **2 actions** are primarily considered for structural reasons
- **5 actions** are aimed to reduce infiltration and
- **3actions** - to reduce other undesired water.

With this background three options of actions have been defined:

- High infiltration reduction option (**HIR**)
- Intermediate infiltration reduction option (**IIR**);
- No infiltration reduction option (**NIR**) but only structural remediation.

The **HIR** option is the most ambitious option of the three. It includes **all 10** proposed actions.

The **IIR** option includes **only 6** of the 10 proposed actions.

- ANB considers **action no 2** as not being efficient because the corresponding source contributes with a comparatively small portion to the total infiltration and other undesired water.
- This is also the case for **action no 7.** It has been stated that it is not easy to separate the mixed drainage and wastewater from the Metro stations.
- Further, **action 9** and **10** are considered considerably expensive compared with the other 8 actions and for this reason were not included in this option.

The **NIR** option, finally, includes only **2** of the actions proposed in Table 2.6, as these are primarily aimed to guarantee the structural stability in the sewer network and the Caseta.

The three options are presented in detail in Table below.

Table 2.6 Targets for reduction of infiltration and other undesired water until 2015

Origin	Flow 2010 m^3/s	Flow reduction HIR, m^3/s	Flow reduction IIR, m^3/s	Flow reduction NIR, m^3/s
Infiltration from water network leakage	0.44	0.22	0.22	0
Drainage from industries	0.11	0.11	0	0
Drainage from lakes	0.50	0.50	0.50	0
Infiltration from Dambovita river	0.93	0.79	0.79	0.79
Infiltration from groundwater (part linked to high level of groundwater table)	1.38	0.96	0.96	0
Infiltration from groundwater (part linked to bad structural conditions of sewers)	0.10	0.07	0.07	0.07
Metro drainage	0.09	0.09	0	0
Infiltration from Caseta left drain in city centre (10 km)	1.26	0.89	0.89	0
Infiltration from Caseta left drain downstream city centre (7 km)	0.27	0.19	0	0
Infiltration from Caseta right drain downstream city centre (7 km)	0.27	0.19	0	0
Total reduction, infiltration		***3.31***	***2.93 0.86***	
Total reduction, other undesired water		***0.71***	***0.50***	***0***
GRAND TOTAL REDUCTION		**4.02**	**3.43**	**0.86**
Remaining infiltration + undesired water	***5.36***	***1.35***	***1.94 4.50***	
Remaining infiltration	***4.66***	***1.08***	***1.73 4.50***	

The options analysis has revealed that the IIR option is the most advantageous and it can assure an optimum investment and operational costs for Glina WWTP.

2.4.2.2 Design parameters for mechanical and biological treatment stages

The design horizon is 30 years; respectively the design year is 2040. This design horizon refers to both the **hydraulic flow and the loads of pollutants** in the inlet to Glina WWTP.

Main element for designing the mechanical treatment phase (inlet pumping stations, coarse and fine screens, as well as grit chambers) is the hydraulic flow. On the other hand, the main element for designing the biological stage and sludge treatment is the load of pollutants.

Design flows

According to the Romanian design norms SR 1846-1 from September 2006 the design flows that must be treated in different treatment stages at a WWTP shall be calculated based to the **dry weather flow** (DWF), taking into consideration:

- the peak day factor
- the peak hour factor.

The design of a wastewater treatment plant shall be made using the *maximum hourly dry weather flow* - MHDWF - that includes the influence of the two above factors.

In case of the stage 2 of the Glina WWTP

- the peak day factor was established to be 1.20 based on flow values measured in 3.01.2010
- the peak hour factor depends on the *design year* (variation between 1.20 and 1.15) and the chosen *option for infiltration reduction* (variation between 1.22 and 1.15).
For the IIR option this factor will be 1.20 in both years - 2015 and 2040.

Definition of different flows

Type of flow	Notation	Definition	Explanation
Dry weather flow	DWF	WWF+I	Average dry weather flow for a certain period of time with dry weather conditions including wastewater (WWF) and infiltration (I)
Maximum daily dry weather flow	MDDWF	DWF*Peak day factor	Maximum daily dry weather flow for a certain period of time (for instance one year)
Maximum hourly dry weather flow	MHDWF	DWF* Peak day factor* Peak hour factor	Maximum hourly flow during the day with maximum daily dry weather flow for a certain period of time

Table 2.7 shows the calculation of maximum daily and maximum hourly flows in case of the three options considered for infiltration reduction.

Table 2.7 Calculation of maximum daily and maximum hourly flows for Glina Stage 2

Option	Year	MDW m^3/s	MDDWF, m^3/s	MHDWF, m^3/s
High infiltration reduction option (HIR)	2015	6.94	1.20*6.94 =8.33	1.20*1.21*6.94=10.07=**10.1**
	2040	7.68	1.20*7.68=9.22	1.20*1.22*7.68=11.24=**11.2**
Intermediate infiltration reduction option (IIR)	2015	7.53	1.20*7.53=9.04	1.20*1.19*7.53=10.75=**10.8**
	2040	8.27	1.20*8.27=9.92	1.20*1.20*8.27=11.91=**11.9**
No infiltration reduction option (NIR)	2015	10.10	1.20*10.10=12.12	1.20*1.15*10.10=13.94=**13.9**
	2040	10.84	1.20*10.84=13.01	1.20*1.15*10.84=14.96=**15.0**

The design of the stage 2 of Glina WWTP has to consider the intermediate infiltration reduction option (IIR), which leads to a maximum hourly dry weather flow (MHDWF0 of 11.9 m^3 /s as the design flow.

The **mechanical stage** (coarse and fine screens, grit chambers, grease removal and primary sedimentation) **shall treat up to 2 times the MHDWF**. Further, in the **biological stage all flows up to 1 times the MHDWF** shall be treated**.**

Table 2.8 Design flows for different options

Option	Year	Design flow biological treatment, m^3/s
High infiltration reduction option (HIR)	2015	1*10.1= **10.1**
	2040	1*11.2= **11.2**
Intermediate infiltration reduction option (IIR)	2015	1*10.8= **10.8**
	2040	1*11.9= **11.9**
No infiltration reduction option (NIR)	2015	1*13.9= **13.9**
	2040	1*15.0= **15.0**

Design loads for the year 2040 are presented in Table 2.9.

Table 2.9 Design parameters for Glina WWTP, Stage 2 – flow and load

Parameters	Unit	IIR
Flows		
Average dry weather flow (DWF)	m^3/s	8.27
Maximum daily dry weather flow (MDDWF)	m^3/s	9.92
Maximum hourly dry weather flow (MHDWF)	m^3/s	**11.9**
Design flow for the **mechanical treatment** stage	m^3/s	23.8
Design flow for the **biological treatment** stage	m^3/s	11.9
Loads		
BOD_5	kg/d	145,000
Tot-N	kg/d	37,200
Tot-P	kg/d	5,200
SS	kg/d	215,000
COD	kg/d	410,000

Table 2.10 gives information about current (2010) and future (2040) loads and concentrations in sewage coming to Glina WWTP.

Table 2.10 A Loads and concentrations in wastewater to be treated by Glina WWTP

Indicator	Unit	Situation 2010	Target (2040)		
			HIR	IIR	NIR
Total organic load (BOD_5)	kg/d	80,750	145,000	145,000	145,000
from domestic customers	%	96	98	98	98
from industry	%	2	1	1	1
from commerce, public services	%	2	1	1	1
BOD_5, influent	mg/l	80	218.6	203	154.87
Tot-N, influent	mg/l	24.3	56	52	39.67
Tot-P, influent	mg/l	1,08	7.86	7.3	5.57
SS, influent	mg/l	165	324	301	230
COD, influent	mg/l	253	618	574	438

Table 2.10 B Glina WWTP design capacity

Indicator	**M.U.**	**Actual situation (2011)**	**Future situation (2040)**
Direct flow from Caseta	m^3/d	438,834	835,000*
Hydraulic design capacity	m^3/d	864,000	2,058,000** 1,029,000***
Biological design capacity	kg BOD/day	73,425	145,000
Plant design capacity as population equivalent			
calculation using 60g BOD/p.d. (as in the initial FS)	**p.e.**	**1,836,000**	**2, ,**
Volume of treated wastewaters as required by Directive 91/271/CEE	m^3/d	438,834	832,500
Total BOD treated/eliminated	kg BOD/day	67,500 / 66,200	145,000 / 127,137
Total COD treated/eliminated	kg COD/day	163,200 / 155,000	410,000 / 320,684
Total N treated/eliminated	kg N/day	10,500 / 7,000	37,200 / 30,055
Total P treated/eliminated	kg P/day	1,930 / 1,600	5,200 / 4,485
Total MTS treated / removed	kg / day		215,000 / 189,992

* IIR Option
** for the mechanical treatment phase
*** for the biological treatment phase

The treated effluent should comply with the Romanian standard NTPA - 011, which transposes the Urban Wastewater Treatment Directive 91/271/EEC (Table 2.11).

Table 2.11 Effluent requirements according to NTPA - 011

Parameter	**Maximum concentration, mg/l**	**Minimum reduction %**
Biochemical oxygen demand (BOD_5	25	70 – 90
Chemical oxygen demand (COD)	125	75
Total suspended solids (SS)	35 (more than 10,000 i.e.)	90 (more than 10,000 i.e.)
Total Phosphorus (Tot-P)	1 (more than 100,000 i.e. or sensitive area)	80
Total Nitrogen (Tot-N)	10 (more than 100,000 i.e. or sensitive area)	70-80

Description of Glina WWTP, Stage 1+2

The Glina WWTP after extension according to the design for Stage 2 is described below. The design is to a large extent conventional, including mechanical treatment with coarse and fine screens, grit chambers, grease removal, primary sedimentation, biological treatment according to the activated sludge process with both Nitrogen and Phosphorus removal (bio-P and chemical precipitation) and secondary sedimentation.

The sludge treatment consists of gravity thickening followed by mechanical thickening of primary sludge, mechanical thickening of biological surplus sludge, mesophilic digestion of primary and secondary (biological) surplus sludge, dewatering of the digested sludge in centrifuges and finally incineration of all sludge.

The **ARS (Activated Return Sludge)** process configuration was adopted for Stage 1 and also for Stage 2. With the ARS process, part of the COD conversion, as well as the nitrification and denitrification processes take place in reactor tanks **(ARS tanks)** introduced on the return sludge stream from the secondary sedimentation tanks (SST) to the bioreactors, before mixing it with the primary effluent.

Due to the high solids content of the return sludge (8.5 kg/m^3), the necessary total bioreactor volume could be significantly reduced (30-50 % approximately). The MLSS concentration in the activated sludge tanks **(AS tanks)** could be maintained at lower levels, reducing the sludge loading on the secondary sedimentation tanks and, correspondingly, the SST area required.

With the adopted ARS concept, the organic and hydraulic capacity of the biological stage was increased by approximately 50% and respectively 130%, compared with the capacities that could be achieved with the equal bioreactor volumes and sedimentation tanks area with a conventional activated sludge design.

The main treatment components included in Stage 1+2 are the following;
Septic sludge reception facility

- Coarse screens;
- Inlet pumping station;
- Fine screens;
- Aerated grit chambers with grit removal;
- Primary sedimentation tanks;
- Biological reactors;
- Secondary sedimentation tanks;
- Storm water treatment tanks;
- Primary sludge thickening in gravity thickeners;
- Primary sludge thickening in gravity belt presses;
- Surplus activated sludge storage (SAS buffer tank);
- SAS thickening in belt presses;
- Raw thickened sludge mixing tank (mixing buffer tank);
- Sludge digestion (Mesophilic digestion);
- Digested sludge storage (digested sludge storage tanks & emergency storage tanks);
- Sludge dewatering (centrifuges);
- Sludge incineration of dewatered digested sludge

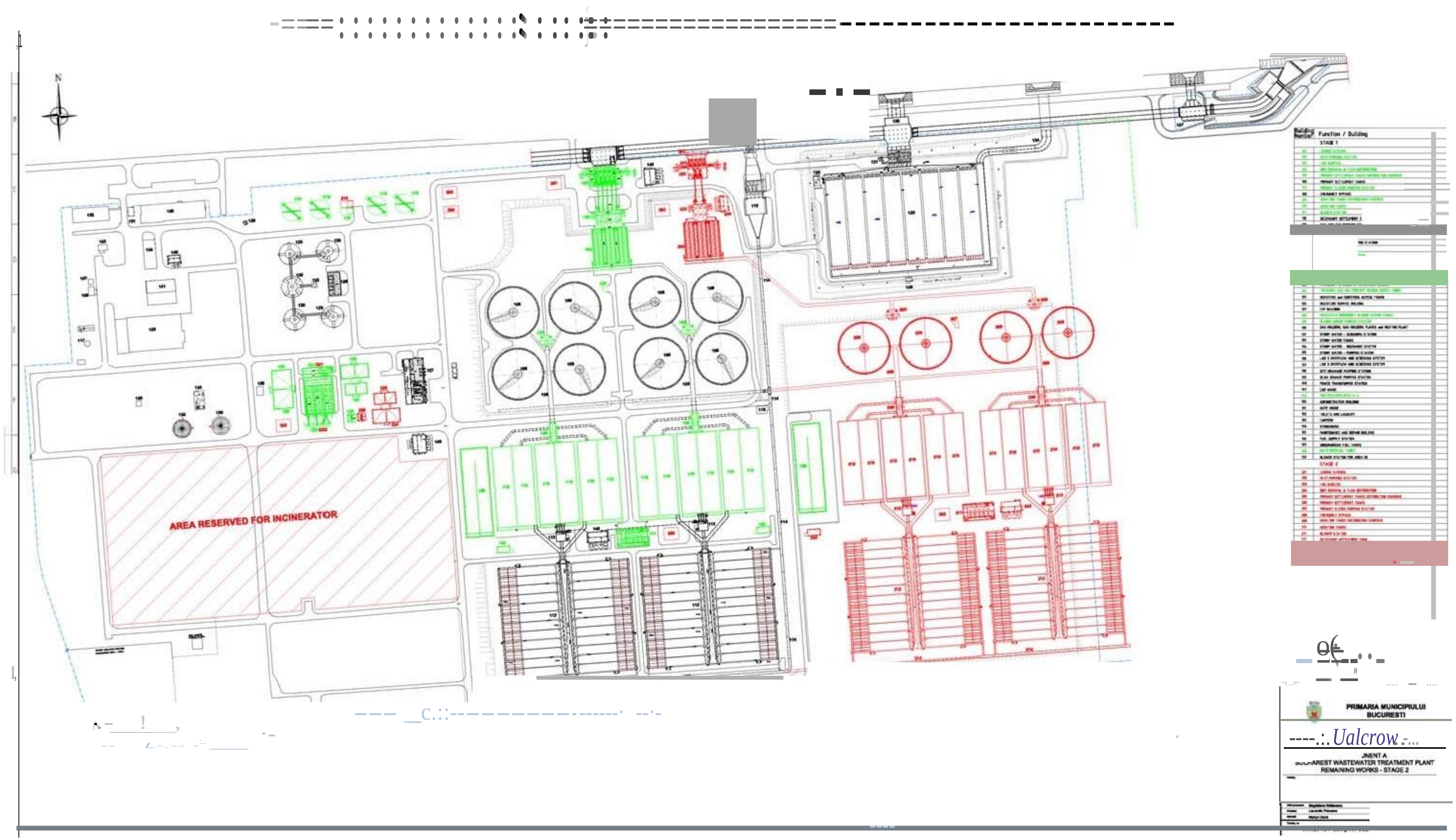


Figure 2.3 GlinaWWTP' Stage 1+2 configuration

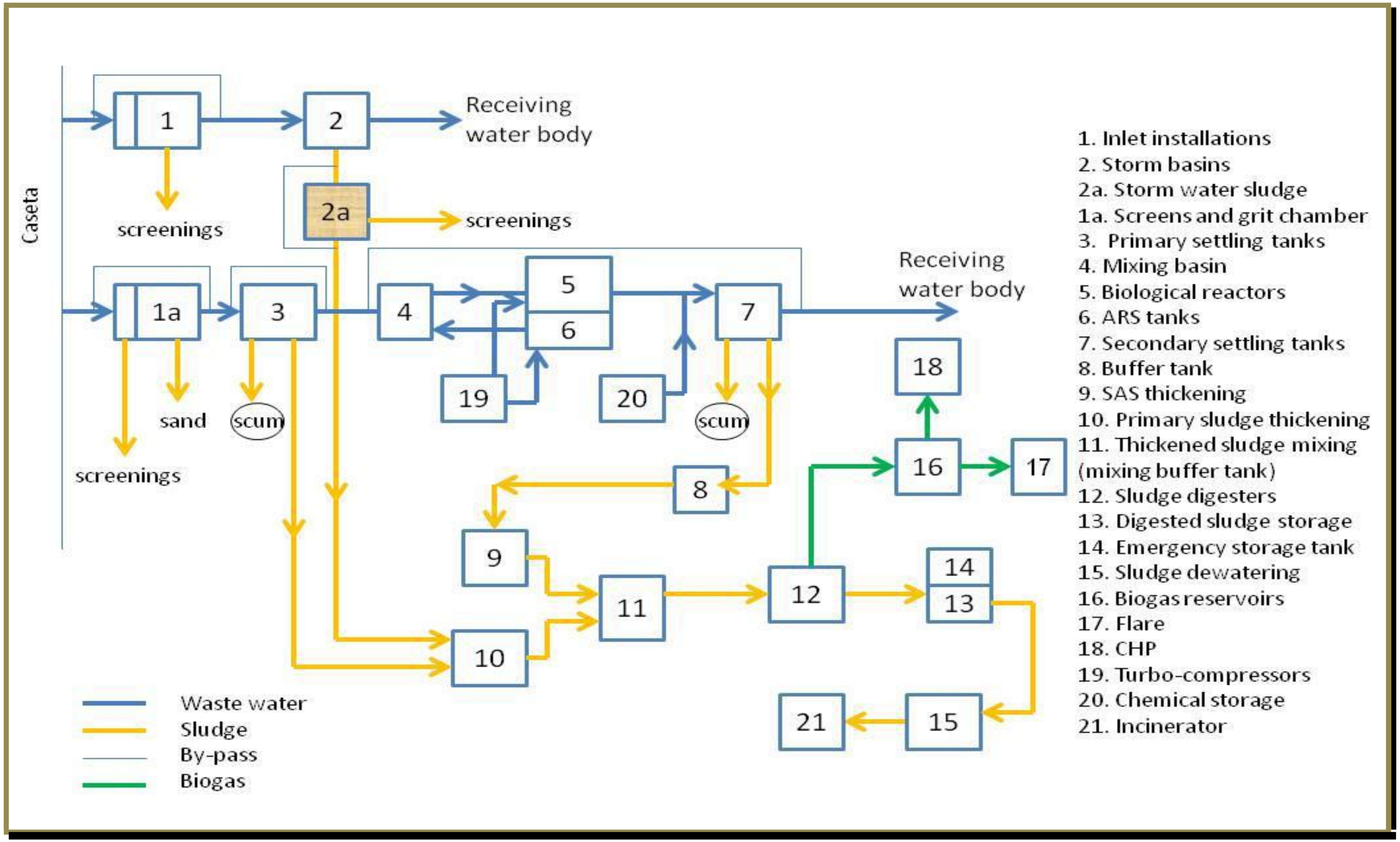


Figure 2.4 Flow diagram of Glina WWTP, Stage 1+2

Detailed description of wastewater treatment

(a) Inlet works

In front of the entrance to Glina WWTP a station for **septic sludge reception** will be constructed. Tankers with collected septic sludge will have smooth and easy access to the station and under proper control will empty their load into the Caseta to be mixed with the incoming wastewater.
The reception station will be equipped with efficient odour treatment.

In the future wastewater will enter into Glina WWTP by gravity from the Caseta through 2 inlet constructions situated close to each other.
The existing inlet construction for Stage 1 contains 5 coarse screen channels with 10 coarse screens inside an existing building. For Stage 2, **2 more coarse screen channels will be built with 4 coarse screens in a new building.** Screenings are removed by a conventional rake system.

After the coarse screens the wastewater enters into 2 inlet pumping stations, also situated close to each other. The existing inlet pumping station for Stage 1 contains 5 centrifugal dry mounted pumps, of which 1 will operate as a stand-by pump when Stage 2 will be in operation. For Stage 2, **2 more inlet pumps** will be installed in the **new pumping station**. The inlet pumps will be operated with the SCADA system to **always** distribute **2/3** of the current sewage to the existing construction **(Stage 1)** and **1/3** to the new construction **(Stage 2),** see design in section 1**.**

The flow will be recorded by 5+2 electromagnetic flow meters.

(b) Mechanical treatment
From the inlet pumping stations, the wastewater will pass fine screens and grit removal channels with grease removal.

The existing installation for Stage 1 contains 5+1 standby fine screens. For Stage 2, **2 more fine screens** will be installed in a **new building**. The screenings will be collected by conveyors and compacted by 3 screw compactors.

Removal of grit for Stage 1 is provided in 6 parallel channels or chambers. For Stage 2, **3 more grit removal chambers** will be constructed outside and in direct connection with the new building for the fine screens. The grit chambers will be separated by longitudinal baffles.

The grit channels will be equipped with coarse bubble diffusers, arranged longitudinally, on one side of the channels in order to create a spiral air flow.

The sand and grit are collected by travelling bridge scrapers in hoppers installed at the inlet of each channel. Each bridge serves two channels. Removal of sand is carried out by air-lifts. Sand is washed and dewatered in 4 vortex washing/classifier units. Wash water with removed organic material is pumped back into the grit channels.

To remediate the lack of grease removal equipment for Stage 1, **grease removal equipment for 6+3 channels** will be installed for Stage 1+2. Grease shall be collected by surface scrapers in pits and removed by tankers to the grease pumping station in the anaerobic digestion plant.

(c) Primary sedimentation

The existing construction for Stage 1 contains 8 primary sedimentation tanks. For Stage 2, **4 more primary sedimentation tanks** will be constructed. As mentioned below, 2/3 of the hydraulic flow will always go to Stage 1 and 1/3 to Stage 2, which means that all 12 primary sedimentation tanks will be equally loaded. In total, 2 distribution chambers in front of the existing 8 primary tanks and 2 in front of the 4 new primary sedimentation tanks will guarantee an even water distribution.
For the case of emergency but also for process optimisation reasons, a **by-pass** of the primary sedimentation tanks is provided.

The 8 existing primary sedimentation tanks are arranged in two groups, one per sub-line with 4 tanks each. The 4 new tanks will also be arranged in two groups, one per sub-line with 2 tanks each.

The primary sludge is collected by a rotating scraper in a sludge hopper in the centre of the tanks. 4 pumping stations have been constructed, one for each sub-line. Sludge will be removed automatically and semi-continuously, based upon a time control system, removing sludge from each tank in sequences.

All primary sedimentation tanks are equipped with an automatic scum removal system, collecting the scum into a separate pit, arranged as an oil separator. Wastewater contained in the scum is separated and flows by gravity to the site drainage network, whilst scum shall be removed by tankers to the anaerobic digestion.

(d) Biological treatment

As mentioned above, the **ARS (Activated Return Sludge)** process configuration has been adopted for Glina WWTP Stage 1+2. According to the design for Stage 2, the capacity expressed as tank volumes has been increased with 100 % compared with Stage 1.

The main features of the ARS design for Stage 2 are:

- The 2 **central tanks** in the **2 aeration tank groups** in each of the 4 **sub-lines** (fig 2.3) are **ARS** tanks. The 4 sub-lines consist of six tanks each. The return activated sludge (RAS) is fed to each ARS tank by the adiacent RAS pumping station;
- Solid Substance concentration in ARS tanks is 7-8 g/l, according to the recirculation rate;
- The return activated sludge (RAS) flows over weirs to the **mixing chamber**, where it is mixed with the primary effluent; the return activated sludge (RAS)/wastewater mixture is fed to the 4 AS tanks, positioned left and right of the return activated sludge (RAS) tanks in each of the 4 sub-lines;
- Design solid substance (SS) concentration in AS tanks is 3.2 g/l, but can vary between 2 and 3.2 g/l, according to the temperature and sludge age;
- 4 (one for each sub-line) mixing and distribution chambers with 400 m^3 capacity each, have been constructed upstream of the bioreactors. Each distribution and mixing chamber is adequately designed to accommodate 6 m^3/s of settled water and an equivalent 6 m^3/s return activated sludge flow.

According to Directive 91/271/EC UWWTD and Romanian Law NTPA 011/2002 for sensitive areas, the plant is designed for Phosphorous removal. To reach the requirement for removal of Phosphorous the plant solution has to introduce both biological (BIO-P)and chemical treatment.

The **BIO-P process** with side-stream activated sludge hydrolysis has been implemented in order to enhance biological Phosphorous removal and improve denitrification by production of easily biodegradable organics or Volatile Fatty Acids (VFA). The hydrolysis of part of the Return Activated Sludge (RAS) takes place in side-stream anaerobic tanks. Approximately 5-10% of the the Return Activated Sludge (RAS) flow is diverted to the BIO-P tanks, designed for a retention time of approximately 30 hours. The hydrolysed sludge is then returned back to the ARS tanks.

Remaining Phosphorous to be removed for meeting the requirement of maximum 1 mg/l in the effluent will be treated by a c**hemical precipitation process** using Ferric Chloride ($FeCl_3$) as a 13,8% solution.

The implementation of these two treatment processes for Phosphorous removal has been achieved by the construction of:

- **2 anaerobic (BIO-P) tanks** with a total capacity of 22,000 m^3, including necessary mixing equipment;
- **2 side-stream recycling sludge pumping stations** feeding the BIO-P tanks. Total capacity is 750 m^3/h;
- **1 chemical plant** for supplementary Phosphorous removal, which includes a chemical storage tank with a volume of 240 m^3, 4 daily dosing tanks with a total capacity of 16 m^3 and necessary conveying and dosing pumps.

For Stage 2 no more tanks and equipment for BIO-P has been designed in addition to the existing tanks and equipment from Stage 2.

(e) Aeration system

The **ARS** and **AS** tanks have been equipped with **diffused aeration systems** and **mixers**. Air to the ARS and AS tanks is supplied by two independent groups of **Turbo Compressors** Approximately 2,700 **fine bubble membrane diffusers** have been installed in each ARS tank and 1,800 diffusers in each AS tank.

By the adoption of **intermittent aeration** (typical duration of the aeration cycles is **44-50%** of the time in the **ARS tanks** and **58-75% in the AS tanks**), the nitrification and denitrification efficiency can be optimised. Due to varying oxygen requirements, determined by the broad temperature variation, the duration of aeration and non-aeration cycles need to be adjusted accordingly. Cycles (aeration-mixing) are estimated to have durations of approximately 1-2 hours.

(f) Secondary sedimentation

The **mixed liquor** from the aeration tanks is conveyed to the secondary sedimentation tanks via open channels. Following to the design for Stage 2, the capacity expressed as tank surface area has been increased with 100 % compared with Stage 1, meaning from 48 to 96 tanks.

Attention has been paid to the achievement of equal distribution of flow to all secondary sedimentation tanks, even with tanks out of operation. The mixed liquor is introduced centrally to each lane of 12 sedimentation tanks, by two (one per lane) 30 m long overflow weirs. Flow velocities in the distribution channels are low and size of the inlet ports to the tanks has been selected in order to create sufficient high local head loss to achieve equal distribution.

Tanks are sized in order to achieve less than 20 mg/l SS in the effluent in Stage 1. The surface area and depth of the tanks have been calculated in order to achieve the aforementioned clarification efficiency even when biological sludge has poor settling properties (design Sludge Volume Index = 150 ml/l). The sludge hopper is situated at the inlet end of the tanks. The inlet arrangement includes a flocculation chamber and low positioned inlet slots (0.40 m high). Clarified effluent flows over 80 m long weirs, distributed over a large area at the outlet end of each tank.

(g) Return Activated Sludge (RAS) pumping stations

The design return activated sludge rate (RAS) has been calculated at 67% of the wastewater flow. The maximum RAS recirculation rate and the capacity of the RAS pumping stations and the corresponding channels and pipes are set at 100% of the wastewater flow. The extra capacity shall allow for increase of the recirculation rate, e.g. in case of low solids content in the RAS.
4 RAS pumping stations (one per sub-line) with 6 m^3/s capacity each has been constructed.

(h) Scum collection – Scum pumping stations

Scum from the primary sedimentation tanks is removed by the surface skimmers; the scum collected in the primary tank chambers is transferred by the scum pumping station in the anaerobic digestion. Scum and floating sludge collected in the secondary sedimentation tank is also collected in scum chambers arranged as grease separators/traps. From the scum chambers, water is drained to the site drainage network and scum is removed by tankers and disposed of in the RAS/SAS pumping stations

(i) Storm water treatment

The storm water treatment line consists of:

- Inlet works;
- 5 inlet channels leading to the storm water tanks;
- Coarse screens installed in all 5 channels downstream the inlet works;
- Fine screens installed in 3 channels upstream the storm water tanks;
- 8 rectangular storm water tanks with a total volume of approximately 60,000 m^3;
- Outflow culvert with 3 compartments, each of 2.0 m width and 2.0 m height, leading to a stilling pond;
- 7 outlet pipes with a diameter of 1.6 m passing under the Caseta;
- 7 outlet culverts, each of 1.95 m width and 2.15 m height, leading to Dambovita river;
- Return flows and drainage pumping station feeding the Caseta;
- Sludge transfer pumping station feeding the Stage 1 inlet fine screens.

The storm water tanks will operate as primary sedimentation tanks accepting flow under gravity from the Caseta chamber No. 2 via coarse and fine screens. Sludge collected from the basins will be transferred to the Stage 1 inlet fine screens. This solution has been adopted in order to remove grit and sand that will be collected with the sludge, since no separate grit removal facilities were foreseen in the design of Stage 1.

Detailed description of sludge treatment

(j) Primary Sludge Thickening (Gravity thickeners)

The primary sludge, collected from the primary sedimentation tanks and the storm water tanks, operated as primary sedimentation tanks, is pumped to the **primary sludge thickeners**. Gravity thickening will be achieved in **4 circular tanks,** where feeding is taking place at the centre of the tanks through a feeding well. The thickened sludge is withdrawn from the conical centre pit shaped in the bottom of the tank. Conventional sludge - collecting mechanisms with vertical pickets, stir the sludge gently, thereby opening up channels for water to escape.

The primary sludge thickeners will be equipped with efficient odour treatment.

(k) Primary Sludge Thickening (Belt filter presses)

The 5+2 stand-by Belt filter presses installed for *sludge dewatering of digested sludge in Stage 1* will not be used for this purpose during Stage 1+2. Instead, they will be used for *further thickening of the primary sludge already thickened.* This means that the primary sludge (6% DS) from the 4 existing primary thickeners will be pumped to the **7 Belt filter presses** to be thickened to 12% DS. The supernatant liquid from both - thickeners and presses - will be pumped to the inlet of the ARS tanks. The thickened sludge will be pumped to the **buffer tank** in order to be mixed with the thickened activated sludge (SAS). The mixture is fed to the digesters.

The Belt filter presses will be equipped with efficient odour treatment.

(l) SAS storage (SAS buffer tanks)

The Surplus Activated Sludge (SAS) removed from the secondary sedimentation tanks is pumped via the SAS pumping station to **2 buffer tanks.**
These tanks will be also equipped with efficient odour treatment.

(m) SAS Thickening (Gravity Belt Thickeners)

The SAS transfer pumping station brings the surplus secondary sludge to the SAS thickening plant. The thickening of the SAS will be carried out with **6+1** stand-by **mechanical gravity belt thickeners**. The sludge is concentrated as the free water drains by gravity through a porous horizontal belt. A typical SAS thickening plant comprises the gravity belt thickeners, the polymer feed, the polymer preparation station, the belt washing system, the belt tensioning system, the flocculation chamber etc. The gravity belt thickeners will be equipped with efficient odour treatment.

(n) Thickened Sludge mixing (mixing buffer tank)

The 2 thickened sludge buffer tanks have been constructed and serve as **mixing tanks** and temporary storage of the **thickened SAS and the primary thickened sludge**. The sludge mixing is necessary in order to achieve a uniform loading of the digesters and to avoid organic and temperature shock loads. The thickened sludge buffer tanks are sized for more than one day holding capacity and, to avoid sedimentation and to achieve good level of mixing, are equipped with submersible mixers. These tanks will be equipped with efficient odour treatment.

(o) Sludge Digestion (Mesophilic High-Rate digestion)

5 digesters of 8,000 m^3 volume each are used for the anaerobic digestion of the thickened sludge.

No more digesters will be constructed in addition to the existing 5 from Stage 1. The selected process is a mesophilic high rate anaerobic digestion.

At the digester entrance, the raw sludge it is mixed with recirculated digested sludge in order to be seeded and pre-heated. The mixture of raw sludge and recirculated sludge is transported to the heat exchangers, where the sludge is heated. The heated sludge mixture is transported via the feeding line into the digester .The operating temperature is 35-37°C. The mixing of the egg-shaped digester will take place via internal mechanical mixing. The 5 digesters will be fed via the digester feed pumping station. In order to achieve efficient digestion it is required to feed the digester, if possible, in a pumping cycle throughout 24 h/d.

(p) Digested Sludge Storage (Digested sludge storage tanks & emergency storage tanks)
The digested sludge is directed to the **digested sludge buffer tanks** by gravity. The **2 buffer tanks**, one stand-by, has been constructed for emergency cases, such as problems in digestion process, etc. The tanks are sized similarly to the thickened sludge buffer tanks and they are provided with mixers to maintain sludge in suspension. These tanks will be equipped with efficient odour treatment.

(q) Sludge Dewatering (Centrifuges)
The digested sludge from the digested sludge buffer tanks will be fed to the dewatering plant.
For dewatering of the digested sludge a number of **5+1** stand-by **centrifuges** have been installed in the Thickening – Dewatering building, together with the 7 gravity belt thickeners for SAS and the 7 belt filter presses *initially* designed for dewatering of digested sludge for Stage 1 (but finally used for future thickening of the thickened primary sludge).

The selection of centrifuges for digested sludge dewatering is based on different approaches regarding work environment, technical and economic aspects. The fact that the centrifuges are closed units improves significantly the working environment for the sludge dewatering as the odour problems and emission of aerosols to the surrounding environment is minimized. The sludge dewatering centrifuge is also a very compact unit requiring little space for installation.

The sludge dewatering stage will be equipped with efficient odour treatment. Details on the recommended techniques are given in chapter 6.4.

1.1.2 Description of the gas handling
In the anaerobic digestion, during biochemical decomposition of the organic matters biogaz or digester gas is produced. The digester gas is a mixture of about 2/3 methane and 1/3 carbon dioxide having an average calorific value of about 5.590kcal/Nm^3 (approximately 6.5 kWh/Nm^3). The quantity of gas produced during the decomposition of sludge organic matter dependents on its composition; the specific gas production for municipal sewage sludge is about 0.8 to 1.1 Nm^3 /1 kg decomposed organic dry solid matter. Approximately 35,000-40,000 m^3 biogas per day will be produced after Stage 2 has been taken into operation.

A Combined Heat and Power (CHP) plant is constructed to use the biogas and standby boilers will act as back-up to the CHP plant.

Table 2.12 Data regarding components for Stage 1+2

Component	Number of components Stage 1	Number of components Stage 2	Dimension	Other specifications
Septic sludge reception	Number of facilities: 0	Number of facilities: 1	-	-
Coarse screens	Number of screens: 10	Number of screens: 4	Width: 2.0 m; Depth 8.0 m;	Design flow: 10.5 m^3/s; Type: Inclined bar screen, 50 mm bar spacing.
Inlet pumping station	Number of pumps: 4+1	Number of pumps: 2	Total capacity 43,200 m3/h; Pump design capacity: 7,200 m3/h;	Centrifugal dry mounted pumps; Electromagnetic flow meters: 5.
Fine screens	Number of screens: 5+1	Number of screens: 2	Width: 2.0 m; Depth 2.45 m;	Design flow: 10.0 m3/s; Type: Step screen, 6 mm bar spacing; Screw screening compactors: 2 with total capacity 4 m3/h.
Aerated grit chambers	Number of grit chambers: 6	Number of grit chambers: 3	Width: 4.0 m; Depth: 4.08 m; Length: 38.0 m; Total volume: 3,716 m3	Design flow: 10.0 m3/s; Retention time: 6.2 min; Traveling bridge scrapers: 3 twin; Air blowers: 2+1 with total capacity of 1,100-3,700 Nm3/h.
Primary sedimentation tanks	Number of tanks: 8	Number of tanks: 4	Circular tanks with a diameter of 55 m and a periphery depth of 2.9 m; Total surface: 28,500 m2; Total volume: 100,800 m3.	Design flow: 10.0 m3/s; Surface load: 1.9 m/h; Retention time: 1.87 h Radical scrapers with 29 m length.
Biological reactors	Number of Activated Sludge tanks (AS): 8	Number of Activated Sludge tanks (AS): 8	Width: 21.0 m; Depth: 5.85 m; Water depth: 5.3m; Length: 86.0 m; Total volume: 149,600 m3.	Design MLSS: 3.2 kg SS/m3.

Component	Number of components Stage 1	Number of components Stage 2	Dimension	Other specifications
	Number of Activated Return Sludge tanks (ARS): 4	Number of Activated Return Sludge tanks (ARS): 4	Width: 21.0 m; Depth: 6.40 m; Water depth: 5.9 m; Length: 86.0 m; Total volume: 81,000 m3.	Design MLSS: 8.5 kg SS/m3; Wastewater/RAS mixing tanks: 2 with total volume 800 m3; Submersible mixers.
	Number of Hydrolysis tanks: 2	Number of Hydrolysis tanks: 0	Total volume: 22,000 m3.	-
Secondary sedimentation tanks	Number of tanks: 48	Number of tanks: 48	Rectangular tanks: Width: 9.5 m; Water depth: 4.0 m; Length: 65.0 m; Total surface: 59,280 m2; Total volume: 238,800 m3.	Design flow: 10.15 m3/s; Surface load: 1.23 m/h; Retention time: 3.26 h; Chain scrapers.
Storm water treatment tanks	Number of tanks: 8	Number of tanks: 0	Rectangular tanks: Width: 20.0 m; Water depth: 3.9 m; Length: 96.5 m; Total surface: 15,440 m2; Total volume: 60,200 m3.	Design flow: 20.0 m3/s; Surface load: 4.7 m/h; Retention time: 0.84 h;
Primary sludge thickening (Gravity thickeners)	Number of thickeners: 4	Number of thickeners: 0	Circular tanks with a diameter of 20 m and a periphery depth of 3.5 m; Total surface: 1,256 m2; Total volume: 4,396 m3.	Surface load: 75 kg TS/m2,d
Primary sludge thickening (Belt filter presses)	Number of presses: 0	Number of presses: 5+2	Total capacity: 120 m3/h;	Operation time: 20 h/d.

Component	Number of components Stage 1	Number of components Stage 2	Dimension	Other specifications
Surplus activated sludge storage (SAS buffer tank)	Number of tanks: 2	Number of tanks: 2	Rectangular tanks: Width: 11 m; Water depth: 6 m; Length: 11m; Total surface: 121 m2; Total volume: 726 m3.	Retention time: 4.8 h.
SAS thickening (Gravity Belt thickeners)	Number of thickeners: 3+1	Number of thickeners: 5	Total capacity: 800 m3/h;	Operation time: 20 h/d.
Raw thickened sludge mixing tank (mixing buffer tank)	Number of tanks: 2	Number of tanks: 2	Rectangular tank: Width: 13.9 m; Water depth: 6m; Length: 13 m; Total surface: 181 m2; Total volume: 1,084 m3.	Retention time: 38 h.
Sludge digestion (Mesophilic digestion)	Number of digesters: 5	Number of digesters: 0	Egg shaped digesters with total volume of 40,000 m3.	Retention time: 15 d design year 2040.
Digested sludge storage	Number of tanks: 1+1	Number of tanks: 0	Rectangular tank: Width: 19.8 m; Water depth: 6 m; Length: 20 m; Total surface: 396 m2; Total volume: 2,376 m3.	Retention time: 42 h.
Sludge dewatering (Centrifuges)	Number of centrifuges: 0	Number of centrifuges: 5+1	Total capacity: 150 m3/h;	Operation time: 20 h/d.

2.4.2.3 Sludge generation and disposal

Sludge generation

For the design of Glina WWTP Stage 2, the sludge amount has been estimated based on a mass balance for to the year 2010, from which a load forecast for the design year 2040 was elaborated. The sludge will be stabilized in digesters and dewatered before disposal or possible further treatment in an incineration plant. It is understood that the dewatering process for digested sludge for Stage 2 shall include the centrifuges, which will be installed for the operation Stage 1.

Design sludge production for Glina WWTP, Stage 2 is presented in table below.

Table 2.13 A Design sludge production, Glina WWTP, Stage 2

Operation period	**Sludge amounts after dewatering, m^3/d (33%DS)**	**Sludge amounts after dewatering, kg/d (33%DS)**	**Ash amounts after incineration, kg/d**
Design production, Stage 2 All sludge digested	503	166,120	83,760

Table 2.13 B Yearly sludge production, Glina WWTP Stage 1 and 2

Operation period	**Sludge amounts after dewatering, m^3/year**	**Sludge amounts after dewatering, tones DS/year**	**Ash amounts after incineration, tones /year**
Updated design production, Stage 1 (33% DS)	108,000	35,640	-
Design production, Stage 2 (33% DS)	183,740	60,630	30,574

The designed amount and characteristics of sludge generated from operation of WWTP Stage 1 is presented in Table 2.15. (162,000 m^3/year with 22% dry substances - DS).

The currently obtained amount of sludge obtained in the year 2011 (104,000 m^3/year with 25% dry substances) is disposed off by landfilling. In order to comply with the legislation in force (NT 757/2004) this amount is treated with lime to increase the DS content to 35% and to reduce pathogenic contamination. The phase 1 sludge disposal is contracted to a company authorized for non-hazardous and hazardous waste management.

Between two transports for landfilling the sludge is temporary stored inside the WWTP on a concrete platform, having a surface of 800 m^2 and provided with channels for spillage collection. The frequency of transports is established in order not to exceed the storage capacity.

Sludge quality

Table no **2.14 a.** presents the quality of dewatered sludge based on sludge samples analyzed during the period April-May 2012.

The provision of the GD 937/2010 for classification, packing and labeling of hazardous substances have been used for estimation of the hazardous or non-hazardous character of the sludge.

Art 4, alin (5) of this regulation says that substances classified as hazardous based on their effects on the human health and/or on the environment existent in materials/preparations as impurities or as additives should be considered when their concentrations are equal or higher than concentrations provided in Table no 1 of this regulation. The concentration in Table 1 of GD 937/2010, reported as % of weight, are between 1% and 0.1%.

In case of Glina sludge the concentrations of hazardous heavy metals such as cadmium, chromium, copper, nickel and lead, expressed as % of weight of dry substance, are between 0.0006 and 0.09%. These concentrations are sustaining the non-hazardousness of the Glina sludge and its classification (as required by the GD 856/2002) within the List of Waste to the code **19 08 05 – sludge from the municipal wastewater treatment**

Table 2.14.a. Composition of Glina sludge

Analysed Components	**MU**	**laboratory name** **sampling date**	**laboratory name** **sampling date**	**laboratory name** **sampling date**	**laboratory name** **sampling date**	**laboratory name** **sampling date**
		Givaroti **18.04.11**	**Givaroti** **08.05.12**	**Givaroti** **15.05.12**	**ECOIND** **08.05.12**	**ECOIND** **17.05.12**
Cd	mg/kg d.s.	2.20	3.36	2.95	1.94	2.95
Cr	mg/kg d.s.	186.00	282.82	282.48	228.00	306.00
Cu	mg/kg d.s.	298.00	338.50	342.76	374.00	342.76
Ni	mg/kg d.s.	35.00	53.73	51.66	49.20	51.66
Pb	mg/kg d.s.	80.00	102.35	100.51	88.30	100.51
Zn	mg/kg d.s.	1167.00	1461.09	1477.84	1603.00	1477.84
Dry subst.	%	-	-	33.45		33.73

The sludge quantity obtained after dewatering in the actual functioning conditions, with a humidity of around 75%, is of 104000 m^3/year. This amount has to be sent for disposal by landfilling.

In order to fulfill the landfilling conditions the sludge is treated with lime in order to increase its dry content till 35%, reduce solubility of heavy metals and pathogenic contamination.

Table 2.14.b shows the quality of the sludge sent for landfilling in May 2012, while Table 2.14.c. shows the results of leachability tests performed on the same samples.

Table 2.14.b Composition of sludge sent for landfilling

Sludge Characteristics	UM	Sampling Date: 04.05.2012	Sampling Date 11.05.2012	Sampling Date 18.05.2012
Humidity /Moisture	%	81.24	79.82	78.84
Dry Substance (d.s.)	%	18.76	20.18	21.16
TOC	mg/kg d.s. %	45600 4.56	48000 4.80	46000 4.60
Cd	mg/kg d.s. %	0.21 0.000021	<0.02 0.000002	<0.20 0.00002
Cr	mg/kg d.s. %	0.47 0.000047	<0.05 0.000005	<0.05 0.000005
Cu	mg/kg d.s. %	0.23 0.000023	0.82 0.000082	0.58 0.000058
Ni	mg/kg d.s. %	0.16 0.000016	<0.1 0.00001	<0.1 0.00001
Pb	mg/kg d.s. %	0.31 0.000031	0.24 0.000024	0.29 0.000029
Zn	mg/kg d.s. %	7.14 0.000714	7.84 0.000784	6.12 0.000612
Sum of heavy metals as %	%	0.000821	0.000907	0.000734

Disposal of the sludge generated by the phase 1 instalations is contracted with a company authorised to transport and eliminate hazardous and non-hazardous waste. Between 2 transports the sludge is stored temporary on a concrete platform provided with channes for collecting leaks. The frecvency of transports is established so as not the exceed the storage

Table 2.14.c Results of leachability tests performed on samples of treated sludge sent for landfilling during May 2012

Analysed characteristics	Values									Methods of analysis
	T1; L/S = 2 l/kg mg/kg d.s.			T2; L/S = 10 l/kg mg/kg d.s.			T3; C0 mg/l			
Sampling Date	**18.05.12**	**11.05.12**	**4.05.12**	**18.05.12**	**11.05.12**	**4.05.12**	**18.05.12**	**11.05.12**	**4.05.12**	
pH	7.80	7.52	7.80	7.82	7.59	7.82	7.65	7.48	7.65	SR ENV 12506/2002
chlorides	1924	2010	2562	2986	2864	3976	1516	1494	1890	SR ENV 12506/2005
Sulfates	1672	1343	1984	3342	2762	3920	1184	965	1320	SR ENV 12506/2005
COD (dissolved organic carbon)	328.6	318.4	272.4	712.4	698.8	532.6	212.6	212.0	180.2	SR ENV 13370/2005
TSD (total solids dissolved)	7120	6120	8148	8924	9892	10962	-	-	-	SR ENV 13370/2005
Cupper	0.12	0.5	0.12	0.32	0.5	0.26	0.09	0.05	0.09	SR ENV 12506/2005
Nichel	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	SR ENV 12506/2005
Zinc	2.18	1.42	3.62	5.14	3.18	6.52	1.96	1.26	2.36	SR ENV 12506/2005
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.002	<0.002	<0.002	SR ENV 12506/2005
Chromium total	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.005	<0.005	SR ENV 12506/2005
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	SR ENV 12506/2005
Lead	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.02	<0.02	<0.02	SR ENV 12506/2005

In conformity with the table no 2.14.c. the leaching tests performed on the sludge samples show that the dewatered sludge fulfills the conditions imposed for disposal on a class “b” landfill – for non-hazardous waste. meaning that:

Chlorides are under the limits imposed by the Order 95/2005 for non-hazardous waste which are 10,000 mg/kg d.s. at a Liquid/Solid report =2 l/kg; 15,000 mg/kg d.s. at a Liquid/Solid report (L/S) = 10 l/kg; 8,500 mg/l at C(0)

- Sulfates are under the limits imposed by the Order 95/2005 for non-hazardous waste which are 10,000 mg/kg d.s. at a Liquid/Solid report =2 l/kg; 20,000 mg/ kg d.s. at a Liquid/Solid report (L/S) = 10 l/kg; 7,000 mg/l at C(0)

- COD are under the limits imposed by the Order 95/2005 for non-hazardous waste which are 380 mg/kg d.s.u at a Liquid/Solid report =2 l/kg; 800mg/kg d.s. at a Liquid/Solid report (L/S) = 10 l/kg; 250 mg/l at C(0)

- TDS are under the limits imposed by the Order 95/2005 for non-hazardous waste which are 40,000 mg/kg.d.s.u at a Liquid/Solid report =2 l/kg; 60,000 mg/kg d.s.u at a Liquid/Solid report (L/S) = 10 l/kg;

- heavy metals are under the limits imposed by the Order 95/2005 for non-hazardous waste which are:

Cupper: under 25 mg/kg d.s.at L/S =2 l/kg; 50 mg/kg d.s. at L/S = 10l/kg; 30 mg/l at C(0)
Nichel: under 5 mg/kg d.s.at L/S =2 l/kg; 10 mg/kg d.s.u at L/S = 10l/kg; 3 mg/l at C(0)
Zinc: under 25 mg/kg d.s at L/S =2 l/kg; 50 mg/kg d.s.at L/S = 10l/kg; 15 mg/l at C(0)
Cadmium: under 0.6mg/kg d.s. at L/S =2l/kg; 1mg/kg d.s. at L/S=10l/kg; 0.3 mg/l at C(0)
Cromium total: under 4 mg/kg d.s. at L/S=2 l/kg; 10 mg/kg d.s. at L/S=10l/kg; 2.5 mg/l at C(0)
Lead: under 5mg/kg d.s. at L/S =2 l/kg; 10 mg/kg d.s. at L/S = 10 l/kg; 3 mg/l at C(0).

One sample of dewatered digested sludge taken from Glina WWTP in 8th April 2011 has been incinerated in the laboratory and the resulted ash was analyzed.

Table 2.15 Comparison of ashes from Glina sludge and from reference sludge

Substance	Unit	Digested sludge. Glina WWTP. 2011	Digested sludge. Henriksdal WWTP (Stockholm). 1997
Dry solid content (DS)	%	18.53	25.8
Ash after incineration in laboratory to 550 ˚C	% of initial DS	41.4	38.9
Na	mg/kg ash	2.624	1.980
Mg	mg/kg ash	36.457	10.200
Al	mg/kg ash	62.539	18.720
Tot-P	mg/kg ash	18.877	40.714

Substance	Unit	Digested sludge. Glina WWTP. 2011	Digested sludge. Henriksdal WWTP (Stockholm). 1997
S	mg/kg ash	3.790	15.000
Cl	mg/kg ash	457	<100
K	mg/kg ash	20.894	3.800
Ca	mg/kg ash	241.839	37.857
Ti	mg/kg ash	582	5.326
Mn	mg/kg ash	2.057	303
Fe	mg/kg ash	65.350	102.631
Ba	mg/kg ash	442	525
V	mg/kg ash	82.7	46
Total Cr	mg/kg ash	1.364	114
Co	mg/kg ash	21.4	185
Ni	mg/kg ash	202	42
Cu	mg/kg ash	1.513	885
Zn	mg/kg ash	8.547	1.322
As	mg/kg ash	<0.01	<10
Pb	mg/kg ash	294	93
Sr	mg/kg ash	914	203
Mo	mg/kg ash	32.5	10

From this table it can be seen that the concentrations of most of the analyzed heavy metals are higher in the Glina sludge ash than within the reference sludge ash.

Strategic Sludge Disposal Alternatives

In the field of sludge disposal there are large differences between the countries within Europe. The general trend is that incineration and recycling has increased overall due to more stringent legislation concerning landfilling.

Recycling sludge as fertilizer on agricultural land is a popular disposal route that has been promoted by the European Commission. However, in recent years several countries within the EU have enforced laws forbidding or limiting the use of sewage sludge on land due to the fear of heavy metals accumulation in the soil.

Landfilling remains the main sewage sludge disposal alternative for many countries within the Europe. There are two possibilities in terms of sludge landfilling: mono-deposits and mixed-deposits which are more common. One of the problems of landfilling is the poor physical properties of the sludge resulting in handling and confinement problems. To be landfilled the sludge should be stabilized and dewatered to lower the emissions of odour and to reduce the pollution of the landfill leachate. In some countries the usual advantage of landfilling that of being cheaper than incineration has entirely disappeared due to the high cost of handling and limiting of its environmental impact.

Thermal treatment involves removal of the organic part of the sludge leaving only the ash component for final disposal. In addition to the main goal of thermal processing, that is disposal of the sludge, the use of its stored energy and minimization of its environmental impact is important. By thermally treating the sludge the volume to be disposed is drastically reduced, the toxins in the sludge are destroyed and odour emission is eliminated.

The three disposal options presented above have been assessed in order to decide which is appropriate for future disposal of the sludge produced at Glina WWTP.

Agriculture use

The fertilization of agricultural areas with sewage sludge has positive effects by supplying nutrients like Nitrogen and Phosphorus and improving the soil quality due to the high content of organic substance.

In contrast to these good effects by applying the sludge on agriculture land dangerous substances from the sludge may imply risks for the human health soil and the environment in general. Except heavy metals the appearance of new more dangerous substances in the sludge, such as medical residual substances or pesticides with possible carcinogenic effects can increase the potential risks.

The application of agricultural land could be made only if specific conditions for the land - as slope, level of ground water, type of soil - are fulfilled and could be made in connection with only some types of cultivated crops. These conditions are limiting the appropriate agricultural land surfaces.

Direct application on land can be made only during short periods of time, early spring and autumn, when the land is free of crops; thus storage places are needed to be arranged in conditions to avoid environmental pollution.

In addition, the applied amount of sludge (per ha and year) is conditioned by the content of nutrients and heavy metals both in soil and sludge, fact that is limiting the amount of sludge applied yearly per surface unit.

All these limitations and the large amount of sludge led to the idea that agricultural land in Ilfov county is not sufficient for using all Glina sludge in agriculture and land surfaces from other counties are needed, this meaning transport distances over 60 – 80 Km. It results that sludge transportation will become very costly, a big source of fuel (unrecoverable resource) consumption, as well as being an important air pollution source (25 tracks traveling every day on at least 60-80 km x 2 ways).

The sludge can also be used for **soil production** to be applied in parks, golf lands, green spaces, as well as for landfill coverage. But not enough such surfaces are available any time and at distances to be considered reasonable.

Another reason to not rely on this option is that just the suspicion of the presence of toxins and viruses in the sludge will make it very difficult, if not impossible. This is a common reaction regarding the sludge generated from large cities.

It results that the options still available for Glina sludge disposal are landfilling and incineration.

Landfilling

Directive 1999/31/EC and Romanian GD 162/2002 demands a reduction of biodegradable waste dumped or put on landfills. Biodegradable waste must be separated from other waste and pre-treated in order to reduce their organic fraction. Consequently, the international trend is that dumping of sludge (that even after digestion contains a large organic content) can not represent a long-term disposal solution for the future.

As landfilling of organic material like sewage sludge will most probably be **prohibited** in the coming years, it can be considered only as a **temporary solution**.

In Romania, most landfills are used for solid waste disposal. Biodegradable waste must be separated from other waste and mechanically/biologically pre-treated (i.e. composted or similar) in order to reduce the organic fraction of the waste. Today, when constructing a new landfill, most often special facilities for biological treatment of organic components are constructed as well.

The dumping of sewage sludge does not often take place, but if the sludge from Glina WWTP should be put in landfills, it will rapidly **generate shortage of landfilling capacity**, which will result in higher dumping costs.

Additionally, it is obvious that the large number of transports that would be needed for sludge transport to the landfill compared to needs for ash transport may create **traffic problems and air quality impacts.** Therefore landfilling of sewage sludge should be practiced only in special situations and does not represent a long-term solution for the future.

Incineration

In Europe a trend to incinerate sewage sludge is evident. First argument for using incineration is that its agricultural use will be more and more difficult. Another important reason for this trend is that landfilling of sewage sludge and organic material in general will be limited or forbidden in the near future. The available landfill capacity is often limited and dumping of sludge contributes of course to an earlier depletion.

In general. *the technical considerations* sustaining incineration are:

- large reduction of the final sludge volumes;
- the normally used technique - fluidised bed combustion - provides stable operation with high combustion efficiency;
- according to the EU a fluidised bed is considered the best available technique (BAT) for the combustion of sewage sludge.

Environmental considerations are as follows:

-thermal destruction of toxic organic compounds is very efficient;

- incineration minimise odour generation;
- potential risks for release of metals, dioxins and furans by the flue gas could be avoided by well known techniques such as:
  - injection of activated carbon in the flue gas for retention of mercury and organic pollutants;
  - electrostatic precipitator or bag filter for removal of dust and heavy metals;
  - dry desulphurisation systems which are also able to clean the gas of HCl and HF.

Arguments for the specific case of Glina WWT are:

- the proposed incinerator will be in **compliance with IE Directive and BAT** described in the BREF for Waste Incineration (2006).
- the **dispersion study** of emissions from a future incineration plant has demonstrated the insignificant impact of generated emissions even in case of cumulating them with the background pollution;
- the large reduction of the final ash volumes will lead to a considerably **reduced** number of needed **transports** carried out by lorries, which is an important benefit for the environment;
- **recovered heat** from the fluidized bed will be used to produce steam for electricity generation.

Economic arguments

From economic point of view it is well known that incineration requires

- **Higher capital costs** compared with other disposal options;
- **Higher operation costs** compared with other disposal options, **except** for **transportation**, which is essential for this option.

For Glina WWTP, the recovered heat from the fluidised bed will be used to produce steam to be fed into steam turbines for electricity production. The **economic value** of this **electricity** will be considerable, in an order of roughly 50% of what will be produced in the CHP station from using biogas generated during anaerobic digestion.

To correctly compare the two remaining options – landfilling and incineration - from the economic point of view, a calculation of Net Present Value (NPV) with a discount rate of 6% has been carried out for the design horizon of 30 years.

Already with **the current price** for transportation and dumping of dewatered sludge (70 EUR/tone) and of incinerated ash the **NPV is lower for the incineration option.** For ash disposal the price per tone was assumed to be three times higher than the price of disposal the dewatered sludge. as the ash is a hazardous waste.

The influence of the price for transportation + dumping on the NPV over 30 years for the two options is shown in Fig. 2.3. Only if the price for transportation + dumping would decrease to just below the current level, the NPV would be lower for the Landfill option. This is however not possible from the actual prospective and more than probably the price will raise in the near future.

Considering all issues presented above, the **Incineration option** should be recommended for Glina WWTP. Incineration can be used every month of the year and just during short periods of maintenance a temporary solution to store the dewatered sludge is available. If well planning these periods and by assuring the services of an international contractor specialized in incinerator maintenance, it may be possible to carry it out by just storing the dewatered sludge on site.

Design parameters for the Incinerator

The following design parameters have been chosen for the incineration plant at Glina WWTP
.

Table 2.16 Design parameters for the incineration plant at Glina WWTP. Stage 2

Operational option	Unit	All sludge digested
Dewatered sludge after digestion	m^3/d	503
	kg DS/d	166,120
	DS. %	33
Incinerated ash	m^3/d	50
	kg /d	83,760
	DS. %	100

Proposed configuration for the incineration process.

The sewage sludge arriving at the plant from the centrifuges has a DS content of 28-33%. It is fed to a silo that has an 8 hours holding capacity. In case the sludge has a lower DS content than 33% it is dried in a steam-driven dryer to up to 33% DS content and then fed into the fluidized bed where it is burned at a temperature of 850ºC.

The flue gases leaving the fluidized bed combustion chamber will pass over heating surfaces in which steam is generated to drive the steam turbine generator and in which combustion air for the fluidized bed is heated. The flue gases leaving the fluidized bed boiler will be cleaned in a flue gas cleaning system comprised of an ESP; additive injection and mixing system; and a bag filter before the flue gas is exhausted to atmosphere through a stack.

In selecting the process configuration, the best available techniques (BAT) for sewage sludge incineration was taken into account, as well as the need to comply with the EU Directive for industrial emissions (IED).

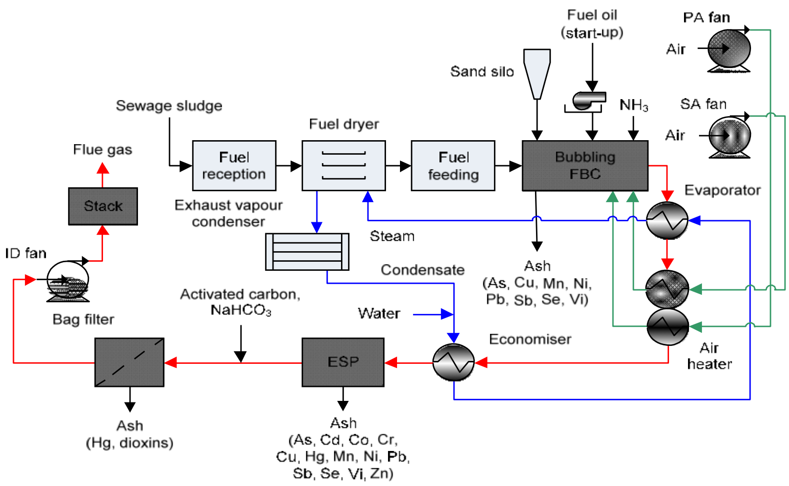
In the light of the above BAT conditions, the proposed configuration of the incineration plant has provided the following elements:

- *Drying of sewage sludge using heat recovered from the incineration*. as much as possible in order to avoid the need of using additional fuels for plant normal operation.

- *Combustion into a fluidized bed.* The primary combustion air is heated to help maintaining the temperature. The combustion chamber should be designed and operated in such a way that the gas resulting from the process has a temperature of at least 850ºC for a minimum of 2 seconds in the presence of at least 6% v/v oxygen on dry basis after the final injection of combustion air.

- *Auxiliary burners for start–up and shut-down.*

Figure 2.5 Chosen incineration process configuration



(a) General process description

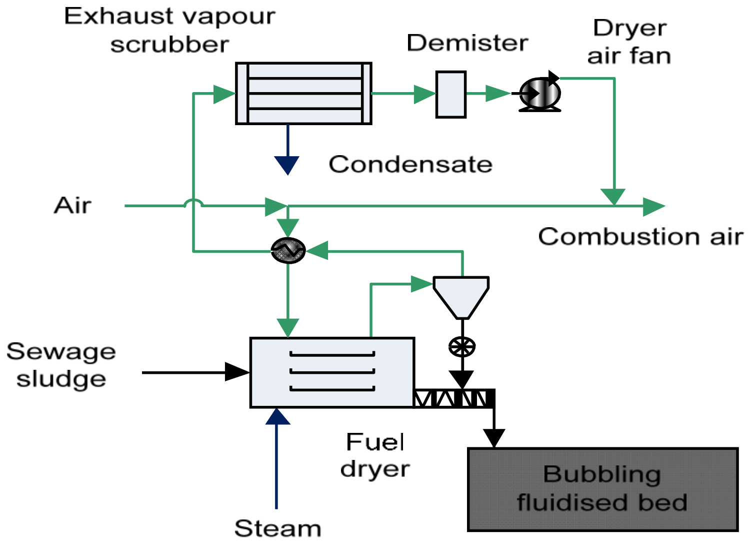
The sewage sludge arriving at the incinerator is dried in a **steam dryer** to 67% moisture content and then fed into the fluidized bed where it is burned at a temperature of 850°C. The flue gases leaving the furnace pass over heating surfaces in which steam is generated to drive the fuel dryer and the combustion air for the fluidized bed is heated. The flue gases leaving the boiler are then cleaned in the downstream flue gas cleaning system, comprising an **electrostatic precipitator (ESP**) and a **bag filter** before the flue gas is exhausted to atmosphere through the stack.

(b) Fuel drying

The dryer is an **indirectly heated rotary drum dryer** driven by 10 bar saturated steam supplied from the fluidized bed boiler. The simple design of the rotary drum allows operational and maintenance costs to be kept at a minimum. **The indirect dryer design means there is no pollution of the flue gases and the risk of explosions is minimized.** This type of dryer is employed in several modern sewage sludge incinerators.

A low **drying temperature** recommended to be between 65 and 70ºC is chosen to minimize losses. For the purpose of this Feasibility Study a temperature of **67ºC** was assumed. The dryer is a counter current flow heat exchanger where the exit water temperature approaches the sludge inlet temperature (67ºC in our case).

Figure 2.6 Configuration of air and evaporated vapours drying process



To transport the evaporated water from the dryer a **flow of air** is passed through the dryer. Within the dryer the air will be wetted until it reaches saturation at 67ºC. The fine sludge particles leaving the dryer with the air stream are separated out in a **dust separator** before fed to the fluidized bed.

The air leaving the dust separator is passed through a **heat exchanger** to heat up the dryer's incoming air after which it is scrubbed to remove fine particles.

The drying air pre-heater is integrated with **a scrubber** and the surfaces on the gas side are continuously cleaned by water from the scrubber. In the drying air scrubber most of the water evaporates and is separated out. After passing over a **demister,** part of the air used to discharge the evaporated moisture from the dryer is fed to the fluidized bed where it is used as combustion air; the remaining part is returned to the dryer in order to prevent any odour or harmful substances from being discharged into the air. To overcome the pressure drop within the fuel drying system a

suction fan is placed downstream of the demister.

It is reported that the condensed water from a steam dryer applied to sewage sludge typically has a high COD (ca. 2 000 mg/l) and N-content (ca. 600-2 000 mg/l) and may often contain other pollutants (e.g. heavy metals) from the sewage sludge. The condensed water therefore will be pumped back to the inlet of the plant for treatment before final discharge and the remaining condensates may be incinerated.

(c) Combustion

Bubbling fluidized bed (Figure 2.7) is proven as reliable for sewage sludge combustion.

Figure 2.7 Typical layout of a dry waste-fuelled bubbling fluidized bed

To achieve a sufficiently high combustion temperature during normal operation of the plant without using additional combustion support fuels, the sewage sludge fed to the fluidized bed should not have a moisture content of more than 65%. In the chosen plant configuration the sewage sludge is dried to moisture content of **67% (DS content of 33%)** before it is fed to the fluidized bed.

To achieve a high burnout of fuel/sludge, meaning high combustion efficiency, **an operating temperature of 850ºC** was selected. The combustion chamber is refractory-lined to keep heat losses to a minimum. (Note however that there are some examples of sewage sludge incinerators, often fluidized bed processes, that operate at temperatures close to 820ºC without deterioration in incineration performance).

The bubbling fluidized bed provides stable operation and even temperature distribution within the combustion chamber. The combustion air to the fluidized bed is supplied by two fans: one primary air fan injects air underneath the bed and one secondary air fan injects air just above the fluidized bed. An **excess air value of 25%** is chosen.

Due to the high volatile matter of the fuel, the final burnout of fuel will occur in the freeboard just above the bed. The fluidizing **velocity of the bed is 1.5 m/s** and the bed **surface area is of 16 m²**. A sufficient height of the furnace will ensure that the legislative requirement to have a **minimum residence time of 2 seconds at the temperature of 850ºC** after the last air injection will be met.

(d) Boiler heating surfaces

Immediately downstream of the combustion chamber, a **NOx reduction agent** (e.g. ammonia or urea) is sprayed into the flue gas to reduce the emission of NOx. An effective NOx reduction reaction takes place only within a narrow temperature window.

Downstream of the NOx reduction zone **tubed heating surfaces** are placed. The first bank of heating surfaces is an **evaporator** where saturated steam is raised at 10 bar. Part of this steam is used in the fuel dryer, the remaining being **excess steam (to be recycled)**.

In the **air-heater** placed downstream of the evaporator the air is heated from slightly above ambient temperature to **216ºC** before it is fed into the combustion chamber. A finned-tubed **economizer** is placed downstream of the air heater.

(e) Flue gas cleaning

The flue gas leaving the boiler (described before) will contain fine sludge solids entrained from the fluidized bed. as well as fine particles of ash. The first stage of the proposed flue gas cleaning system is an **electrostatic precipitator** (ESP) where the majority of the particulate in the flue gas will be removed. Metals present in the flue gas which have condensed on the particles will also be removed from the flue gas but Mercury will be not captured in the ESP.

Downstream of the ESP and upstream of the bag filter **activated carbon and sodium bicarbonate ($NaHCO_3$)** will be injected into the flue gas steam. The activated carbon will be used to remove Mercury from the flue gas and $NaHCO_3$ will react with HF and HCl. as well as SO_2 forming salts which will be removed in the **bag filter** placed downstream. The purpose of the bag filter is twofold: firstly. for the removal of fine particles and secondly as a chemical reactor where activated carbon and $NaHCO_3$ react in the dust cake formed on the bag filter with the impurities in the flue gas. **Compared to wet systems** the proposed dry removal system with $NaHCO_3$ is less expensive both in terms of capital cost as well as in operating cost. The dry system is also less complex since **no wastewater handling is required**.

Table 2.17 Sludge composition used in the heat and mass balance calculation

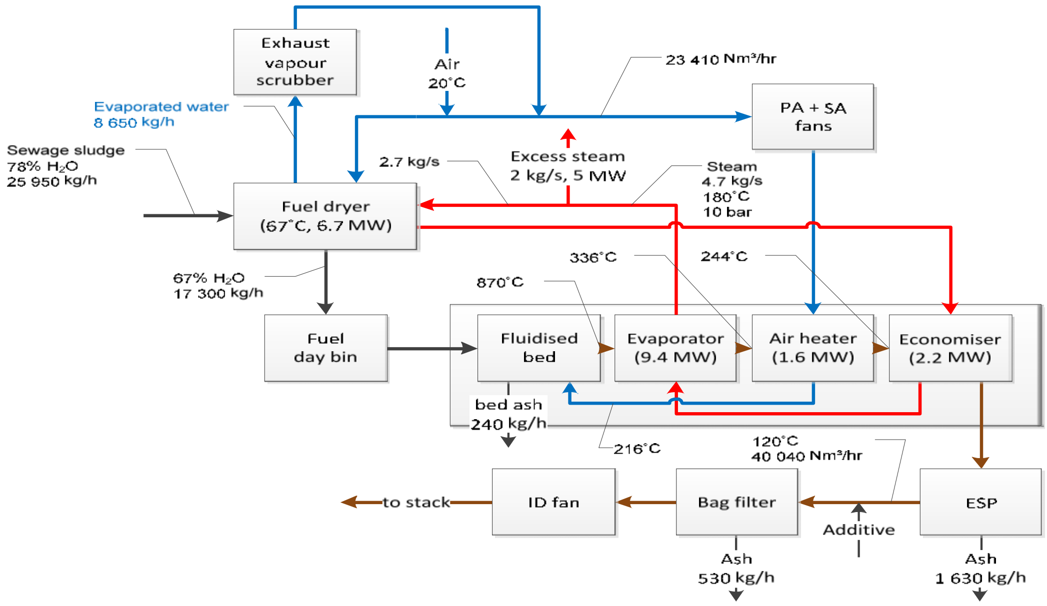
Sludge components	Unit	Value
Water content (Moisture)	%	67
C	% dry basis	30.4
H	% dry basis	4.2
N	% dry basis	3.9
O	% dry basis	18.3
S	% dry basis	1.2
Cl	% dry basis	0
Ash	% dry basis	42
Gross Calorific Value (GCV)	MJ/kg. dry basis	13.92
Net Calorific Value (NCV)	MJ/kg. dry basis	13

Process performance data (mass and energy balance)

The amount of dewatered sludge with a 33% dry substance content sent for incineration is assumed to be around 481m ^{3}/ day. The composition of the sludge used as fuel chosen for the calculation of the overall mass and energy balance (Figure 2.8) is shown in Table 2.18.

It was assumed that 10% of solids discharged from the system are removed as bottom ash from the furnace whilst 68% and respectively 22% are removed in the electrostatic precipitator / bag filter.

Figure 2.8 Heat and mass balance for the proposed plant layout



Comparison between BAT (from BREFs) and projected solutions for Glina WWTP stage 2.

All designed operations involved in wastewater treatment, sludge treatment and further sludge incineration are in compliance with BAT described in BREF.

In case of waste water treatment BAT is to remove biodegradable substances using one of the appropriate biological treatment system or a combination of systems such as:

- complete-mix activated sludge process
- membrane bioreactor
- thickening/percolating filter
- aerobic expanded bed
- biofilter fixed-bed process followed by nitrification/denitrification where the waste water contains a relevant nitrogen load.

When a Central biological WWTP will be used it is BAT to:

- buffer the incoming wastewater streams to equalize the contaminant level
- treat the incoming wastewater by a combination of:
    - primary/mechanical treatment
    - one or two stages of aeration
    - secondary sedimentation to protect the receiving stream from excess suspended solids.

The concept of Glina WWTP is using the mentioned processes and is conceived to comply with the requirement of the Urban Waste Water Treatment Directive – 91/271/EEC

For **handling the sludge** resulted from wastewater treatment BAT is to use one or several of the following options:

- sludge thickening
- stabilization (biological or chemical)
- sludge conditioning and dewatering
- sludge drying
- thermal sludge treatment
- landfilling the sludge on site

Sludge treatment at Glina WWTP is conceived by sludge thickening, biological stabilization by anaerobic digestion, conditioning and dewatering and finally sludge incineration.

In selecting the **incinerator configuration**, best available techniques (BAT) for sewage sludge incineration was taken into account, as well as the need to comply with the EU Directive for industrial emissions (IED).

BAT for sludge incineration is considered to be:

- *fluidized bed technology* - because of the higher combustion efficiency and lower flue-gas volumes that generally result from such system;

- *drying of the sewage sludge by using heat recovered from inside the incinerator*, to the extent that additional combustion support fuel is not required for the normal operation of the installation (in this case. normal operation excludes start-up. shut-down and the occasional use of support fuels for maintaining combustion temperatures).

In the light of the above BAT conditions, the proposed configuration of the incineration plant has provided the following elements:

- *Drying of sewage sludge using heat recovered from the incineration.* as much as possible in order to avoid the need of using additional fuels for plant normal operation.

- *Combustion into a fluidized bed.* The primary combustion air is heated to help maintaining the temperature. The combustion chamber should be designed and operated in such a way that the gas resulting from the process has a temperature of at least 850ºC for a minimum of 2 seconds in the presence of at least 6% v/v oxygen on dry basis after the final injection of combustion air.

- *Auxiliary burners for start–up and shut-down.*

Table 2.18. Comparison between BAT provisions and Glina incinerator process

BAT provisions for sludge incineration	Glina incinerator process configuration
Fluidized bed technology	Combustion into a fluidized bed. having high burning efficiency and generating lower flue-gas volumes
Drying of the sludge by using heat recovered from inside the incinerator	Drying of sludge by using the heat recovered from the incineration process. in order to avoid the need of additional fuels for normal operation
Occasional use of support fuels for maintaining combustion temperatures	Auxiliary burners for start–up and shut-down in order to maintain the needed combustion temperature
Burning temperature - 850ºC.	Burning temperature - 850ºC.
Retention time in the combustion chamber of minimum 2 seconds	Minimum 2 seconds retention time in the combustion chamber in the presence of at least 6% oxygen after the final injection of combustion air.

The BAT technologies for flue gas treatment are as follows:

- apply heat recovery – using heat exchangers to allow preheating of combustion air or waste drying
- use boiler for generation of steam – for energy recovery
- cooling flue gases before exhausting.

The above mentioned techniques are included in the concept of Glina incinerator, as well as the solutions for reducing flue gas pollutant load presented in Table 2.19.

Table 2.19 Techniques for reducing flue gas pollutant load applied to Glina incinerator

Needed actions	BAT techniques for flue gas treatment	Glina incinerator techniques for flue gas treatment
Remove particulate matters	- wet scrubber. - electrostatic precipitator. - bag filter. - catalytic filter	- electrostatic precipitator - bag filter
remove HCl. Hf. and SO2	- wet scrubbing - semi-dry scrubbing - dry scrubbing	- dry scrubbing by injection of sodium bicarbonate ($NaHCO_3$) upstream of the bag filter
remove NOx	- good process control - selective catalytic reduction - selective non-catalytic reduction	- downstream of the combustion chamber ammonia or urea is sprayed into the flue gas to reduce the emission of NOx.
remove VOC-s	- wet scrubbing - membrane separation - adsorption – activated carbon	- adsorption of VOC-s and Hg vapours using activated carbon injected into the flue gas stream before the bag filter

As result of using these techniques for the flue gas treatment of Glina incinerator the emissions evacuated in the air will be even smaller than emission levels associated with the use of BAT (see Table 2.20).

Table 2.20 Emissions estimated for Glina sludge incinerator compared with emission levels associated with the use of BAT - mg/Nm^3 as 1/2 hour average

Pollutants	**Bat emissions (mg/Nm^3 as 1/2 hour average)**	**Glina estimated emissions**	**ELV – IED values**
Total dust - suspended particulates	1 -20	≤1	10
Gaseous and vaporous organic substances. expressed as total organic carbon (TOC)	1-20	≤1	10
Hydrogen chloride (HCl)	1-50	≤1	10
Hydrogen fluoride (HF)	2	≤2	2
Sulphur dioxide (SO_2)	1-150	≤50	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2). expressed as nitrogen dioxide	30-350	≤200	200
Cadmium and Thallium and their components	0.005-0.05	≤0.05	0.05
Mercury and components measured as Mercury (Hg)	0.001-0.03	≤0.05	0.05
Σ other metals	0.005-0.5	≤0.5	0.5
Dioxins and furans	0.01-0.1 ngTEQ/m^3	≤0.1 ngTEQ/m^3	0.1 ng/m^3
Carbon monoxide	5-100	≤100	100

Chapter 3 ACHIEVEMENT AND FUNCTIONING OF THE OBJECTIVE

3.1 Duration of works execution

After the approval of the Cohesion Fund Application, elaborated in order to finance the Glina WWTP Stage 2 construction, a tender for two Works Contracts (Glina WWTP Stage 2 and Incineration of sludge. respectively) together with a tender for a Supervision Contract regarding both Works contracts will be organised during spring 2012.

The construction works and finalization of works contracts mentioned above is planned for December 2015 when the two lines of Glina WWTP shall be in function.

3.2 Functioning time and program

The rehabilitated Glina WWTP is planned to ensure wastewater flow treatment till the year 2040 which is the design horizon.

Design parameters have considered the evolution of Bucharest inhabitant number. as well as the connection of neighbouring dwellings sewage systems: Glina, Popesti Leordeni, Jilava, Magurele, Bragadiru, Domnesti, Chiajna, Dragomiresti Vale, Chitila, Mogosoaia, Otopeni, Tunari, Dobroesti, Pantelimon, Cernica.

The opportunity of other connections in the future will be analysed too, if the case, but they could not bring important flows to Glina WWTP.

The functioning time of the plant will be continuously meaning 24 hours per day, 7 days per week and 365 days per year.

Periodical technical revision of the plant components will be assured without interrupting the treatment process. For accidental interruption emergency solution will be applied so that the quality of the treated effluent to satisfy the discharge conditions.

Chapter 4 DESCRIPTION OF THE EXISTING ENVIRONMENT

In this chapter the existing environment comprising relevant physical, biological and social aspects is described. The boundary of the project area in which the influence of the WWTP could be manifest is framed.

Impacts on the environment related to the WWTP-stage 2 occurring during the construction phase, as well as during the operational phase, will be discussed in other chapter.

4.1 Project area and area of influence

The area covered by this Environmental Impact Assessment is the direct surroundings of the Glina Village. However, since several influences will be manifest beyond this limited area, as well as the influence of a larger area will be affecting the WWTP, a greater surrounding is described as well. Therefore the total area of the Bucharest city has been described as well as a part of the Arges river basin (in some cases).

4.2 Physical environment

4.2.1 Climate

Bucharest is located inside a temperate-continental climate with some excessive nuances belonging to the Romanian Plain (44º25' northern latitude and 26º05' eastern longitude). Bucharest and the entire Romanian Plain are included in the so-called Danubian climate and Mehedinti Getic climate. This type of climate is characterized by four seasons with specific features.

Summer: it is the warmest season. with average monthly temperatures of 20º-23ºC. The daily temperatures may reach also 35º-40º C. The precipitations totalize 190mm and usually have torrential character. The dominant winds blow from NE. SW and W. In this season following the advection of tropical air, often phenomena of drought and dryness occur.

Winter: the average monthly temperatures oscillate between –2.7ºC and 0.2ºC, while the daily values can reach –10 till -20ºC. Especially under the influence of the air circulation from east and north, generating the icy north wind called Crivat. Sometimes there are rich snowfalls and snow storms, while other times there are warm days, due to the advections of Mediterranean air.

Spring: is generally short, with thermal contrasts, even from one day to another and with big inter-monthly thermal jumps (6-10ºC between March and April). The average monthly temperatures vary between 5 and 17 ºC and the precipitations reach 150 mm.

Autumn: it tends to extend into the winter; sometimes it is relatively dry, with average monthly temperatures between 18 and 5.6 ºC.

It is to mention that the active surface of the Bucharest city, different from the plain, changes the values of all climatic parameters. Being the capital of the country, Bucharest is characterized by the most urban climate in Romania. The Popesti-Leordeni commune and Glina Village, however located in the outskirts of Bucharest, have a slightly more moderate climate.

Air temperature

The annual averages have values of over 11 ºC in the center of the city and lower of 11°C in the outskirts. The influence of the city may be noticed on all climatic parameters and Bucharest is, from a thermal point of view, an urban “heat island” caused by the fuel burned in the city and the excessive heating of the concrete, asphalt, bricks and other types of surfaces. The increase of the annual average temperature in the center of the city is felt more and more in the recent years as the city developed by increasing the specific urban surfaces.

Soil temperature and frost

The soil temperature has variations on the territory of Bucharest. Thus, an annual average of 12.7°C is recorded at Afumati (NE of Bucharest) and is lowering from the center of the city to the outskirt.

The soil surface temperature records a minimum in January and a maximum in July. The January maximum reaches average values under –3°C on the territory of the city and under –4°C outside it (Afumati). The July maximum reaches values over 28 °C in the city and under it in the surrounding area (Afumati - 27.3 °C). These values are about 6°C higher than those of the air in the same month in Bucharest and 5-6°C higher than in the rest of the territory.

The average date of the first frost is between November 3 and 5 - in the center of the city, between October 26 and 31 - in the outskirts and between October 8 and 25 - in the Ilfov Agricultural District.

The average date of the last frost is between March 29 and April 1 in the center of the city, delaying in the outskirts of about two weeks later than in the city and even more in the surrounding areas.

The soil depth of freezing is of 0.7-0.9 m.

Air relative humidity and fog
Air relative humidity has annual average values of 74%, increasing from the center of the city to its outskirts (Afumati - 78.2%). Due to the increase of the temperature in the city, a trend of humidity decrease is ascertained in the recent times.

The smallest values of the relative humidity, of less than 70%, characterize the summer months, especially July. The highest values, characterizing the winter months especially December, are of 85-90%.

The high humidity of the air is made obvious also by the phenomenon of fog. Annually, there are 40-50 foggy days, more frequently on the zones near the lakes and rivers.

Opposite to it, there is the urban fog, produced over the whole city of Bucharest, due to the urban atmosphere pollution with smoke, soot, particles of dust and exhaust emissions, etc. The presence of pollutants in the urban atmosphere and their dispersion is conditioned by the weather. Thus, in conditions of thermal inversion, the pollutants are retained in the lower atmosphere while during strong thermal convection they are dispersed in the upper atmosphere. In some cases, especially during transition seasons, the meteorological fog can superpose the urban fog and in such situation breathing may become difficult.

Precipitations
Their annual territorial distribution of precipitations is varying largely. The highest average annual quantities fall over the Bucharest, where the aerosols quantity is bigger (Filaret - 590.9 mm). The precipitations are lower in the outskirts and at the limit with Ilfov Agricultural District (Afumati 538.9 mm).

During the year, there is a maximum of precipitations in June, with the same regime of territorial variation, respectively higher values in the city (97.1 mm) and lower to the outskirts (Afumati 92 mm). February is the month with the smallest amount of precipitations; this means lower than 1/3 of the maximum value of the rain regime (Afumati 21.9 mm).

During the summer there are often downpours, sometimes accompanied by hailstone (occurring 1 – 3 times a year. in the average). Most frequently, this type of rains occurs over Bucharest, where the thermal convection is stronger. It should be noticed that within the city the precipitations are distributed non-uniformly, occurring with some local differences or only in some areas.

The average value of the snow cover thickness varies between 00.0 cm and 9.6 cm at Baneasa and 7.8 cm at Afumati. Higher values are noticed in the city, while lower values are noticed in the open field. The first snow occurs at the end of November, sometimes earlier (end of October), while the last snow normally falls end of March.

Wind regime
In Bucharest, the NE winds are prevalent (23.2 % at Afumati), followed by the SW winds (8.1 % at Afumati). The highest average annual speeds (3.2 m/s at Afumati) are on the NE direction followed by the E direction (3.2 m/s).

4.2.2 Topography, geology and soil

Topography
Bucharest city is located in the southern part of the country. in the Romanian Plain within its subunit Vlasia, approximately 60 km far from the Danube, 100 km from the Carpati Mountains and 250 km from the Black Sea. Its surface extends 53 km on the north-south direction and 46 km - on the east-west direction.

Glina village is located south of Bucharest on the right bank of the Dambovita River.

Theoretically, the center of Bucharest is intersected by the latitude of 44º25’50’’ N and the longitude 26º 4’50’’E. while the Glina Village is intersected by the latitude of 44º23’47’’N and the longitude 26º14’69’’E.

Relief
The field represents the dominant form of the relief followed by valleys and also the flood plains of Dambovita and Colentina rivers, each one with a specific micro-relief. The altitude decreases slowly from 110-100 m in the North-East to 50-60 m in the South-East, with slopes under 2%.

The city of Bucharest and its outskirts are located over the Vlasia Plain. To the NW of Bucharest there is the Ilfov Plain. The rivers are not deep and the river beds are frequently marshy; the groundwater is at a low depth (3-5 m), so that in the rainy period a surplus of humidity occurs.

Geology
The Vlasia Plain, where the city of Bucharest and a part of the Ilfov Agricultural District are located, belongs geologically to the Walachian Platform.

The Bucharest Plain represents a part of Vlasia Plain that has some specific physical–geographical features. Its limit goes in the west to the shore of the Arges-Sabar flood plain, to east - till the Pasarea valley, to north - till the Titu subsidence plain; to the south it has a transitory limit towards the more fragmented Calnau Plain.

In Vlasia Plain immediate underground there is gravel (Colentina gravel), with rich groundwater tables and streams and. on top of them, there is a loess stratum up to 10 m thick.

Earthquakes

The territory of Bucharest and surroundings is affected by two types of earthquakes:

- intermediary earthquakes with the center under the crust 80-100 km deep; they are releasing a huge amount of energy sometimes being catastrophic;
- normal earthquakes located within the crust at a depth of 5-30 km; these earthquakes have a lower energy.

The intermediary earthquakes have their center in the Curvature of the Carpathian Mountains in the Vrancea area. These earthquakes direct their energy on an ellipse stretching out on the North-East / South-West direction.

The normal earthquakes are centered in the Walachian Platform (where the city of Bucharest is located). The stress coming from the Vrancea earthquake forces them to release more often the accumulated energy, thus they remain low-intensity earthquakes.

Soil

Due to the physical and geographical conditions the municipality of Bucharest and its neighborhood are dominated by reddish-brown forest soils to which associate many other types of soil such as argillo-iluvial, cambic chernozems, podzolized and gleyed soils, and alluvial soils.

The well drained surfaces, as the Bucharest Plain, Snagov Plain and Calnau Plain, are covered by reddish-brown soils. On the eroded portions these soils are associated with hydromorphic soils.

In Balotesti-Tunari area, where the soil drainage is weaker, the reddish-brown soils associate with argilloiluvial or cambic chernozems, sometimes gleyed.

The reddish-brown soils represent the most extended zonal type of soil, formed under the ancient forests developed on fields and terraces relatively well drained (ground water at over 6 m). The general humus content is low (2-3%) and the pH is 6.7-7.4. Where the soils are still under the forest, they are subject of a low podzolization process (podzolized reddish-brown soils), are richer in humus (5-8%) and their reaction is acid. In the valleys and depressions, which are humid, the podzolization process is more marked.

The cultivated reddish-brown soils are in several evolution stages, being differentiated by the humus content and the color. Those soils with a darker color and richer in humus (organic matters) are found on fields and terraces and only around some depressions or at the origin of the small valleys. The moderately organic soils are more extended on the territories close to the deep valleys. The weak organic soils are found only on Glina-Balaceanca terrace.

Inside the area of interest the chernozems come next in occurrence after the reddish-brown soils. The cambic chernozems appear only in a few patches in the east of the Ilfov Agricultural District and in the south-east of Bucharest.

More extended are the argilloiluvial soils as they occupy Movilita Plain and also Calnau Plain (east of Berceni quarter). The grey soils are found on the terrace of Glina-Balaceanca and some points in Movilitei Plain.

Soil characteristics on Glina WWTP site

The site of Glina WWTP was subject of an Association Contract signed in 2004 between the Municipality of Bucharest and the Glina commune in order to facilitate the finalization of the Glina WWTP. In the frame of this Association Contract a surface of 42 ha from the private property of Glina commune is given for free use to the Bucharest Municipality for the whole duration of construction and functioning of the plant. The former use of this piece of land was theoretically agricultural - communal grazing land - as shown by the Order 435 /2002 of Ilfov County Prefectura.

The geological and hydro-geological conditions of the site have been investigated within the Geotechnical Study performed by the company Geotec Consulting SRL based on a number of 11 geotechnical boreholes grouped in function of the construction objects in 4 categories:

Zone A: 3 geotechnical boreholes (FG 1. 2 and 3) placed in the area of SAS thickening + thickening sludge buffer tanks; sludge dewatering + digested and emergency sludge buffer tanks; CHP building. A soil sample from borehole FG1 (named F1) was analyzed.

Zone B: 3 geotechnical boreholes (FG 4. 5 and 6) placed in the area of secondary settlement tanks + RAS/SAS pumping station. A soil sample from borehole FG4 (named F2) was analyzed.

Zone C***:*** 3 geotechnical boreholes (FG 7. 8 and 9) placed in the area of screens for storm basins + storm basins + return pumping station. A soil sample from borehole FG9 (named F3) was analyzed.

Zone D: 2 geotechnical boreholes (FG 10 and 11) – in the area of flow distribution and fine screens + grit removal. A soil sample from borehole FG10 (named F4) was analyzed.

The position of boreholes is shown on the General Layout presented within the following 2 figures.

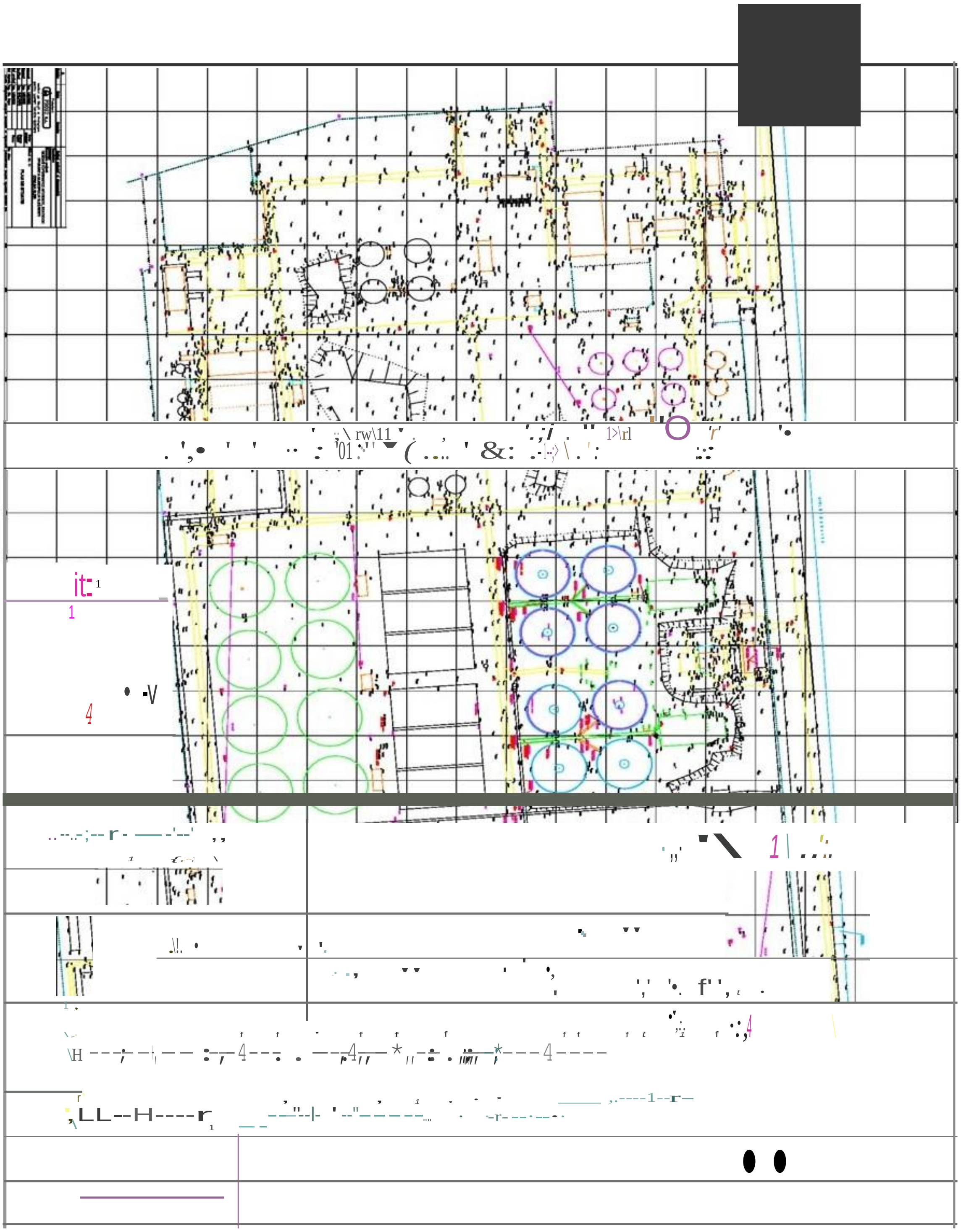


Fig. 4.1 Boreholes generallayout (Geotechnical study-Geotec Consulting SRL)

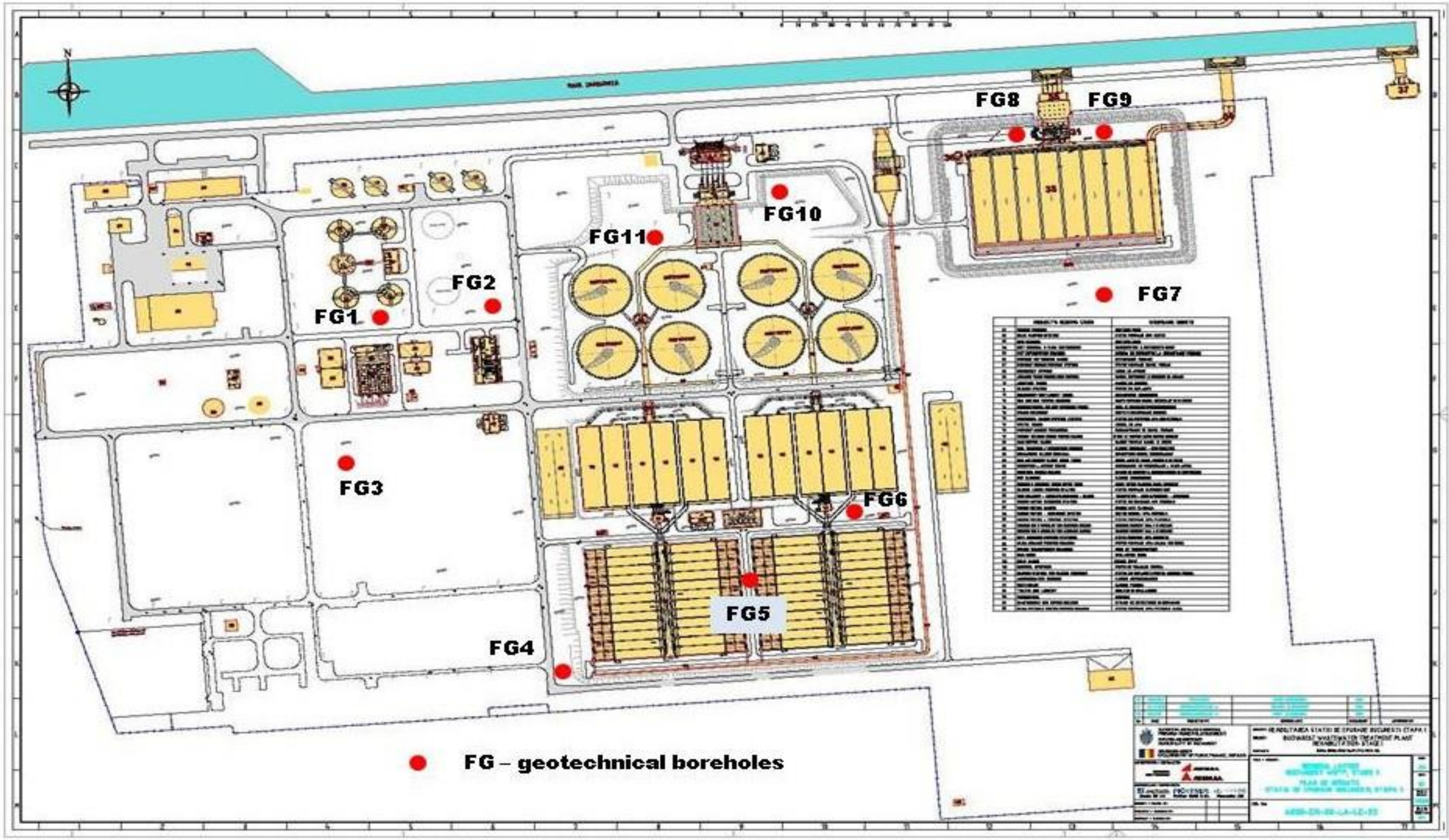


Fig 4.2 Actualized boreholes general layout

The following lithological structure was found in the first strata including the top soil of the investigated site:

A Zone (FG1, FG2 and FG3)

- 0.0 – 0.9m heterogeneous filling materials mainly consisting of either ballast and sandy silty clay material or sandy silty clay with gravel and fragments of construction materials. over two years old;

B Zone (FG4, FG5 and FG6)

- 0.0 – 1.1m heterogeneous filling materials mainly consisting of either sandy silty soil with remaining of construction materials or fine to coarse gravel with sandy silt. which was not compacted and it is over two years old;

C Zone (FG7, FG8 and FG9)

- 0.0 – 2.2m heterogeneous filling materials mainly consisting of ballast, clay-material and fragments of construction materials. which was not compacted and it is over two years old;

D Zone (FG10 and FG11)

- 0.0 – 1.3m heterogeneous filling materials consisting of clay soils with fragments of construction material, non-compacted over two years old.

Due to the variety of surface filling materials and to the decision to replace it anyway, soil samples of 0.0-0.20m have not been analyzed and only samples taken from a depth of – 1.5m which could be representative for the site history have been considered.

The investigation was oriented to identify only some types of pollutants that were considered as having a higher probability to be detected in the area (phenols, cyanides and heavy metals) due to possibly former very old industrial activities in the peripheral zones of Bucharest.

Table 4.1 Results of soil samples analyses

Soil sample	**Cyanides and Heavy metals in soil samples (mg/kg dried solids)**									
	Cyanides	**Co**	**Cr3+**	**Cd**	**Cu**	**Ni**	**Pb**	**Zn**	**Cr6+**	**Hg**
F1 (-1.5m)	0.00	13.6	66.36	0.26	26.5	45.6	23.6	104.1	0.24	0.038
F2 (-1.5m)	0.02	9.4	49.62	0.24	62.1	27.6	22.1	116.3	0.08	0.026
F3 (-1.5m)	0.00	11.1	39.02	0.42	57.2	37.1	36.5	325.4	0.08	0.028
F4 (-1.5m)	0.10	13.9	60.45	0.26	28.4	43.3	28.4	169.4	0.15	0.017
Values for less sensitive areas										
Target values	1	15	30	1	20	20	20	100	1	0.1
Alert values	**10**	**100**	**300**	**5**	**250**	**200**	**250**	**700**	**10**	**4**
Intervention values	20	250	600	10	500	500	1000	1500	20	10

Phenols have not been found in any soil sample. Cyanides were found only in one sample being in smaller concentration that the target value. Heavy metals concentrations determined in the samples are under the alert values; this means that the area was not polluted by activities implying heavy metals use. The explanation of the some metal concentrations higher than the target values but smaller than the alert values it is that they represent a feature of the natural background related to the strata participating to the soil formation and are not an expression of a former pollution.

4.2.3 Landscape

In the surroundings of the WWTP the landscape can be considered as flat and non-attractive. The power plant with its overhead power lines (high tension) and other industrial buildings dominate the landscape on the left bank of Dambovita River. On the right bank of the river there is a higher relief towards the Glina Village. just after the perimeter of the WWTP. Towards the south-west of the WWTP a huge landfill – Ochiul Boului - is located.

Other main element of the landscape is the road with its bridge across the Dambovita River between of the landfill and the village.

4.2.4 Surface waters - Rivers and lakes

Bucharest is located upstream the confluence of Dambovita and Colentina, both rivers belonging to Arges basin respectively Arges- Vedea hydrographic space.

At regional level it can be considered that Arges, Dambovita, Colentina and Ialomita rivers are parts of a hydrological and hydro-technical system. This system could direct the Arges water towards Bucharest, Ialomita water towards Colentina and during high waters periods, the Dambovita waters towards Arges, through Colentina. These actions are serving for Bucharest protection against flooding.

River Arges

River Arges has a total basin surface of 12.590 km^2 and a length of 327 km. The average multi-annual flow is of 49.7m^3/s at Budesti, after the confluence with river Sabar, 62.8m^3/s after the confluence with Dambovita and 63.1m^3/s at its discharge in Danube River.

Dambovita River

Dambovita River has a basin surface of 2.824 km^2 and a length of 286 km. Downstream of Dudu commune its river bed is channeled and partially dammed. The flow regime is influenced by the deviation of its high water towards Ciorogarla (at Brezoaiele) the downstream mixing with the Bucharest wastewaters at Glina and the inflow of Colentina lakes at Balaceanca.

The multi-annual average flow of Dambovita river is 11.1m^3/s. As a very high monthly average, even a value of over 40m^3/s is recorded (originated from rains and less from snow melting). The lowest monthly averages values of recorded flow are around 1.40m^3/s.
The daily minimum flow in the warm period (April-November) at Contesti is 2.97m^3/s. but can also decrease to 0.60m^3/s. while in the cold period (December–March) it is of 2.21m^3/s. The annual daily average minimum flow is of 2.24m^3/s.

The high waters of river Dambovita represented a real danger for Bucharest and the high waters of the year 1975 have proved that accidents in the flooding defense system are still possible. To avoid such situations the first actions to be taken are to detour the high waters towards a hydro-technical knot at the Lunguletu locality a deviation of 300m^3/s from Dambovita to Ciorogarla river being possible here. In the past in the same purpose the river bed within Bucharest was widened at 27 m (1865) and channeled (1868 – 1900) increasing the transportation capacity from 20-30 m^3/s to 125 m^3/s.

The use of the river water is especially for the Bucharest drinking water supply at Arcuda Drinking Water Treatment Plant being captured about 2.8 m^3/s of Dambovita river flow.

Colentina River

Colentina River has a basin surface of 636 km^2 and a length of 80 km. merging with Dambovita downstream Bucharest. In the past Colentina was a small river “mostiste” type; it was marshy and frequently dried up in summer time. The first stage of harnessing lasted until 1945 when the Bucharest-Ghimpati channel was dug and a significant number of lakes (Buftea. Mogosoaia, Baneasa, Herastrau, Floreasca and Tei) were arranged.

The multi-annual average flow at Colacu section is of 0.63m^3/s.

Lakes

On the territory of Bucharest and Ilfov county there are over 100 lakes of various origins. Most of them are ponds created along the “mostiste”–type valleys; some are typical river “limans” while other lakes were created in anthropic excavations and by damming. Most of these lakes are small but some of them have a large surface. The largest valley lakes resulted by damming are located on Colentina river. Lacking an adequate flow to refresh large lakes, Colentina River is supplemented with water from Ialomita stream.

All the lakes together with some neighboring territories constitute entertainment areas. Also, their water may be used for other purposes such as fishery, irrigation and even as industrial water resource.

4.2.4.2 Surface water quality

A section of the river quality map of Romania is presented bellow (extracted of the Report “State of the Environment” – 2008). From this map it can be noticed that the classification by the water quality of the rivers in the analyzed area is as follows:

- Dambovita (downstream Bucharest): degraded

- < Arges before confluence with Dambovita: category I
- < Arges downstream confluence with Dambovita: category II

- < Danube before confluence with Arges: category II

Fig 4.3 The chemical state of surface water in Arges basin (source: State of the Environment - 2008)

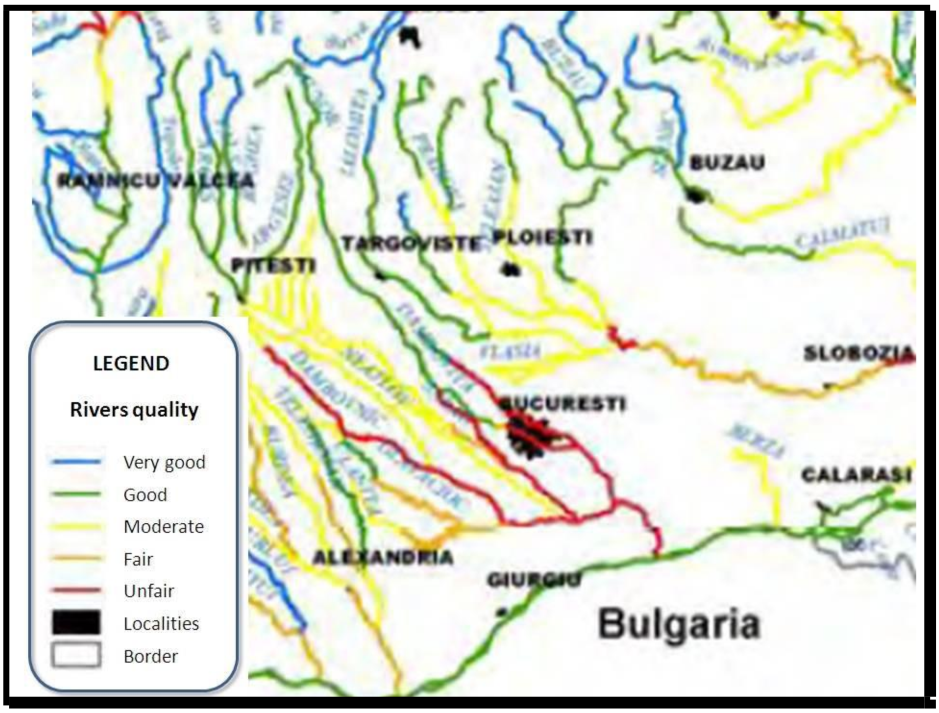


Fig 4.4 The biological state of surface water in Arges basin (source: State of the Environment - 2008)

Water quality of rivers, natural and artificial lakes is investigated within the Water Quality Monitoring System by determining, with a frequency of 4 to 12 times per year, some indicators that illustrate the influence on the aquatic organisms.

Assessment of the *river water* quality from **physical and chemical** point of view is based on the values of 5 groups of indicators:

- oxygen regim:	dissolved O_2. BOD_5 . COD;
- nutrient regim:	NO_2. NO_3. NH_4. PO_4. total P;
- mineralization degree:	conductivity, fixed residue, chlorides, sulphate, Ca+. Mg+, Fe+, Mn+, etc;
-metals:	Zn, Cu, Cr, Cd and other heavy metals;
-micro-pollutants:	phenols, detergents, other priority organic substances.

Assessment of the river water quality from **biological** point of view is based on the Saprobic Index.

The classification of the monitoring sections in one of the 5 quality classes is made by comparing determined data with the indicators' limit values, established by the **Norm 1146/2002** on reference objectives for classifying surface water quality.

Reference objectives correspond to the values of **second class of quality**, which is the class reflecting the quality conditions for protection of the aquatic ecosystems.

The classification of *lakes* from quality point of view is based on both physical & chemical indicators and the degree of trophy. For defining the last one the chlorophyll "a" and phytoplankton biomass are used.

The water quality of rivers in Arges basin

In the context of this study the quality of water in Dambovita River downstream Bucharest and in Arges River downstream the confluence with Dambovita is important.

The high values of dissolved Oxygen in monitored rivers of Arges basin have classified them as satisfying the quality objectives, except the part of Dambovita river downstream Bucharest that is affected by the untreated wastewater discharged from Bucharest. The same river segment is characterized by exceeding the imposed values for **BOD_5** and **COD.**

In general, no exceeding of **N-NO_3** limit value has been registered in rivers of Arges basin and only rare exceeding have been determined for river Dambovita downstream Glina.

The values of **N-NH_4** show a high degree of pollution in river Dambovita downstream Bucharest that contributes to the pollution of Arges River downstream the confluence with Dambovita – zone where exceeding has been also registered.

In the same sections of the river Dambovita - downstream Bucharest and of river Arges– downstream confluence with Dambovita, the **saprobic index for macro-zoobentos** exceeded the target objective, which is the value of 2.3; this fact is expressing the amplitude of impact caused by organic pollutants.

Fig. 4.5 Spatial evolution of BOD, COD, dissolved Oxygen and saprobic index (I.S.) in the water of river Dambovita

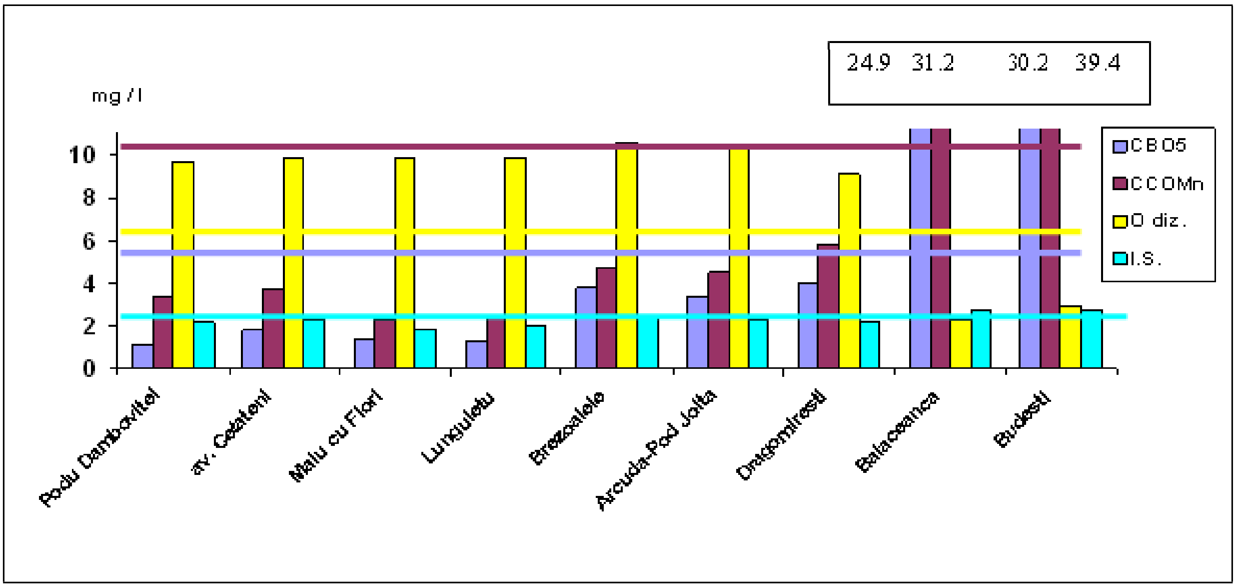
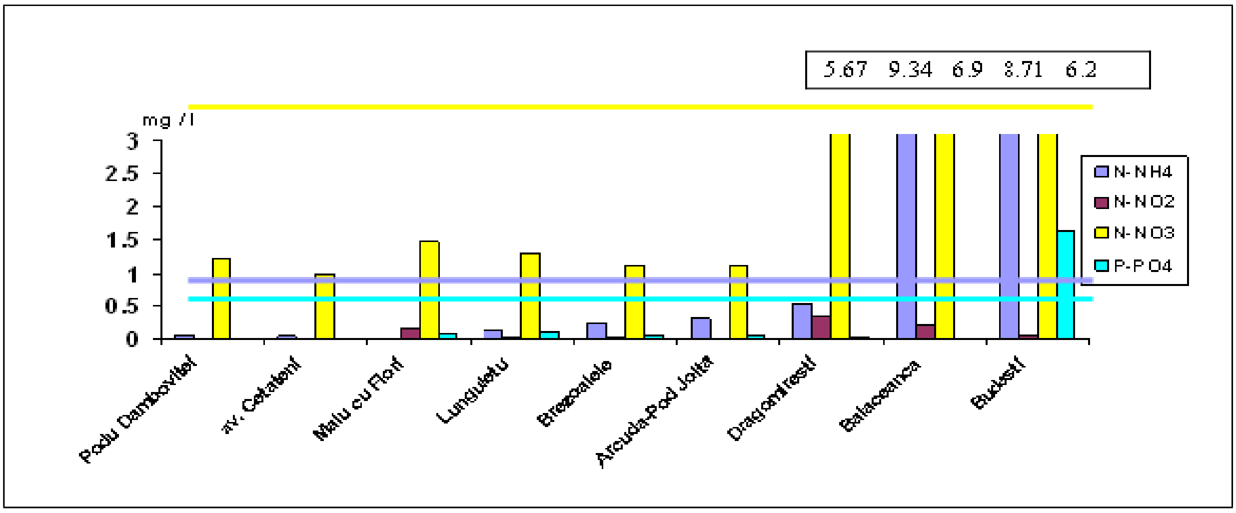


Fig. 4.6 Spatial evolution of nutrient concentration (N and P) in the water of river Dambovita



The water quality of lakes in Arges basin

Exceeding of indicator limit values in the water of lakes have been registered as follows:

- for **BOD and COD** - in case of lakes situated on river *Colentina* (Buftea, Herastrau, Mogosoaia, Tei, Floreasca, Plumbuita, Pantelimon I and II, Cernica) and in Vacaresti lake on river *Dambovita*;

- for **N-NH_4 and P-PO_4 -** in lakes situated on river *Colentina* and in lakes situated on rivers *Dambovita*, Arges and Neajlov (Vacaresti,Valcele and Comana);

- exceeding of limit values for **heavy metals** are registered in case of 3 storage lakes on Arges river;

- hypertrophic accumulation of **biomass** over 10 mg/l have been registered in the water of lakes on river *Colentina.*

The water quality in Dambovita river in the period 2006-2010

The assessment of water quality in river Dambovita during the years 2006-2010 is based on data provided by the National Administration *"Apele Romane - Directia Bazinala de Apa Arges* - in the frame of the monitoring program "**Ecological Status** – **Vulnerability to Nutrients".** The received data are concerning water quality in the monitoring points Lacul Morii. Balaceanca and Budesti. These data were used to generate the graphs in figure 4.5 from which the remarks presented below have resulted.

LACUL MORII (Dambovita upstream Bucharest)

►*From* **biological point of view:** the quality of water varied substantially in the period 2006-2010, being classified in classes from oligotrophy to hipertropy. As consequence the global class of quality was defined as being the hipertropy.

►From **physico-chemical point of view** the analyzed indicators have classified the lake water in the following quality classes:

Class 2 – for the Oxygen regime
Class 1 – for the Nutrients (excepting the year 2006)
Class 1 – for Salinity
Class 1 – for Priority Substances of natural origin

On the other hand. for the indicator "Other specific relevant pollutants" the available data classified the lake water in classes 2 (years 2007. 2008) and 3 (years 2009 and 2010).

BALACEANCA and BUDESTI (Dambovita downstream Bucharest)

►As **biology** there has been variations of values that classified the water quality as follows:

Classes 2-4 – for plankton
Classes 3-5 –for macro-zoobentos.

Remark: in 2010 there is an improvement tendency of the biologic indicators that are classifying the water quality in classes 2-3.

►In the same period, the values of **physico-chemical** indicators, not exactly favorable, have been almost stable, classifying the water quality as follows:

Class 5 – for the Oxygen regime
Class 5 – for the Nutrients
Class 5 – for Other specific relevant pollutants
Class 2 - for Salinity
Classes 2 and 3 – for Priority Substances of natural origin.

The observations above based on graphs in figure 4.5 lead to the following conclusions:

- all pollution indicators have registered higher values downstream Bucharest in comparison to those registered upstream (Lacul Morii);
- between the values of organic pollution indicators registered in survey points downstream Bucharest (Balaceanca. Budesti) there are no significant differences, proving that the natural rehabilitation process is surpassed and could not face the water high pollution.

The table 4.2 shows the pollutant concentrations upstream and downstream Bucharest, as annual average values in the period 2006-2010**.**

Table 4.2 Pollutant concentrations upstream and downstream Bucharest as annual average values in the period 2006-2010

Parameters	UM	Lacul Morii						Balaceanca					
		2006	2007	2008	2009	2010	**Average**	2006	2007	2008	2009	2010	**Average**
Average Flow	m^3/s	n.a	n.a	n.a	n.a	n.a	n.a	25.9	16.1	13.3	8.1	13.6	**15.4**
Suspended solids	mg/l	41.1	42.3	36.1	24.6	17.3	**32.3**	157	175	160	128	113	**146.48**
BOD_5	mg/l	3.03	6.9	4.8	1.8	6.3	**4.6**	45.6	62	70	64	47	**57.68**
COD - Cr	mg/l	13.3	23.4	18.7	6.0	20.1	**16.3**	169	213	211	200	129	**184.57**
Total N	mg/l	1.9	1.6	0.7	0.7	1.8	**1.34**	24	28	18	20	20	**22.0**
Total P	mg/l	0.01	0.02	0.03	0.09	0.02	**0.03**	2.48	3.35	2.80	2.21	2.30	**2.62**

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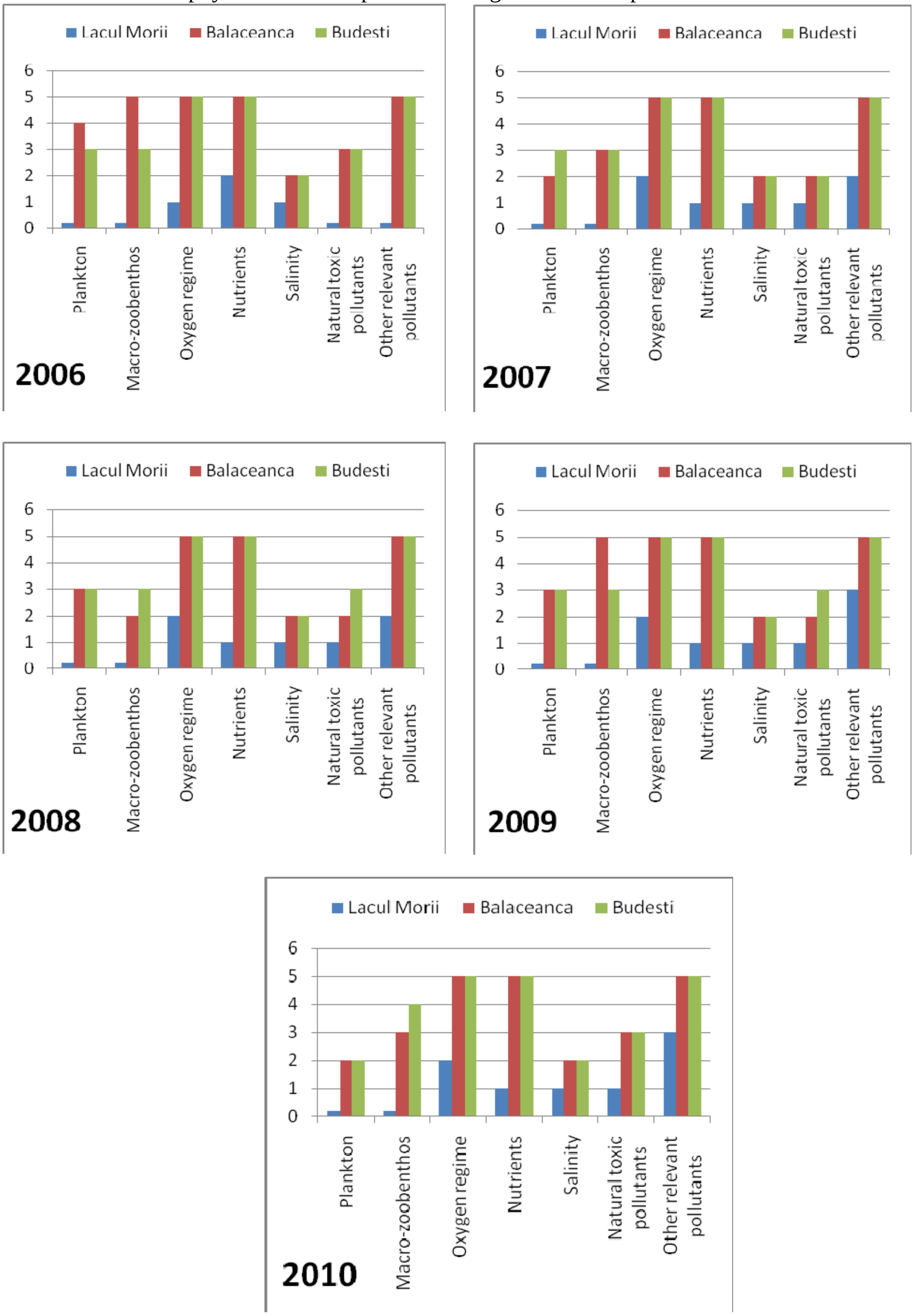
Fig. 4.7 Classification of Dambovita River in water quality classes in function of biological and physico-chemical parameters registered in the period 2006-2010.



4.2.5 Groundwater

Bucharest, as well as the neighboring area, has three categories of underground water: the upper aquifer, the captive water located in the Fratesti gravel layers and the lower aquifer located deep under the Fratesti gravel.

- The upper aquifer is composed of coarse sands and gravels - alluvial deposits along the Damboviţa and Colentina River valleys - and was initially used for water supply. Due to its small depth below the soil surface it is highly vulnerable to pollution.

- The Fratesti layers are composed of coarse deposits separated by clay and having a thickness between 70-100 m. are now the main resource for groundwater supply.

- The lower aquifer is composed of fissured karstic limestone from the cretaceous and lower Jurassic period and can be found at around 600 m depth.

The upper aquifers of the Damboviţa and Colentina are of particular interest to the sewerage studies. With a thickness of 2m to 11m, the Dambovita aquifer lies at depths of 4m to 15m. The Colentina aquifer is closer to the surface in the northwest (3m to 17m) and sinks deeper to the southeast (up to 10m to 28m). The thickness of the aquifer is typically between 4 and 10m.

Ground water levels in Fratesti strata fall from 86m in the North West extremity of the city to 60m in the vicinity of Glina WWTP.

The Fratesti layers are intensely exploited by many underground catchments, especially for industrial use. Research recently developed shows that within the city limits there are more than 500 deep wells exploiting the water-bearing layer of Fratesti layers.

Investigations of the hydro-geological situation made around the Glina landfill gave the following results:

- < the landfill is not contained by continuous physical barriers and the pollution of the groundwater is obvious both on the floor and on the northern edge of the landfill. Contaminants are transported by the leachate from the landfill surface to the groundwater and from the upper aquifer to lower aquifer in the Dambovita flood plain;

- near the WWTP site the water of deep wells is already undrinkable because of the increased content of nitrogen compounds and organic matter. Landfill leachate is considered the most likely source of pollution;

- in the shallow aquifers the groundwater flows from south-east to nord-east discharging in the Dambovita river.

Groundwater characteristics

Groundwater characteristics are determined on water samples extracted from wells on Glina site having the purpose of lowering the level of the phreatic strata.
The table below shows characteristics of groundwater on Glina WWTP in 2010.

As well known, the first groundwater strata in the whole southern region of Romanian plain is polluted by organic compounds, nitrates and nitrites. This kind of pollution, together with the microbiological one, were the main arguments sustaining the centralized water supply of Bucharest neighboring dwellings, Glina being one of them.

Table 4.3 Groundwater characteristics on Glina site

Indicators	UM	Determined Values	Values for groundwater bodies in Arges - Vedea Basin (Order 137/2009)
pH		7.85	6.5-9.5
Residues	mg/l	428	
Conductivity	micro S	593	
Oxygen dissolved	mg/l	0.45	
COD - Mn	mg $KMnO_4$/l	49	
COD - Cr	mg O_2/l	42	
Na + K	mg/l	87	
Cl^-	mg/l	221	250
SO_4	mg/l	234	250
NH_4	mg/l	0.35	0.5 - 4.2
NO_2	mg/l	0.49	0.5
NO_3	mg/l	74	50
N total	mg/l	9.43	
PO_4	mg/l	0.3	
P total	mg/l	0.360	
As	mg/l	0.003	0.01
Cd	mg/l	0.002	0.005
Pb	mg/l	0.04	0.01-0.08
Hg	mg/l	0.0002	0.001

4.2.6 Air quality

Within the area of interest in relation with the Glina WWTP there are an important number of air pollution sources - important roads, the industrial zone on the Dambovita left bank, the Glina landfill, as well as the commercial units and the industrial platforms on the right bank of Dambovita and in the outskirts of Bucharest. All these activities have an impact on the ambient air quality in the Glina village and surroundings.

The intense traffic in the area – on the ring-way, A2 highway and roads surrounding the villages - results in emissions of sulphur dioxide, nitrogen oxides, benzene, carbon monoxide and fine dust. The emissions from the PROTAN factory activities and Ochiul Boului landfill mainly influence the air quality by unpleasant odours.

Except the pollution of the ambient air resulting of the human activities, the atmosphere is subject of a natural contamination, process in which the dust storms have an important role. Their impact is stronger in the absence of adequate vegetal cover. Further along the Dambovita River, odour can be considered as noticeable. This is also due to the so-called “dead arms” or stagnant waters, downstream the river.

Fig. 4.8 WWTP position in connection with the Glina village and Ochiul Boului landfill

The air quality is assessed based on the following Romanian regulations:

- Order 592/2002 for approval of the Norms establishing limit values, thresholds values and criteria and assessing methods for sulphur dioxide, nitrogen dioxide, nitrogen oxides and suspended particulates (PM10 and PM2.5), lead, benzene, carbon monoxide and ozone in the ambient air

- Order 1271/2008 for approval of the classification of localities within Bucharest agglomeration and Cluj, Dolj and Iasi counties in air lists following the provisions of the Order 745/2002 on defining agglomerations and classification of agglomerations and zones for air quality assessment in Romania.

Table 4.4 Limit Values (VL). Guiding Values (GV) and Alert Thresholds (AT) – in conformity with Order 592/2002

Limit Values (LV) and Guiding Values		**Alert thresholds**	**Mediation period**
NO_2	LV = 200 µg/m^3 – 18 exceedings admitted	400 µg/m^3 – during 3 consecutive hours in points that are representative for air quality on a surface of at least 100 km^2 or for the entire zone agglomeration	1h
	LV = 40 µg/m^3		1 year
NOx	GV = 30 µg/m^3 – for protection of ecosystems in non-built zones		1 year
CO	LV = 10.000 µg/m^3		
SO_2	LV = 350 µg/m^3 – 24 exceedings accepted	AV = 500 µg/m^3 during 3 consecutive hours in points that are representative for air quality on a surface of at least 100 km^2 or for the entire zone or agglomeration	1 h
	LV = 125 µg/m^3		24 h
	LV = 20 µg/m^3		1 year
Suspended particulates PM 10	LV = 50 µg/m^3		24 h
	LV = 40 µg/m^3		1 year

Assessment of the air quality for Bucharest municipality and the surrounding areas representing the Bucharest agglomeration has been based – as required by Order 592/2002 - on the results of the air quality monitoring obtained from the monitoring stations the emission inventories and modeling of dispersion in the atmosphere achieved by using meteorological data.

Lists containing the classification of Glina and Popesti Leordeni dwellings in conformity with the provisions of Order 592/2002 are provided in the Order 1271/2008.

Table 4.4 shows the lists where these administrative units are classified from the point of view of pollutants of interest by the Order 1271/14.10.2008 (for approval of the classification of localities within Bucharest agglomeration and Cluj, Dolj and Iasi counties in lists as required by Order 745/2002 on establishing and classifying of agglomerations and zones in the purpose of air quality evaluation in Romania).

Table 4.5 Air pollution lists where Glina and Popesti-Leordeni are mentioned

Poluant	List	
	Glina	Popesti-Leordeni
PM_{10}	List 3	List 3
NO_2	List 3 Sub-list 3.1	List 2
CO	List 3 Sub-list 3.3	List 3 Sub-list 3.3
SO_2	List 3 Sub-list 3.3	List 3 Sub-list 3.2

Notes:

List 1 - Agglomerations and zones where the levels of concentrations of one or more pollutants are higher than the limit value plus the margin of tolerance or higher than the limit value in case of no margin of tolerance has been fixed**.**

List 2 - Agglomerations and zones where the levels of concentrations of one or more pollutants are between the limit value and the limit value plus the margin of tolerance.

List 3 Sub-list 3.1 - Agglomerations and zones where the levels of one or more pollutants are lower than the limit value, but situated between this one and the upper level of assessment

List 3 Sub-list 3.2 - Agglomerations and zones where the levels of one or more pollutants are lower than the limit value, but situated between the upper level of assessment and the lower level of assessment

List 3 Sub-list 3.3 - Agglomerations and zones where the levels of one or more pollutants are lower than the limit value, but do not exceed the lower level of assessment.

Within the agglomerations of interest, the spatial distribution of pollutant concentrations shows different values.

The concentration of pollutants in the area where the Glina WWTP is located is presented in the table bellow.

Table 4.6 Level of background air pollution concentrations within a radius of 2000 m around Glina commune

Pollutant	Time coverage	Pollutant concentration [µg/m³]	Limit values (VL) provided by Order 592/2002 [µg/m³]
PM_{10}	year	25 - 27	VL = 40 µg/m³
PM_{10}	24 h	29 - 31	VL = 50 µg/m³ – 35 excedances allowed
CO	Upper value of the daily average on 8 hours duration	1800 – 2300	VL = 10000 µg/m³
NO_2	Year	15 – 19	VL = 40 µg/m³
NO_2	1 h	134 – 191	VL = 200 µg/m³ – 18 excedances allowed
NOx	year	21 - 27	VG = 30 µg/m³ – for protection of sensitive ecosystems in non-build zones
SO_2	year	11 - 14	VL = 20 µg/m³ – for protection of ecosystems
SO_2	24 h	31 - 34	VL = 125 µg/m³ = 3 exceeding allowed
SO_2	1 h	61 - 69	VL = 350 µg/m³ = 24 exceeding admitted

By comparing these concentrations with the limit values of the investigated indicators provided by the Order 592/2002, it results that all are substantially under the limit values provided by this order. .

4.2.7 Odour

In the immediate surroundings of the Glina WWTP location there is the Ochiul Boului landfill. as well as some industrial and commercial activities that generate odour hindrance for the Glina Village. The PROTAN enterprise - an animal body processing factory - has to be firstly mentioned. It gives serious hindrance to the village, mainly in summer. With a wind direction coming mostly from the north-east, the smell is coming directly over the village.

Further along the Dambovita River, odour can be considered as noticeable. This is also due to the so-called "dead arms" or stagnant waters, downstream the river.

4.2.8 Noise

In the area of interest the main sources of noise are the car traffic along the village, the activity at the Ochiul Boului landfill and the activity on the WWTP site.

The road inside the village is in a bad shape, supplemental nuisances resulting from stopping and acceleration of trucks and cars and also horns from the traffic. At the landfill, noise is generated by the activities of waste unloading and leveling/compacting. On the WWTP site the noise is generated at present by the construction activity and in the future by the functioning of the plant equipments.

A detailed evaluation was made in year 2008 when the strategic noise map of Bucharest agglomeration was elaborated. This strategic noise map shows the limits between the areas with different noise levels comprised between 40 and 80 db (A).

Figures 4.9 and 4.10 showing the noise levels in the Glina zone indicate that:

- the highest noise level - 70 db(A) - was registered along the main roads. the a2 highway and Bucharest ring-way, both during the day and night period; high noise level of 65-70 db(A) was also registered along the road accessing the Ochiul Boului landfill, but only during the day period;

- the average level of noise in the area of interest in case of the Glina WWTP is comprised between 50-65 db(A) both, during the day and night period; the highest level is registered in the immediate vicinity of the main roads, while the remaining surface has a noise level of 45-55 db(A);

- the dwelled areas - Glina and Popesti Leordeni villages – are mainly characterized by noise level between 45-55 db(A), except few households situated near the main roads, where 60-65 db(A) is registered.

Considering the accepted values of noise (STAS 10009-88) the actual uses of the land in the area do not generate excessive noise levels for the dwelled areas.

Figure 4.9 Noise map- Glina zone Reference time 6:00-22:00
(Extracted of strategic noise map of Bucharest agglomerations)

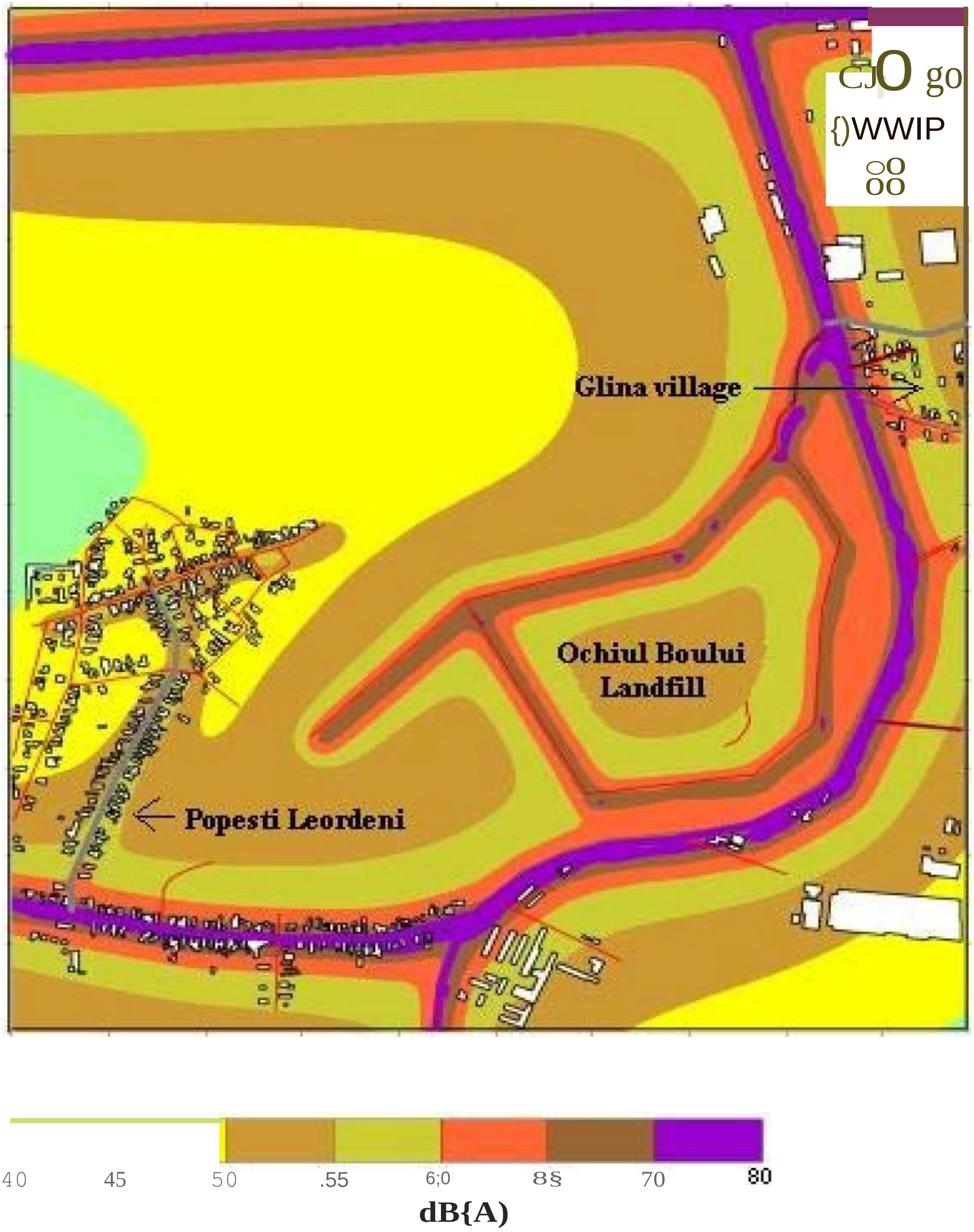
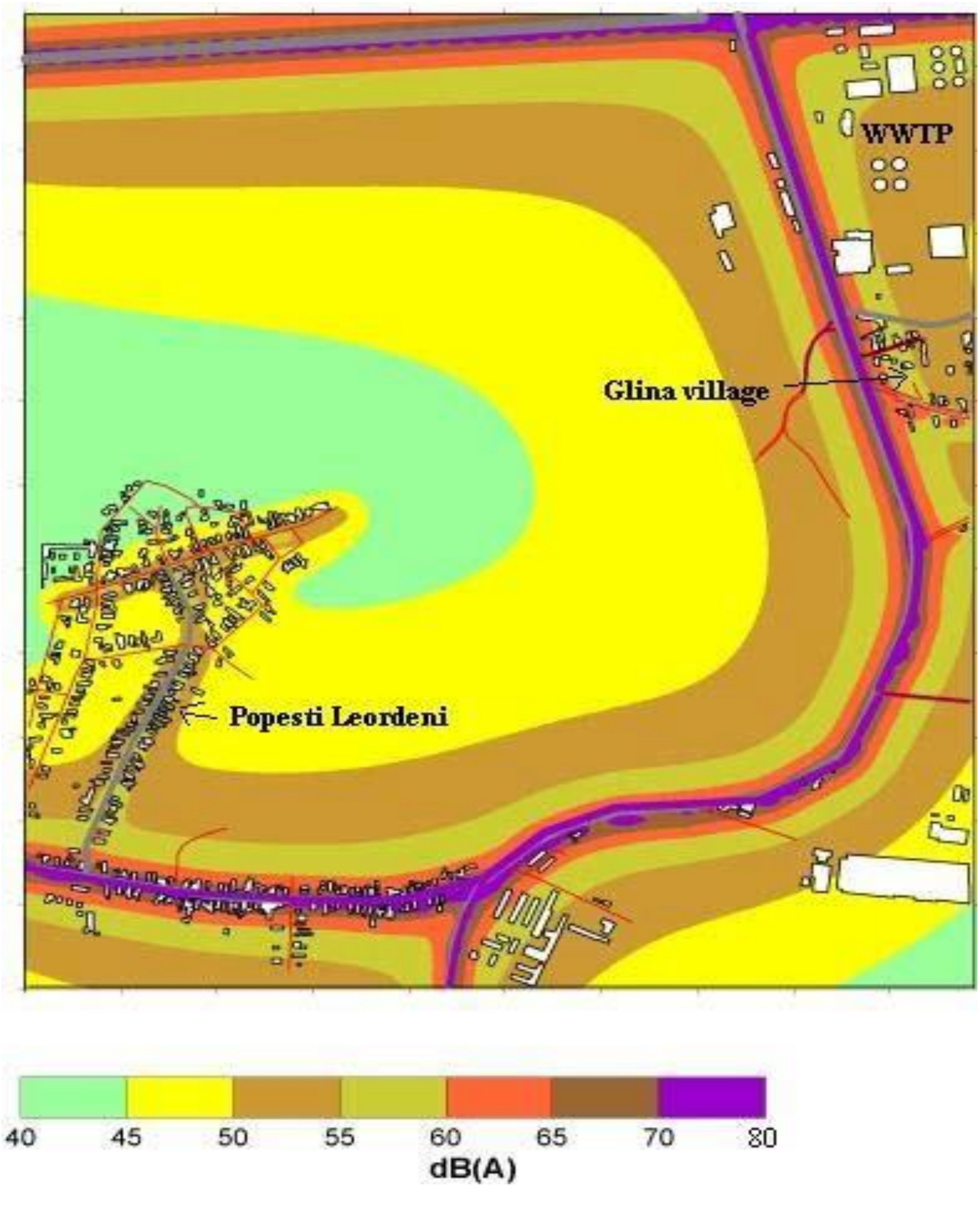


Figure 4.10 Noise map - Glina zone Reference time 22:00 – 6:00
(Extracted of strategic noise map of Bucharest agglomerations)



4.3 Biological environment

4.3.1 Flora and fauna

Flora

Within the natural landscape, the vegetation has an important role. as it is one of the natural factors with a large economic and ecologic importance.

The flora of Bucharest zone and in particular that of the surrounding areas includes - depending on the geographical conditions - the vegetation of the inter-stream areas, the flood plain vegetation and the hydrophilic vegetation.

The inter-stream area vegetation is characterized by the high frequency of the forests where predominate the cerise (Quercus cerres), Italian oak (Quercus frainetto) and the long-thorned oak (Quercus pedunculiflora). The under-wood developed in the leaf-bearing forests of the inter-stream areas is represented by the may tree (Crataegus monogyna. C. Pentagyna), privet (Ligustrum vulgare), bloody twig (Cornus sanguinea), hip rose (Rosa canina), blackthorn (Prunus spinosa) etc.

The grassland vegetation, developed in the clearings of the forests and on the small strips or patches without areas used for agriculture, contains to a large extent the hair grass (Festuca valesiaca. F. pseudovina), andropogon (Chrysopogonetum gryllus) and Stipa capillata.

The natural pastures and hayfields, not very vast in the area surrounding the city, are composed of associations of bulbous bluegrass (Poa bulbosa), graminaceae with rhizomes (Bromus inermis, Poa angustifolia, Agropyron repens), wormwood (Artemisia austriaca), couch grass (Cynodon dactylon), bristle grass (Setaria glanea), leguminous mesophilic plants (Trifolium repens, T. pratense).

The flood plain vegetation develops under the conditions of a higher humidity, in the flood plains and on the valleys and is represented by grassy and ligneous associations.

The ligneous vegetation is composed of willows and osier riverside coppices (Salix alba, S. fragilis, S. cinerea, S. triandru), alders (Alnus glutinosa), poplars (Populus alba, P. negra, P. canescens). The mixed foliage forests located in the flood plains are composed of elm (Ulmus laevis) and oak, together with the soft woods mentioned before.

The grassland vegetation in the higher flood plains is represented most frequently by species such as the yellow lily (Iris pseudocorus), water plantain (Alisma plantago), and meadow foxtail grass (Alopecurus pratensis).

The hydrophilic vegetation develops in the lower sides of the valleys and flood plains with exceeding humidity and on the borders of the stagnant waters. The following species are frequent there: the sedge (Carex acutiformis, C. riparia), the club rush (Typha angustifolia, T.califolia) and especially the reed (Phragmites communis).

The marginal sides of the lakes and flood plain meadows are invaded by vegetation composed of the yellow water lily (Nuphar lateum), the white water lily (Nymphaea alba), frog lettuce (Potamogeton natans) and of underwater vegetation, such as the hornwort (Myriophyllum verticillatum), frequent in the lakes Caldarusani, Snagov and Balteni, stoddard-curly pondweed (Potamogeton crispus) and Vallismena aspiralis.

Also, close to the lakes borders, but under the conditions of over 2 m deep waters, a vegetal floating bridge called “plai” or locally “cacioc”, composed of rhizomes of the aquatic plants over which are deposed the decomposed aerial remains of the respective vegetation and the dust brought by the wind. This layer may reach a thickness of 80 – 100 cm and one can walk over it as on dry land.

Fauna

For the development and organization of the territory in connection to the peri-urban area/city area relations, the fauna is important due to its cynegetic, leisure and entertainment character.

Certain individuality as regards the species of the fauna may be distinguished according to the biotopes within the Bucharest peri-urban area.

The territory of the Bucharest peri-urban area comprises four categories of animal species groups with cynegetic importance, connected to the forest, grassy vegetation and aquatic vegetation biotopes.

►*The forest fauna* is represented by the species whose life is connected mostly to the forest environment. The mammalians of the most interest are the roe deer (colonized in Balta Neagra forest, and then extending in the Cocioc, Ciolpani, Ciogaia woods), the stag (in Snagov forest and park Gruiu, Vlasia and Vladiceasca forests), the wild boar (found especially in Cernica, Tanganul, Pasarea forests), the roebuck (in the larger forests – Cernica, Pustnicul, Pasarea, Branzeasca, Caldarusani, Surlani, Vlasia, Snagov, Gruiu, Vladiceasca, Ciolpani, Cocioc, Ciocanitoarea, Raioasa), as well as the wolf, fox, and rarely the wild cat.

The birds of cynegetic interest are the pheasant (Phasiamus colehicus), colonized especially in the Balta Neagra–Caldarusani, Surlani, Vlasia and Snagov forests and the woodcock (Scolapax scolapax) in all forests in the north of the area.

As regards the birds without hunting importance giving a special charm to forests, it is to notice the jay (Garrulus glandarius), the woodlark (Lulula arborea), the nightingale (Luscinia magarhynehos), the wood-pecker (Dendrocopos medius) etc.

►The *fauna specific to the plain grassy vegetation,* corresponding to the fauna area of forest-steppe, is represented by some species of cynegetic interest, as the hare (Lepus europeus), the polecat (Putorius putorius), the ermine (Mustela eriminea), the common marten (Mustela nivalis), and among the birds, the quail (Coturnix coturnix).

►*The fauna specific to the grassy flood plain and flood plain meadow vegetation* presents a special attraction, especially through birds: the great duck (Anser anser), the common heron (Ardea cinerea), the red heron (Ardea purpurea) and the moor hen (Fulica atra). Close to the water live the otter (Lutra lutra) and the mink (Lutreola lutreola), while in the riverside coppice - the fox and in the higher flood plains - the hare.

►*The aquatic fauna* represents the highest tourist attraction constituting a main component of the natural factors used for leisure and entertainment. The first place is occupied by the fish fauna composed of various fresh water species – the European perch (Perca fluviatilis), the carp (Cyprinus carpio), Ray's bream (Abramis branea), the European catfish (Silurus glanis), the pike (Esox lucius), the bleak (Alburnus alburnus). All these species are subject of a sporting, entertainment and illegal fishing, in full development.

Despite the above mentioned information on the flora and fauna the project area and its direct surroundings have not ecological/environmental importance.

4.3.2 Rare and endangered species

No information is available related to the presence of rare or endangered species on or near the site of the WWTP.

No natural sensitive habitats and reserve areas are in the surroundings of the project area.

4.3.3 Sensitive habitats and reserves.

NATURA 2000 sites and other protected areas are located **at long distances from the project area** and even from Bucharest municipality.

The Natura 2000 Scroviştea site was nominated based on the Habitats EU Directive for the protection of natural habitats and wild fauna other than wild birds. The Scrovistea site is a remaining of the Codrii Vlasiei large forest that covered in the past all the Romanian Plain and contains a complex of lakes, ponds and forests.

The Natura 2000 Grădiştea-Căldăruşani-Dridu site was nominated based on the Birds EU

Directive, for the 83 species of protected wild birds out of which 22 species are strictly protected at European level. In Ilfov county this site is reprezented by the lakes Căldăruşani and Balta Neagră, the water storage basins on the rivers Cociovaliştea and Vlăsia that represent ideal places for nesting, refuge and food for wild birds and the surrounding forests.

Near Bucharest, on the territory of Ilfov county, there are 3 protected natural areas of national interest: the forest Snagov, the lake Snagov and the forest Scrovistea that is superposed on the Natura 2000 Scroviştea site.

The Snagov forest is a national park having as purpose the protection and conservation of samples containing natural elements of special values. It contains many monumental oaks, ashs and limes**,** having strain diameter of 80-100 cm and hights of more than 30 meters.

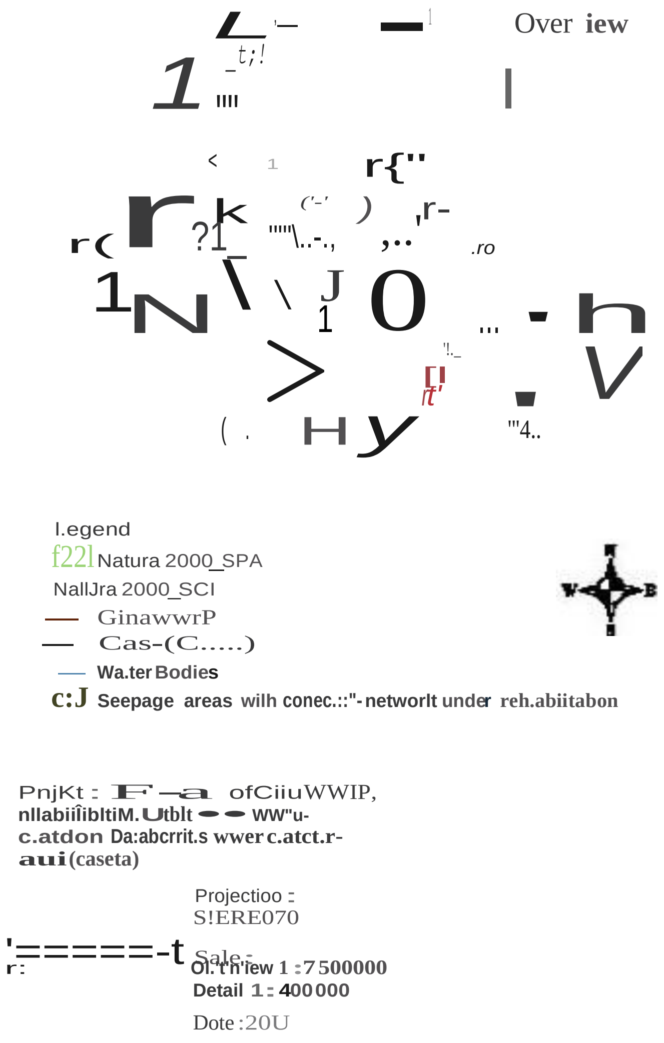
The Lake Snagov, situated at 25-30 km of Bucharest, is a river „liman" on the Ialomiţa river; with a depth of 9 m it is the deepest lake in the Romanian Plain. On his shores, besides the reed and rush, one could find white and yellow lilies as well as the indian lily recently acclimatizated. The fish fauna, very attractive for fishermen, is reach in species as bream, carp, perch, catfish, pike and roach.

Besides these protected areas in Ilfov county, in Bucharest there are only some secular trees registered as natural monuments, out of which only two are the nearest of the project area, respectively on the territory of **the Cernica monastery**.

Other protected areas

At 15 km north-east of the project site and beyond the Colentina river catchment area, which is separated from the Dambovita river system, there is an architectural and natural protected objective - Cernica monastery and forest.

No objectives of cultural public interest are in the surroundings of the project area.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4.4 Demography

Bucharest is the capital of Romania while the Village of Glina is one of the suburbs at the direct surroundings of Bucharest Municipality.

The census of 2002 has indicated for Glina a number of 7147 inhabitants out of which 5921 Romanians. 2 Hungarians. 1222 Gypsies and 2 Bulgarians

The data regarding the large *age groups* of the population (young, adult and elderly), show the prevalence of the 20-59 years group, followed by group of the 0-24 years. Thus, it may be noticed that the proportion of the working age population between 20 and 59 years has relatively high values.

Similar to other Romanian zones the number of women represents 51.8% of the total population.

4.5 Land use

The land, which will be used for the WWTP stage II is either already in use and partially constructed or defined as part of the sanitary perimeter of the works.

The land currently available, as part of the sanitary perimeter, is not cultivated. No human habitation or activity such as farming will be endangered or directly impacted by the extension and completion of the WWTP.

The surroundings of the work site are dominated by industrial activities and the landfill.

4.6 Social services

Education
In the village of Glina there is a kindergarten and a primary school; for higher education (high school) children have to travel to Bucharest.

Glina village is a relatively poor dwelling and most of the inhabitants do not have a high education.

Water supply
Water supply to the village is through groundwater resources. However the leachate from the landfill is polluting the groundwater and based on samples is not suitable for drinking purpose, this being confirmed by water analyses made for the wells provided for Glina WWTP.

There is no sewer system provided for the village, households having mainly outside uncontrolled toilets.

Power supply
At the Glina village a small transformer is used for providing electric energy to households. Since the power plant is located nearby power supply should not be a problem.

Health care
The conditions for personal health in the Glina Village are considered as being poorly due to lacking of connections to drinking water of good quality and of connections to the sewerage system. Family medical care is assured by qualified personnel. For important medical care services Glina inhabitants are sent to the hospitals in Bucharest.

4.7 Economic activities

As already described different industrial activities are widely spread in the direct surroundings of the WWTP. The most important industrial activities in the area where many of the Glina inhabitants are working are the power plant and the landfill. But also the PROTAN factory for the processing of animal bones and a distillery (Dumalex Stalingrad) are to be mentioned.

Chapter 5 POLLUTANT SOURCES and MEASURES FOR ENVIRONMENTAL PROTECTION

Introduction

The impact on the environment generated by the WWTP stage 2 will be caused by the pollutants emitted during the construction phase and during the operational phase (when line 1 and 2 are in operation, including sludge treatment by incineration).

In this chapter the pollutant emissions are described as well as measures for their effects reduction, while in the next chapter the impact on the environment is assessed.

5.1 Water pollutant emissions

Construction phase

During WWTP stage II construction phase the water emissions could consist of drainage water and domestic wastewaters.

Management measures:
The drainage water will be introduced in the existent drainage system. The drainage system is already in function and the new worksite will probably require only more pumps put in functions during some periods.

For managing domestic wastewaters that will appear during construction period the company contracting the Phase 2 works will provide locally ecological toilets.

The eventually polluted waters resulted mainly from platform or equipment cleaning activities will be introduced into the inlet of WWTP line 1 that will be in function during construction phase of WWTP line 2. This kind of wastewater will appear only occasionally and their volume will be not significant.

The above measures will eliminate any possible negative impact on river water during construction phase. Compared to the actual situation, during the construction phase no supplemental impact on surface water is to be expected.

Operation phase

A) Operation in normal functioning conditions.

The basic purpose of the WWTP is to reduce the pollution load to the Dambovita River, Arges River and Danube River. However, even **in normal functioning conditions**, the wastewater treatment process generates a certain amount of internal wastewater streams out

of which the following are to be mentioned:
- domestic wastewater from offices, workshops, canteen etc.;
- wastewater from the sludge thickeners and sludge dewatering periodical cleaning;
- wastewater from other cleaning activities – platforms, buildings;
- storm water from the site of the WWTP.

The first 3 types of waste waters will be canalized to the plant inlet, before coarse screens and treated together with the plant inflow. The storm water from the WWTP site will be directed to the inlet of the storm waters basins.

The sludge incinerator of the Glina WWTP was also considered when discussing water pollutant emissions during operation phase. Emissions to water may occur mainly if wet gas cleaning systems are used, although this wastewater can disappear by evaporation.

In the concept of the Glina sludge incinerator no wet or semi-dry gas cleaning treatment is proposed, but wastewater could still arise from other sources such as:
- reversible flow water from ion exchange (around $1m^3$/week)
- cleaning of boiler (around $500m^3$/year. meaning less than 2 m^3/d)
- cleaning of storage containers (around $500m^3$/year. meaning less than 2 m^3/d).

All these wastewaters will be sent to the plant inlet. As flow and load one could say they are completely not significant and will not modify the characteristics of the influent entering the treatment plant.

B). Operation in abnormal functioning conditions

During the plant operation some abnormal conditions and functional accidents could appear. Such situations and the measures to be taken to prevent or intervene **in case of disturbances or accidents in functioning of different components of the plant** are mentioned in the Plan for management of such situation presented below.

Table 5.1 Plan for management of functioning disturbance and accidents

Critical points	Types of accidents	Disturbance /Accident causes	Prevention/intervention measures
Inlet of the wastewater from Caseta into WWTP	Accidental discharge of wastewater into the river by weirs accidental opening	Incorrect functioning of th inlet constructions	- Correct operation of weirs and inflow pumping station - Respecting the programs for regular revisions and current repairing

Discharge of primary sedimentation tanks	Effluent of the primary sedimentation tanks exceeds the design parameters for the biological stage	Incorrect functioning of screens. grit chambers and primary sedimentation tanks	- Continuing cleaning of coarse and fine screens - Periodic removal of sand accumulated in grit chambers and grease collected - Correct distribution of influent to the sedimentation tanks
	Loss of primary sludge together with the effluent of primary sedimentation tanks	- Incorrect functioning of traveling bridge scrapers - Incorrect functioning of pumping stations removing the sludge collected in the central hoppers of settling tanks	- Good control of traveling bridge scrapers - Respecting the programs for regular revisions and current repairing of the primary sludge pumping stations
Discharge of secondary sedimentation tanks; the treated effluent is not complying discharge conditions	High values of BOD. COD that does not comply with the effluent discharge conditions	- Low oxygen concentration because bad functioning of AS basins aeration system or blowers failure - low concentration of activated sludge - RAS pumping is not functioning	- Respecting the functioning regime of blowers that are introducing air into the AS basins; - Increasing the activated sludge recycling rate; - Periodical revisions of blowers and RAS pumping stations
	High values of suspended solids in the effluent; loss of activated sludge with the effluent;	- Failure in AS basins oxygenation - appearance of floating sludge - sludge bulking; SVI over 150; - malfunctions of secondary sedimentation tanks. respectively of traveling bridge scrapers	- Good air supply in the AS basins; - Increasing the activated sludge recycling rate; - Equal hydraulic loading of the secondary sedimentation tanks - Assuring control and good functioning of traveling bridge scrapers
	High values of Nitrogen compounds	Disturbance of nitrification and denitrification processes	- Respecting the blowers functioning regime of air supply to the AS basins;
	High values of Phosphorus compounds	- Failure in BIO-P functioning - Inefficient chemical treatment for Phosphorus removal (reactant dosing deficiencies)	- Good control of the chemical precipitation process for P removal - Flexible dozing of ferric chloride in function of Phosphorus concentration

Temporary sludge storage	Uncontrolled spillage from pipes. basins. reservoirs	- Insufficient tightness - Pumping stations failure	- Control of integrity of pipes and basins; immediate remediation of defects; - Avoid capacity exceeding - Periodical revisions of pipes and basins state
Anaerobic digestion	Failure in process functioning	- pH variations (acidification); - large temperature variations under the mesophilic regime; - high concentration of toxic compounds (i.e. heavy metals)	- Respecting the digesters supply regime with crude sludge; avoid loading shocks; - Maintain temperature in mezophilic range; - Control of heavy metal concentrations in sludge
Incineration	Non-compliance with regulated conditions for emissions in the air.	- Low net calorific value of the sludge; - sludge high humidity (more energy consumption for drying) - flue gas cleaning system does not working correctly	- Use supplementary fuel and auxiliary burners - Control of sludge dewatering process; - Remediation of failures / deficiencies of gas cleaning components
	Air pollution due to powder spreading in the air	- Ash bunkers bad maintenance and incorrect ash handling	- Respecting the program of ash removal - Observing the rules of ash handling
	Interruption of incinerator functioning for a longer period of time	- Incinerator regular revision - Important technical failure	- Use of thickened mixed sludge and SAS buffer tanks offers a storage capacity for 3-4 days; - Dewatered sludge could be stored on the existing platform ($800m^2$) for 3-4 days. too. - In case of interruption of incineration longer than 1 week, the dewatered sludge will be sent for disposal on a landfill.

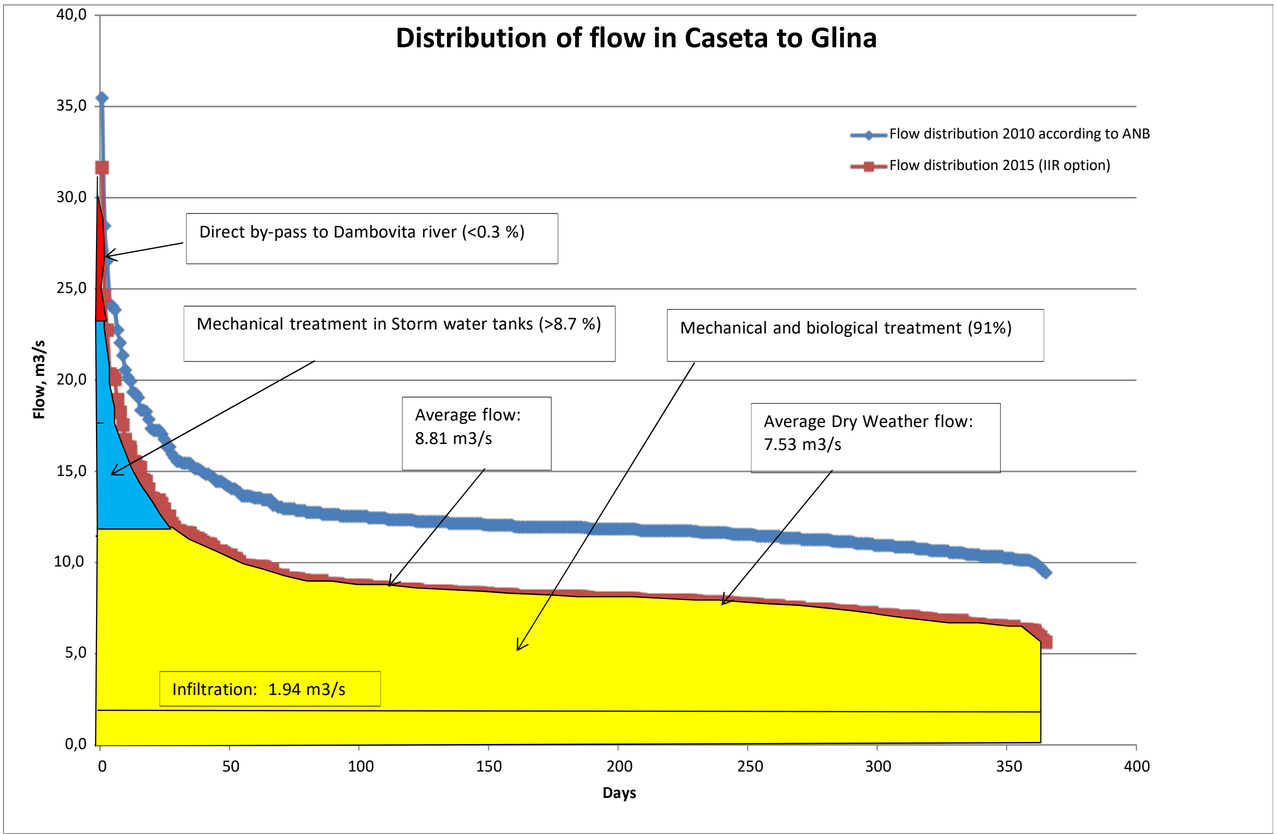
C) Performance of the WWTP during storm water conditions

Storm water conditions occur comparatively seldom and the possible resulting problems with overflows from the sewer network could not last long time compared with periods of dry weather. The situation during rains of different intensity was evaluated in order to know if the quality objectives established for the receiving water body are always met.

From the measurements of wastewater flow brought by the Caseta to Glina WWTP during the period November 2007 - December 2010, described in the graph below, it results that the measured daily average flow varies between 9.5 m3/s and 35.5 m3/s. The maximum momentary flow is 42 m3/s.

The infiltration flow during this period was 5.36 m3/s. As planned. for the Intermediate Infiltration Reduction option (IIR) the infiltration into the sewer network shall be reduced with 3.43 to 1.94 m3/s in the end of 2015.

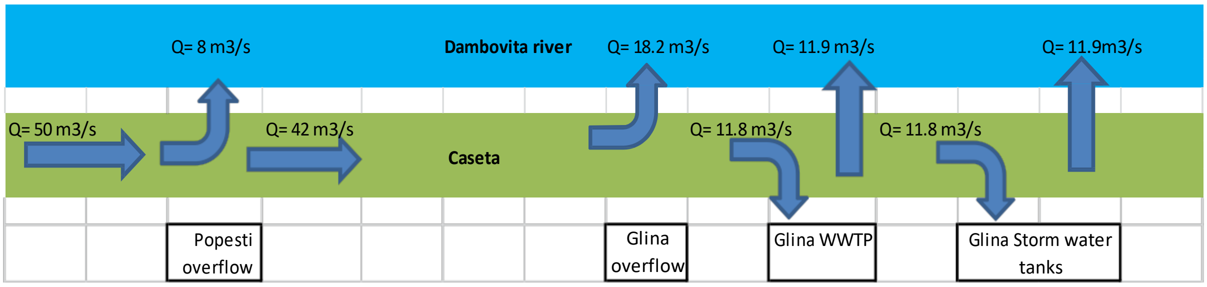
The wastewater flows up to 11.9 m3/s will always be pumped into the Glina WWTP plant and be completely treated. According to the distribution curve, this is the case during 1050 days of 1150 or 91 % of the time.



When the flow exceeds 11.9 m3/s (during 9% of the time), the exceeding part up to 23.8 m3/s will be treated in the Storm Water Tanks.

During 4 days of in total 1150 or 0.3% of the time, the average flow to Glina is expected to exceed 23.8 m3/s and this exceeding part will be bypassed directly to Dambovita river.

The above described situation is detailed in the schema below.



From the Caseta, the wastewater can be by-passed to Dambovita river at the Popesti overflow and at Glina WWTP. All wastewater flows exceeding **42** m3/s are discharged to Dambovita river at Popesti overflow. At Glina WWTP, the flow exceeding 24 m3/s will be by-passed untreated to the Dambovita river. This means that at Glina WWTP the maximum flow that will be by-passed without treatment is **18.2** m3/s. (42-23.8 = 18.2).

To find out the influence of different rains on the pollution of Dambovita river, ANB has studied three different rains with a hydraulic model. These rains are defined in the Table below.

Table 5.2 Rains regime considered by the ANB application of the hydraulic model

Parameter	Option		
	1	2	3
Occurrence. once every "n" year (n = 2.5; 3; 10)	2.5 years	3 years	10 years
Discharge time from Popesti overflow. hours	0	5.92	33.92
Maximum rain intensity. mm/h	10.8	16.3	31
Average rain intensity. mm/h	7.7	11	45

Considering the calculated design loads for 2040 the concentration of COD. BOD_5. SS. Tot-N and Tot-P have been calculated for different flows conditions.

The table below shows concentrations of the pollutants in wastewater in the Caseta, Popesti overflow, Glina overflow, Glina WWTP outlet, Glina storm water tanks outlet and the combined outlet at Glina WWTP (Glina overflow + Glina WWTP (full treatment) + Glina WWTP (storm water treatment) for the dry weather flow conditions 2040.

Table 5.3 Pollutant concentrations in dry weather flow conditions

Parameter	Caseta flow upstream Popesti	Popesti overflow	Caseta flow downstream Popesti	Glina overflow	Glina WWTP (full treatment)	Glina WWTP (storm water treatment)	Glina WWTP (total average)
Flow. m^3/s	8.27	0	8.27	0	8.27	0	8.27
COD. mg/l	574	-	***574***	-	97	-	97
BOD_5. mg/l	203	-	***203***	-	17	-	17
SS. mg/l	301	-	***301***	-	17	-	17
Tot-N. mg/l	52	-	***52***	-	4.3	-	4.3
Tot-P. mg/l	7.3	-	7.3	-	0.9	-	0.9

It results that during dry weather conditions there is no discharge of wastewater by the Popesti and Glina overflows, as well as from the storm water tanks at Glina. In the same way the concentrations were calculated for the 3 different rains considered.

Table 5.4 Pollutant concentrations in conditions of the flow option no 1 (1 rain every 2.5 years)

Parameter	Caseta flow upstream Popesti	Popesti overflow	Caseta flow downstream Popesti	Glina overflow	Glina WWTP (full treatment)	Glina WWTP (storm water treatment)	Glina WWTP (total average)
Flow. m^3/s	42	0	42	18.2	11.9	11.9	42
COD. mg/l	13	-	13	113	17	79	76
BOD_5. mg/l	39	-	39	39	3.53	25	24.9
SS. mg/l	9	-	59	59	1	30	34
Tot-N. mg/l	10	-	10	10	0.2	9	7.0
Tot-P. mg/l	1.4	-	1.4	1.4	0.1	1.26	0.99

Table 5.5 Pollutant concentrations in conditions of the flow option no 2 (1 rain every 3 years)

Parameter	Caseta flow upstream Popesti	Popesti overflow	Caseta flow downstream Popesti	Glina overflow	Glina WWTP (full treatment)	Glina WWTP (storm water treatment)	Glina WWTP (total average)
Flow. m^3/s	72	30	42	18.2	11.9	11.9	42
COD. mg/l	66	66	66	66	10	46	44
BOD_5. mg/l	23	23	23	23	0.2	16	14
SS. mg/l	34	34	34	34	1	17	20
Tot-N. mg/l	5.8	5.8	5.8	5.8	0.1	5.4	4.1
Tot-P. mg/l	0.8	0.8	0.8	0.82	0.05	0.74	0.58

Table 5.6 Pollutant concentrations in conditions of the flow option no 3 (1 rain 1/10)

Parameter	Caseta flow upstream Popesti	Popesti overflow	Caseta flow downstream Popesti	Glina overflow	Glina WWTP (full treatment)	Glina WWTP (storm water treatment)	Glina WWTP (total average)
Flow. m^3/s	172	130	42	18.2	11.9	11.9	42
COD. mg/l	28	28	28	28	4	9	19
BOD_5. mg/l	0	10	10	10	1	7	6
SS. mg/l	14	4	4	14	0	7	8
Tot-N. mg/l	2.4	2.4	.4	2.4	0.05	.3	1.7
Tot-P. mg/l	0.34	0.3	0.34	0.34	0.02	0.31	0.24

The calculated pollutant concentrations have been compared with the requirements included within the **Directive 91/271/EEC** and the **Romanian standard NTPA – 011,** as well as the quality objectives established by the **Dambovita river management plan.**

When comparing requirements of the EEC Directive and NTPA-011 with the calculated concentrations for dry weather conditions and the three rains. it is obvious that the dilution effect is very high in case of big rains.

For the flow options no 2 (1 rain/3years) and 3 (1 rain/10years), the pollutant concentrations in the Caseta are already below the requirements.

During dry weather conditions, the concentrations are much higher in the Caseta but the concentrations in the treated wastewater at Glina are definitely below the required levels.

For flow option no. 1, referring to 1 rain occurring once in 2.5 years, the dilution of the wastewater is not very high, which means that the concentrations of BOD_5. SS and Tot-P in the wastewater discharged by the overflow at Glina are slightly higher than the requirements, which is also the case of the Tot-P concentration in the storm water tanks effluent. However, as the concentrations of the pollutants in Glina WWTP total effluent (the last column) represents the combined effluent from Glina WWTP. it results that Glina WWTP reaches all requirements also for this option.

The conclusion of the above simulation is that even in conditions of big rains the total effluent of the Glina WWTP will have no negative impact on the water quality in the Dambovita river.

The treatment of waste water collected by the Caseta through the Glina WWTP will eliminate a significant pollutant amount as shown in table 5.7.

Table 5.7 presents:

- the actual and the future pollutant load in the influent of Glina WWTP
- the pollutant load in the effluent after treatment
- the amounts of pollutant reduction that is achieved through WWTP as kg/per day

Table 5.7 Amount of pollutants reduced through Glina WWTP in 2015 and 2040

Parameters	**Influent** mg/l		**Effluent conditions** mg/l	**Amount of pollutant reduced by Glina WWTP**	
	Year 2015 11.3 m3/s	**Year 2040 11.9 m3/s**		**Year 2015 kg/d**	**Year 2040 kg/d**
COD	253		125	124,969	320,684
BOD	80	203	25	53,687	127,137
Suspended solids	165	301	35	126,962	189,992
Total N	24.3	52	10	13,961	30,055
Total P	1.08	7.3	1	98	4,485

The design treatment parameters, which are conditioning the effluent characteristics, have been established considering the limits values within the European Directive on Urban Wastewater Treatment (91/271/EEC), implemented in the Romanian legislation (NTPA 011/2005):

5.2. Air pollutant emissions

Construction phase

Pollutant emissions in the air during the WWTP stage II construction phase will consist mainly of:

- dust resulting from excavations and from construction of concrete components
- gases from traffic for transporting of materials.

Measures: - To reduce dust emissions wetting the work areas will be made regularly where possible and appropriate;
- To reduce pollution by traffic gases optimization of vehicles and equipment inside the construction area will be implemented and controlled.

Effects: The above described emissions will not modify the existing situation described in Chapter 4.

Operation phase

Pollutant emissions
During the functioning of WWTP stage II the sources of air emissions will be:

a)- water treatment processes happening in open air;
b)- combustion of biogas in gas engines;
c)- sludge incineration.

a) Atmospheric emissions from water treatment processes/ Odour emissions
Many components of the lines I and II have large opened and uncovered surfaces (i.e. aeration tanks. settlement tanks. etc.). Normally, from these installations no substantial emissions of gases such as CO2, CH4, etc. will occur. The emission of these gasses only occurs from the sludge digestion process, which takes place in completely closed digestion tanks and the generated gases are collected in special reservoirs – biogas reservoirs.

Odours are related to emissions of H_2S and other gases (i.e. mercaptanes etc.) eliminated in minor quantities. Odour emissions from water treatment will be produced especially at the beginning of the treatment process, after the raw wastewater enters the WWTP. It is considered that odour emissions will be highest at the inlet works, screens, grit and sand removal. Odour emissions in the air could probably occur from some other elements of the treatment plant that are in the open air, such as the primary and secondary settlement tanks, aeration basins and primary and secondary sludge thickeners.

Measures: - For reducing odour emissions a part of the compartments will be covered and the air will be purified before exhausting (see more details in Chapter 6. point 6.4)
- The centrifuges used for digested sludge dewatering are closed units and this

will minimize the odour problems and emissions of aerosols within the working environment where the sludge dewatering is achieved.

- In order to implement measures for the other compartments a study of odour monitoring will be performed in the first period of functioning of the whole WWTP.

b) Atmospheric emissions from combustion of biogas in gas engines

The daily production of biogas is evaluated to be between 34.000 – 49.000 Nm^3, while the composition of the biogas approximately will be as follows:

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CH_4: around 60 %
CO_2: around 40 %
N_2: around 0.5 %
Other gases: around 0.1 %

The biogas resulted from the sludge anaerobic digestion is sent to the gas holders and from there is fed into the gas burning engines. By combustion the gas engines convert the biogas into electricity with a process efficiency of 33% (6.5 kWh/Nm^3 biogas).

The biogas combustion generates mainly CO_2 as emission in the air. Normally, this gas is used by plants in photosynthesis process, but in large quantities it can generate greenhouse effect. The biogas combustion generates also NOx in quantities estimated to 560-820 Nm^3/day, while the SO_2 emissions would not surpass 70-90 Nm^3/day. Emissions of dust will be negligible.

Measures: The biogas combustion emissions are evacuated in the atmosphere only after treatment.

c) Emissions from sludge incineration

During the sludge incineration the water content is vaporized, volatile substances are destroyed and inorganic compounds are transformed in ash, leading to emissions of dust and burned gases.

In order that emissions into air from the incinerator shall not exceed the limit values set out in parts 3 of Annex VI of Directive 2010/75/EU on industrial emissions (IE Directive), the incinerator shall be operated under controlled conditions and shall be equipped with sophisticated flue gas cleaning systems (details are presented in chapter

Incineration plants usually produce flue-gas volumes between 4500-6000m^3/t of burned dry material – if optimally operated. Emissions of SO_2, NOx, HCl, HF and heavy metals depend mainly on the sludge composition, whereas the CO and VOC emissions are mainly determined by the furnace operational parameters. Dust emissions depend upon flue-gas treatment performance

Table below gives an overview of the typical **crude gas components** (after the boiler) before the flue gas treatment.

Table 5.8 Crude flue gas components as daily average after the boiler

Components	Units	Type of waste incinerated by fluidized bed incinerators		
		Municipal waste	Hazardous waste	Sewage sludge
Dust	g/Nm^3	1-5	1-10	30-200
CO	mg/Nm^3	5-50	<30	5-50
TOC	mg/Nm^3	1-10	1-10	1-10
PCDD/PCDF	mg/Nm^3	0.5-10	0.5-10	0.1-5
Hg	mg/Nm^3	0.05-05	0.05-3	0.2
Cd	mg/Nm^3	<3	<5	<2.5
Other heavy metals	mg/Nm^3	<50	<100	800
Nitrogen oxides counted as NO_2	mg/Nm^3	250-500	100-1500	<200
Dinitrogen oxides	mg/Nm^3	40	20	10-150
Sulphur compounds counted as SO_2	mg/Nm^3	200-1000	1500-50000	n.a.

Source: BAT for incineration

Measures:
There are 2 types of measures applicable for reduction of incineration emission:

- controlling operating conditions as Art. 50 of the IE Directive is requiring
- using processes/devices for emissions cleaning.

Controlling operating conditions

1). The incinerator will be operated in such a way as:

- to achieve a level of total organic carbon in the slag and bottom ashes less than 3 % or the loss on ignition to be less than 5 % of their dry weight;
- the gas resulting from the incineration of sludge is raised in a controlled and homogeneous fashion and even under the most unfavorable conditions to stay for at least two seconds to a temperature of at least 850°C measured near the inner wall of the combustion chamber.

2). The combustion chamber shall be equipped with at least one auxiliary burner. This burner shall be switched on automatically when the temperature of the combustion gases after the last injection of combustion air falls below the temperature of 850 °C. It shall also be used during plant start-up and shut-down operations in order to ensure that the temperature is maintained all times as long as unburned waste is in the combustion chamber.

3). The incinerator shall operate an automatic system to prevent sludge feed in the following situations:

(a) at start-up until the temperature of 850 °C has been reached;

(b) whenever the temperature of 850 °C is not maintained;

(c) whenever the continuous measurements show that any emission limit value is exceeded due to disturbances or failures of the waste gas cleaning devices.

4) Waste gases from the incinerator will be discharged in a controlled way by a stack, the height of which was calculated in order to safeguard human health and the environment.

Using processes/devices for emissions cleaning

Reduction of NOx emission

Immediately downstream of the combustion chamber, a **NOx reduction agent** (e.g. ammonia or urea) is sprayed into the flue gas to reduce the emission of NOx. An effective NOx reduction reaction takes place only within a narrow temperature window. Detailed information on parameters of the respective device will be established through the future contract for design and construction of the incinerator.

Reduction of particulates emission

The Feasibility Study recommends ***an electrostatic precipitator (ESP) followed by a bag filter***. The ESP will remove the majority of the particulates in the flue gas, including heavy metals that are condensed on them, except Mercury.

Reduction of VOC-s and Mercury

Downstream of the ESP. activated carbon and sodium bicarbonate ($NaHCO_3$) will be injected into the flue gas steam. The activated carbon will remove the possibly remaining VOC-s and Mercury from the flue gas, while $NaHCO_3$ will react with HF and HCl, as well as with SO_2, forming salts which will be retained in the bag filter placed downstream.

The purpose of the bag filter is twofold: firstly, for the removal of fine particles and secondly, as a chemical reactor where activated carbon and $NaHCO_3$ react in the dust cake formed on the bag filter with the impurities in the flue gas. A substantial part of pollutants in the crude gas is retained by the flue gas treatment, as it can be seen in table 5.9.

Further, the retained contaminants are transported to a silo, via a closed system and the cleaned flue gas is passed through a blower into the stack.

Compared to wet systems, the proposed dry removal system with $NaHCO_3$ and activated carbon is less expensive, both in terms of capital cost and operating cost. The dry system is also less complex since no wastewater treatment is required.

Any slag formed in the incinerator remains in the sand bed. In order to maintain the properties of the sand in the bed, a part of the bed mass is withdrawn during the combustion process. The withdrawn material is sieved and can be fed back as reusable material. The remaining fraction is stored in a container for disposal.

Table 5.9 Pollutant concentrations in cleaned gas emissions of municipal incinerators

Components	Daily average (mg/m3)		Thirty minute averages (mg/m3)	
	Limits according to 2010/75/EU	Typical values	Limits according to 2010/75/EU	Typical values
Dust	10	0.1-10	20	0.1-15
CO	50	1-50	100	1-150
TOC	10	0.1-10	20	0.1-25
PCDD/PCDF	0.1	n.a	n.a	-
Hg	0.05	0.0005-0.03	n.a	-
Cd	0.05	n.a.	n.a	-
Other heavy metals	0.5	n.a	n.a	-
NO_2	200	20-200	400	30-450
SO_2	50	0.5-50	200	0.5-250

(Source: BAT for incineration)

The Glina incinerator will be built, equipped and operated in such way that the emission limits, as have been set out in the EU Directive 2010/75/EU will not be exceeded. For this reason the estimation of pollutant emissions was achieved by applying the emission limit values for incineration, provided by GD 128/2002 as amended and supplemented (similar to those of Directive 2010/75/EU), for the following parameters of operation predicted in the frame of two working scenarios "High load" and "Low load". For each of these two scenarios the worst cases were considered, corresponding to the highest emissions.

Table 5.10 Working parameters for Glina Sludge Incinerator*

Parameter	High load (110% load)	Low load (50% load)	Measure Unit
Fuel flow	523	238	m^3/d (sludge 33% dry solids)
Flue gas speed	22.352	10.16	m/s
Flue gas flow	20.08	9.127	m^3/s (120 ^oC; 1.01325 bar)
	13.951	6.341	Nm^3/s (0^oC. 1.01325 bar)
	15.706	7.139	kg/s
Flue gas temperature	120	120	^oC
H_2O in flue gas	43	43	vol%
Oxygen in flue gas	2.4	2.4	vol% O_2 wet (actual) flue gas
	4.18	4.18	%vol O_2 dry flue gas
Stack characteristics			

Internal diameter	1.0695	1.0695	m
Internal area	0.8984	0.8984	m^2
Nominal load - 476 m^3/day (sludge with 33% dry solids)			

* Data supplied by the beneficiary.

In the above described conditions the pollutant emissions will be those presented in table 5.11.

Table 5.11 Emissions estimated for Glina Sludge Incinerator operation

Pollutant	Emissions (t/yr)	
	High load (110%)	Low load (50%)
Total dust - suspended particulates	4.47	2.03
Particulates –PM10	2.89	1.31
Particulates –PM2.5	1.93	0.88
Gaseous and vaporous organic substances. expressed as total organic carbon (TOC)	4.34	1.97
Hydrogen chloride (HCl)	4.85	2.20
Hydrogen fluoride (HF)	0.87	0.39
Sulphur dioxide (SO_2)	22.98	10.45
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2). expressed as nitrogen dioxide	86.88	39.49
Cadmium and components expressed as Cadmium (Cd)	0.0211	0.0096
Mercury and components measured as Mercury (Hg)	0.0211	0.0096
Arsenic and components measured as arsenic (As)	0.000114	0.000052
Lead and components measured as lead (Pb)	0.152842	0.069472
Chromium and components measured as chromium (Cr)	0.000019	0.000009
Copper and components measured as copper (Cu)	0.000102	0.000046
Nickel and components measured as nickel (Ni)	0.000019	0.000009
Dioxins and furans (TEF-PCDD/PCDF _as maximal value of 1)	0.000042	0.000019
Carbon monoxide (CO)	63.26	28.75

The values in table 5.11 have been used to evaluate the impact on the air quality due to the functioning of the sludge incinerator and for establishing of the optimal height of the incinerator stack. The results of the dispersion study performed in these purposes are presented in chapter 6.

Effects: The air quality in the area of dwellings will be not modified if the above functioning conditions will be observed. This effect was demonstrated by the dispersion study elaborated on the basis of the project parameters.

5.3 Noise and vibration sources and protection measures

Construction phase

The main sources of noise in the area of interest are the car traffic along the Glina village. the A2 highway and Bucharest ring-way, the activity at the Ochiul Boului landfill and the activity on the WWTP site.

During the construction of the WWTP phase 2, noise and vibrations will be generated by:
- building activities.
- traffic related to the transport of construction materials/equipment
- functioning of the phase 1 equipments.

The functioning of phase 1 equipment, mainly blowers and large pumps will generate noise that will be a constituent of the sonorous background with a constant level. Traffic noise could increase if transport of the dewatered sludge will become a regular activity.

Measures*:* - Optimization of vehicles and equipment traffic inside the construction area will be implemented and controlled in order to reduce pollution by noise.

Effects*:* The noise generated by the construction activities and. Similarly, the noise generated by the transport of construction materials and equipment for the phase 2 of Glina WWTP is expected not to surpass the accepted level for industrial sites - 65 db (A).

Operation phase

Noise sources*:* During the operation phase the noise level in the area will depend on the car traffic, the activity in the Ochiul Boului landfill and the functioning of the Glina WWTP equipment.

The traffic noise is not expected to change in comparison to the actual situation, as well as the noise generated by the activity in the Ochiul Boului landfill. The specific noise source will be the functioning of mechanical equipment (blowers and large pumps), the incinerator equipment and probably the flare for burning combustible gases when capacity of gas reservoirs and burners is exceeded.

***Measures*:**

- In order to reduce the noise and vibrations generated by the mechanical equipment. the blowers and large pumps will be placed inside buildings, on solid foundations capable to reduce vibrations and attenuate noise.
- All buildings containing equipment will be noise insulated by construction.

The equipment placed outside buildings has typical low sound pressure and will have a relatively small contribution to the general noise level in the area.

The noise sources and abatement measures in case of the sludge incinerator are presented in Table 5.12

Table 5.12 Noise sources and abatement measures in case of sludge incinerator

Area relevant to noise	Local noise level dB(A)	Reduction measures
Main building	80	Enclosure with multi-shell construction or gas concrete, ventilation channels with silencers, tight gates
Equipments	85	Low noise valves, noise-insulated tubes
Flue gas cleaning (ESP. chimney, etc)	80	Noise insulation, silencer for the stack
Disposal of residues (bottom ash discharge, loading and transport	70-80	Enclosure, loading of residues inside the bunker

The flare for burning combustible gases will be used only in case of emergency, because normally the combustible gases produced by anaerobic fermentation will be burned continuously for energy generation. Therefore the flare is of no significance as noise source.

Effects: Considering the actual environmental quality, described in Chapter 4, the new noise sources will not generate supplemental nuisances capable to modify the existing noise levels in the WWTP surrounding area, that are comprised between 50-75 db(A).

5.4 Waste generation and management

Construction phase

Waste generation

During the construction phase of Glina WWTP Stage 2 building waste and domestic waste will be generated.

The exact amount or volume of building waste (soil. concrete. wood. metal scraps. etc.) could not be exactly predicted. Similarly, the amount of domestic waste will depend on the number of workers engaged on the site and the number of equipment and spare pieces that will be provided (packaging waste).

Management measures

- A part of the construction waste could be considered as reusable materials (metal scraps. wood. packaging. even concrete). Recyclable types of waste will be collected separately, on dedicated places and - based on contracts - sent to companies specialized in industrial waste recycling.

- Another part of construction waste – not recyclable, also separately collected, will need disposal solutions. A contract with a construction waste disposal landfill will be signed for transport and disposal of non-recyclable construction waste.

- The excavated fertile soil will be stored on the site and reused for its restoration at the end of construction phase.

- Domestic wastes will be collected separately, in adequate recipients, by types and considering their reuse potential. Their management will include a contract with a sanitation company for specific solutions, both for re-usable and non-reusable waste.

Table 5.13 Types of waste generated during the construction phase

Waste index	Type of waste	Disposal solution
17 00	**Construction and demolition waste**	
17 01 01	concrete	recycling or landfilling
17 01 07	mixture of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	landfilling
17 02 01	wood	recycling
17 02 03	plastic	recycling
17 04 07	mixed metals	recycling
17 04 11	cables other than those mentioned in 17 04 10	recycling
17 05 04	soil and stones other than those mentioned in 17 05 03	landfilling
17 06 04	insulation materials other than those mentioned in 17 06 01 and 17 06 03	landfilling

17 09 04	mixture of construction and demolition waste other than those specified at 17 09 01. 17 09 02 and 17 09 03	landfilling
20 00	**Municipal waste and similar waste**	
20 01 01	paper and cardboard separately collected (as packaging from equipment)	recycling
20 01 28	paint, inks, adhesives and resins other than those mentioned in 20 01 27	landfilling

During the construction of the WWTP Stage 2, the water and sludge Line 1 will be in operation and will produce solid waste from screenings/grit removal and dewatered sludge. Screenings and grit will be temporary deposited on the intermediate storage platform and finally sent to a landfill. The dewatered sludge will be sent to the landfill too, or used for soil production purposes – if acceptable.

Operation phase

Waste generation

During the functioning of WWTP stage II specific technological wastes and domestic waste will be generated.

Domestic waste will be generated by activities from the canteen, offices and premises cleaning, green spaces maintenance and will be managed based on the contract with a sanitation company, similarly to Stage I waste. The types of domestic waste expected to be generated, as well as their disposal solutions, are presented in Table 5.17.

Specific or technological waste resulted from WWTP stage II are the followings:

- Screenings from coarse and fine screens; they will be collected by conveyors, washed and compacted and finally incinerated;

- Sand and grit collected from grit chambers; after washing, dewatering and classifying, the sand and grit is deposited on outside platforms, in order to be used for building purposes or to grit the road in winter time;

- Different types of sludge, which treatment was already presented in chapter 2

- Incineration waste – their management is discussed further in chapters 5 and 6.

Temporary storage facilities for sludge generated in Stage 2 are provided in different phases of sludge treatment as follows:

- sludge from primary sedimentation tanks will be pumped to a new primary mixing tank (**with 2 compartments – one for emergency)** to be mixed with the stage 1 sludge thickened by existing gravidity thickeners (till 6% DS). The sludge from the primary sludge mixing tank is sent to the existing 7 belt filter presses for further thickening (till 12% DS);
- the surplus activated sludge (SAS) removed from secondary sedimentation tanks is stored in **2 SAS buffer tanks** before dewatering by gravity belt thickeners;

- after dewatering, the thickened surplus secondary sludge (SAS) is mixed with the dewatered primary sludge in **2 buffer tanks**; from where the sludge is feed to the digesters;
- the digested sludge is directed to **2 buffer tanks for digested sludge** – **one of them being in stand by as emergency storage tank**; these tanks are sized similarly to the thickener sludge buffer tanks and provided with mixers.

The waste temporary storage places/installations will be designed and constructed to prevent nuisances for environment:

- all basins for sludge storage will be sealed and waterproofed
- emergency capacities for sludge storage will be provided
- outside platforms will be constructed of concrete and provided with channels for spillage collection that lead to the site sewerage
- inside storage places for dewatered sludge to be incinerated will be provided with channels for spillage collection that lead to the site sewerage, too.

Inside the incineration plant there is a depositing area that includes, besides the sand storage area, fuel reservoir and storage of chemicals used for flue gas cleaning, the following premises:

- 2 special depositing places, one silo for dewatered sludge, another for dewatered screenings
- 1 silo for bottom ash
- 1 silo for flying ash
- 1 silo for APC residues (air pollution control residues from the flue gas treatment).

Dust prevention. To prevent dispersion in the environment during handling for transport and intermediate storage the ashes and flue gas treatment these residues are wetted.

Wetting of bottom ash is even indicated for its preparing to be used as construction material or before disposal. This treatment is described as bottom ash ageing (chap. 4.6.6 - BREF 0806). As the BREF says, the bottom ash may be stored in the open air or in specific covered buildings for several weeks. The storage is generally performed in stockpiles on a concrete floor. Drainage and run-off water are collected for treatment. The stockpiles shall be wetted, using a sprinkler in order to prevent dust formation and emissions and to favor the leaching of salts and the carbonization. The stockpiles may be turned regularly to ensure homogeneity of the processes that occur during the ageing process (uptake of CO2 from the air due to the moisture. draining of excess water. oxidation. etc.). In practice, an ageing period of 6 to 20 weeks is commonly prescribed for treating bottom ash.

Storage of flue gas treatment residues (APC) should be made separately from bottom ash because they are subject of different treatment processes (i.e. cement solidification, vitrification and melting already presented in chapter 5.4).

Inside Glina incinerator there is a large surface dedicated to compartments for separate storage places of bottom ash, flying ash or APC residues that will be used for temporary storage of these solid residues, as well as storage facilities for necessary reactants e.g. ammonia, activated carbon, etc.

As generic requirements applied to all waste storage places it is to consider:

- not to exceed the stated maximum capacity of storage areas
- the storage area should have drainage infrastructure to collect all possible run–off
- there is an obligation to have in place systems and procedures to ensure that waste intended to be transferred is packaged and transported in accordance with legislation concerning the safe carriage.

Tables 5.14 and 5.15 present the estimated amounts of generated sludge by types and the amount of incineration residues when Glina WWTP Stage 2 will be completed.

Table 5.14 Yearly sludge production, Glina WWTP Stage 1 and 2

Operation period	**Sludge amounts after dewatering. m^3/year**	**Sludge amounts after dewatering. tones DS/year**	**Ash amounts after incineration. tones DS/year**
Current production (from February -March 2011 data, 25% DS)	104,000	22,970	-
Original design production. Stage 1 (22% DS)	162,000	35,640	-
Updated design production, Stage 1 (33% DS)	108,000	35,640	-
Design production, Stage 1 + 2 (33% DS)	183,740	60,630	30,574

Table 5.15 Yearly and daily generation of incineration waste

Amount of incineration waste	**t/day**	**t/year**
TOTAL out of which:	83**.76**	**30,574**
bag filter ash	17.83	6,508
ESP ash	58.01	21,176
bottom ash and slag	7.92	2,890

Besides the sludge, screenings and grits (sand) are generated within the treatment process but - compared to the amount of sludge – their amount is very small. Estimations indicated that the total amount of this type of solid waste will be approximately 60-70 m3/day.

Solid waste resulted from sludge incineration generally comprises the incombustible fraction of sludge plus residues from flue-gas cleaning. Through incineration about 99.6 % of sludge pollutants are concentrated in solid residues. Out of them 70-80% are found in the fly ash and filter cake fraction and a smaller percent – in slag and bottom ash.

As a result of their chemical properties, the different elements contained in the sludge are distributed specifically in the incineration solid residues. The Table 5.6 shows the general distribution as percentage of six heavy metals within the solid residues although variations from plant to plant depending on the method used for gas cleaning usually happen.

In modern well operated incinerators the total organic carbon (TOC) in bottom ash is typically below 1%; it comprises mainly elementary Carbon but, to a certain extent, other organic compounds could be found, too. The spectrum of these compounds lies from short-chain compounds up to low volatile species such as PAH or PCDD/E.

Table 5.16 Distribution of heavy metals as result of incineration process
(Source: BREF for incineration)

Heavy metals	**Solid residues to landfill (%)**				**Active carbon (%)**	**Release to environment (%)**		
	Slag /bed ash	Fly ash/ESP ash	Filter cake	**Sum**		To air	To water	**Sum**
Hg	<0.01	0.0	99.88	99.88	0.05	<0.01	0.07	0.07
Cd	1.3	94.2	4.49	99.99	<0.01	<0.01	<0.01	<0.01
As	14.6	80.0	5.39	99.99	<0.01	<0.01	<0.01	<0.01
Pb	41.2	56.0	2.75	99.95	<0.01	0.03	0.02	0.05
Cu	75.9	22.4	1.69	99.99	<0.01	<0.01	0.01	0.01
Zn	41.9	56.9	1.17	99.97	<0.01	0.01	0.02	0.03

Metals as Pb, Cu, Zn are mainly concentrated in slag and bottom ash. Other heavy metals, as As, Cd, Hg, are to a great extent volatilized and highly enriched in fly ash and filter cake.

Considering the content of heavy metals in the Glina dewatered sludge that by incineration will be concentrated within remaining solid residues, it is expected that these wastes to be hazardous. The characteristics of the ashes from incinerator bed, from ESP and from bag filters have to be established by testing. If tests show that they are hazardous – stabilization treatment is recommended.

Procedures and standards applied for classification and treatment of granular waste are provided within the **Ministerial Order 95/2005** (on establishing criteria for acceptance of waste for landfilling and procedures for acceptance to each landfill classes) – Section 3 – entitled “Methods for sampling and analyses”. The recommended standard is **EN 12457/1-4 - Leaching - Compliance test for leaching of granular waste and sludge.**

The ash resulted after sand separation is fine and could be hazardous. Only after leachability testing it should be classified. In this respect, it is recommended to take into account stabilization of the ash, if it will be classified as hazardous.

Disposal solutions available for incineration waste

When speaking about disposal of solid waste generated by incineration it is important to make a distinction between residues directly resulting from the incineration process and those resulted from reaction with additives within the treatment processes of flue gases.

The first category is called *residues from combustion* and the latter category is called *air pollution control residues - APC residues*.

Residues arising directly from combustion of sludge are:

- *fly ash* resulting from the stack of the incinerator;
- *bed ash and slag,* resulting from the bottom of the incinerator; it could be landfilled with or without specific treatment or it could be used as filling material in civil and industrial construction.

The air pollution control residues - APC residues resulting from *flue gas treatment* contain concentrated amounts of pollutants and therefore, normally, are not considered appropriate for recycling purposes. For them, the main objective is to establish a safe final disposal option.

In case of the flue gas cleaning system recommended within the Feasibility Study only residues from *dry flue gas treatment* will result.

- *Residues from dry flue gas treatment* are mixtures of calcium and/or sodium salts. mainly chlorides and sulphites/sulphates and possibly non-reacted chemical reagents – lime or sodium bicarbonate. This mixture also includes heavy metals and some fly ash (that has not been removed by the precedent dust removal step).
  The normal way of disposal is landfilling. Being a potential hazardous waste, the leachability of this waste is to be considered, especially because the reduction of this characteristic by solidification is difficult due to the high content of salts.

- *Residues from flue–gas polishing.* Recycling options of this waste type depend on the absorbent used – activated carbon, coke, lime, sodium bicarbonate. The wasted activated carbon can be incinerated within the process it-self. If a mixture of reagents and activated carbon is used – as in Glina case - the residue will sent for disposal as hazardous waste.

Treatment of air pollution control residues (APC residues) could be made by:

A. solidification
B. thermal methods such as vitrification, smelting and sintering;
C. chemical stabilization–precipitation or binding metals to minerals by sorption to result more insoluble forms that the original untreated residues;
D. combining the sludge produced by treating the scrubber solutions with fly ash to obtain Bamberg cakes (not relevant in our case).

Some details on the mentioned treatment solutions are presented below.

A. Solidification has as purpose to produce a material with physical and mechanical properties that decrease the contaminant release from the residue matrix. In parallel with the improving of leaching behaviors, a decrease of hydraulic conductivity and porosity, as well as an increase of resistance (durability) and volume is obtained. The final solidified product is usually cast in blocs before landfilling or directly landfilled.

Solidification methods can use several mostly inorganic binder reagents – cement, lime and other pozzolanic materials such as coal fly ash, cement kiln dust, but also organic binders such as bitumen/asphalt. The most prevalent technique is by far cement solidification.

B. Thermal treatment methods are used only in few countries. Upon the characteristics of the final product these methods can be classified in three categories: vitrification, smelting and sintering. Major drawbacks of these methods for which **they are not recommended in Glina case** are:

- supplementary energy consumption
- additional flue gas treatment required due to the release of vaporized heavy metals from the thermal process.

C. Chemical stabilization. The main concept of chemical stabilization is to bind the heavy metals in more insoluble forms than they are in the original untreated residues. For this purpose chemical stabilization makes use of both precipitation of metals in new minerals and binding of metals by sorption. These methods are completed by dewatering.

In some countries, notably the USA, the air pollution control residues are combined with the incinerator bottom ashes and managed as a single residue. This has the negative effect of increasing the amount of waste to be handled, but the heavy metals content and leachability per kg of the combined product decrease.

Disposal measures recommended for GlinaWWTP waste

In case of Glina WWTP the disposal of the technological waste (screenings and grit/sand. bed slag and ashes. fly ash and APC residues) will be externalized by contracting this activity with specialized companies which are authorized to dispose non-hazardous and respectively hazardous waste.

Even in such situation consideration will be given to any possibility of minimization of waste amount and harmfulness (as required by the Art. 53 of the IE Directive).

The Glina incinerator will generate the following types of solid wastes:

- bottom and flying ashes
- APC residues (air pollution control residues from the flue gas treatment).

Considering the presence of heavy metals in the Glina dewatered sludge, it is “a priory” expected that APC residues will be hazardous.

The characteristics and polluting potential of the ash from incinerator bed (bottom ash) has to be established by testing. These tests shall concern the total soluble fraction and heavy metals soluble fraction by applying the provisions of Ministerial Order 95/2005.

In case of Glina incinerator, different types of incineration wastes will be collected separately. It results that they could be treated separately - in relation to their specific characteristics - or could be mixed and treated together as hazardous waste. The treatment and disposal of incineration waste will be contracted with a company authorized for disposal of hazardous waste.

The BREF (wi_bref_0806) recommendation is that such treatment "*is typically performed at dedicated plants located near the end-destination of the product;*" thus, individual incinerators have no need to install treatment equipment.

There are the following treatment options in case of Glina incineration waste:

- for separate treatment of waste that are not hazardous – possibly only bottom ash - the recommended solution is **bottom ash ageing** and use as filing material;

- for the incineration waste that will show hazardous characteristics the recommended treatment technique is **solidification**;

- in case all incineration waste will be mixed and treated together the best treatment solution is **solidification and disposal on a landfill for hazardous waste**.

Bottom ash treatment using ageing

For ageing, bottom ash may be stored in the open air or in specific covered buildings for several weeks. In practice an ageing period of 6 to 20 weeks is commonly prescribed for treating bottom ash before landfilling or use as a construction material.

Fresh bottom ash is not a chemically inert material; it takes CO2 from the air and water (from air humidity). The results of ageing are lowering the pH due to uptake of CO2, ash hydration and particle cohesion due to changes in mineral phases. These effects reduce the leachability of metals and cause a stabilization of the bottom ash, making it more suited for recovery or disposal by landfilling.

The storage is generally performed in stockpiles on a concrete floor. The stockpiles may be wetted. in order to prevent dust formation and emissions and to favour the carbonization. Drainage and run-off water are collected for treatment. The stockpiles may be turned regularly to ensure homogeneity of the processes and to reduce the residence time in the dedicated facilities.

Solidification

Solidification method uses several mostly inorganic binder reagents (cement, lime and other pozzolanic materials) or organic binders such as bitumen/asphalt and enough water to ensure that hydration reactions will take place for cement binding. The residues are thereby incorporated in the cement matrix. Typically, the metals within the residues will react with water and cement to form hydroxides or carbonates, which are less soluble.

The most prevalent technique is **cement solidification.** The mixing proportions and handling actions associated with the processes are to be established by testing into a specialized laboratory. The solidified product is relatively easy to handle and the risk of dusting is very low. The release of heavy metals from the products is typically very low. The solidified product is generally either landfilled or used as backfilling material.

Cement-based solidification techniques rely on equipment that is readily available. Usually, it is performed at dedicated plants located near the end-destination of the product; thus, individual incinerators have no need to install solidification equipment.

As inconvenient is to mention the increase of volume to be disposed of. The addition of cement increases with about 50 % the amount of waste to be handled.

Solidification can be used for all types of incineration residues, meaning Glina mixed incineration waste.

Fig. 5.1 WWTP layout with details on incinerator specific equipment and storage facilities

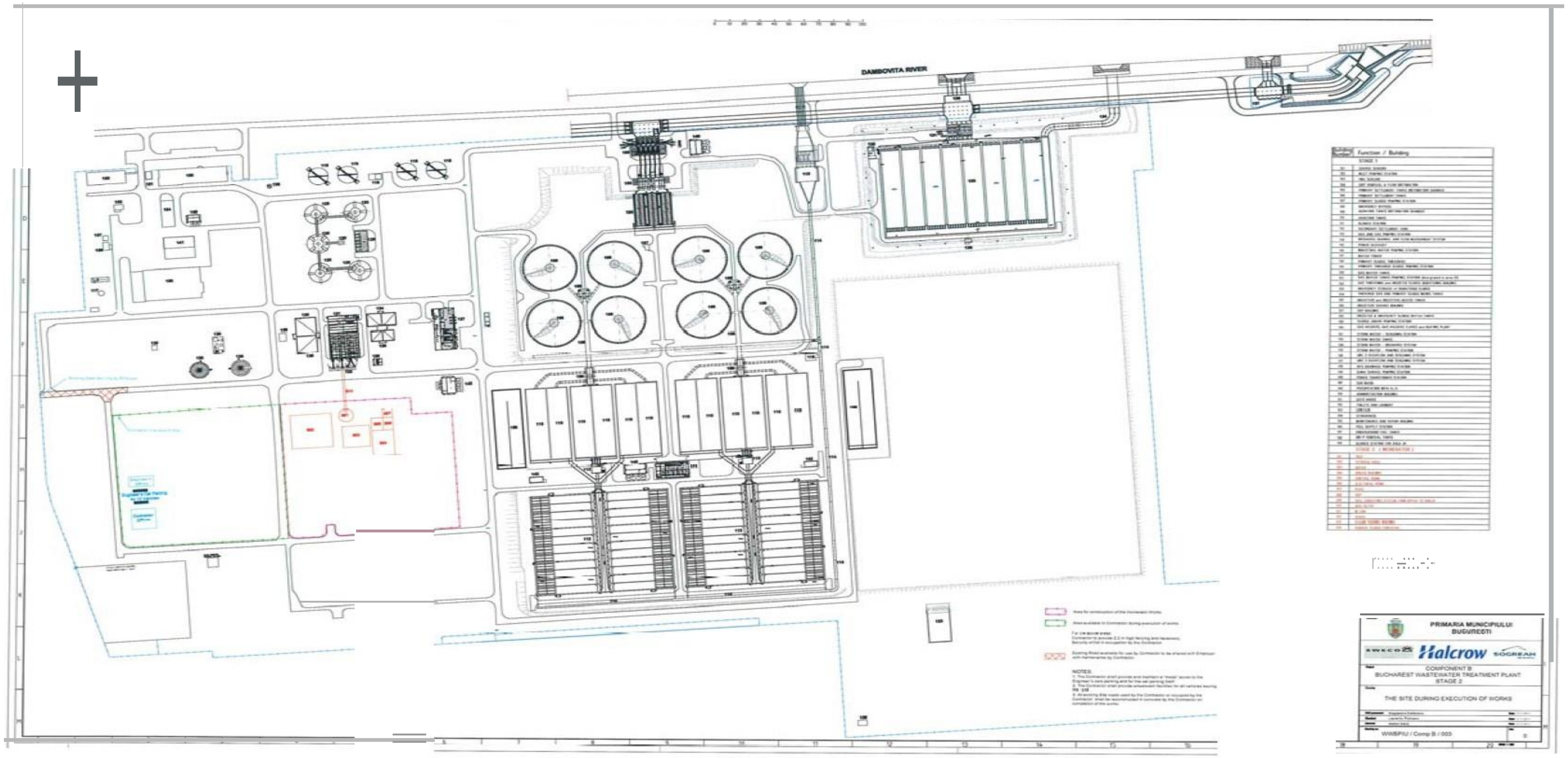
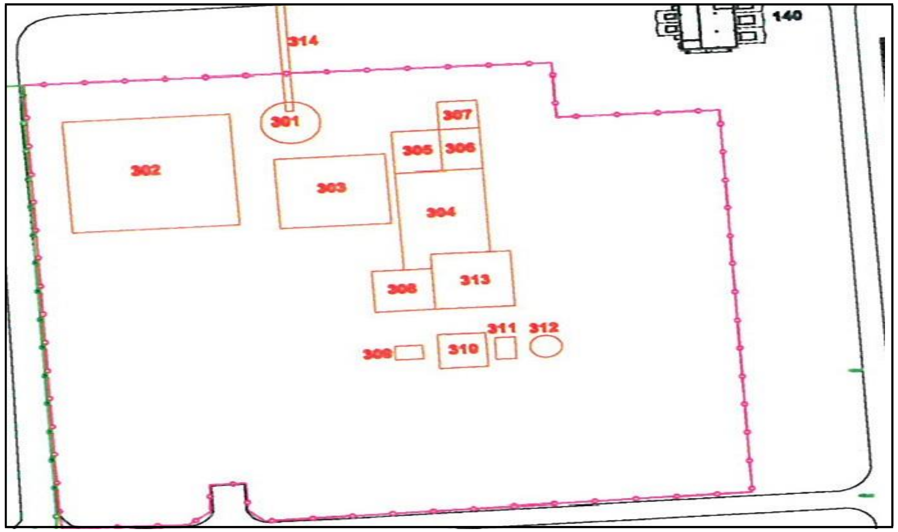


Fig. 5.2 Details on INCINERATOR SITE LAYOUT



	STAGE 2 (INCINERATOR)
301	SILO
302	STORAGE AREA
303	DRYER
304	BOILER BUILDING
305	CONTROL ROOM
306	ELECTRICAL ROOM
307	HVAC
308	ESP
309	FUEL CONVEYING SYSTEM FROM DRYER TO BOILER
310	BAG FILTER
311	ID FAN
312	STACK
313	STEAM TURBINE BUILDING
314	SEWAGE SLUDGE CONVEYOR

Table 5.17 Types of waste generated during operation phase and recommended disposal solutions

Waste index	Type of waste	Disposal solution
19 01	**Wastes from incineration**	
19 01 05*	filter cake from flue gas treatment (collected within the bag filter)	landfilled as hazardous waste
19 01 07*	solid wastes from gas treatment (from electrostatic precipitator)	landfilled as hazardous waste
19 01 12	bottom ash and slag other than those mentioned in 19 01 11	landfilled as non-hazardous waste after stabilization –if the case
19 01 19	sands from fluidized beds	partial recycled and landfilled
19 08	**Wastes from waste water treatment**	
19 08 01	screenings	landfilled
19 08 02	waste from de-sanding	recycled or landfilled
19 08 05	sludge from treatment of urban waste water	incinerated or landfilled
20 00	**Municipal waste**	
20 01 01	paper and cardboard separately collected (as packaging or not)	recycled
20 01 11	textiles	landfilled
20 01 28	paint. inks. adhesives and resins other than those mentioned in 20 01 27	landfilled
20 01 36	discarded electrical and electronic equipment other than those mentioned in 20 01 21. 20 01 23 and 20 01 35	recycled
20 02 01	mixed municipal waste	landfilled
20 03 03	street-cleaning residues	composting

5.5 Management of hazardous substances and hazardous waste

Construction phase

The hazardous substances used during the construction of Phase II of Glina WWTP are as follows:

- Fuels.
- Hydraulic oils
- Mineral oil paints and varnish. free of halogenated solvents
- Non-chlorinated engine/gear lubricating oils.

Fuels, which are a specific type of hazardous substances, will be supplied periodically and stored in dedicated reservoirs.

The other hazardous materials used by the company in charge with the construction of WWTP components will be supplied periodically and deposited by type, in distinctive places inside storehouses, separately from other materials.

Part of the hazardous substances used during the construction phase could become hazardous waste and will be found also on the list of generated hazardous waste.

On the other hand, the construction of the Line II will be accompanied by the generation of waste resulted from equipment functioning and/or repairing. The existing Maintenance and Repair Workshop has clear procedures on how to manage hazardous waste resulted from phase I equipment functioning and repairing. These procedures will be extended to management of waste resulted from construction of phase II.

Protection measures
The storage places will be assured by observing the specific norms and in such a way to prevent/retain any spillage in the environment. They will be equipped with impermeable concrete floors having spillage retaining channels. All hazardous materials will be stored in closed tanks, vessels or drums placed separately inside the storehouse. The storage areas will be organised in such a way to be easily monitored/controlled. Records on entrance and delivery of materials will be kept and consumed materials will be reported monthly.

Operation phase
During the functioning of the WWTP similar hazardous substances and materials as those mentioned for the construction phase will be used, but to this list some new substances will be added such as:

- polymers for thickening and dewatering of the sludge
- reactants for flue gases treatment within the sludge incineration process

From the use of these materials it results empty recipients as hazardous packaging waste.

Management measures
Management of the above hazardous substances and resulted hazardous packaging waste will be made observing the appropriate procedures, respectively separate storage and control. Table below shows some types of generated hazardous waste resulted from using hazardous substances and materials and the appropriate manner of their management.

Table 5.18 Hazardous waste types and appropriate options of management.

Waste Name	Code	Management options			
		Temporary on-site storage	Sent for recycling	Sent for controlled landfilling	On site Incineration
Aqueous liquid waste from oil/grease pollutant separation	05 08 04				X
Paints and varnish free of halogenated solvents	08 01 02	X		X	
Machining emulsions free of halogens	12 01 09	X			X
Hydraulic oils containing only mineral oil	13 01 06	X	X		

Non-chlorinated engine, gear and lubricating oils	13 02 02	**X**	**X**		
Mixture of grease and oil from wastewater treatment	19 08 03				**X**
Empty recipients from polymers, reactants and other hazardous materials	19 08 99	**X**	**X**	**X**	

Specific provisions related to waste oils management

Waste oils are governed by the Waste Framework Directive 2008/98/EC, especially by Article 21, which stipulates that:

(a) waste oils are collected separately, where this is technically feasible;

(b) waste oils are treated in accordance with Articles 4 (waste hierarchy) and 13 (protection of the environment and human health);

(c) where this is technically feasible and economically viable, waste oils of different characteristics are not mixed and waste oils are not mixed with other kinds of waste or substances, if such mixing impedes their treatment.

Thus, it is crucial to collect as much as possible this very valuable resource, in order to avoid the contamination of the environment and to be able to profit from the very high recovery potential of this waste stream, by handing them to authorized collectors that will ensure their adequate recovery.

Collection of used oils in Romania, as regulated by the GD no 1159 of 10.02.2003, shall be made in closed and tight recipients, stored in especially dedicated spaces; these spaces will be secured by enclosures and arranged in such a way to prevent any uncontrolled spillage. Collection shall be made by categories of oils types as established by Annex 1 of the GD no 1159 of 10.02.2003 described below.

Collection Category 1

13 01 10	Mineral non-chlorinated hydraulic oils
13 02 05	Mineral non-chlorinated engine, transmission and lubricant oils
13 02 06	Synthetic engine transmission and lubricant oils
13 02 08	Other engine, transmission and lubricant oils
13 03 07	Mineral non-chlorinated insulating and heat transmission oils

Collection Category 2

12 01 07	Mineral non-chlorinated lubricant oils
12 01 10	Synthetic lubricant oils
13 01 11	Synthetic hydraulic oils
13 01 1 3	Other hydraulic oils

Collection Category 3

12 01 06	Waste machining oils containing halogens (except emulsions)
13 01 01	Chlorinated hydraulic oils containing PCB-s or PCT-s less than 50ppm
13 01 09	Mineral chlorinated hydraulic oils
13 02 04	Mineral chlorinated machining, transmission and lubricant oils
13 03 01	Insulating and heat transmission oils containing PCB-s or PCT-s less than 50 ppm
13 03 06	Mineral insulating and heat transmission chlorinated oils, others than those specified to 13 03 01

Collection Category 4

12 01 19	Easy biodegradable lubricant oils
13 01 12	Easy biodegradable hydraulic oils
13 02 07	Easy biodegradable machinery, transmission and lubricant oils
13 03 08	Synthetic insulating and heat transmission oils
13 03 09	Easy biodegradable insulating and heat transmission oils
13 03 10	Other insulating and heat transmission oils
13 05 06	Oils from oil/water separators
13 05 06	Combustible oils and combustible Diesel

The collected waste oils will be delivered to authorized collectors together with a declaration specifying oil types / collection category / quantity and the fact that they are not contaminated with other products and do not contain more than 50 ppm PCB.

5.6 Site closure

Upon **definitive cessation** of activities all installations of the Glina WWTP will be dismantled and the land surface will be leveled as much as to be similar with the general level of the area.

Upon definitive cessation of the activities, the operator will assess the state of soil and groundwater contamination by relevant hazardous substances used, produced or released by the installations. If the plant installations have caused significant pollution of soil or groundwater by relevant hazardous substances compared to the initial state, the operator will take the necessary measures to address that pollution so as to return the site to that state. For this purpose, the technical feasibility of such measures may be taken into account.

In order to ensure a correct closure of the plant, this objective will be considered as a design phase element, making suitable plans to minimize risks during later decommissioning.

A program for design improvement will be put in place focused on the following items:

- avoid as much as possible underground tanks and pipes;
- if not possible to avoid them they should be protected by secondary containments and provided with suitable monitoring programs
- provide means for drainage and clean-up of basins, reservoirs, vessels and pipes prior to dismantling.

In parallel with the main design a plan for site closure has to be elaborated. This plan shall contain:

- methods for dismantling of buildings, basins and installations
- methods for flushing and removal of reservoirs, vessels and pipes
- solutions for closing waste storage areas and waste disposal areas
- tests for verifying soil contamination.

During the whole life of the plant there is a need to maintain and update the site closure plan in order to demonstrate that the buildings and installations can be decommissioned avoiding pollution and the site could be returned anytime to a satisfactory state for being reused.

Chapter 6 IMPACT ASSESSMENT

6.1 Impact on surface water -

In compliance with requirements of the Water Framework Directive 2000/60/EC the global assessment of a surface water status is made at the level of water body that is defined as a significant segment of a river, lake, channel or coastal water delimitated by:

- Basic criteria: category, typology, physical characteristics

- Additional criteria: ecological status, the presence of protected areas and hydro-morphological alterations. (Hydro-morphological characteristics are used to define non-modified water bodies, heavily modified water bodies and artificial water bodies).

The water body is the unit used for verifying and reporting the manner of reaching the environmental target objectives. The assessment of anthropic pressures is based on the comparison of the water body status with the environmental objectives referring to it.

Along river Dambovita, in the year 2008, a number of 7 water bodies have been defined.

Characterization of the water bodies status
Characterization of the natural water bodies' status (rivers. lakes) is based on:
Ecological status
Chemical status
Characterization of the artificial/heavily modified water bodies' status is based on:
Ecological potential
Chemical status

The global status of the water bodies (natural, artificial or heavily modified) is determined by the most unfavorable situation registered for one of the following elements: ecological status / ecological potential or chemical status.

Environmental objectives
The actual environmental objective established for Romanian waters is reaching the good ecological and chemical status till the year 2015, by implementing the pollution abatement measures proposed for the period 2010 – 2015. More clearly this means:

- reaching the good ecological status and chemical status for natural water bodies, respectively the good ecological potential for artificial/heavily modified waters;
- no deterioration of the actual status of surface and ground waters.

Table 6.1 Elements used for characterization of the water bodies' status

<table>
<tr><th colspan="18">GLOBAL STATUS</th></tr>
<tr><th colspan="12">NATURAL WATER BODIES</th><th colspan="6">ARTIFICIAL WATER BODIES or HEAVILY MODIFIED WATER BODIES</th></tr>
<tr><th colspan="10">Ecological Status</th><th colspan="2" rowspan="2">Chemical Status</th><th colspan="4" rowspan="2">Ecological Potential</th><th colspan="2" rowspan="2">Chemical Status</th></tr>
<tr><th colspan="5">Rivers</th><th colspan="5">Lakes</th></tr>
<tr><td>Very good</td><td>Good</td><td>Moderate</td><td>Poor</td><td>Very poor</td><td>Ultra-oligotrof</td><td>Oligotrof</td><td>Mezo-oligotrof</td><td>Eutrof</td><td>Hipertrof</td><td>Good</td><td>Other than good</td><td>Good</td><td>Moderate</td><td>Poor</td><td>Very poor</td><td>Good</td><td>Other than good</td></tr>
<tr><td colspan="5">Status established based on the following elements:

Biological
Hydro-morphological
Physical-chemical
Specific pollutants</td><td colspan="5">Trophic degrees based on the following indicators:
P total
N mineral total
Fitoplancton
Clorofile "a"
Disolved Oxigen</td><td colspan="2">Established in function on respecting or not environmental quality standards (EQS).

Priority substances and other pollutants concentration have relevance</td><td colspan="4">Potential established based on the following elements:
Biological
Physical-chemical
Specific pollutants</td><td colspan="2">Established in function on respecting or not environmental quality standards (EQS).

Priority substances and other pollutants concentration have relevance</td></tr>
</table>

Related to this study subject – Glina WWTP - the following water bodies are of interest:

- Dambovita downstream "Lacul Morii" – upstream APA NOVA discharge (GLINA)
- Dambovita upstream APA NOVA discharge (GLINA) – confluence with ARGES River.

Below the following data are presented:

- Characterization of the water bodies status on the river Dambovita (**Table 6.2)**
- Environmental objectives for water body's status on the river Dambovita (**Table 6.3)**

The characterization of water body ***Dambovita downstream Lacul Morii reservoir – upstream APA NOVA discharge,*** which is a heavily modified water body, has indicated:

- *a moderate ecological potential*
- *a good chemical status.*

The environmental objectives for this water body are:

- a less sever ecological potential than a good one
- a good chemical status

Reaching these objectives does not need other efforts than maintaining the actual situation and no deterioration of the present status.

The water body ***Dambovita upstream APA NOVA (GLINA) discharge – Confluence with ARGES river,*** which is an heavily modified water body, is characterized by:

- *a moderate ecological potential*
- *other than a good chemical status.*

The target set up in River Basin Management Plan as environmental objectives for this water body are:

- a good ecological potential
- a good chemical status.

Reaching these objectives means improvement of the actual situation, which can be possible only in case of finalizing and good functioning of the Glina WWTP that will eliminate the main cause of the actual precarious situation of this water body.

Reaching these objectives means improvement of the actual situation, which can be possible only by finalizing and good functioning of the Glina WWTP.

Table 6.2 Ecological status / Ecological potential and chemical status of surface water bodies on DAMBOVITA River

Name of the surface water body	Code of the water body	Ecological status		Artificial water bodies and heavily modified water bodies				Chemical status	
		Evaluation	Class of confidence	Artificial water body Y/N	Heavily modified water body Y/N	Ecological Potential		Evaluation	Class of confidence
						Evaluation	Class of confidence		
Dambovita upstream the confluence Aninoasa – entrance Vacaresti storage basin	**RO10a***	**M**	**M**	**N**	**N**			**G**	**M**
Dambovita downstrem Vacaresti storage basin – upstream hydrotechnical branch point Brezoaiele	**RO10a***	**M**	**M**	**N**	**N**			**G**	**M**
Dambovita –upstream hydrotechnical branch point Brezoaiele – downstream Drinking Water Treatment Plant Arcuda	**RO10a***			**N**	**Y**	**MoEP**	**L**	**G**	**M**
Dambovita downstream Drinking Water Treatment Plant Arcuda – entrance water reservoir Lacul Morii	**RO10a***			**N**	**Y**	**MoEP**	**L**	**G**	**M**

Water reservoir Lacul Morii	**ROLA 02b**			**N**	**Y**	**MoEP**	**L**	**G**	**M**
Dambovita downstream water reservoir Lacul Morii – upstream APA NOVA (GLINA)discharge	**RO10a***			**Y**	**Y**	**MoEP**	**L**	**G**	**M**
Dambovita upstream APA NOVA (GLINA) discharge – Confluence with ARGES River	**RO10a***			**N**	**Y**	**MoEP**	**L**	**F**	**M**

Ecological status: H=very good
G=good
M=moderate
P= poor
B=bad

Ecological Potential: HEP =High ecological potential
GEP =Good ecological potential
MoEP = Moderate ecological potential

Chemical Status: G= good
F= Other than good

Class of Confidence: L = Low;
M= Medium

Y = Yes
N = No

= **heavily modified and artificial water body**

Table 6.3 Environmental Objectives for surface water bodies on Dambovita River

Name of the body of surface water	Code of the Body of surface water	Environmental Objectives			Characteristics of the body	
		Ecological status	**Chemical status**	**Global status**	**Type**	**In conformity with**
Dambovita: upstream of confluence with Valea Badenilor- upstream confluence Aninoasa	RW10.1.25_B3	Good	Good	Good	Sensitive zone	GD 352/2005
Dambovita: upstream confluence Aninoasa – entrance water storage reservoir Vacaresti	RW10.1.25_B4	Good	Good	Good	Sensitive zone	GD 352/2005
Dambovita: upstream hydrotechnical branch point Brezoaiele – downstream storage reservoir Vacaresti	RW10.1.25_B5	Good	Good	Good	Sensitive zone	GD 352/2005
Dambovita: upstream hydrotechnical branch point Brezoaiele – downstream Drinking Water Treatment Plant Arcuda	RW10.1.25_B6	Good Ecological Potential	Good	Good Ecological Potential	Vulnerable zone Sensitive zone	HG 964/2000 GD 352/2005
Dambovita: downstream Drinking Water Treatment Plant Arcuda – entrance water reservoir Lacul Morii	RW10.1.25_B7	Good Ecological Potential	Good	Good Ecological Potential	Vulnerable zone Sensitive zone Water intended for human consumption	HG 964/2000 GD 352/2005 HG 100/2002 GD 567/2006
Dambovita: downstream water reservoir Lacul Morii – upstream discharge APA Nova (upstream GLINA)	RW10.1.25_B8	Objective less severe for the Ecological Potential	Good	Objective less severe for the Ecological Potential	Vulnerable zone Sensitive zone	GD 964/2000 GD 352/2005
Dambovita: upstream discharge APA Nova (upstream GLINA) – confluence with Arges River	RW10.1.25_B9	Good Ecological Potential	Good	Good Ecological Potential	Vulnerable zone Sensitive zone	GD 964/2000 GD 352/2005

Within the Management Plan for the Hydrographic Basin Arges-Vedea, which is part of the National Management Plan for the Segment of the International Hydrographic Basin of the Danube River included in the Romania's Territory (approved by the GD no 80/2011 - Of J. no 265/14.04.2011), the environmental objectives for the water body *Dambovita upstream Arcuda Pod Joita – confluence with Arges River* are expressed as nutrient concentrations, respectively total Nitrogen under 5mg/l and total Phosphorus under 0.5mg/l.

In order to establish the efficiency of the measures proposed for the water quality improvement and the possible risks of non-reaching the established environmental objectives a forecast of the water quality from nutrient point of view in year 2015 has been made by ANAR, by using a mathematical modeling with the WaQ-Water Quality program/model.

This model was elaborated for predicting the water quality from nutrient point of view (total Nitrogen and total Phosphorus) by considering the river load in total N and total P, the emissions due to punctual and diffuse pollutant sources, as well as the natural background.

For the sub-basin "Dambovita upstream Arcuda Pod Joita – Confluence with Arges river" the WaQ-Water Quality program was applied for normal conditions, dry weather conditions and in conditions of 3 types of rains of different intensities having a frequency of 1 to 2.5; 3; and 10 years.

The information used in modeling was as follows:

- the quality and flows of Glina effluent and rain water by-passed to Dambovita river at Popesti overflow and Glina overflow
- the quality monitoring data of the river water registered in the last 10 years
- emissions due to punctual and diffuse pollutant sources
- the natural background data

The results obtained by application of the model to the sub-basin, within the mentioned conditions, have indicated for the monitoring section Budesti, nutrient concentrations that are falling within the class of "good chemical state" (meaning total N under 5mg/l and total P under 0.5 mg/l).

It was concluded that by finalization of the WWTP phase 2 the wastewater discharged from the Bucharest agglomeration will help the achievement of the environmental objectives from the nutrient point of view for the water bodies downstream Glina.

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The impact of finalising construction of Glina WWTP on Dambovita River will lead to a substantial improvement of water quality downstream Bucharest and subsequently, an improvement of water quality in Arges River and reduction of pollutants brought into the Danube River.

The improvement of water quality in Dambovita River will have direct effects such as:

- increasing the capacity of auto-purification of the river water
- increasing the biologic and genetic biodiversity (as vegetation. birds. mammals)
- rincreasing the abundance of life forms in river water and on the river banks
- reduction of some nuisances (odours. floating refuse. unpleasant water colour)
- progressive reduction of groundwater pollution and prevention of its further pollution
- improving the landscape along the river.

On its trajectory downstream Bucharest, till the confluence with Arges River, the water of Dambovita is used only for irrigation. Water supply of households in the neighbouring dwellings is made of underground resources. Even in this situation the above favourable effects will lead to the extension of some water and land uses by:

- development of irrigations and extension of the cultivated lands
- increasing of the fishing activity
- appearance of new industrial uses, especially small scale industries. but not only;
- new opportunities for recreation activities along the river;
- possible extension of dwelled areas.

The new or extended water and land uses will have beneficial socio-economic effects on the area expressed as:

- growth of agricultural and industrial production
- more working places
- increasing of the properties value
- better life standards for inhabitants.

6.2 Impact on Groundwater

Construction phase
The construction of several elements of the WWTP stage II implies that the soil to be excavated in some zones. This action is necessary especially for piping and foundations under large structures. Due to the need of working in a dry environment, groundwater level has to be lower and this will impose the extraction of water.

Lowering of groundwater table could generate disagreements to households using wells for wetting vegetable gardens. This negative form of impact will have low amplitude and will be temporary, lasting only during a part of the construction period.

Another form of impact on the groundwater could be generated by accidental spillage of chemicals and fuel used during construction. To avoid such situation these materials will be stored in closed tanks, vessels or drums placed separately inside the storehouse. The storage area will be equipped with impermeable concrete floor having channels for spillage retaining and removing in order to avoid soil and groundwater pollution.

Operation phase

The quality of the groundwater will not be affected by the operation of the WWTP stage II. No losses of wastewater from components of the plant are possible because all basins will be waterproof.

In order to prevent pollution of groundwater all structures will be constructed in impermeable concrete. The degree of structures waterproof will be tested and restored (if the case) before start-up of the WWTP stage II functioning.

Similarly to the construction phase, during the functioning phase there is a risk of groundwater pollution by spillage of chemicals, sludge or fuels.

To avoid such accidents the storage of containers containing chemicals or other materials will be organized in dedicated spaces inside buildings, having concrete floors and spillage collection channels. In case of spillage occurrence, the spilled material will be safely removed.

There is no real risk of potential groundwater contamination due to sludge storage because:

- all basins for sludge storage are sealed and waterproofed
- emergency capacities for sludge storage are provided
- outside platforms for sludge storage are of concrete and provided with channels for spillage collection that lead to the site sewerage
- storage places for sludge to be incinerated are inside buildings and provided with channels for spillage collection that lead to the site sewerage.

All sludge storage places/ basins will be subject of periodical survey within the process monitoring plan.

In conclusion, no impact on groundwater is expected during finalizing and operation of Glina WWTP stage II.

6.3 Impact on Soil

Construction phase

For the construction of several elements on the territory designated for the WWTP stage II the soil has to be excavated and resulted materials have to be removed from the area. It is a normal practice to collect separately the fertile soil and the rock material (ground rocks) beneath the fertile soil.

The fertile soil will be separately deposited on the site in order to be reused for land remediation in places where such actions are needed.

The ground rocks will be evacuated from the site and landfilled. Specialized companies that are managing non-hazardous waste landfills or construction waste landfills will be contracted for disposal of this material.

The soil and ground rocks could also be polluted by accidental spillage of chemicals and fuels. Therefore chemicals will be stored in closed vessels or drums, placed separately, inside the storehouse. The storage areas will be equipped with impermeable concrete floors having spillage retaining channels. Fuels will be stored in dedicated underground tanks within the Fuel Supply Station that will be constructed observing all protection and safety measures.

Operation phase

During the functioning phase no excavations will normally occur. The land surface that remains unoccupied by installations/buildings will be covered with grass and even ornamental plants.

Accidents generated by spillage of chemicals and fuels will be still possible and for avoiding such risks the above mentioned security measures will be taken.

The appropriate management will avoid any pollution due to waste. Disposal of technological waste is planned by incineration, recycling or landfilling. For landfilling and recycling of technological waste, as well as for disposal of domestic waste and packaging, contracts with authorized companies will be negotiated.

The storage areas for waste or chemicals will be designed and operated in such a way as to prevent the accidental release into soil. Any storage place shall have retaining channels for contaminated rain water run-off, fire-fighting operations or contaminated water arising from spillage.

In conclusion, no impact on soil is expected as result of the construction and operation of stage II of Glina WWTP, if normally operated.

6.4 Impact on air

Construction phase

The general impact on air could be produced by emissions of dust particulates, gases/vapors and odours.

Construction of WWTP stage II will not generate specific odours, gases and vapors, but some combustion gases and dust emissions may occur from car traffic and excavations.

From environmental point of view and considering the sensitive receptor, which is the Glina village, traffic gases and dust emissions are not capable to modify the general quality of the air in the dwelled area, due to the small space occupied by constructions to be achieved compared with the space that will remain free of constructions.

It is to mention that no air pollution data in dwelled areas were recorded during the construction of first stage, which was larger and more complex and included demolition of installations.

No written or spoken complaints were registered from the inhabitants of the nearest dwelled area – Glina commune.

Operation phase

During the functioning of WWTP stage II air emissions will arise from the site as a consequence of water treatment processes happening in open air, combustion of biogas in gas engines and sludge incineration. Two types of impact forms could be discussed as caused by these emissions:

- odours
- effects on air quality.

Impact of emissions from water treatment processes

Normally, from plant components having large opened and uncovered surfaces (i.e. aeration tanks. settlement tanks. etc.) no substantial emissions such as *CO2. CH4 and other gases* will occur. The emission of these gases only occurs from the sludge digestion process, which takes place in completely closed digestion tanks and generated gases are collected in special reservoirs – biogas reservoirs.

Odour emissions from wastewater treatment could appear in any WWTP and will be highest at the inlet works – screens, grit and sand removal. These compartments are covered and provided with ventilation systems and odour treatment devices for air purification before exhausting.

The design of Glina WWTP stage 2 provides odour treatment devices to many plant components. Firstly, the **reception station** - septic sludge reception, the existing building containing 5 coarse screen channels with 10 coarse screens of the stage1 and the 2 more coarse screen channels with 4 coarse screens in a new building representing Stage 2, will be equipped with efficient odour treatment. Similar efficient odour treatment will be provided to the following components of the plant:

- the **primary sludge thickeners**
- the **belt filter presses**
- the **SAS storage** (SAS buffer tanks)
- the **gravity belt thickeners**
- the **thickened sludge buffer tanks** that serve as mixing tanks and temporary storage of the thickened SAS and the primary thickened sludge
- the **digested sludge storage tanks & emergency storage tanks**
- the **sludge dewatering devices** meaning : 5+1 stand-by **centrifuges** together with 7 **gravity belt thickeners for SAS** and 7 **belt filter presses** *initially* designed for dewatering of digested sludge for Stage 1 (but finally used for future thickening of the thickened primary sludge).

Recommended techniques for odorous air treatment

In case of Glina the recommended techniques for odorous air treatment are: wet air scrubbing and carbon adsorption.

Wet Air Scrubbing. Wet air scrubbing is the most flexible and reliable technology for vapor-phase wastewater odor control. This technology can be used to treat virtually any water-soluble contaminant. In addition to hydrogen sulfide and "organic" odors, wet scrubbing is very effective for ammonia removal. In a wet air scrubber the odor contaminants are passed from the vapor phase into an aqueous chemical solution. The chemical balance in the system is automatically and continuously maintained, even under changing loading conditions, minimizing the chance for odor break-through. The application of a multi-stage scrubber allows the utilization of a different chemical solution in each of the stages to efficiently use chemicals and target a wide range of contaminants for treatment.

Hydrogen sulfide can be solubilized with a solution of sodium hydroxide while the other odor-causing compounds are best treated by sodium hypochlorite. In a multi-stage system, sodium hydroxide is used alone in the first stage to solubilize hydrogen sulfide. Sodium hypochlorite is added to the last stage only. By eliminating the sodium hypochlorite from the sulfide removal process the consumption rate for this chemical is greatly reduced.

Carbon Adsorption

In a carbon adsorption system, the air stream is passed over a bed of adsorbent (carbon) and the odor-causing compounds are adsorbed to the surface of the adsorbent. This is the simplest of the wastewater odor control technologies. Adsorption is applicable to a wide range of compounds. Hydrogen sulfide and related sulfur-based compounds are removed effectively by carbon adsorption systems, but ammonia and other nitrogen-based compounds are not effectively treated. Details on installations for odour treatment will be provided by the designer that will be assigned by the bidding of the Yellow FIDIC contract.

The disturbance of the local inhabitants due to odour will decrease compared with the situation without wastewater treatment plant. The arguments sustaining this estimation are the following:

- the plant components causing strongest odours are located at the largest distance from the Glina village;
- many of the plant structures that could produce odour emissions will be introduced in buildings (coarse and fine screens. dewatering equipment) or covered and the air will be treated before exhausting;
- odour generated now by the untreated wastewater will disappear completely, because the compounds in the raw sewage causing odour will be removed by treatment within the WWTP; this will improve the air quality for the inhabitants living downstream Glina WWTP. along the Dambovita River.

In order to verify this estimation during the first period after finalizing the plant stage II, an odour monitoring study will be performed and – if the case – more abatement measures will be proposed.

Impact of emissions from combustion of biogas in gas engines

The biogas burning in order to produce warm water and/or electricity will generate mainly CO_2 and in minor quantities some other gases such as NOx and SO_2 while emissions of particulates (soot and ash) will be negligible.

Estimated emissions will be similar to those of any methane gas burning device respectively similar to those in the table below.

Emission components	Measurement units	Values
O_2	%	2.4 - 4.3
CO_2	%	9.4 – 10.5

NOx	mg/Nm^3	21 - 47
SO_2	mg/Nm^3	10-50
H_2S	mg/Nm^3	<5
Soot	ppm	0.0
Ash	ppm	0.0
Gas Temperature	ºC	70 - 137
Efficiency	%	95.4

Biogas burning motors are provided with devices for biogas cleaning before burning and abatement measures for emission reduction (reduction of H_2S with iron salts. selective reduction of nitrate oxides and adsorption on activated carbon).

In case of emergency or accidents (ex. malfunctioning of biogas burners) the combustible gases produced by anaerobic fermentation will feed a flare burning combustible gases in the open atmosphere. The flare will be enough high to ensure good dispersion of burning gases.

Emissions from biogas burning have been considered within the dispersion study as a background air pollution source.

Impact of emissions from sludge incineration

The Glina incinerator will be designed, equipped, built and operated in such a way that the emission limits as have been set out by **IE Directive 2010/75/EU – Annex VI Part 3** will be not exceeded. These limit values for pollutants in air emissions are presented below.

a) **Daily average values** (values based on a reference quantity of 11% Oxygen and for normal conditions of dry gases temperature = 273 K and pressure = 101.3 kPa).

Total dust - suspended particulates	10 mg/m^3
Gaseous and vaporous organic substances. expressed as total organic carbon (TOC)	10 mg/m^3
Hydrogen chloride (HCl)	10 mg/m3
Hydrogen fluoride (HF)	1 mg/m3
Sulphur dioxide (SO2)	50 mg/m3
Nitrogen monoxide (NO) and nitrogen dioxide (NO2). expressed as nitrogen dioxide	200 mg/m3

b) Average values for 30 minutes (limits in the column A will be respected by 100% of determined values; limits in the column B will be respected by 97% of values).

	A (100%)	**B (97%)**
Total suspended particulates	30 mg/m^3	10 mg/m^3
Gaseous and vaporous organic substances. expressed as total organic carbon	20 mg/m^3	10 mg/m^3
Hydrogen chloride (HCl)	60 mg/m^3	10 mg/m^3
Hydrogen fluoride (HF)	4 mg/m^3	2 mg/m^3
Sulphur dioxide (SO2)	200 mg/m^3	50 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide	400 mg/m^3	200 mg/m^3

(NO2). expressed as nitrogen dioxide for new incineration plants		

c) Average limit values for heavy metals. These average values include gaseous and vaporous emissions of heavy metals and their combinations. All average values will be obtained on a sampling duration of at least 30 minutes and a maximum of 8 hours duration of the sampling period for heavy metals.

Cadmium and components expressed as Cadmium (Cd)	Total 0.05 mg/Nm^3
Thallium and components measured as Thallium (Tl)	
Mercury and components measured as Mercury (Hg)	0.05 mg/Nm^3
Sum of Antimony (Sb). Arsenic (As). Lead (Pb). Chromium (Cr). Cobalt (Co). Copper (Cu). Manganese (Mn). Nickel (Ni). Vanadium (V) and their components expressed as heavy metals	Total 0.5 mg/Nm^3

d) Average limit values for dioxins and furans emission over a sampling period of a minimum of 6 h and a maximum of 8 h.

The emission average value refers to a total concentration of dioxins and furans calculated in accordance with Part 2 of the Directive 2010/75/EU (Equivalence factors for dibenzo-p-dioxins and dibenzo-furans) by using the factors of toxic equivalence.

dioxins and furans	0.1 ng/Nm ^{3}

e) The following emission limit values for concentration of **carbon monoxide (CO)** in combustion gases will not be exceeded, except during the start and stop of the process:

50 mg/Nm^3 – as daily average value
100 mg/m^3 - as average values at 30 minutes
150 mgNm^3 - as average values on 10 minutes

NOTE: The competent authority may authorize exceptions from these emission limit values for waste incinerator using fluidized bed technology, provided that the environmental permit sets an LV of no more than **100 mg/Nm ^{3} for CO as an hourly average** value.

Emission limit values applicable in circumstances of abnormal functioning conditions (breakdown) – described in Article 46/6 and 47 of the Directive 2010/75/EU

The total dust content within emissions into the air shall under no circumstance exceed 150 mg/Nm^3 expressed as average for 30 minutes. The air emissions limit for TOC and the limit values for CO should not be exceeded.

Provisions for cases of abnormal functioning conditions

In case of functional trouble/disturbance the incinerator should reduce or stop the activity as soon as practicable till the normal functioning of the installation could be re-established.

When the emission limit values are exceeded the incinerator will not continue to incinerate without stopping for a period of more than 4 hours uninterrupted. The cumulated duration of functioning in such conditions during one year shall be less than 60 hours in any 12-months period.

Impact of incinerator emissions on air quality

Assessment of the air quality for Bucharest municipality and the surrounding areas representing the Bucharest agglomeration has been based – as required by Order 592/2002 - on the results of the air quality monitoring obtained from the monitoring stations, the emission inventories and modeling of dispersion in the atmosphere achieved by using meteorological data.

The concentration of pollutants in the area where the Glina WWTP is located is presented in the table bellow.

Table 6.5 Air pollution concentrations within a 2000 m radius around Glina commune

Pollutant	Time coverage	Pollutant concentration [μg/m^3]	Limit values (VL) provided by Order 592/2002 [μg/m^3]
PM_{10}	year	25 - 27	VL = 40 μg/m^3
PM_{10}	24 h	29 - 31	VL = 50 μg/m^3 – 35 excedances allowed
CO	Upper value of the daily average of 8 hours duration	1800 – 2300	VL = 10.000 μg/m^3
NO_2	Year	15 – 19	VL = 40 μg/m^3
NO_2	1 h	134 – 191	VL = 200 μg/m^3 – 18 excedances allowed
NOx	year	21 - 27	VG = 30 μg/m^3 – for protection of sensitive ecosystems in non-build zones
SO_2	year	11 - 14	VL = 20 μg/m^3 – for protection of ecosystems
SO_2	24 h	31 - 34	VL = 125 μg/m^3 = 3 exceeding allowed
SO_2	1 h	61 - 69	VL = 350 μg/m^3 = 24 exceeding admitted

By comparing these concentrations with the limit values of the investigated indicators provided by the Order 592/2002, it results that all are substantially under the limit values provided by this order.

As mentioned within the EU Directive 2010/75/EU for zones/agglomerations where the levels of air pollutant concentrations are lower than the limit value and/or alert thresholds set for ambient air, these levels shall be preserved in order maintain the best ambient air quality, compatible with sustainable development.

In order to satisfy this requirement the optimal height of the incinerator stack resulted to be of 30 m. In such conditions, the dispersion of burned gases from the WWTP incinerator will not substantially modify the quality of air in the area as demonstrated by the modeling.

Short presentation of the DISPERSION study

The mathematical modeling of the pollutant dispersion into the atmosphere was used in two purposes:

- for establishing the optimal height of the incinerator stack
- and to demonstrate the impact on the air quality.

The method used for achieving these objectives was based on 2 scenarios that are described below.

Scenario no 1: Background situation

Background assessment was performed taking into consideration the existing air pollution sources before putting into operation of the Glina sewage-sludge incinerator. The evaluation of the existing air pollution background has the following components:

1. ***Assessment of background pollu tion generated by loc al emission-sources. in the area of Glina sludge incinerator:***

For this purpose the pollutant dispersion modeling was performed on a local scale using a grid of 14 km x 14 km, with cells of 350 m x 350 m, centered on the incinerator (perimeter of Glina WWTP). Calculations were performed taking into account the main emission sources within this grid with maximal values of pollutants as accepted by the environmental authorizations published on the environmental authority’s sites. Emission sources considered in modeling are:

- The main industrial emission sources in the area including those important for local pollution such as Glina municipal solid waste landfill, biogas burning in two CHP engines, the thermal plant and the protein-flour mill of SC PROTAN SA, CHPP Titan, CHPP South. Data on these sources emissions have been extracted from the following documents:
    - burning of biogas from the methane tanks of Glina WWTP in two CHP engines, JMS engine supplier for Glina WWTP; JMS engines published technical specification
    - the protein-flour mill SC PROTAN SA Bucharest: Integrated Environmental Permit (draft) 31/16.12.2010
    - CHPP Titan (SC ELECTROCENTRALE BUCURESTI SA - CET Titan): Integrated Environmental Permit 16/21.01.2008
    - Municipal solid waste landfill Glina (SC ECOREC SA): Integrated Environmental Permit 579/04.06.2008; Waste Management Plan for Bucharest. Bucharest City Hall, March 2009
    - CHPP South (SC ELECTROCENTRALE BUCURESTI SA - CET Sud): Integrated Environmental Permit 59/09.10.2009

- Residential sources associated with domestic activities (heating, cooking. etc.).

Fuel consumption data on fuel type, spatial distribution of different residential heating methods and fuel types used – from Bucharest and Ilfov Local Environmental Protection Agency

- Road traffic.

Primary data: Traffic counting data of traffic composition and number of vehicles per hour, average traveling speed, road lengths, Bucharest car fleet structure by vehicle classes, carburant consumption and emission and consumption factors dependant on speed.

Data sources: Romanian Automobile Registry (RAR), Bucharest and Ilfov Local Environmental Protection Agency.

2. ***Assessment of backgroun d pollution generated by the e mission sources in Bu charest agglomeration***

   a. *Industrial sources:* All the major industrial operators (IPPC units) – data from Integrated Environmental Permits and E-PRTR emission reports

   b. *Residential sources:* Fuel consumption data by fuel type, spatial distribution of different residential heating methods and fuel types used – from Bucharest and Ilfov Local Environmental Protection Agency

   c. *Traffic*: Primary data: Traffic counting data of traffic composition and number of vehicles per hour, average traveling speed, road lengths. Bucharest car fleet structure by vehicle classes, carburant consumption and emission and consumption factors dependant on speed. Data sources: Romanian Automobile Registry (RAR). Bucharest and Ilfov Local Environmental Protection Agency

3. ***Assessment of background pollution due regional transport of pollutants***

Background pollution level due to regional-scale transport of pollutants is based on the annual air quality assessment at national level, results published by the Ministerial Order 1271/2008 for the approval of classification of the localities within Bucharest agglomeration and the counties of Cluj, Iasi and Dolj in lists, according to the Order of the Minister of Waters and Environmental Protection no. 745/2002 on establishing the agglomerations and classifying agglomerations and zones to assess air quality in Romania"

4. ***Assessment of background pollution due to the long range transport of pollutants and due to the natural background***

This assessment was performed by analyzing the background concentration values measured at the closest representative EMEP air quality monitoring stations, located in Hungary, Czech Republic and Austria. (http://www.eea.europa.eu/themes/air/airbase/airbase)

Scenario no 2 Impact of Glina sewage-sludge incinerator operation

This scenario is aimed to assess the impact on air quality due exclusively to the operation of the Glina sludge incinerator. It can indicate if the incinerator operation as unique source could generate pollutant concentration values higher than the limit values or target values settled by law in the ambient air.

To establish an incinerator stack height, optimal in terms of the pollutants dispersion and air quality impact, a mathematical modeling was carried out simulating the incinerator emission impact in case of various possible stack heights – 20, 30, 40, 50 or 60 m. For each of the five considered heights, calculations have been made by two different scenarios, corresponding to a minimal incinerator load of 50% (Low load) and to a maximal incinerator load of 110% (High load). The plant will be expected to operate within specified and acceptable parameters in the whole load range 50 to 110%. The 110% load case was chosen because it has the highest exit gas velocity. The 50% load case was chosen because it has the lowest exit gas velocity. Therefore, depending on the atmospheric conditions and knowing that for example gases and dust in the flue gas will be separated from the flue gas in different ways once it leaves the chimney these cases were chosen as the two extremes.

Fluidised beds are often required to be designed to be able to operate even below 50% load and therefore the request for it to perform under good operating conditions between 50 and 110% load is reasonable. In the case of the Glina incinerator it was assumed that it will operate close to full load all the time and therefore load control is not too important; it is worthwhile however to ask the contractor to design for 50% operation as this can be provided without excessive additional cost.

In each of the scenarios “High load” and “Low load” modeling was performed only for nitrogen dioxide (NO_2). The reason of selecting this pollutant to determine the optimal height of the stack was that, compared to the other pollutants, the ratio between the considered emission and the appropriate limit value in terms of ambient air quality for NO_2 has the highest value for the averaging period of 1 h.

To assess the impact of the other analyzed pollutants: SO_2, PM10, PM 2.5, CO, Pb, As, Cd, Ni, Hg and PAH, relevant for an incinerator operation and regulated by Law no. 104/2011 on ambient air quality, dispersion modeling was performed only for the stack height of 30 m that was determined as optimal, in the mentioned two scenarios taken into account for NO_2 and corresponding to the two loads of incinerator 50% and 110%.

Pollutants dispersion modeling to analyze the exclusive impact of the incinerator operation was performed using the same grid of 14 km x 14 km with cells of 350 m x 350 m and centered on the incinerator, as used to determine background concentrations. The results of modeling for each scenario were compared with the corresponding limit values, target values or critical levels settled by Law no. 104 /2011 on ambient air quality.

Air emissions generated by Glina Sludge Incinerator operation

In order to determine the stack height and to evaluate the impact on air quality, the emissions due to the Glina sludge incinerator operation were estimated as follows:

Table 6.6 Emissions estimated for Glina Sludge Incinerator operation

Pollutant	Emissions (t/yr)	
	High load (110%)	Low load (50%)
Total dust - suspended particulates	4.47	2.03
Particulates –PM10	2.89	1.31
Particulates –PM2.5	1.93	0.88
Gaseous and vaporous organic substances. expressed as total organic carbon (TOC)	4.34	1.97
Hydrogen chloride (HCl)	4.85	2.20
Hydrogen fluoride (HF)	0.87	0.39
Sulphur dioxide (SO_2)	22.98	10.45
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2). expressed as nitrogen dioxide	86.88	39.49
Cadmium and components expressed as Cadmium (Cd)	0.0211	0.0096
Mercury and components measured as Mercury (Hg)	0.0211	0.0096
Arsenic and components measured as arsenic (As)	0.000114	0.000052
Lead and components measured as lead (Pb)	0.152842	0.069472
Chromium and components measured as chromium (Cr)	0.000019	0.000009
Copper and components measured as copper (Cu)	0.000102	0.000046
Nickel and components measured as nickel (Ni)	0.000019	0.000009
Dioxins and furans (TEF-PCDD/PCDF _as maximal value of 1)	0.000042	0.000019
Carbon monoxide (CO)	63.26	28.75

The estimation of pollutant emissions was achieved based on:

- emission limit values for incineration. provided by GD 128/2002 as amended
- operation parameters predicted for the two working scenarios "High load" and "Low load".

Table 6.7 Working parameters for Glina Sludge Incinerator*

Parameter	High load (110% load)	Low load (50% load)	Measure Unit
Fuel flow	523	238	m^3/d (sludge with 33% dry solids)

Flue gas speed	22.352	10.16	m/s
Flue gas flow	20.08	9.127	m^3/s (120 °C; 1.01325 bar)
	13.951	6.341	Nm^3/s (0°C. 1.01325 bar)
	15.706	7.139	kg/s
Flue gas temperature	120	120	°C
H_2O in flue gas	43	43	vol%
Oxygen in flue gas	2.4	2.4	vol% O_2 wet (actual) flue gas
	4.18	4.18	%vol O_2 dry flue gas
Stack characteristics			
Internal diameter	1.0695	1.0695	m
Internal area	0.8984	0.8984	m^2
Nominal load:	**476 m^3/day or761 t/day (sludge with 33% dry solids)**		

* Data supplied by the beneficiary.

Emissions were calculated based on functioning parameters and ELV-s for incineration, taking into account the fact that ELV-s must be complied with, irrespective of load.

For the pollutants of interest for which ELV-s are set cumulatively, meaning:
- Dust (total particulate matter)
- Sum of Cadmium and components expressed as Cadmium (Cd) and Thallium and components measured as Thallium (Tl)
- Sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V) and their components expressed as heavy metals,

the emissions were also calculated based on ELV-s but applying the ratios given by the appropriate emission factors indicated by the EMEP/EEA 2009 methodology (Table 3-3, Tier 2 emission factors for source category 6.C.b Industrial waste incineration, incineration of sludge from water treatment) in order to distribute emission on individual indicators. (PM10, PM2.5, As, Pb, Ni, etc.).

In absence of any information regarding the presence of Thallium in incinerator emissions – nor an emission factor - we attributed the entire ELV to Cadmium.

Description of the mathematical dispersion modelling software

The model used for the concentration-fields mathematical modeling was OML–Multi, a multi-source model of Gaussian type. The model was designed in theory to include the main physical phenomena governing the atmospheric dispersion of pollutants coming from industrial sources or from other sources. The model can include point sources and area sources.

The structure of OML-Multi consists of:

- the meteorological processor - computational method of physical parameters required for dispersion modeling process. based on meteorological measurements;
- the dispersion model - computational method for estimating the concentration fields in a predefined receptor system based on physical parameters and other necessary inputs (emission data. information on land profile. etc.).

Input data

- hourly meteorological data:
- sources related data: physical parameters of sources
- emission data: mass flow, exhaust temperature;
- time variation: factors that describe the variation in time of emissions
- receptors network related data: receptor coordinates defined in a spherical or rectangular coordinate system.

Output data

Output data are represented by concentrations fields defined in receptors network nodes. OML-Multi generates in all network nodes hourly, 8 hours running, daily, monthly and annual average concentrations, percentiles and other statistical values important in assessing air quality.

For each scenario, the concentration fields were extracted from the calculation grid (spatial domain of 14 km x 14 km, cells of 350 m x 350 m, centered on the incinerator) and interpolated by GIS methods and the results are presented as pollution maps as follows:

- Spatial distribution of pollutant concentrations corresponding to the background pollution - Scenario 1
- Spatial distribution of NO_2 concentrations due to the impact corresponding only to Glina sludge incinerator operation - Scenario 2
- Spatial distribution of pollutant concentrations (except NO_2) for the stack height of 30 m, corresponding only to Glina sludge incinerator operation - Scenario 2.

Results of modeling

The following table comparatively shows the NO_2 maximum concentrations obtained by modeling the impact due to the **exclusive operation of the sludge incinerator** for the two loads of 50% and 110%, and for all considered stack heights, respectively: 20 m; 30 m; 40 m; 50 m and 60 m.

The graphs in Fig. 6.2 and 6.3 illustrate the variations of these maximum values depending on the stack height for each load, both for the annual average concentrations and for the maximum hourly concentrations (the 19^{th} value) of NO_2.

Table 6.8 Maximum concentrations of NO_2 obtained for the exclusive incinerator operation, for different loads, depending on the height of the stack - µg/m^3

Stack height (m)	Impact due to exclusive incinerator operation			
	High load (110 %)		Low load (50 %)	
	NO_2 - hourly 19th value	NO_2 – annual average	NO_2 - hourly 19th value	NO_2 – annual average
	µg /m³			
20	29.80	1.55	24.00	1.09
30	19.00	0.95	13.07	0.62
40	12.47	0.59	8.87	0.39
50	9.13	0.37	6.59	0.25
60	7.07	0.25	5.23	0.16

Fig. 6.1. Variation of the NO_2 maximum annual average concentrations obtained for the exclusive incinerator operation by different loads and heights of the stack

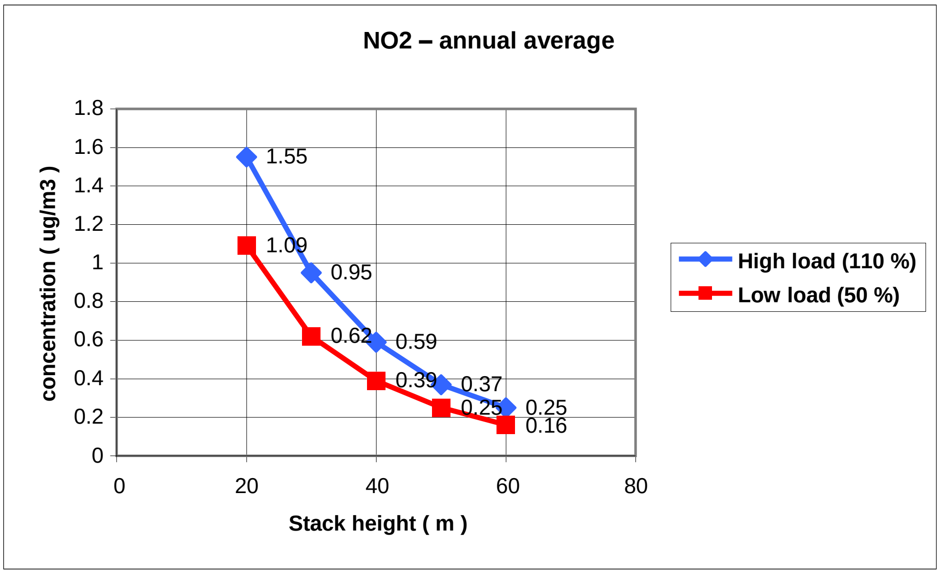
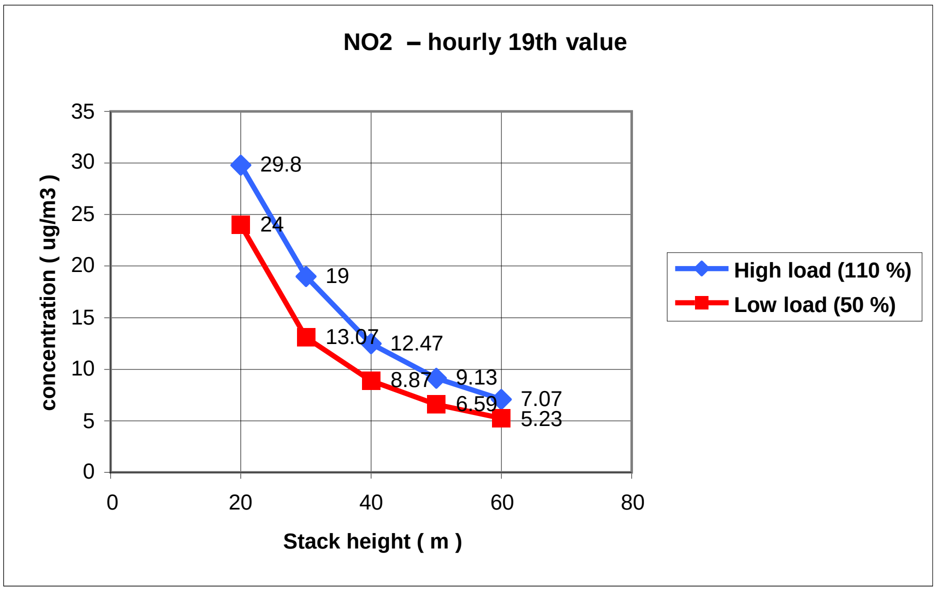


Fig. 6.2 **Variation of the NO_2 highest maximum hourly concentrations obtained for the exclusive incinerator operation by different loads and heights of the stack**



The stack height of 30 m was determined as optimal because at this height the impact of the incinerator operation on ambient air quality is low, the generated pollution levels being far below the corresponding limit/target values/critical levels and given that a further increase in the stack height causes a minor reduction of the impact. The limit values are not exceeded even by the cumulative effect with the background concentrations.

Table 6.9 presents the maximum concentrations obtained by modeling the impact associated to the exclusive sludge incinerator operation for the stack height of 30 m.

In case of each pollutant, the concentrations are compared with the corresponding limit values/target values/critical levels and the last two columns show the percentage represented by the maximum concentration value from the limit value/target value/critical level.

Table 6.10 presents the maximum concentration values for the sensitive receptors in the areas surrounding the incinerator (localities), obtained by modeling for the stack height of 30 m.

This table contains:

- the concentration values corresponding to the exclusive sludge incinerator operation for the two loads (High and Low)
- the background concentrations
- and concentrations corresponding to the cumulative impact.

In each case the concentration values are compared with the corresponding limit values/ target values/ critical levels.

The areas of highest ambient air concentrations are shown on **the pollution maps**.

To assess the **overall existing background pollution** in the Glina incinerator impact-area, the corresponding contributions of the four components of background concentrations were summed on the grid 14 km x 14 km, with cells of 350 m x 350 m. The same grid was used for the dispersion modeling of pollutants released solely by the operation of the Glina incinerator (scenario 2).

The cumulative concentrations were obtained by summing the estimated background concentrations and the estimated concentrations due to incinerator operation, in each cell of the grid and the resulted concentrations were compared to the limit values.

The contributions of different sources are cumulative in each point of the grid (receptor).

This estimation method of cumulative impact concentrations represents a **"worst-case-scenario" type approach,** since the real concentrations will be normally less than the predicted values. Such situation can happen **only** in case of simultaneity of the most adverse weather conditions in terms of pollutant dispersion (for both - maximal emissions from incinerator operation and from other pollution sources) combined with simultaneous pollutant transport from both groups of sources to the impact receiver- the dwelled zone placed downstream.

The approach chosen for this work consisted in modeling the separate contributions of the other existing sources, also taking into account the medium and long distance transport of pollutants and respectively the contribution due to incinerator operation. Since the estimated background concentrations are significantly higher than those estimated for incinerator operation, no maps illustrating the cumulative concentrations were drawn up because the cumulative maps would have been identical to those illustrating the background when compared with the Limit values/Target values.

Dispersion modeling for the pollutants released by the incinerator was conducted for the stack height of 30m that ensures compliance with the limit values/target values for air quality. Thus it has been demonstrated that the cumulative concentrations cannot exceed the limit values for air quality in sensitive (dwelled) areas.

Table 6.9 Maximum concentrations obtained by modeling the impact associated to the exclusive sludge incinerator operation for the optimal stack height of 30 m and for the two loads

Pollutant	Averaging period	Maximum concentration Scenario 2- exclusive incinerator operation		Measure units	Limit values (LV) / Target values (TV) / Critical levels (CL)	% of the LV/TV/CL High load 110%	% of the LV/TV/CL Low load 50%
		High load 110%	Low load 50%				
NO_2	1 h	19.00	13.06	μg/m^3	200	9.50	6.53
	yr	0.94	0.62	μg/m^3	40	2.35	1.55
CO	8 h	22.50	13.10	μg/m^3	10.000	0.23	0.13
SO_2	1 h	7.32	5.07	μg/m^3	350	2.09	1.45
	24 h	4.09	2.72	μg/m^3	125	3.27	2.18
	yr	0.38	0.24	μg/m^3	20	1.90	1.20
PM10	24 h	0.14	0.09	μg/m^3	50	0.28	0.18
	yr	4.70×10^{-2}	3.11×10^{-2}	μg/m^3	40	0.12	0.08
PM2.5	yr	3.16×10^{-2}	2.08×10^{-2}	μg/m^3	25	0.13	0.08
As	yr	2.56×10^{-6}	1.68×10^{-6}	μg/m^3	6×10^{-3}	0.04	0.02
Cd	yr	3.45×10^{-4}	2.26×10^{-4}	μg/m^3	5×10^{-3}	6.90	4.52
PAH	yr	6.30×10^{-5}	1.88×10^{-6}	μg/m^3	-	-	-
Hg	yr	3.45×10^{-4}	2.26×10^{-4}	μg/m^3	-	-	-
Ni	yr	4.25×10^{-7}	2.79×10^{-7}	μg/m^3	2×10^{-2}	2.13×10^{-3}	1.40×10^{-3}
Pb	yr	3.44×10^{-3}	2.26×10^{-3}	μg/m^3	0.5	0.68	0.45

Table 6.10 Maximum concentrations obtained by modelling for the optimal stack height of 30 m and for the two loads. extracted for the sensitive receptors in the areas surrounding the incinerator

Pollutant	**Averaging period**	**Maximum concentration Scenario 2- exclusive incinerator operation**		**Maximum background concentration Scenario 1**	**Locality**	**Measure units**	**Limit values (LV) Target values (TV) Critical levels (CL)**	**Maximum concentration Cumulative impact**	
		High load 110%	**Low load 50%**					**High load 110%**	**Low load 50%**
NO_2	1 h	11	7.33	175.11	Glina	μg/m^3	200	186.11	182.44
	yr	0.46	0.27	26.48	Popeşti - Leordeni	μg/m^3	40	26.94	26.75
CO	8 h	12.5	7.02	1407.29	Glina	μg/m^3	10.000	1419.79	1414.31
SO_2	1 h	4.21	2.76	18.87	Glina	μg/m^3	350	23.08	21.63
	24 h	1.65	0.86	8.04	Popeşti - Leordeni	μg/m^3	125	9.69	8.9
	yr	0.18	0.11	2.19	Popeşti - Leordeni	μg/m^3	20	2.37	2.3
PM_{10}	24 h	0.07	0.04	29.08	Popeşti - Leordeni	μg/m^3	50	29.15	29.12
	yr	2.28×10^{-2}	1.35×10^{-2}	15.85	Popeşti - Leordeni	μg/m^3	40	15.8728	15.8635
Cd	yr	1.66×10^{-4}	9.8×10^{-5}	0.07×10^{-3}	Popeşti - Leordeni	μg/m^3	5×10^{-3}	2.36×10^{-4}	1.68×10^{-4}
PAH	yr	3.03×10^{-2}	8.18×10^{-3}	0.043×10^{-3}	Popeşti - Leordeni	μg/m^3	-	3.03×10^{-2}	8.22×10^{-3}
Ni	yr	2.05×10^{-4}	1.21×10^{-4}	0.21×10^{-3}	Popeşti - Leordeni	μg/m^3	2×10^{-2}	4.15×10^{-4}	3.31×10^{-4}
Pb	yr	1.66×10^{-3}	9.81×10^{-4}	0.0077	Popeşti - Leordeni	μg/m^3	0.5	9.36×10^{-3}	8.68×10^{-3}

Conclusions regarding the optimal stack height and the impact on air quality

The analysis of the modeling results achieved in the two scenarios leads to the following conclusions concerning the impact of Glina sludge incinerator operation on air quality and regarding the optimum stack height.

- In case of NO_2 the analysis of the impact on ambient air quality due to exclusive operation of sludge incinerator for the 5 stack heights, studied for each of the two loads 110% and 50%, indicates that the maximum concentration values obtained by modeling are well below the corresponding limit values for both averaging periods (hour. year).
- The reduction of NO_2 pollution peaks generated by incinerator operation, due to a stack-height increase from 20 m to 30 m, is significant. Thus, for short averaging periods (1 hour), this reduction approaches 36% of the maximum concentration estimated for the height of 20 m in case of the load of 110% and to approx. 45% - in case of the load of 50%. This reduction is much less significant as the stack height increases.
- For the stack height of 30 m in areas with sensitive receptors to NO_2 pollution generated by incinerator operation, i.e. the localities in the area of maximum impact, there are no exceeding of the corresponding limit values in the case of the cumulative impact of incinerator operation and background levels for any of the averaging periods.
- The cumulating of the maximum short term (hourly. daily) concentrations generated by incinerator operation with the background maximum concentrations is unlikely to achieve. This can happen only in case of simultaneity of the most adverse weather conditions in terms of pollutant dispersion for both emissions, from incinerator operation and from other pollution sources, combined with simultaneous pollutant transport from both groups of sources to the downstream receiver of the maximum cumulative impact.
- For the stack height of 30 m, in the case of exclusive incinerator operation, the maximum concentrations for the other analyzed pollutants (SO_2, PM10, PM2.5, CO, Pb, As, Cd, Ni, Hg and PAH) are well below the corresponding limit/target values for all the averaging periods. Limit values/ target values in the areas with sensitive receptors to the pollution generated by the incinerator (i.e. localities situated in the area of maximum impact) will not be exceeded by the cumulative impact with the background levels generated by other emission sources.

It can be concluded that a height of 30 m for the stack of Glina sludge incinerator is optimal to ensure the atmospheric dispersion of the pollutants emitted from the incinerator and to determine a low impact of its operation, not significantly affecting the compliance with the limit/ target values/critical levels for the ambient air. As a supplementary assurance of the best protection, a height till 40 m for the stack of Glina sludge incinerator could be considered.

6.5 Noise impact

Construction phase
During the construction phase noise will be produced by the building activities on site and by the traffic related to the transport of construction materials and waste.

The noise generated by the construction activities is expected not to surpass the accepted level for industrial sites - 65 db(A). Being a temporary nuisance and taking into account the location of the new construction within the site, it can be considered as not increasing the impact on the dwelled areas.

The traffic on roads in the surrounding of dwelled areas is a constant element of the environmental conditions and it is not expected to consistently change, as well as the noise generated by the activity in the Ochiul Boului landfill. Traffic noise could increase if transport of the dewatered sludge produced by the stage 1 of WWTP (for landfilling or recycling) will become a regular activity, but such a situation is not yet foreseen.

Operation phase
Noise generated by the traffic is not considered to become an issue for the local inhabitants even if during plant operation phase the number of cars transporting materials/personnel will increase, because a new access to the plant will be arranged opposite to the dwelled zone.

During the WWTP functioning period, another noise source could be the functioning of mechanical equipment, mainly blowers and large pumps. In order to reduce the negative effects due to the noise produced by equipment all blowers and large pumps will be placed inside buildings, on solid foundations capable to reduce vibrations and attenuate noise.

The mechanical equipment placed outside buildings has typical low sound pressure levels and will have a relatively small contribution to the general noise level in the dwelled areas.

The flare for burning combustible gases will be used only in case of emergency, because normally the combustible gases produced by anaerobic fermentation will be used for energy generation. Therefore the flare is of no significance as a noise source.

The described new sources will not generate supplemental nuisances capable to consistently modify the existing noise levels (see figures 4.15 and 4.16) that are comprised between the following values:

- 65-70 db(A) – along the main roads - A2 highway, the Bucharest ring-way and the road accessing the Ochiul Boului landfill;
- 50-70 db(A) – in the WWTP area
- 45-55 db(A) – in Glina and Popesti Leordeni villages, except the households situated near the main roads, where 60-65 db(A) is registered.

Considering the accepted values of 60-65 db(A) for industrial areas (STAS 10009-88) the new noise sources will not generate an additional impact for the dwellings in the area

6. 6 Impact related to the consumption of energy and chemicals

Construction phase

The construction of the WWTP stage II requires energy for the building activities on the site and elsewhere - for processing materials (i.e. concrete) that are used in the construction. The use of energy during the construction phase is not of major importance for the overall environmental impact of the WWTP when compared with the good effects of its activity.

No special chemicals will be used in the construction phase, except paints and ground coats. Consumption of these materials will not have a larger impact than in case of other buildings. All packaging waste resulted from such chemicals are to be correctly evacuated by the construction company.

Operation phase

The use of energy in the form of electricity can be split in two components, respectively for the water line and for the sludge line.

The electricity consumed by the water line is mainly for pumping and biological processes (aeration of activated sludge basins), the other plant components using comparatively small amounts of electricity.

The energy consumption by the sludge line is mainly for sludge pumping, anaerobic digestion sludge thickening and dewatering.

The Glina WWTP will not only consume electricity, it will also produce energy by conversion of biogas, steam reuse and outlet turbines (if the case).

The estimated consumption and production of electricity is summarized in Table 6.11.

Table 6.11 Estimated electricity consumption and generation

Activities	**Phase 1 +2 (kWh)**
Wastewater treatment	44,879,000
Sludge treatment	6,130,500
Incineration	5,440,000
TOTAL CONSUMPTION	**5 , , 00**
Energy generation (anaerobic digestion) **Energy generation (outlet turbines)** **Energy generation (steam turbines)**	 **2, 0,000** **,000**
NET CONSUMPTION	**1 , , 00**

It results that there will be a substantial consumption of energy within the Glina WWTP but the stage II project is providing different possibilities to reduce it by recovery of energy, use of heat from biogas burning, steam (from incinerator) and possibly power generated by outlet turbines.

Chemicals use

Basically, the *treatment of wastewater* does not require addition of chemicals, except the tertiary step for Phosphorus removal, where Ferric chloride (13.8% Fe) is used.

The *sludge treatment* needs chemicals, possibly polymers for thickening and dewatering. Also the incineration process uses some chemicals such as sodium bicarbonate and activated carbon for the retention of flue gas pollutants.

The yearly consumption of chemicals within the WWTP is presented in the table below.

Table 6.12 Estimated chemicals consumption

Plant process	Type of chemicals used	Quantity – t/year
Phosphorus Removal	Ferric chloride (as solution containing 13.8% Fe)	29200
Sludge Dewatering	Polymers	811
Sludge Incineration	Sand	3650
	Sodium bicarbonate	2200
	Activated carbon	60

An uncertainty is related to the consumption of additional fuel for the start-up of incineration process. One can not say if significant supplemental fuel is necessary for starting incineration because at this stage the sludge calorific value is not really known. It is still certain that supplemental fuel will be used only during the start up of the process.

Ferric chloride storage on WWTP location

Storage of $FeCl_3$ is made inside the building containing the chemical plant for supplementary Phosphorous removal. Inside the chemical plant 2 storage tanks with a volume of 120 (240 m^3 in total) are provided for storage of the $FeCl_3$. The solution needed for wastewater treatment will be prepared daily in 4 dosing tanks with a total capacity of 16 m^3 and will be introduced in the water stream by dosing pumps.

As much as possible the chemical substance must be stored in original containers. The storage tanks should be confectioned of rubber, plastics (polyethylene polypropylene, PVC or Teflon.

If packaging recycling to the manufacturer is impossible, their disposal shall be assured as hazardous waste.

Procedures for handling and actions for emergency situation

$FeCl_3$ is hazardous by ingestion, is irritant for skin and could produce eyes damage

The measures to avoid/control exposure of personal during handling $FeCl_3$ are:
- Avoid skin contact
- Wash hands before breaks and after work
- Rubber gloves for hand protection:
- Safety glasses for eye protection

Measures in case of emergency situation

In case of accidental release in the environment

- Pick up mechanically – if solid substance; pick for disposal in tightly closed containers
- Avoid solutions spillage entering surface water or soil infiltration
- Use lime to neutralize ferric chloride solution

Fire-fighting measures:

- Even in solid phase **$FeCl_3$** is not combustible, but toxic vapor may appear upon intense heating;
- Suitable extinguishing media recommended in case of fire are water, foam, carbon dioxide, dry powder. Water resulted from fire fighting should not be discharge on soil or surface waters.

One can say that the consumption of chemicals for wastewater treatment and sludge disposal within Glina WWTP will be not significant as type and quantities and will not impact the environment by the hazardousness of the substances.

6.7 Impact on the landscape

Construction phase

During the construction phase a temporary impact on the landscape will be observed from the dwelled area – Glina village – that is located south of the plant. The impact will be related to the presence of building equipment and excavations for different basins. After the completion of the construction these visual nuisances will disappear.

This visual impact is not considered to be significant because of its limited duration, the relatively small surface occupied by the stage II constructions and installations (7 ha out of the total surface of 65 ha) and the relative long distance to the village households.

Operation phase

Since part of the WWTP structures has been already built during the stage I, the additional visual impact of the stage II components will be not very obvious. The main visual impact is related to the sludge digesters that are very visible, but these structures are part of the stage I, already constructed. Most of the new structures to be built will be comparable with some of the existing ones. The maximum height of these structures will be only some meters above the ground level, except the incinerator that will be a higher construction having a stack of at least 30 meters height.

When completely constructed and the remaining free land will be covered by vegetation, the plant site will appear as a well organized space. Trees, brushes and flowers will be planted on the alley borders and other trees rows will be planted in parallel to the fence surrounding the site, in order to form a vegetal curtain to hide a part of the plant components. Finally, the Glina WWTP will be an objective with no negative impact on the surrounding landscape.

6.8 Impact on biological environment

Construction phase

The implementation of the WWTP stage II new structures need that their locations to be free of vegetation. The removal of vegetation will be limited to shrubs and grass because no trees are present on the site. This action will have a negative effect on the fauna, since several species (such as rodents. lizards. rabbits. etc.), living now on the site and in its surroundings, have to move away towards other locations.

Operation phase

After the completion of the WWTP the land unoccupied by constructions and installations will be covered by grass and flowers; trees will be planted on the alleys border and parallel to the site fence. It is not expected that the animal species will return to the site when the completed WWTP will be in operation, but it would be possible a large number of birds (seagulls especially) to halt for short time on and near the water surface, even inside the plant territory. Such situation, already observed during this study elaboration, is not a real negative effect.

6.9 Impact on human health

For the people working on the site during **construction phase**, the contractor will have to elaborate and implement a Health and Safety Plan. The safety measures will be brought to attention of all personnel that will be obliged to respect them.

Wearing protective clothes and boots, safety helmets, protective glasses, ear plugs, etc. will reduce risks for human health, that are related to fire and explosions, asphyxiation, mechanical injuries and poisoning.

Hygiene facilities will be part of the site arrangement and will help for avoiding different diseases generated by pathogenic germs living in wastewater.

During the **operation phase** similar measures for health and safety will be imposed. These measures will consider the potential risks specific to activities in construction and operation of WWTP described below.

Fire and explosions
The generation of methane (component of biogas) can cause fire and/or explosions depending on the simultaneous presence of oxygen and an ignition source. Methane is generated in the digestion tanks, stored in gas holders and used by gas engines to generate warm water or electricity. Therefore these units are specially designed and accidental ignition sources are avoided. If the WWTP is operated and maintained properly, no dangerous situations for fire/explosions will appear.

Asphyxiation
Asphyxiation can only occur in confined spaces where the oxygen content is low and gases as carbon monoxide or carbon dioxide are in higher concentration than usual. Entrance to these spaces is prohibited for unauthorized persons. Only trained personnel, using specialized equipment, will have access in such spaces in order to avoid accidents.

Poisoning
The WWTP personnel who is handling chemicals or who may be in contact with hazardous substances and gases when working on the site will have to be aware of this risk and take all needed protective measures. Preventive measures described for handling $FeCl_3$ solution have to be observed by the plant personnel.

No potential dangerous situations will occur for people outside the WWTP or living in the surroundings due to the type and the concentration of chemicals used for wastewater and sludge treatment. As a consequence, poisoning is not a real issue for such persons.

Mechanical injuries
Several components of the mechanical equipment have movable parts, which can cause accidentally serious injuries. These parts will be clearly marked and only trained personnel will have access within places containing equipment presumed to generate mechanical injuries. For visitors such places will be accessible only under supervision.

Supplementary to the specific measures described above, fencing, lighting, guarding and watching of the works and visitors will be provided anywhere it will be needed. During construction and operation all reasonable efforts will be taken to keep the site and works out of risks for individual persons. In such conditions the impact on human health and safety is insignificant.

Beside the above described risks it is to mention that for the inhabitants of the Glina Village and people living downstream the plant, the risks related to the potential spread of infectious diseases will be substantially reduced. WWTP ensuring improved conditions for preserving human health.

6.10 Impact on dwellings

The impact on dwellings is expressed by the effects on groundwater deepness, air quality, noise level, land use and socio-economic aspects.

Water supply of households in the neighbouring dwellings is no more made from underground resources. All three villages of Glina commune are connected to a centralized water supply and sewer system.

During the construction of WWTP stage II phase, the *level of the groundwater* will be lowered due to the need of working in a dry environment. Lowering the groundwater table could generate disagreements to households using wells for watering their vegetable gardens. This negative impact is expected to have low amplitude and be temporary, lasting only a part of the construction period.

Avoiding negative effects on dwellings due to gaseous emissions

Construction of WWTP stage II will generate minor *dust emissions* from traffic and excavations. These emissions will not modify the general quality of the air in the area and especially in the Glina village, due to the large size of the phase II location (65ha) and small constructed area (8.5ha).

Odours at the plant inlet due to the content of H_2S, NH_3 and mercaptans and other NMCOV in the wastewater will be reduced due to removal of materials deposited inside the Caseta and sewage main collectors, which are subject of fermentation causing odours.

Odour emissions could still appear at the influent entrance in the WWTP and further in the area of sludge thickeners. These compartments will be covered and the air will be purified before exhausting. Efficient odour treatment will be provided to the following components of the plant: the plant inlet installation - screens and pumping stations, primary sludge thickeners, SAS buffer tanks, thickened sludge buffer tanks, digested sludge storage tanks and emergency storage tank, as well as to the buildings housing the equipment for sludge dewatering (gravity belt thickeners for SAS. belt filter presses and centrifuges).

The height of 30 m for the stack of Glina sludge incinerator was defined as optimal to ensure the atmospheric dispersion of the pollutants emitted from the incineration process and to determine a very low impact, not affecting the compliance with the limit/ target values/critical levels for the air quality. For more assurance a stack height till 40 m could be considered.

The biogas combustion gases from CHP devices will be evacuated in the atmosphere only after treatment in order to reduce the pollutant concentration ($NaHCO_{3,}$ wet scrubbing, activated carbon treatment).

Traffic inside the Glina WWTP will be optimised in order to reduce the air pollution with burned gases.

A new modern access road will be constructed in order to avoid nuisances due to the traffic related to WWTP (especially dust).

At the plant limit, in parallel to the fence surrounding the site, a vegetal curtain is proposed to be created by planting trees and brushes; grass will cover the surfaces not occupied by constructions/installations; trees and flowers will border the alleys. The new vegetal cover of the site will improve the air quality by retention of particulates, consumption of CO_2 and raising the O_2 concentration.

Noise produced during the construction of WWTP stage II by the building activities and by the traffic related to the transport of construction materials and waste will not impede the life conditions in the neighboring dwellings.

During the functioning period, main noise source will be the mechanical equipment (blowers and large pumps). Measures for noise abatement and the large surface of the site will contribute to the reduction of any supplemental impact on dwellings due to noise, whose level inside Glina village will remain within the limits of 45-55 db(A).

The implementation of the Glina project stage II will have beneficial *socio-economic influences* on dwelled areas expressed as new job opportunities for local people, appearance of small scale companies, extension of the dwelled area, increasing of the properties value, all these effects leading finally to an improved life standard for the inhabitants.

6.11 Accident Management Plan

The elaboration of the Accident Management Plan is the task of the Glina Plant operator.

The legal basis of such a document is provided mainly by the Law of water and Law for civil protection and the Order 638/420/2005 for approval of the Regulation on management of emergency situation generated by flooding, dangerous meteorological phenomena, accidents to the hydro-technical constructions and accidental pollution.

The Accident Management Plan is required for delivery of the environmental authorization when the plant will be put in function. A version of such a plan is already elaborated for Glina WWTP stage I. This plan has to be completed and detailed with measures related to Glina WWTP stage II after its finalization.

In the following some principles and elements to be taken into account when elaborating the Glina WWTP Accident Management Plan are detailed.

The most probable negative event that could happen in the activity of a WWTP is an *accidental pollution of the surface water receiving the treated effluent.*

An accidental pollution of water is usually due to discharge/loss of untreated waste water or effluent having abnormal characteristics. This situation could be caused by:

- accidental discharge of unusual pollutants into the sewage system by clients connected
- natural disasters – heavy rains, large fire, earthquake, etc.
- interruption of electricity supply causing partial plant functioning breakdown.

The above mentioned accident causes have low probability to appear but they could produce disastrous effects for the treatment process, quality of the WWTP effluent and the receiving surface water. For such reason the Plan for risk management elaborated by the plant operator has to be focused mainly on avoiding and abatement of accidental pollution.

The risk management plan shall refer to:
- prevention and preparing for intervention in case of accidents
- operative measures for intervention
- actions for remediation of negative effects after accident.

In case of Glina WWTP the mentioned plan has to include at least:
- procedures for rapid announcement of persons having tasks in prevention/intervention/remediation (names in hierarchical order with contact data. type of information to be provided to each one)
- establishing action teams for each critical point and define responsibilities
- lists of materials/equipment to be available for accidental situations and supply rules for them
- planning trainings of the intervention teams
- list of authorities that could help / contribute to accident effects abatement
- list of downstream activities that could be affected by the accidental pollution
- rules for reporting on the accident, intervention actions and applied remediation measures.

The Plan shall identify:
- critical points
- most probable types of accidents
- possible accident causes
- recommended measures
- responsibilities for each critical point/type of action.

A list with main potential pollutants and specific abatement measures shall be compiled. too.

The table below describes the estimated most probable critical points, types of accidental pollution and their possible causes in case of Glina WWTP. For these types of accidents specific measures/actions and responsibilities have to be provided.

Critical points	Types of accidents	Accident causes	Proposed measures
Inlet of the wastewater from Caseta into WWTP	Accidental discharge of wastewater into the river by weirs accidental opening	Incorrect functioning of the inlet constructions	- Correct operation ot the weirs and influent pumping station - Executing current repairs and scheduled revisions
Discharge of primary sedimentation tanks	Effluent of the primary sedimentation tanks exceeds the	Incorrect functioning of screens, grit chambers and primary sedimentation tanks	- Continuous cleaning of screens; - Periodic discharge of sand accumulated in grit chambers;

	design parameters for the biological stage		- Periodic discharge of collected grease - Correct distribution of influent to the primary sedimentation tanks
	Loss of primary sludge together with the effluent of primary sedimentation tanks	- Incorrect functioning of traveling bridge scrapers - Incorrect functioning of pumping stations removing the sludge collected in the central hoppers of settling tanks	Control of functioning regime of the bridge scrapers and sludge pumps; - Executing current repairs and scheduled revisions of pumps and bridge scrapers
Discharge of secondary sedimentation tanks; the treated effluent is not complying discharge conditions	High values of BOD. COD that does not comply with the effluent discharge conditions	- Low oxygen concentration because bad functioning of AS basins aeration system or blowers failure - low concentration of activated sludge even when exceeding recommended recycling rate - RAS pumping is not functioning	- Observing the blowers functioning regim; - Raising the activated sludge recycling rate - Executing current repairs and scheduled revisions of blowers and RAS pumps
	High values of suspended solids in the effluent; loss of activated sludge with the effluent;	- Failure in AS basins oxygenation - appearance of floating sludge - sludge bulking; SVI over 150; - malfunctions of secondary sedimentation tanks. respectively of traveling bridge scrapers	- Repairing blowers and maintain the AS normal aeration regime. - Equalize the hydraulic load in all secondary sedimentation tanks; - Repairing traveling bridge scrapers within secondary sedimentation tanks.
	High values of Nitrogen compounds	Disturbance of nitrification and denitrification processes	Respect the aeration regime in the AS basins
	High values of Phosphorus compounds	- Failure in BIO-P functioning - Inefficient chemical treatment for Phosphorus removal	- Compliance with the functioning parameters of the Phosphorus chemical precipitation plant; - Accurate and flexible dosing

		(reactant dosing deficiencies)	of ferric chloride in relation to the Phosphorus concentration
Temporary sludge storage	Uncontrolled spillage from pipes. basins. reservoirs	- Insufficient tightness - Pumping stations failure	- Continuous monitor of pipes. basins/tanks tightness; - Immediate repair of identified defects; - Non-exceeding the capacities; - Current repairs and scheduled revisions
Anaerobic digestion	Failure in process functioning	- pH variations (acidification) - large temperature variations under the mesophilic regime; - high concentration of toxic compounds (i.e. heavy metals)	- Observing the digester supply program ; - Avoid load shocks; - Respecting the temperature regime; - Control the heavy metals concentrations in supplid sludge
Incineration	Non-compliance with regulated conditions for emissions in the air.	- sludge high humidity (more energy consumption for drying) - flue gas cleaning system does not working correctly	- Use auxiliary burners and supplementary fuel; - Remediate defects of the burning gas cleaning system
	Air pollution due to powder spreading in the air	- Ash bunkers bad maintenance and incorrect ash handling	- Respecting the program of ash discharge; - Respecting the ash handling conditions
	Interruption of incinerator functioning for a longer period of time	- Incinerator regular revision - Important technical failure	- Use sludge storage capacities (buffer basin for thickened sludge + buffer basin for digested sludge; being designed for a 38 h retention time. these basins will assure sludge storage for more than 3 days; - Dewatered sludge will be stored on the existing storage platform (800 m^2) for at least other 3 days. - In case of incineration interruption for more than 6-7 days the sludge could be eliminated by depositing. as practiced with the sludge generated in phase 1.

Chapter 7 GLOBAL EVALUATION OF THE PROJECT IMPACTS

In order to synthesize the elements presented in Chapter 7 the table 7.1 has been elaborated.

From this table one can conclude the followings

a) most forms of the impact of the analyzed project are:

- direct (14 of 22);
- significant (16 of 22)
- positive (17 of 22)
- permanent (18 of 22)

b) only 5 forms of impact are negative;

c) almost half of the impact forms are cumulative (11 of 22);

d) more than half of the impact forms will appear in medium time (12) while the other will appear in short time (10).

Table 7.1 Characterization /classification of identified impact forms related to the construction and operation of Glina WWTP stage II

Identified impacts	**Significance of impact**		**Nature of impact**					**Term of appearance**		**Duration of impact**	
	Significant	**Not-significant**	**Direct**	**Indirect**	**Pozitive**	**Negative**	**Cumulative**	**Short**	**Medium**	**Temporary**	**Permanent**
Impact on surface water Improving of water quality in Dambovita river downstream Bucharest	**x**		**x**		**x**			x			**x**
Increasing the capacity of auto-purification of the river water	**x**			x	**x**		x		x		**x**
Increasing the biodiversity (vegetation. fishes. reptiles. birds. mammals);	**x**			x	**x**		x		x		**x**
Increasing the abundance of life forms in river water and on the river banks;	**x**			x	**x**		x		x		**x**
Improving the area general perception due to reduction of floating refuse and unpleasant water colour	**x**		**x**		**x**			x			**x**
Increasing of the fishing activity		x		x	**x**				x		**x**
New recreation activities along the river	**x**			x	**x**		x		x		**x**
Development of irrigations and extension of the cultivated lands	**x**			x	**x**				x	x	
Appearance of new companies especially small scale industries on the river banks;	**x**			x	**x**		x		x	x	
Improving of water quality in Arges River after the confluence with Dambovita	**x**		**x**		**x**		x		x		**x**
Reduction of pollutants brought into the Danube River	**x**		**x**		**x**				x		**x**

Identified impacts	**Significance of impact**		**Nature of impact**					**Term of appearance**		**Duration of impact**	
	Significant	**Non-significant**	**Direct**	**Indirect**	**Pozitive**	**Negative**	**Cumulative**	**Short**	**Medium**	**Temporary**	**Permanent**
Impact on groundwater **L**owering of level		x				**x**		x		x	
Impact on air Disappearance of odour generated by the untreated wastewater	**x**		**x**		**x**		x	x			**x**
Sludge incineration and biogas burning will generate CO_2. NO_2. SO_2 and particulates		x	**x**			**x**		x			**x**
Noise Noise produced by more traffic and equipment such as blowers and large pumps		x	**x**			**x**		x			**x**
Consumption of resources Energy and chemicals consumption	**x**		**x**			**x**		x			**x**
Lanscape Local appearance of new constructions. green spaces and tree curtains surrounding the site. Improvement the landscape along the river	**x**		**x**		**x**		x	x			**x**
Impact on fauna Effects on the fauna since several species have to move away their habitat. Sea-gulls invasion.		x	**x**			**x**		x			**x**
Impact on human health Reducing the risks of infectious diseases for people living in the plant surroundings and downstream	**x**		**x**		**x**			x			**x**
Impact on dwellings and other objectives Possible extension of dwelled areas;		x	**x**		**x**		x		x		**x**
Increasing the properties value due to the improvement of the general perception of the area	**x**		**x**		**x**		x		x	x	
Socio-economic effects - more working places; - increased income for local inhabitants - improved life standards	**x**		**x**		**x**		x		x		**x**

Chapter 8 ENVIRONMENTAL CONTROL AND MONITORING

The monitoring program will be implemented in order to survey the impact of the Glina WWTP on the environment. Based on the monitoring results it will be possible to control the environment quality and, when necessary, to undertake additional measures for further reduction of negative impacts.

The monitoring data will be used also to demonstrate the compliance with legislation and conditions imposed by the environmental permit. These data will be periodically reported to the interested authorities.

Aspects considered when scheduling the monitoring program are related to the identified impacts that:

- can be measured and expressed by parameters
- are measurable without excessive costs
- are important for the surroundings
- can be mitigated or reduced.

The monitoring program contains: parameters, proposed measurement frequency and location of sampling points.

The monitoring program shall be composed of two parts:

- processes monitoring program
- emissions monitoring program

Monitoring of wastewater treatment process

Waste water treatment process will be monitored in each step from the entering of influent till the discharge of the treated effluent.

Treatment phase	Plant component	Monitored item	Parameters
Primary treatment stage	inlet devices – pumps within the distribution chamber	inflow wastewater	- flow - quality parameters: SS, COD, BOD, total N, total P, heavy metals and others (as requested by the water permit).
	coarse/fine screens	screenings	quantity as DS
	grit chambers	sand	quantity as DS
	grease separators	grease	quantity as volume
	primary settling tanks	influent	- quality parameters: SS, COD, BOD, total N, total P, heavy metals
		effluent	- flow - quality parameters: SS,

			COD, BOD, total N, total P, heavy metals
		primary sludge	- flow - concentration as total SS/DS/VS
	storm basins	effluent	- flow - quality parameters: SS, COD, BOD, total N, total P, heavy metals
		primary sludge	- flow - concentration as total SS/DS/VS
Secondary (biological) treatment stage	aeration tanks	activated sludge suspension	- Oxygen concentration - temperature - SS/DS/VS - sludge volume index - microbiological composition
	ARS tanks	activated recycled sludge	- flow - SS/DS/VS
	secondary settling tanks	effluent	- flow - quality parameters: SS, COD, BOD, total N, total P, heavy metals, etc.
		surplus activated sludge – SAS	- flow - SS/DS/VS

Monitoring of sludge treatment processes

Sludge thickening stages will be surveyed by:

- concentration of sludge in primary sludge thickeners (gravity thickeners), total DS/VS
- flow and concentration of primary sludge after belt filter presses - total DS/VS
- quantity and concentration of excess activated sludge in SAS buffer basins as total DS/VS
- load of SAS thickening – gravity belt thickeners for SAS - as total DS/VS and polyelectrolyte consumption
- quantity of mixed thickened sludge in mixing buffer tanks and sludge concentration-DS/VS

Sludge anaerobic digestion will be monitored by automatic measuring of:

- daily inflow in digestion tanks
- pH
- temperature
- mixing regime
- fatty acids concentrations
- biogas production – Nm^3/day
- biogas components – CH_4, CO_2, H_2S, NH_3, etc.

Dewatering of digested sludge will be monitored by:

- quantity of digested sludge stored in storage tanks and emergency storage tanks and concentration - as total DS/VS
- centrifuges performance in dewatering digested sludge: load, conditioner consumption, quantity of dewatered sludge/cycle, humidity reduction, total DS/VS.

Monitoring of incineration process

Monitoring of incineration parameters is assured by automatic equipment – for ex. infrared cameras for combustion monitor and control or devices placed at the stack exit - and are visualized on the control panel installed in the process control room

Sludge feed in the incinerator will be monitored to know:

- quantity feed
- its characteristics – humidity and net calorific value

Combustion process *monitored parameters:*

- temperature at the inner wall of the combustion chamber
- quantity of air injected by the 2 funs (placed underneath and above the fluidized bed)
- oxygen concentration in the combustion chamber
- fluidized bed velocity
- turbulence of gases in the combustion zone
- residence time of gases at the temperature of 850°C after the last air injection
- auxiliary burners functioning time
- quantity of supplemental fuel consumption.

Flue gas treatment*:*

- electrostatic precipitator operation parameters; quantity of ash collected
- quantities of additives introduces into the flue gas flow
  - NOx reduction agent (NH3 or urea)
  - NaHCO3
  - activated carbon
- bag filter operation; quantity of ash collected

Operational parameters of ***auxiliary installations*** *related to the combustion chamber:*

- sludge dryer (rotary drum dryer) that includes an heat exchanger for heating drying air; an demister and a suction fun
- boiler
- evaporator
- combustion air heater
- economizer
- steam turbine

Incineration residues:

- quantity of the bottom ash. ESP residues, bag filter residues, APC residues
- quantity of sand replaced from the fluidized bed
- pollutant content in all mentioned residues (pH, sulphates, chlorides, TOC, heavy metals)

Monitoring of emissions at the stack exit:

- flue gas flow
- flue gas temperature
- flue gas pressure
- oxygen content in flue gas
- water vapors in the flue gas
- flue gas pollutant contents (as mentioned in the Emissions Monitoring program - below)

Monitoring and control of flue gas emissions is assured by automatic devices placed at the stack exit and data are visualized on the control panel installed in the process control room.

The periodicity of specific emissions analyses will comply with the regulation in force (GD 128/2002 actualized) and the environmental authorization.

The results of emissions measurement will be recalculated to the standard conditions specified in the regulations: temperature - 173K, pressure -101.3kPA, 11% oxygen using conversion factors, equations and PC programs.

8.1 Emission Monitoring Program during the construction period

Table 8.1 Proposed Emission Monitoring Program during the construction period

Environment component	Emission or monitored parameter	Frequency	Monitoring location
Soil	Types and quantity of leakage or spills	Daily	WWPT stage I and II site; Chemical stores
Waste	Types and quantities of construction	Daily	WWTP stage II site
	Quantity of municipal waste	Weekly	WWTP stage II site
	Quantity and quality of dewatered sludge (determining at least dry substance and heavy metal content	Daily	WWTP stage I
	Sand (quantity as DS)	Daily	grit chamber of Line I
	Screenings (quantity -DS)	Daily	coarse and fine screens of Line I
Water	Line I effluent by determining flow and quality parameters as established by the Water authorization no 291/26.12.2011	Daily	Effluent discharge point into Dambovita river

	Groundwater – level and quality of discharged groundwater from wells	Monthly	Survey wells near the area of stage II constructions
Air	Emissions of CHP gases: NO2, SO2, H2S, gas temperature, ash particulates	Continuously	At the stack
	Ambient air quality: SO_2, NO_2, NH_3, H_2S, CO, particulate matters - PM10 and PM2.5 fractions, heavy metals in the PM10 fraction of the particulate matters and NMVOC (for odors).		
Noise	Noise level	Four times per year	At the site limits

8.2 Monitoring program during the operation period

Table 8.2 Proposed Monitoring Program during operation period

Environment component	Emission or monitored parameter	Frequency	Monitoring location
Water	Effluent - flow - quality (pH, CBO_5, COD, N, P, suspended solids, etc)	continuously	Effluent discharge point
	Surface water quality (pH, CBO_5, COD, N, P, suspended solids, etc)	Monthly	Dambovita upstream and downstream
	Groundwater level and quality	Monthly	Survey wells
Air	Emissions from biogas burning within CHP: particulates, NO_2, CO, TOC, HCl, HF, SO_2;	Continuously	Gas engines stack
	Flue gases from sludge incinerator: - flow - temperature/pressure - oxygen content - vapors content - pollutant content (NO_2, CO, particulates, TOC, HCl, HF, SO_2, etc.)	Continuously	Incinerator stack
	Flue gases from sludge incinerator: - heavy metals - dioxins and furans	At least twice per year. except for the first year of operation when one	Incinerator stack

		measurement each 3 months is required	
	Ambient air quality: SO_2, NO_2, NH_3, H_2S, CO, particulate matters - PM10 and PM2.5 fractions, heavy metals in the PM10 fraction and NMVOC (for odour).	Continuously.	At the local stationary station
Waste	Sand (quantity as DS)	Daily	Grit chambers of Lines I + II
	Screenings (quantity -DS)	Daily	Coarse and fine screens of Lines I +II
	Domestic waste - quantity	Weekly	WWTP site
	Quantity and pollutants concentration for: - bed ash - ESP ash - filter ash - APC residues	Weekly	WWTP incinerator
Noise	Noise level	Four times per year	At the site limit
Soil	Types and quantity of leakage or spills	Daily	WWPT stage I and II site; chemical stores; fuel reservoirs

All results of measurements will be registered and processed in order to offer an easy manner to verify the conformation with authorized operation conditions and limit values for emissions established by regulations.

Environmental control and monitoring during Glina WWTP operation is focused especially on water, air and waste. Equipment for automat sampling and monitoring of emissions in water and air will be installed.

8.3 Aspects related to the water quality control and monitoring

Points for **measurement of influent and effluent water** characteristics will be placed in sections where representative data could be obtained. Measurement points and conditions will be established in common with the water authorities and included in the water authorization.

The adequate functioning of the equipment for automat monitoring of water quality shall be verified by annual controls and test. Calibration of this equipment will be made by parallel measurements with reference methods at least once by 3 years.

The monitoring of groundwater for relevant hazardous substances is also necessary. The regular maintenance and surveillance of measures taken to prevent emissions to soil and groundwater will be subject of the periodic checking in relation to relevant hazardous substances found on the site.

8.4 Aspects related to the air quality control and monitoring

The air monitoring program is related especially to the sludge incineration process. Monitoring of air emissions will be carried out in accordance with the Directive 2010/75/EU on industrial emissions - **Parts 6 and 7 of Annex VI.** A special attention will be given also to odour emissions, this being a disturbing element for human life. For this reason measurements of H_2S and mercaptans will be made at the plant limit in the vicinity of Glina households.

Equipment for measuring incineration process parameters and air emissions will be provided as required by the European and national regulations. The functioning of the automated measuring systems shall be subject to control by mean of parallel measurements with the reference methods at least once per year, as set out by point 1 in Part 6 of Annex VI within the Directive 2010/75/EU on industrial emissions.

Sampling and analyses of pollutants, including dioxins and furans, as well as methods for calibration of automatic measurement systems will be in conformity with European Community reference standards – CEN. In case of lacking CEN standards, equivalent international standards will be applied.

Measurement conditions (as requested by **IE Directive 2010/75/EU**)

Air emissions resulted from sludge incineration process will be controlled by continuous measurements of the following indicators: NOx, CO, total particulates, TOC, HCl, HF, and SO2. The competent authority will determine the location of the sampling or measurement points to be used for the monitoring of emissions.

The incineration process will be controlled by continuous measurements of the following process parameters:

- temperature (near the inner wall or at another representative point of the burning chamber as authorized by the competent authority)
- oxygen concentration
- pressure, temperature and water vapors content in flue gases.

The residence time, minimum burning temperature and the oxygen content of waste gases will be subject of appropriate verification at least once when the plant is brought into service and under the most unfavorable operating conditions anticipated.

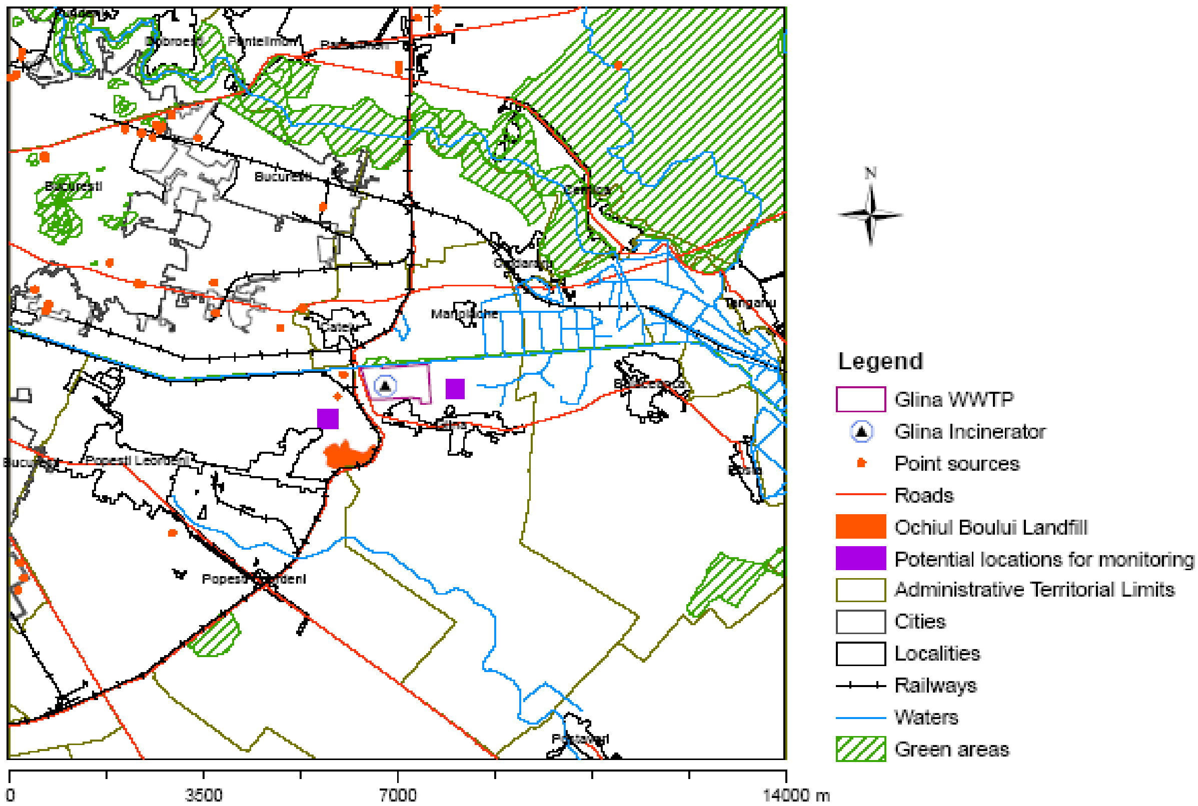
All air emissions and process **monitoring results shall be recorded**, processed and presented in such a way as to enable the competent authority to verify compliance with the operating conditions and emission limit values which are included in the permit.

Monitoring of ambient air quality

For this type of monitoring it is recommended to install a local air monitoring station containing devices that are doing automatic measurements. The main quality parameters to be monitored are: SO_2, NO_2, NH_3, H_2S, CO, particulate matters - PM10 and PM2.5 fractions, heavy metals in the PM10 fraction of the particulate matters and NMVOC (for odours).

At present, there is no ambient-air quality monitoring station in the area of Glina WWTP impact.
A possible location of an air-quality monitoring station could be one of the two perimeters illustrated on the map "Potential locations for air-quality monitoring station in the area of Glina sludge-incinerator". These perimeters were selected in order to catch as much as possible the impact of the incinerator and WWTP and less of other emission sources in the area, except these ones. **It is to mention that this monitoring station is not part of the analyzed project and consequently will be not covered by the financial application**.

Potential locations for air-quality monitoring in the area of Glina sludge-incinerator



8.5 Aspects related to the waste quality control and monitoring

In case of Glina WWTP the disposal of the technological waste (screenings and grit/sand. bed slag and ashes. fly ash and APC residues) will be made by landfilling on non-hazardous or respectively hazardous waste deposits.

Monitoring and control of waste characteristics will be performed on site periodically in order to verify the appropriateness of the disposal solution.

During the construction of the incinerator the generated dewatered sludge need to be sent to a landfill because it is not appropriate for agricultural use, considering the content of heavy metals. The hazardousness of the dewatered sludge will be monitored by periodically testing of the leachability of heavy metals (As, Cd, Cr, Co, Cr, Hg, Pb, Mo, Zn, etc) in order to establish the type of landfill for its disposal.

Procedures and standards to be applied for classification and treatment of granular waste are provided within the **Ministerial Order 95/2005** on establishing criteria for acceptance of waste for landfilling and procedures for acceptance to each landfill classes – Section 3 – entitled "Methods for sampling and analyses". The recommended standard is **EN 12457/1-4 – Lixiviation** – Test for verifying the conformity to lixiviation of granular waste and sludge.

The testing results will be compared with the criteria for conformation with the conditions for landfilling on different landfills classes included in Section 2 of the Order 95/2005 (pollutant values in leachate obtained in different lixiviation conditions meaning liquid/solid proportions).

After putting in function of the incinerator, the sludge heavy metal content will be concentrated within solid residues such as bed ashes. ESP ash and filter ash.

The characteristics of the ashes from incinerator bed, from ESP and from bag filters need to be also monitored by periodical testing, including leachability of heavy metals (As, Cd, Cr, Co, Cr, Hg, Pb, Mo, Zn, etc), in order to confirm the adequacy of the disposal solution.

The appropriate solution seems to be – at least for the moment - landfilling in dedicated cells for hazardous waste on the territory of a municipal landfill. If in the future a new technology for recycling these ashes will be developed, this opportunity will be considered.

Chapter 9 MAIN OPTIONS STUDIED

As discussed above, there are no other options to consider for Glina WWTP stage 2 than the extension of the WWTP stage 1. Glina Stage 2 will be designed for the treatment of wastewater generated of Bucharest municipality and 10 surrounding dwellings.

9.1 General Options Description

During work with the Feasibility study and from design and operation of Stage 1 experience, different options have appeared to be considered when designing Stage 2. The general description of these options is presented below.

Table 9.1 General Options Description

General tasks	Specific tasks	Options
Sewage network	Reduction of infiltration flow to the sewer network	High infiltration reduction option (HIR), reduction: 4.02 m^3/s
		Intermediate infiltration reduction option (IIR), reduction: 3.43 m^3/s
		No infiltration reduction option (NIR), reduction: 0.86 m^3/s
Sludge treatment	Final sludge disposal	Agricultural use
		Landfilling
		Incineration

9.2 Screening of options

The options defined in Table 9.1 are discussed and screened in Tables 9.2 - 9.4.

Table 9.2 First screening of options

Specific task	Option	Justification for selection	First screening
Reduction of infiltration flow to the sewer network	High infiltration reduction option (HIR); reduction: 4.02 m^3/s	**- Advantages:** 1. Indicates an **offensive** action plan to reduce the infiltration; 2. Results in a **decrease** of the needed investments for the **WWTP**; 3. Results also in **lower** O&M costs for the **WWTP**.	Retained

		- **Disadvantages:** 1. It may be **hard to implement** HIR **until 2015**. If the planned measures in the Caseta cannot be fulfilled until 2015, there may be problems to meet the effluent requirements for the extended WWTP, which will be considered very **negative** by the authorities and EU.	
	Intermediate infiltration reduction option (IIR). reduction: 3.43 m^3/s	- **Advantages**: 1. The Intermediate infiltration (IIR) option takes into consideration the possibility that the measures to reduce the infiltration may take **longer** to realize. which **secures** the ability to produce an effluent with **quality** according to the **EU Directive**; 2. An assumption of **slower** implementation of the plan to reduce the infiltration does, however, **not mean** that the **long term target** for reduction cannot be met in the end; it is just a matter of time. 3. The IIR option is considered to be a **realistic** option to implement until 2015. - **Disadvantages:** 1. The IIR option will result in **higher** investment costs for the **WWTP** than HIR; The IIR option will also result in **higher** operation and maintenance (O&M) costs for the **WWTP** than for HIR.	Retained
	No infiltration reduction option (NIR). reduction: 0.86 m^3/s	- **Advantages**: 1. This No infiltration reduction option (NIR) takes into consideration the possibility to **not** reduce the infiltration very much. 2. This means **considerably reduced costs (investment as well O&M** costs) of the measures for the **Caseta** and the **sewer network**. - **Disadvantages:** 1. The NIR option will result in **higher investment costs for the WWTP;** 2. The NIR option will result in **higher** operation and maintenance (O&M) costs	Retained

		3. Even if no measures are taken to reduce the infiltration flow, **actions must be taken** to **secure the structure** of the Caseta.	
Final sludge disposal	Agricultural use	**- Advantages:** 1. **Positive effects** on **crops** by supplying nutrients like N and P **2.** Can contribute to **improvement of soil fertility** due to the high content of organic substance **3.** Comparatively **easy to handle** (by professional contractors). - **Disadvantages**: 1. **Presence of heavy metals** in the sludge 2. **High transport cost** 3. The **impact** on the environment from sludge **transportation** will be considerable.	Retained
	Landfill	- **Advantages**: 1. Easy to handle**;** is the main option in Romania today (78.6%). 2. The **capital cost** for landfills is comparatively **low** - **Disadvantages:** 1. The **operation costs** for transportation and handling of the sludge will be **very high** for a sludge with a comparatively low DS content 2. The **impact** on the **environment** from sludge **transportation** will be important 3. This option will **not be allowed to be used** in the future 3. The **landfills capacity** would be rapidly consumed.	Retained
	Incineration	- **Advantages:** 1. Incineration **reduces the amount** of sludge to a large extent; 2. Handling of the residue (ash) is most often **easy to carry** out; 3. The **cost** for handling the small amounts of sludge is comparatively **low**; 4. **Eliminate** organic compounds and odour. - **Disadvantages**: 1. The **capital cost** for incineration is **high**; 2. The ash from incineration may be	Retained

		hazardous waste with consequences for both. further handling and final disposal; - **Justification for selection** The quality of being able to considerably reduce the sludge amounts is of extreme importance, especially for a very large WWTP as Glina. This quality outweighs all disadvantages.	

For choosing the final sludge disposal solution it was necessary to further analyze the three options - *agriculture use*, *landfill* and *incineration.*

To compare the three sludge disposal options a calculation of **Net Present Value** (**NPV**) **of CAPEX and OPEX** has been carried out for the design horizon 2040, with a discount rate of 5% -Table 9.3. Considering the environmental impact, the ENPV was calculated also as economic externalities for CO2 emissions during transport - Table 9.4.

In the frame of these ENPV calculations the values for different parameters used were the followings:

Transport per vehicle, as dewatered sludge	15 m3/transport
Transport per vehicle, as ash after incineration	11 tons/transport
Distance to landfill (2 ways)	100 km
Distance to agriculture areas (2 ways)	200 km Diesel
consumption	25 l/100 km
Specific diesel emission	2660 g/l diesel

Table 9.3 NPV for Agricultural use, Landfilling and Incineration options

MEUR.

Agricultural use			**Landfilling**			**Incineration**		
CAPEX	OPEX	CAPEX +OPEX	CAPEX	OPEX	CAPEX +OPEX	CAPEX	OPEX	CAPEX +OPEX
3.28	129.83	133.11	0.00	122.88	122.88	63.99	73.08	137.07

Within the calculation in table 9.3:

- the OPEX for landfill and incineration includes the cost for landfilling, which is assumed to be **1 time** the transportation cost for the dewatered sludge (with 35% DS) and **3 times** the transportation cost for the ash, as the ash may be considered as hazardous waste.

- the cost for transportation of sludge to agricultural land with a DS concentration of 28% is assumed to be 50% higher, because the sludge is delivered to different places, which is more expensive. Total OPEX for this option also includes the spreading.

The figure 9.1 shows the influence of the transport price on the NPV for the three options (2012-2040).

Today, with the current price for transportation and disposal (35 EUR/ton for transport and 35 EUR/ton for disposal) of dewatered sludge or incinerated ash, the NPV is the lowest for the landfill option (122.88 MEUR), while the NPV for incineration is the highest (137.07 MEUR). The NPV for the agricultural option is found to be 133.11 MEUR.

If the price for transportation would increase to 38 EUR/ton, the NPV would be the highest for the agricultural use option. With a price for transportation of 42 EUR/ton also the landfill option would be higher than the incineration option. This is indeed possible and, according to ANB, the transportation price can become as high as 50 EUR/ton and even higher in the future.

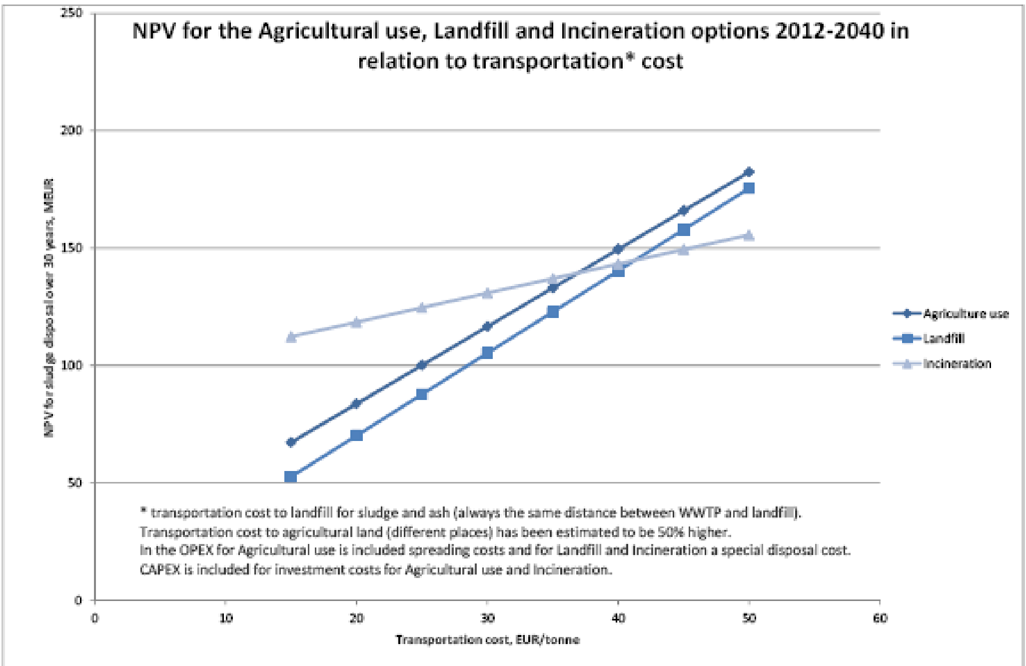


Fig.9.1 NPV for the three options as related to the transport cost, MEUR

Related to the environmental impact, it has been calculated that a considerably greater number of transports is needed for the agriculture use and landfill options compared with incineration, which will create problems caused by emissions of CO_2.

To compare the three options from the environmental point of view, the **ENPV** (**Economic Net Present Value**) has been calculated considering the economic externalities for CO2 emissions during transport. The ENPV calculation is presented in Table 9.4.

Table 9.4 ENPV for CO_2 emissions due to transport of dewatered sludge and ash

MEUR

Options	**Agricultural use**	**Landfilling**	**Incineration**
ENPV (2016-1040) With discount rate 5 %)	**959265**	**383706**	**94001**

In summary, considering issues regarding the final sludge handling, the **incineration option is to be recommended** for Glina WWTP.

9.3 Presentation of final options

For further evaluation a decision about the target for the **infiltration flow** in the short perspective (2015) should be considered. The options regarding the infiltration flow, already defined, are further described in Table 9.5.

Table 9.5 Characteristics for the three infiltration reduction options

Characteristics	**Unit**	**High infiltration reduction (HIR)**	**Intermediate infiltration reduction (IIR)**	**No infiltration reduction (NIR)**
Infiltration flow 2015	m^3/s	1.35	1.94	4.50
Dry weather flow 2040	m^3/s	7.68	8.27	10.84
Design flow mechanical treatment 2040	m^3/s	22.4	23.8	30.0
Design flow biological treatment 2040	m^3/s	11.2	11.9	15.0

The choice between these three options is very important for the operation of Stage 2 when it will be commissioned 2015.

- The **HIR** option is the most ambitious option of the three. It includes **all 10** actions presented in the “Financing Substantiation” from August 2010.
- The **IIR** option includes only **6** actions.
- The **NIR** option, finally, includes **2** of the proposed actions as these are primarily aimed to guarantee the structural stability in the sewer network and the Caseta.

The needed extension for each option referring to WWTP Stage 2 is summarized below.

Table 9.6 Needed extensions of equipment in WWTP Stage 2 for the 3 options

Main option	HIR	IIR	NIR
Septic sludge reception	1	1	1
Coarse screens	3	4	7
Inlet pumps	2	2	4
Fine screens	2	2	4
Grit chambers	2	3	4
Grease removal tanks	8	9	10
Primary sedimentation tanks	3	4	7
Aeration tanks	12	12	12
Secondary sedimentation tanks	36	48	60
Gravity thickeners for primary sludge	0	0	0
Mechanical thickening of biological sludge	3	3	3
Digesters	0	0	0
Sludge dewatering centrifuges	2	2	2
Gas holders	0	0	0
CHP	0	0	0
Odour treatment	5	5	5

To be able to define the final option, the options have been compared and evaluated from financial and economic point of view.

Table 9.7 Estimated investment costs for the 3 options, MEUR

Cost parameters	**Option**		
	HIR	**IIR**	**NIR**
Collector rehabilitation	34.84	34.84	41.84
Infiltration reduction and reduction of other undesired water	88.63	39.13	0
Caseta structural strengthening	93.41	93.41	93.41
Glina WWTP, Stage 2	78.89	85.42	99.83
Incinerator	68.42	68.42	68.42
Total	**364**	**321**	**303**

CAPEX and OPEX for the Caseta and Collectors rehabilitation works are based on ANB data and information.

The associated costs for each of the options described above are for:

- Initial investment costs;
- Operating expenses;
- Maintenance and renewals costs;
- Income from the sale of electricity generated by biogas, outlet turbines, steam turbines.

The following assumptions are made:

- A 5 percents discount rate
- A 30 year evaluation period from 2011-2040;
- Stage 2 construction is complete by the end of 2015.

Table 9.8 Evaluation of costs for the 3 options, MEUR

Cost parameter	Option		
	HIR	IIR	NIR
Investment costs (2011)	364	321	303
CAPEX (NPV)	307	272	258
OPEX (NPV)	298	300	330
CAPEX+OPEX (NPV)	**605**	**572**	**588**

The **IIR option** resulted to be the most economic one according to Table 9.8.

Based on all current information, SHS JV consortium recommended **continuing with IIR as the agreed option for further elaboration of the Feasibility Study** and its including in the Cohesion Fund Application.

PART II

EIA of the works the Bucharest sewerage system rehabilitation

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Chapter 1 GENERAL DATA

1.1 Necessity and opportunity of the project

The Municipality of Bucharest is located in the centre of the Romanian Plain, covering an area of 23,787 hectares and is the most important political, economic and cultural centre in Romania. Bucharest Municipality has a combined sewerage system that extends throughout the developed area of the city and surrounding dwelling areas.

The sewer network receives domestic wastewater from approximately 95 % of the population of 1,925,000 persons, wastewater from neighboring communities, industrial wastewater and surface water runoff during storm events. Collected wastewater is transported to the site of Glina wastewater treatment plant (WWTP) to the south-east of Bucharest where, after treatment, it is discharged into the River Damboviţa.

The sewerage system is owned by the Bucharest Municipality, but operated by "Apa Nova Bucharest" – ANB (a subsidiary of Veolia Company).

In relation to the completion of the Glina WWTP with a new treatment line, a recent assessment of the existing sewerage system, undertaken using best available information, concluded that the existing sewerage system provides an enough reasonable level of service in terms of service coverage. However, major deficiencies exist in terms of:

- high level of infiltration into the system.
- inadequate hydraulic capacity leading to high frequency of flooding.

Analysis of the system indicated that the intrinsic hydraulic capacity of the existing gravity network is between a one to one and one in two year storm event. Greater probability of storm events results in network surcharging and flooding from the system resulting in:

- ponding of raw storm sewage in property basements and on access ways;
- pollution of the environment (rivers Dambovita and Colentina, groundwater, soil).

In order to optimize the costs for investment and operation of the Glina WWTP stage 2 and the functioning of the sewerage system technical solutions for rehabilitation of the wastewater collection network have been proposed.

These solutions refer to:

- limiting the entrance of groundwater into components of the sewerage system

- ensuring a good functioning and durability of the main structure bringing wastewater to Glina WWTP – the Casseta

- elimination of diluting wastewater entering the Glina WWTP that could result in reducing cost investment for development of Phase 2 of the treatment plant and its total functioning costs.

The Beneficiary of the Project is the Municipality of Bucharest (MoB), which is also the Contracting and the Implementing Authority.

1.3 The Consultant of Environmental Impact Assessment

The Environmental Impact Assessment Study (EIA) was elaborated by the former SC Enviroassist SRL, (actual SC Artelia Romania SRL) which is registered within the National Register of environmental studies elaborators at the position no.198. The registration Certificate has validity till 13.04.2015.

The EIA is based on data included in the document entitled “Supporting Technical Report Regarding the Works on the Wastewater Network” - August 2011, elaborated by the Apa Nova Bucharest (ANB), which is the provider of water services in Bucharest. This ANB report together with the Feasibility Study for Glina WWTP stage 2 with Incineration and the corresponding EIA studies will serve for the elaboration of the Cohesion Fund Application (CFA).

The Consultant preparing the Cohesion Fund Application (CFA) is the Joint Venture SWECO International AB, Halcrow Group Ltd and Sogreah Consultants (SHS JV) with local sub-consultants Halcrow Romania, Romproed S.A. and Sogreah - Enviroassist.

The Cohesion Fund Application (CFA) will to be submitted end 2011 and its approval is expected to be obtained in the first months of 2012.

1.4 Coordination and correlation elements

The present project is correlated with the Framework Scheme for Arrangement of the Dambovita Hydrographical Basin and do not affect any existing or future objectives in the area.

Chapter 2 DESCRIPTION OF THE PROPOSED PROJECT

2.1 General elements

This chapter presents a description of the sewerage system components and specific data on the projected works intended to be performed in order to optimize the design of the Glina WWTP stage II and eliminate disagreements related to the functioning of the sewerage system as well.

Following completion of the expected investments, the sewerage service will be significantly improved and more close to the target of providing a piped sewerage system to all chosen surrounding areas, by 2015. The neighbouring communities, recommended to be connected with the Bucharest system are: Glina, Popesti-Leordini, Jilava, Chiajna, Chitila, Mogosoaia, Buftea, Voluntari, Dobroesti and Pantelimon.

Without intervention, the incidence of flooding from the system is likely to increase in the future due to the expansion of the system to serve 100% of the resident population, the continued development of the Municipality and connection of sewerage systems of neighbouring communities.

2.2 Detail on the project location and object

The Project area will be Bucharest, which is the Capital of Romania.
The project object is Bucharest sewerage system. This system is unitary conceived, collecting both rainwater and wastewaters within the same system.

Two structural elements define the characteristics of the system:

- the Casseta and the large collectors
- the sewage collection system.

2.2.1 The Caseta

The planning of restructuring of Bucharest infrastructure was made at the beginning of the years ’80. To solve the problem of Dambovita flooding and wastewater collection it was decided to arrange the riverbed as clean water channel and to construct a major collector – the Caseta – under the river channel. In order to control the clean river flow a dam was constructed and a new lake – lacul Morii – was created.

The Caseta was designed to be connected with the existent collectors and to bring the wastewater to the Glina Wastewater Treatment Plant. Before its construction the old river Dambovita was in fact a large open sewer crossing the territory of Bucharest.

In the same period, the first subway line was constructed in parallel with the Caseta on the right (south) shore of the river, between Semanatoarea and Mihai Bravu bridge, from where it leaves the Caseta and continues its trajectory by going north.

The Caseta was designed as a series of concrete semi-caseta-s put in parallel, crossing Bucharest from the western part (near lacul Morii) towards east, on a distance of 17.8 km, till Glina Wastewater Treatment Plant.

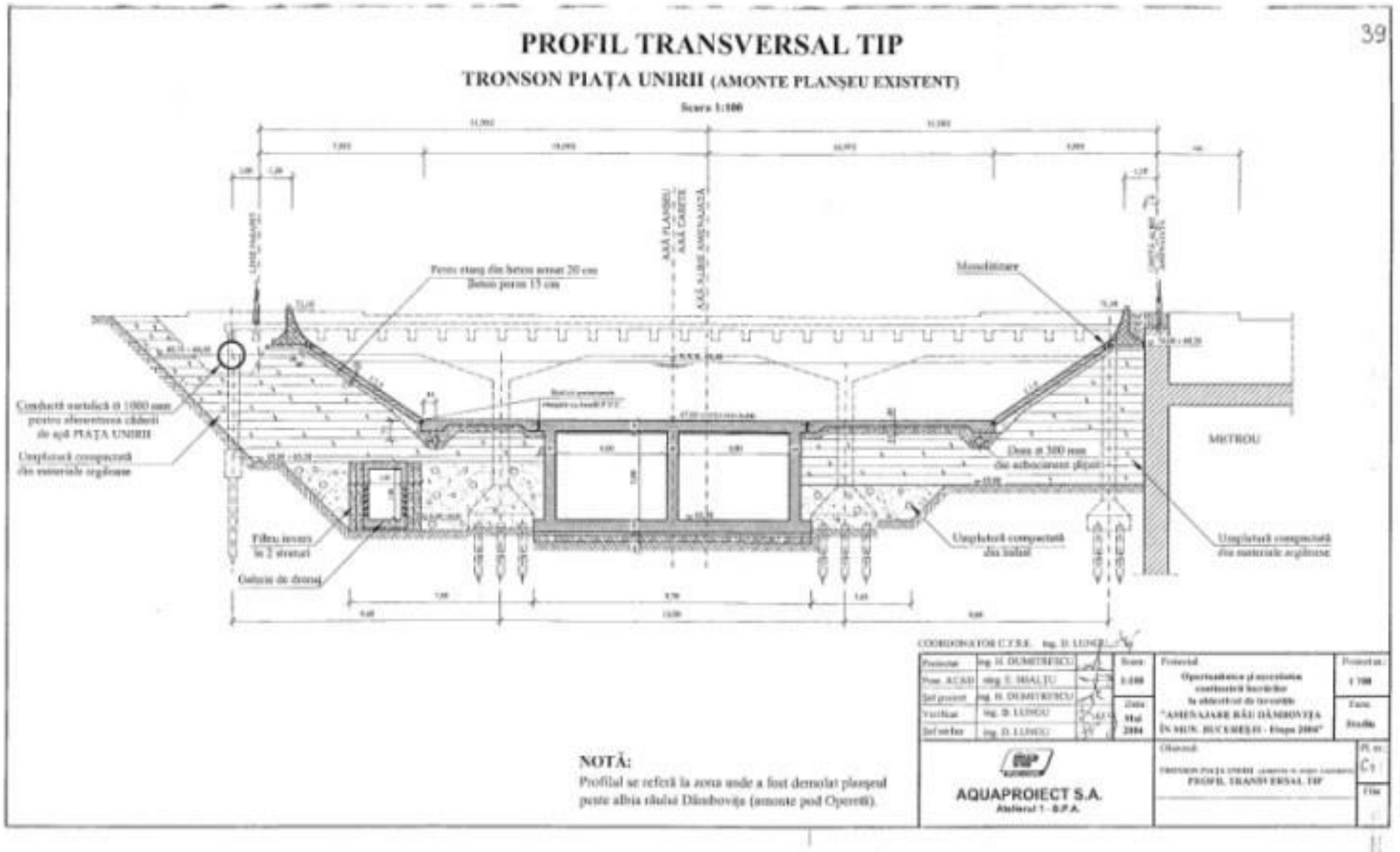
Initially, the Caseta was formed of 2 sections of 3.3. x 2.42 m, the number and dimensions of these sections raising or lowering along its trajectory to Glina. After the Vitan bridge the Caseta, which is comprising there 3 sections, deviates from its trajectory from under the riverbed, goes 3 km along the north shore (left shore) till after the Popesti overflow, where it under-crosses the river and continues the final 4 km till Glina along the south shore (right shore). The Caseta comprises 4 sections in the zone of under crossing the river because it includes a collector and, after that, on a short distance – even 5 sections, by including another collector.

Table 2.1 Characteristics of Caseta sectors

No of sectors	Name of sectors	Length of sector (m)	No of sections	Width (m)	High (m)
1	Lacul Morii - Opera bridge	3,186	2	3.3	2.42
2	Opera bridge - Mihai Bravu	5,017	2	4	3.06
3	Mihai Bravu – Vitan bridge	2,267	2	4.5	3.06
4	Vitan bridge – Popesti Hydrotechnical node	7,447	3	4.5	3.06
5	Under crossing the river		4	4.5	3.06
6	Under crossing of the river - Popesti Safety overflow		5	4.5	3.06
7	Under crossing the river – Glina harbour		3	4.5	3.06

The structure of the Caseta is presented in figure below.

Figure 2.1 Caseta transversal section in the area Piata Unirii (upstream the covered zone)



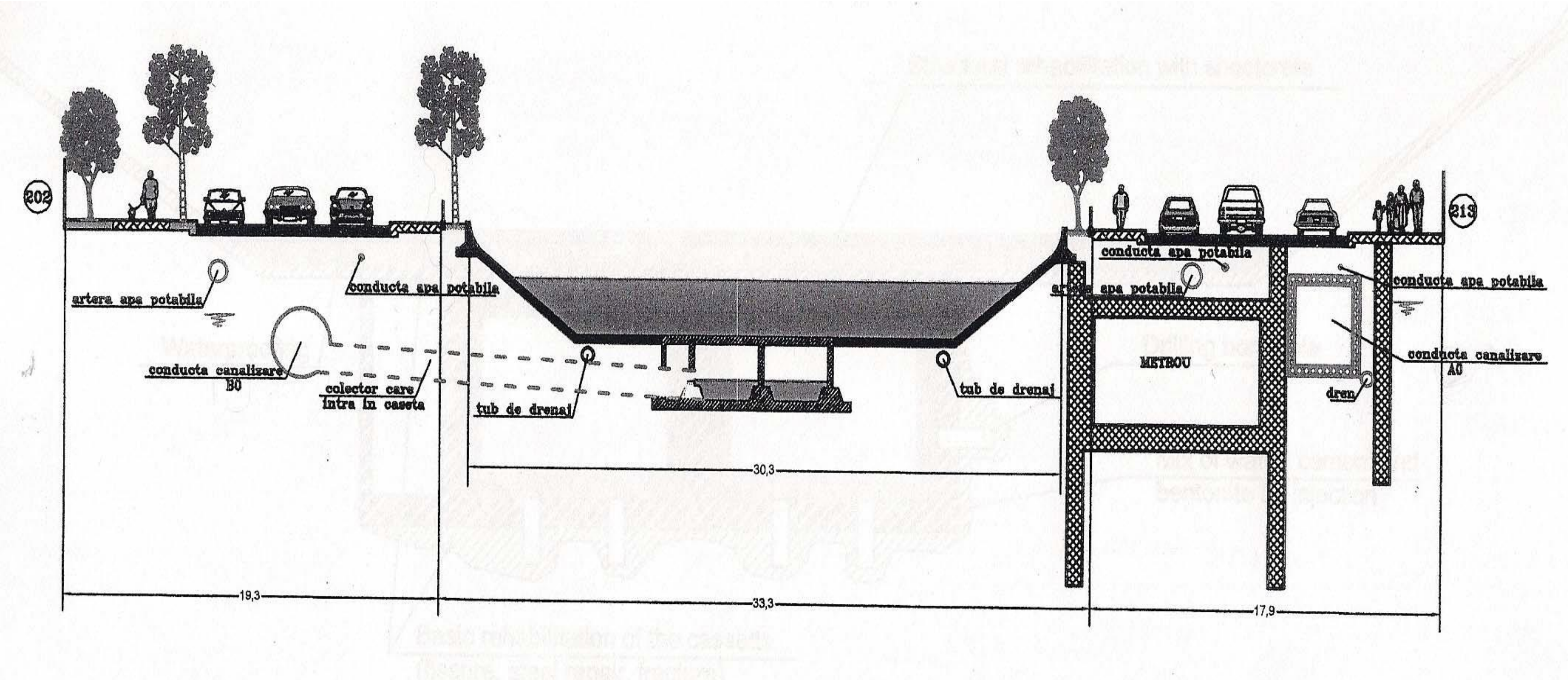


Figure 2.2. The general concept of the upper reach and Caseta project

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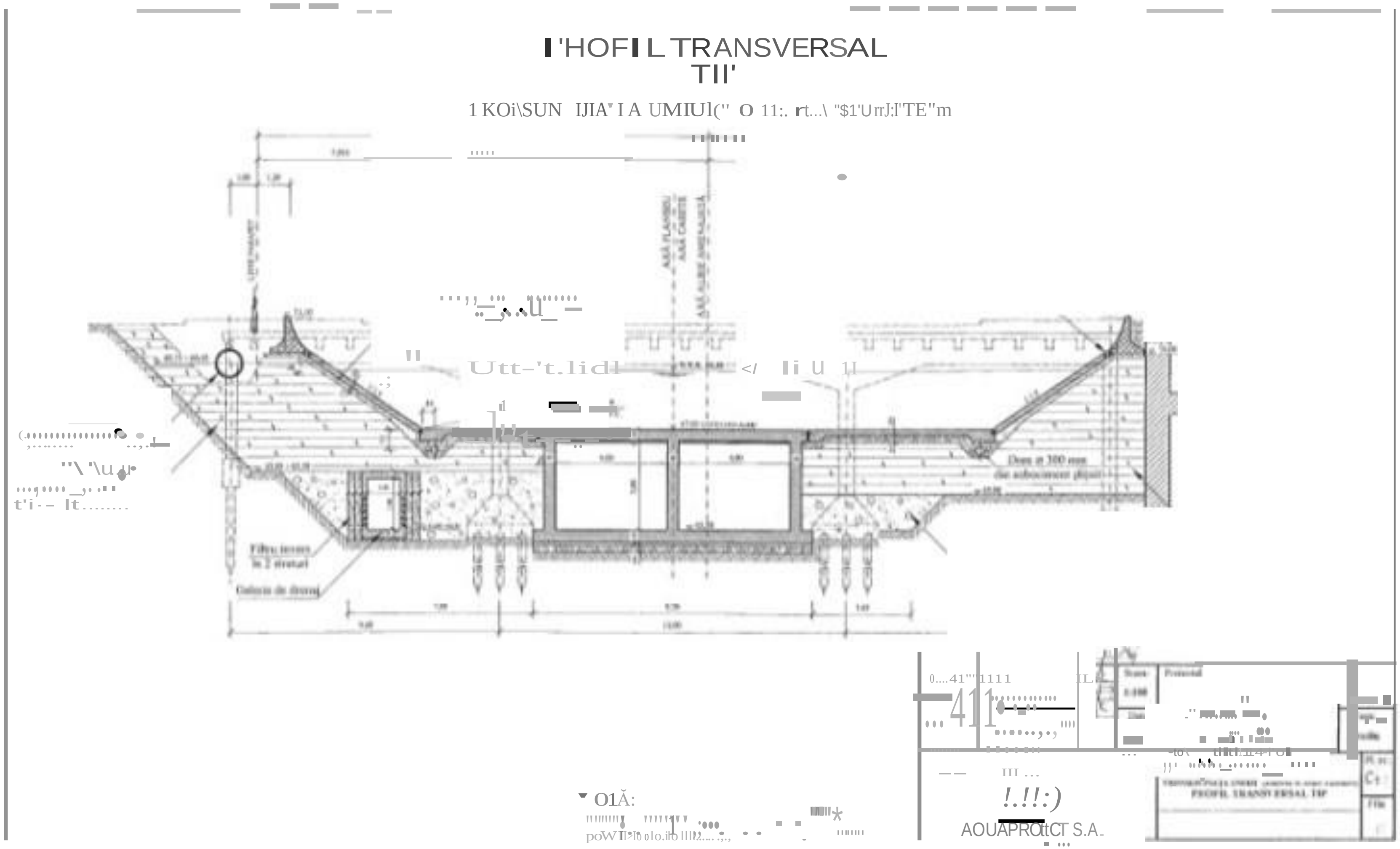


Figure2.3 Caseta tt'anwersalsectioninthe areaPiata Unirii (upstream thecovered zom)

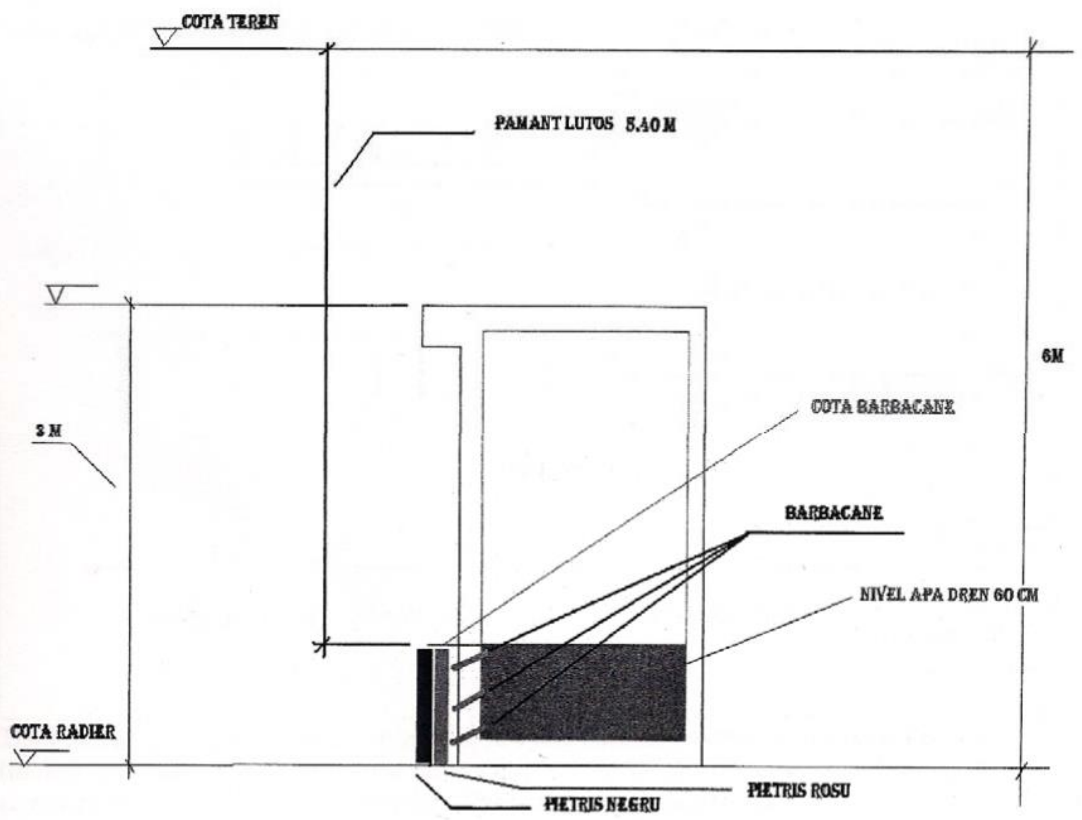


Figure 2.4 Concept of the Main drain of the Caseta

2.2.2 Sewage collection system (Large collectors*)*

The existing sewage system is approximately 2,561 km in length (1,772 km collectors plus 789 km connections). Except some recently constructed segments, the sewerage system is a combined one, collecting both the wastewaters and the rain water.

Twelve principal and eleven secondary collectors collect the wastewater from 6 sectors of Bucharest city and some neighboring dwellings and discharge it to the Caseta. The sewerage system operates predominately by gravity with 13 minor pumping stations serving local low-lying areas.

Before the construction of the Caseta the wastewater was collected by mean of 2 main collectors – A0 and B0 - placed on both sides of the river Dambovita. Today there are 12 main collectors that are discharging wastewater in the Caseta as follows:

- 2 collectors adjacent to the river Dambovita: A0 and B0
- 3 main collectors in the southern part of river Dambovita (right part): A1- A3
- 7 main collectors in the northern part of river Dambovita (left shore): B1-B7

Another collector entering in the Caseta – A4 - is coming from the Glina village near the treatment plant.

The largest reception surfaces are those of collectors A3 – on the right side of the river (35.9 km^2) and B7, which together with C1, receives wastewater from the left side (35.5 km^2).

The initial collector A0, on the right part of the river, has been replaced - due to the construction of the subway - by 2 new collectors - A0a and A0b - built behind of the subway Line no 1.

A0a, with a length of 2.3 km and a general slope of 0.11%, goes from Ciurel to the Opera Bridge, where it discharges in the Caseta, near the monument of the Sanitary Heroes. On its length it receives many collectors that initially discharged in the river.

A0b, which begins at Opera Bridge, is formed of many segments with different sections and slopes (comprised between 0.128% and 0.0%); it received wastewaters collected by the secondary collection network located on the right part of the river Dambovita (i.e. the collector of the former street Izvor, the collectors of the streets 13 Septembrie, Marasesti, Calea Vacaresti and the collector C1 that brings wastewaters from Militari and Drumul Taberei districts).

The initial collector B0, on the left part of the river, stretched from Ciurel to Vitan Bridge. By constructing the Caseta this collector was also divided in many segments by the other main collectors that are discharging directly in the Caseta.

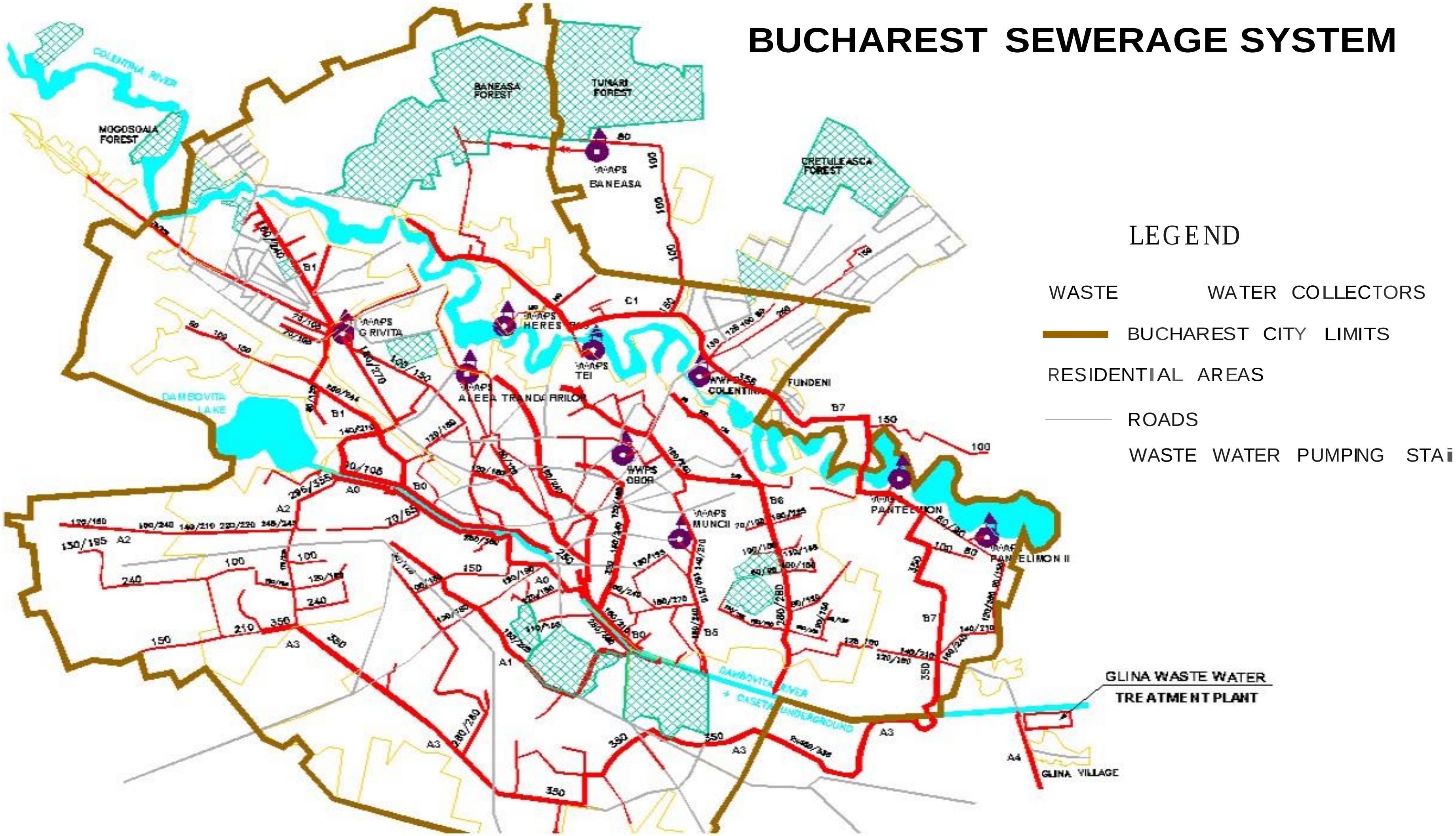


Figure 2.5 Bucharest sewerage system

The first segment – *B0a* – is going from street Popovat till Street Halelor (Unirii Market) where it discharges in the Caseta.

The second segment - B0b – begins before Marasesti Bridge and goes till Foisor Street.

The final segment - from Foisor Street till Mihai Bravu Bridge - is functioning counter posed and receives the secondary collector from Mihai Bravu street.

As resulted from the above description, the old main collectors A0 and B0 have been fragmented by the intersections with other collectors. In the intersection zones the old collectors have been closed by brickworks plastered with cement mortar.

The design shows that the connexions with the Caseta are made of cast iron pipes embedded in concrete, but sometimes they seem to be not correctly placed. In these cases the hydraulic systems are improperly and generate losses of hydraulic load in the collectors.

As part of the Caseta operation and management works, ANB has decided to reduce the number of connections to the Caseta by disconnecting the small collectors and connecting them to the main collectors upstream the Caseta, because the connexions are points with infiltration risks.

2.2.3 Draining of the Caseta.

As mentioned above, the construction of the Caseta was made in the same time with the construction of a section of the subway line between Semanatoarea and Mihai Bravu crossing (8 km). Both these construction – the Caseta and the Metro line – have interrupted the natural course of the groundwater and have determined a significant rising of the groundwater table in the central part of Bucharest. In order to control this problem the Caseta the initial design included 2 rectangular draining galleries, in parallel with Caseta, having a width of 1.2 m and the same height and slope as the Caseta, in the purpose to collect the groundwater and discharge it in the upper reach, downstream the points of flow control.

- The **left / or north drain** is going parallel on the whole length of the Caseta and 3 pumping stations (at the Eroilor, Opera and Mihai Bravu Junctions) were thought to discharge the collected groundwater in the superior reach. These stations have never worked because not being finalised and the groundwater from the drain is entering into the Caseta.
- The **right / or south drain** (on the side with the House of People) is represented by a channel that begins only at Mihai Bravu and goes to the Popesti Hydrotehnical Node and Glina. This drain does not exist between Semanatoarea and Mihai Bravu because, on this section, the Caseta is partially bordered by the subway infrastructure that theoretically includes a draining channel.

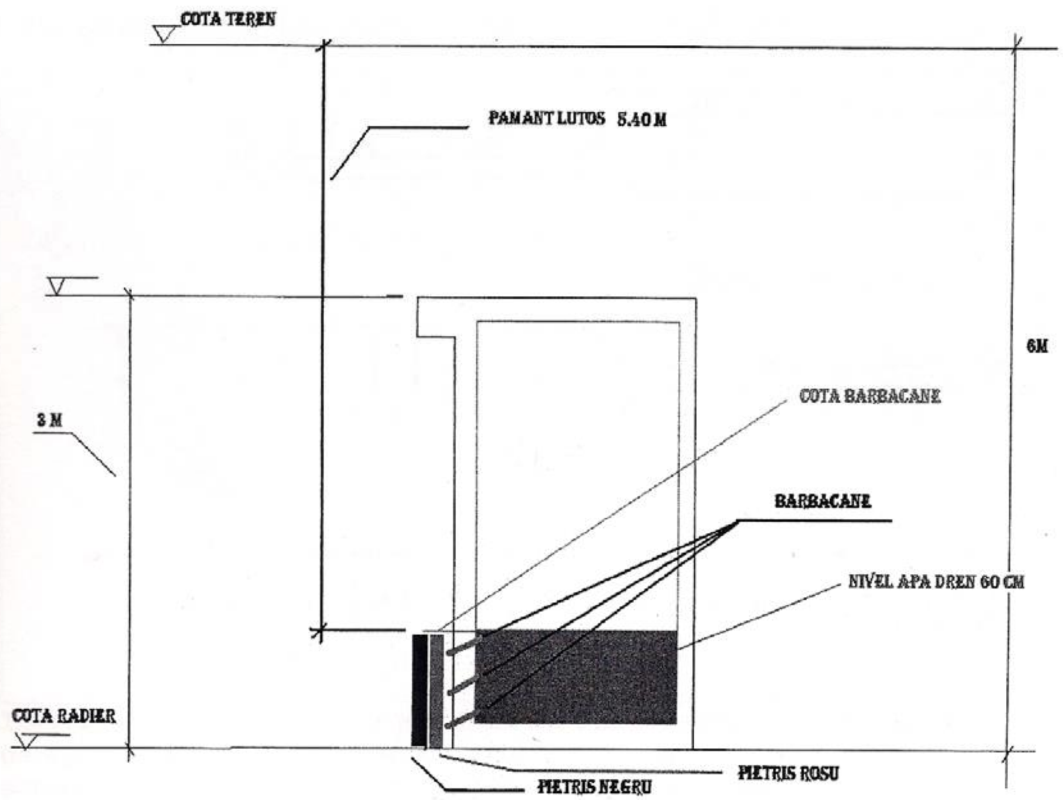


Figure 2.6 Concept of the Main drain of the Caseta

Investigations of the left and right drains (on the last 6.6 km between Vitan and Glina) show that there is no connection with the superior reach. Therefore, it was concluded that these drains discharge the collected groundwater directly into Caseta.

2.2.4 Groundwater infiltrations.

Details on the left drain (main drain)

The trajectory of the left (or north) drain is interrupted in the points of intersection with the collectors that are connected to the Caseta or at the intersections with the access tunnels inside the Caseta. Near these places the drain gallery stops and continues on the other part of the collectors or tunnels. There are passing pipes that are crossing the walls of the drain gallery and enter in the Caseta.

Initially, it was planned these pipes to be used as control access in the drain gallery, but this is impossible because, instead of pipes with diameter 700 mm, pipes with diameter 400 mm have been installed. In some places the passing pipes are sealed by plugs but in others the plugs are missing; as a result the groundwater collected in the drain gallery is flowing inside the Caseta.

Details on the draining of the subway (right bank)

The system used for the construction of the subway has required the building of cast walls that have cut the permeable strata before the groundwater reaches the natural riverbed. In such conditions a drain upstream of the cast walls and a permanent pumping were needed to evacuate the groundwater from around the transport installations. Even with these facilities the construction of the subway resulted in rising of the groundwater table up to the level of the sewage systems because of the following reasons:

- the subway drainage has been never completed;
- the pumping of water from the subway drain is not enough for lowering the groundwater level under the level of the sewage systems.

Therefore, the components of the sewage systems around the subway play the role of a drain and evacuate the infiltrated groundwater to the Glina WWTP.

Besides the groundwater entering into the Caseta from the draining channels, which are not connected to the river bad (superior reach), there are also groundwater infiltrations in different points of the Caseta.

- Significant infiltrations were observed in points where the draining channels are interrupted by the **intersections with the collectors or the inspection tunnels.** In these points the groundwater is flowing around the pipes that are penetrating the drain walls because lacking of seals or because of pipes incorrect placement.

- Infiltrations of groundwater **in Collectors** were identified at the points of junction with the Caseta; this phenomenon is accentuated near the Caseta as a result of the increased groundwater level determined by the blockage of its natural trajectory by the subway and the Caseta.
- Infiltrations of groundwater due to illegal or **unknown connections**.

2.2.5 River water infiltrations (from the superior reach by Caseta ceiling)

The elements used for the construction of the most part of the Caseta consists of prefabricated /pre-cast elements respectively supporting elements, superimposed tiles with the role of lost shuttering, and a structuring tile that assures the interface between the Caseta and the superior reach.

The clean water infiltrates through the weak insulated joint points of the structures, more precisely at the connections between the supporting walls and the superimposed tiles that are not waterproof.

Infiltrations of river water have been identified also through the cracks in the concrete riverbed.

2.2.6 Problems related to the Caseta and collectors functioning

A study performed recently by Apa Nova Bucharest at the request of the Bucharest City Hall has identified the problems related to the Caseta and main collectors that can influence the Glina WWTP design and functioning as being the followings:

i) *Infiltrations*
ii) *Deposition of sediments*
iii) *Lakes water discharge in the sewage system*

Infiltrations

Significant entrance of clean water by infiltration and discharge has been identified inside the Caseta, on the most part of its length, as a result of the following factors:

- Entrance of the groundwater in the Caseta through the **draining not connected to the river bad (superior reach). Non-functioning of the three pumping stations** (Eroilor, Opera si Mihai Bravu) projected to evacuate the groundwater collected by drain placed on the left (north) side of the Caseta in the river channel.

- Significant infiltrations through the **intersection points between the draining and the collectors or the inspection tunnels.**

In these points the groundwater is flowing around the pipes that are penetrating the drain walls because of lacking the sealing or pipes incorrect placement.

- Infiltrations of groundwater **in junction points of Collectors with the Caseta**.
- Infiltrations of groundwater due to **illegal or unknown connections**.
- Entrance of clean water through the **non-waterproof joint points of the constructive components of the Caseta,** especially by the **ceiling**.
- Infiltrations of river water through the **cracks in the concrete riverbed**.

Deposition of sediments and other materials

A lot of compacted sludge and sediments has accumulated in the Caseta during the calm or dry time periods, characterized by reduced flows. Beside the sludge and sediments, construction materials that were not removed after finishing the building works and debris resulted after the ceiling crumbling are accumulated. Such left deposits comprise massive concrete tiles, extensible pillars for ceiling support (Acrow type), etc.

More than 120 left supporting columns used to sustain the shuttering for the Caseta ceiling have been inventoried inside the Caseta. In time around of these columns a lot of sludge, plastic waste and other materials have accumulated resulting in conic formations that are blocking the water flow.

Similarly, concrete or debris formations resulted from collapsing or crushing of the shuttering used for casting the river bed were identified in 13 places inside the Caseta. All these materials accumulated inside the Caseta are modifying its hydraulic capacity by making difficult the water transport especially in periods of reduced flows.

Lakes water discharge in the sewage system

The investigations revealed that the outlet of the drainage systems of lakes Titan, Tineretului and Carol, located on the Bucharest territory, are discharged directly in the sewage network. The water of the lakes discharged in the collectors is sent in the Caseta.

Estimations show that from the lakes a possible 0.5 m^3/s flow is sent to Glina that represents 8% of the clear water flow entering the wastewater treatment plant.

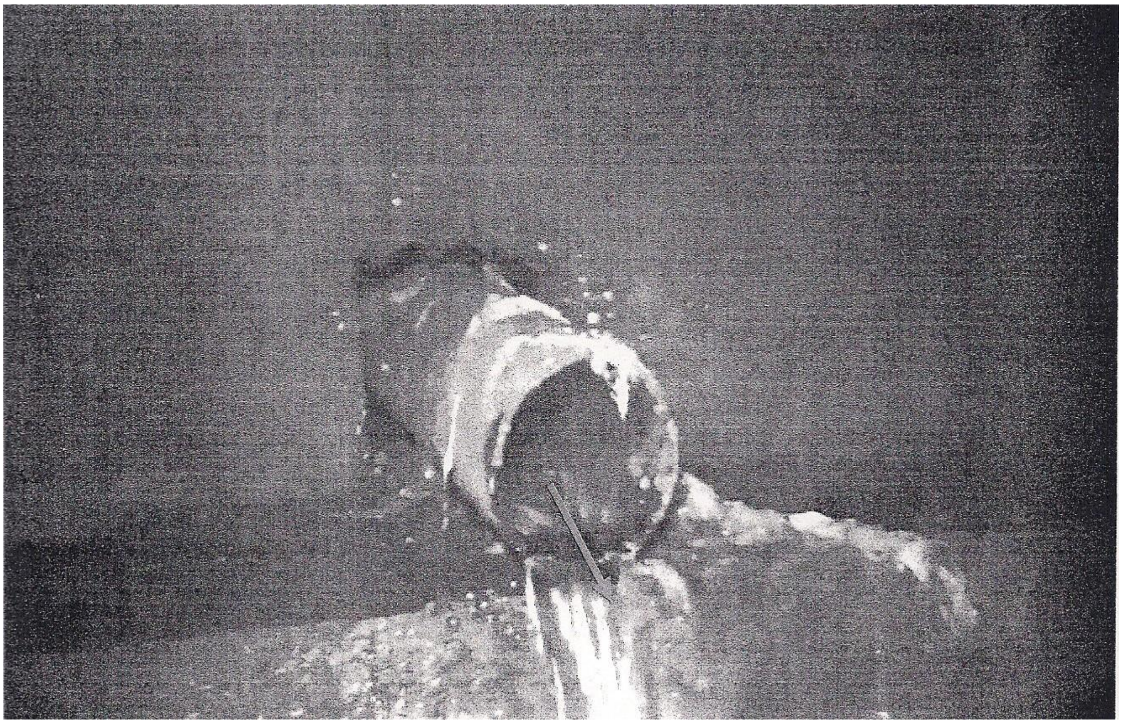
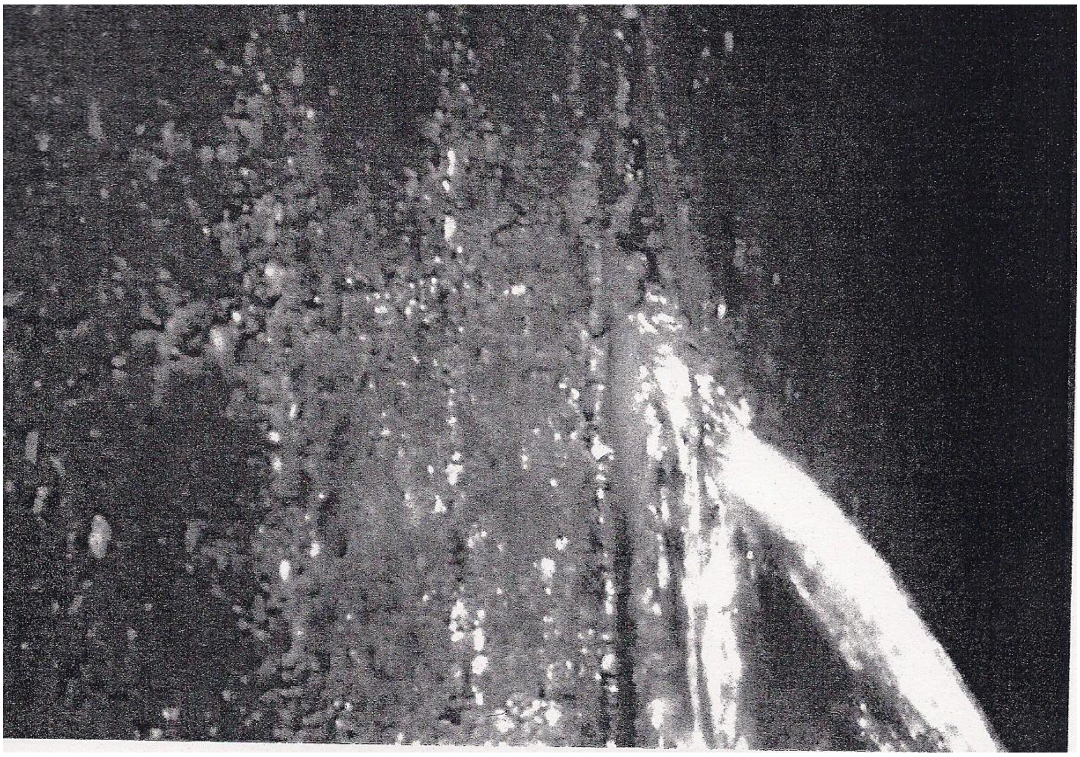


Figure 2.7 Water entering into the Caseta from the left bank drain (main drain).



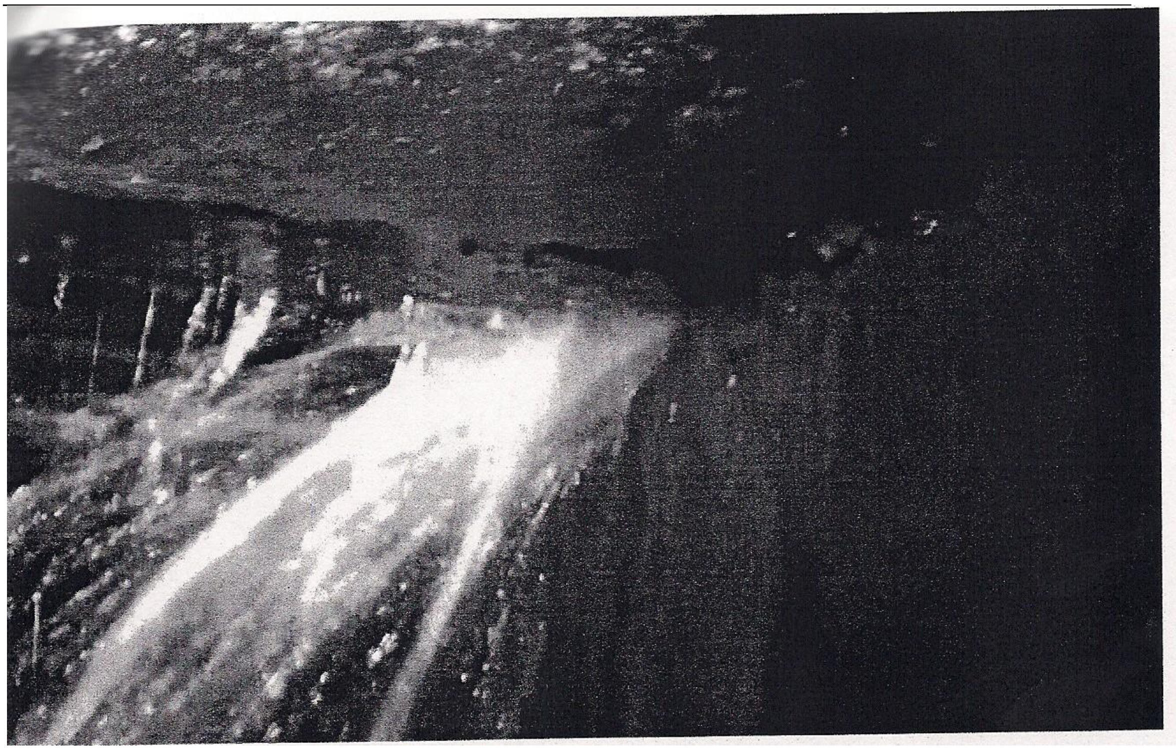
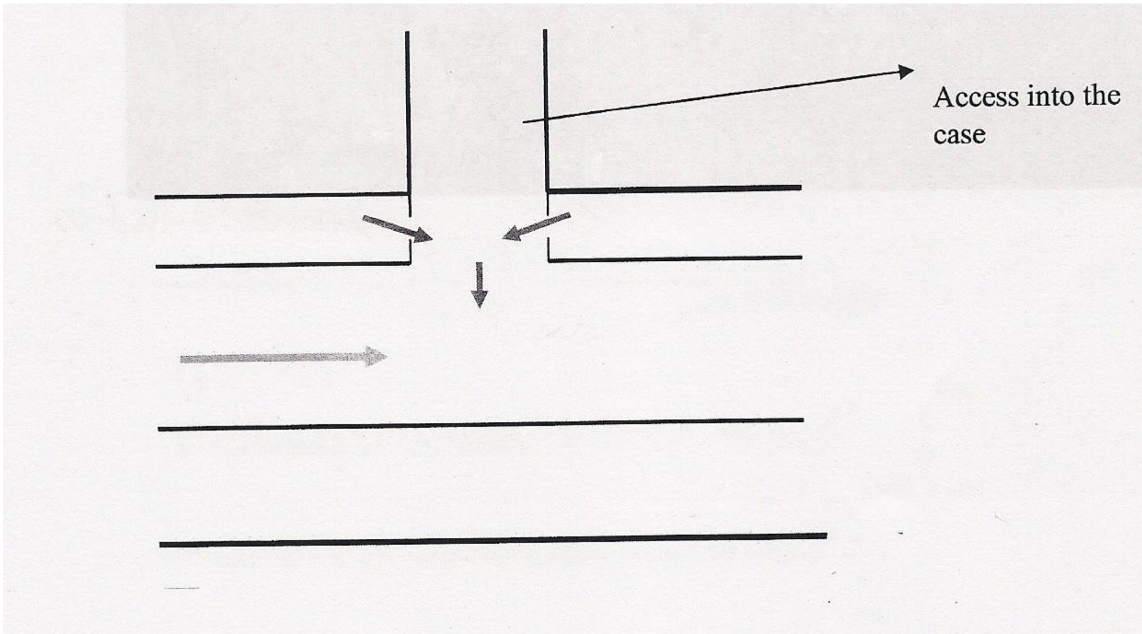


Figure 2.8 Water entering the Caseta from Main drain through the access way



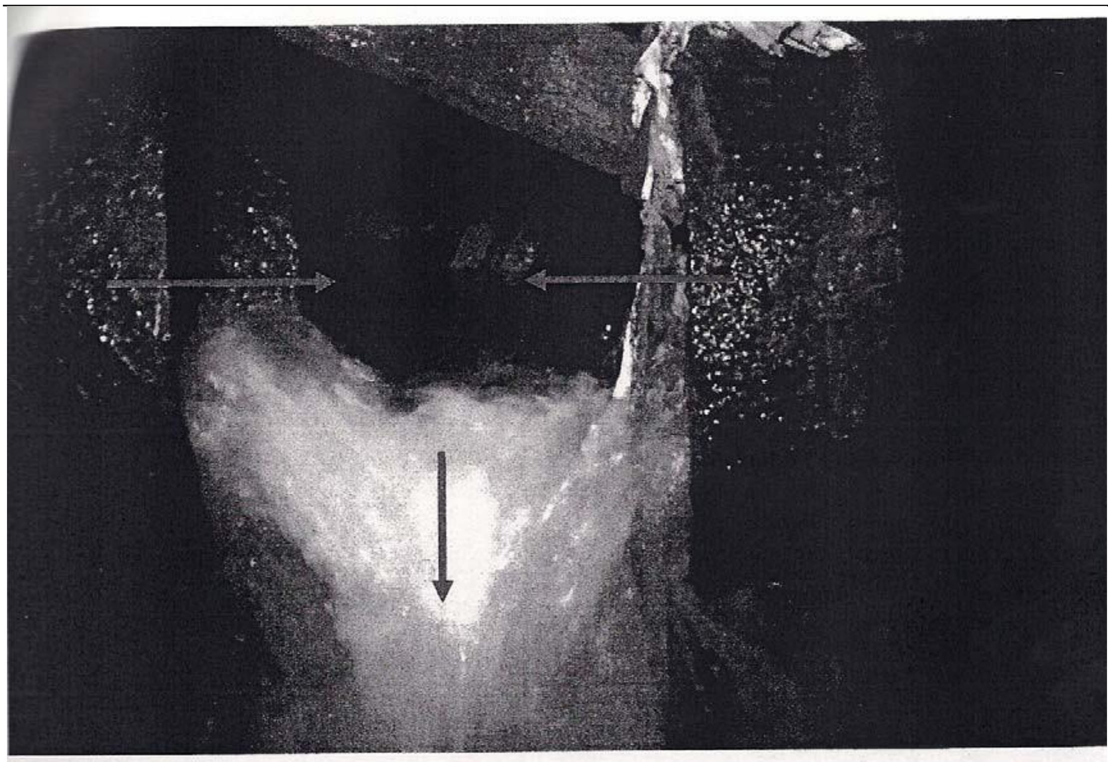
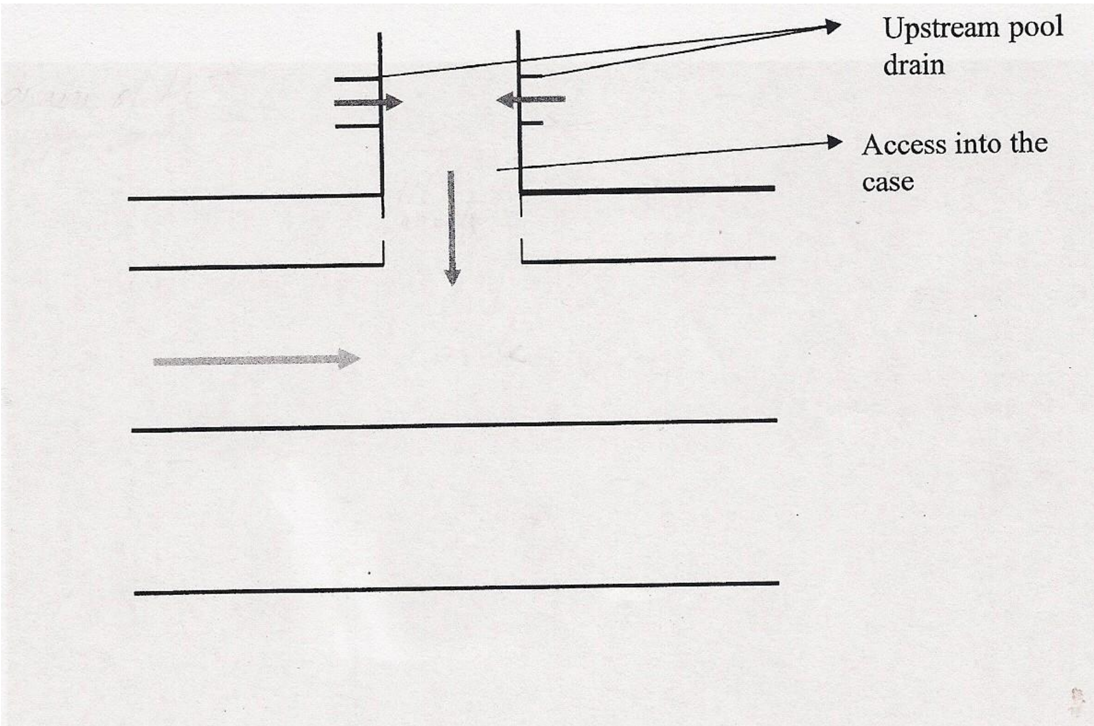


Figure 2.9 Clean water entering Caseta from the upper reach drain through an access way to the Caseta



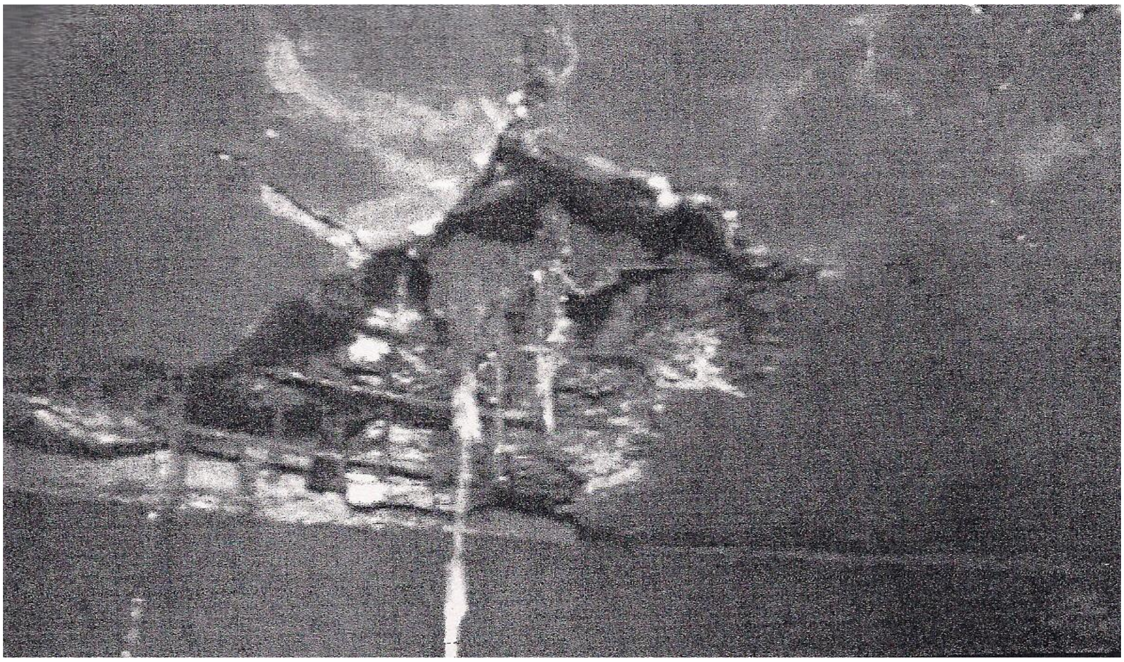


Figure 2.10 Structural damages of the concrete slabs

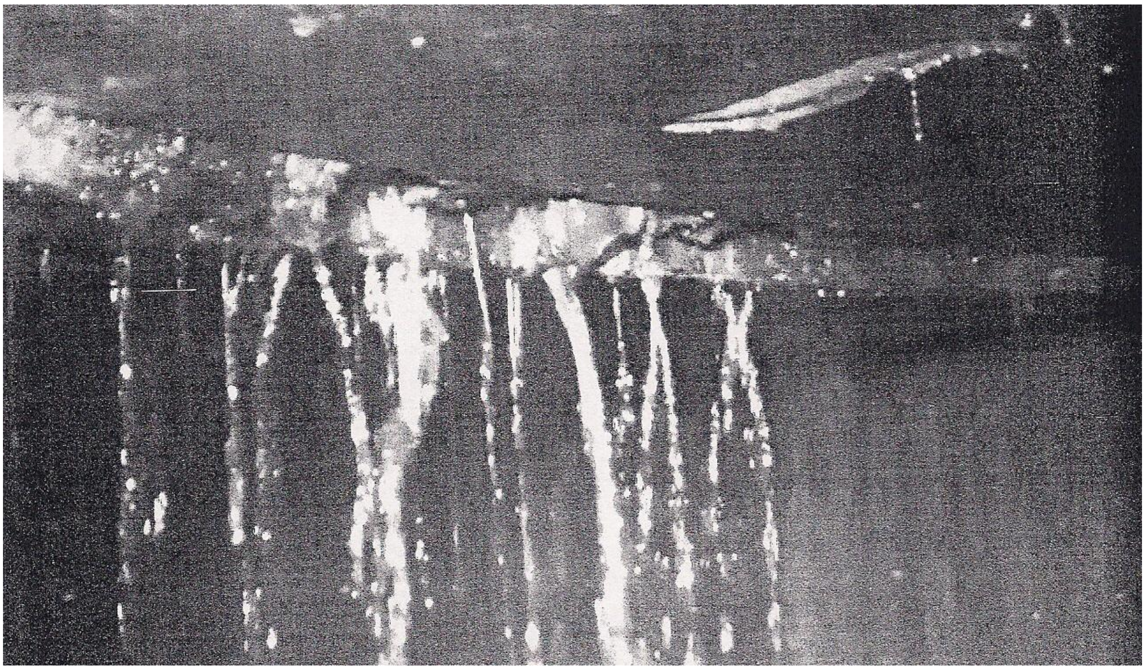


Figure 2.11 Dislocated concrete slabs

Figure 2.12 Deposition of sediments around props left inside the Caseta

2.2.7 Quantitative details on the infiltrations and reduction objectives

The technical data and evaluations concerning clean water entering in the Caseta and sewage collectors are based on a vast campaign of measurements carried out by the Apa Nova Bucharest during the years 2009-2010. The campaign purpose was related to the optimization of the investment provided for Phase 2 of the Glina WWTP.
Table 2.2 presents by origin the estimated flows of infiltration waters and of other undesired water arriving into the Caseta, together with actions for their reduction.

The total amount of infiltration and other undesired water arriving into the Caseta is **5.36 m^3/s,** out of which the estimated **infiltration flow** was found to be **4.66 m^3/s**, while the flow of **other undesired waters is 0.71 m^3/s.**

Table 2.2 Estimated origins of infiltration and other undesired flows (2010)

Action No.	Origin	Nature of undesired water	Reason for reduction	Action to reduce undesired water	Flow m^3/s
1	Infiltration from water network leakage	Infiltration	To reduce infiltration	Leakage control of water supply network	0.44
2	Drainage from industries	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.11
3	Drainage from lakes	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.50
4	Infiltration from Dambovita river	Infiltration	Caseta structural rehabilitation	Waterproofing on 17 km, 60 m width	0.93
5	Infiltration from groundwater (part linked to high level of groundwater table)	Infiltration	To reduce infiltration	Reinstatement of subway drainage system to lower the ground water table	1.38
6	Infiltration from groundwater (part due to structural sewers conditions)	Infiltration	Network structural rehabilitation	Rehabilitation of 36 km sewers	0.10
7	Metro drainage	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.09
8	Infiltration from Caseta left drain in city centre (10 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	1.26
9	Infiltration from Caseta left drain downstream city centre (7 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	0.27
10	Infiltration from Caseta right drain downstream city centre (7 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	0.27
	Total, infiltration (1, 4, 5, 6, 8, 9, 10)				**4.66**
	Total, other undesired water (2,3,7)				**0.71**
	Grand total (1-10)				**5.36**

2.2.8 Options for reduction of infiltration and other undesired water flows

Of the **10** defined actions within Table 2.2

- **2 actions** are primarily considered for structural reasons
- **5 actions** are aimed to reduce infiltration and
- **3 actions -** to reduce other undesired water.

With this background three options of actions have been defined:

- High infiltration reduction option (**HIR**)
- Intermediate infiltration reduction option (**IIR**);
- No infiltration reduction option (**NIR**) but only structural remediation.

The **HIR** option is the most ambitious option of the three. It includes **all 10** actions presented in Table2.2.

The **IIR** option includes **only 6** of the 10 actions presented in Table2.2.

- ANB has reported problems to convince a lot of industries to redirect its drainage from the sewer network and Caseta to Dambovita channel and considers **action no 2** as not being efficient because this source contributes with a comparatively small portion of the total infiltration and other undesired water.

- This is also the case for **action no 7.** It has been stated that it is not easy to separate the mixed drainage and wastewater from the Metro stations.

- Further, **action 9** and **10** are considered considerably expensive compared with the other 8 actions and will not be included in this option.

The **NIR** option, finally, includes **2** of the actions presented in Table 2.2 as these are primarily aimed to guarantee the structural stability in the sewer network and the Caseta. The three options are presented more in detail in **Fel! Hittar inte referenskälla.**.

Table 2.3 Options for reduction of infiltration and other undesired water until 2015

Origin	Flow 2010 m^3/s	Flow reduction HIR, m^3/s	Flow reduction IIR, m^3/s	Flow reduction NIR, m^3/s
Infiltration from water network leakage	0.44	0.22	0.22	0
Drainage from industries	0.11	0.11	0	0
Drainage from lakes	0.50	0.50	0.50	0
Infiltration from Dambovita river	0.93	0.79	0.79	0.79
Infiltration from groundwater (part linked to high level of groundwater table)	1.38	0.96	0.96	0
Infiltration from groundwater (part linked to bad structural conditions of sewers)	0.10	0.07	0.07	0.07
Metro drainage	0.09	0.09	0	0
Infiltration from Caseta left drain in city centre (10 km)	1.26	0.89	0.89	0
Infiltration from Caseta left drain downstream city centre (7 km)	0.27	0.19	0	0
Infiltration from Caseta right drain downstream city centre (7 km)	0.27	0.19	0	0
Total reduction, infiltration		**3.31**	**2.93**	**0.86**
Total reduction, other undesired water		**0.71**	**0.50**	**0**
Grand total reduction		**4.02**	**3.43**	**0.86**
Remaining infiltration + undesired water	**5.36**	**1.35**	**1.94**	**4.50**
Remaining infiltration	**4.66**	**1.08**	**1.73**	**4.50**

The options analysis has revealed that the IIR option is the most advantageous from economic point of view and technically becuase it assures a realistic design flow for Glina WWTP stage 2, correlated with an optimum functioning of the sewerage system, in most acceptable cost conditions.

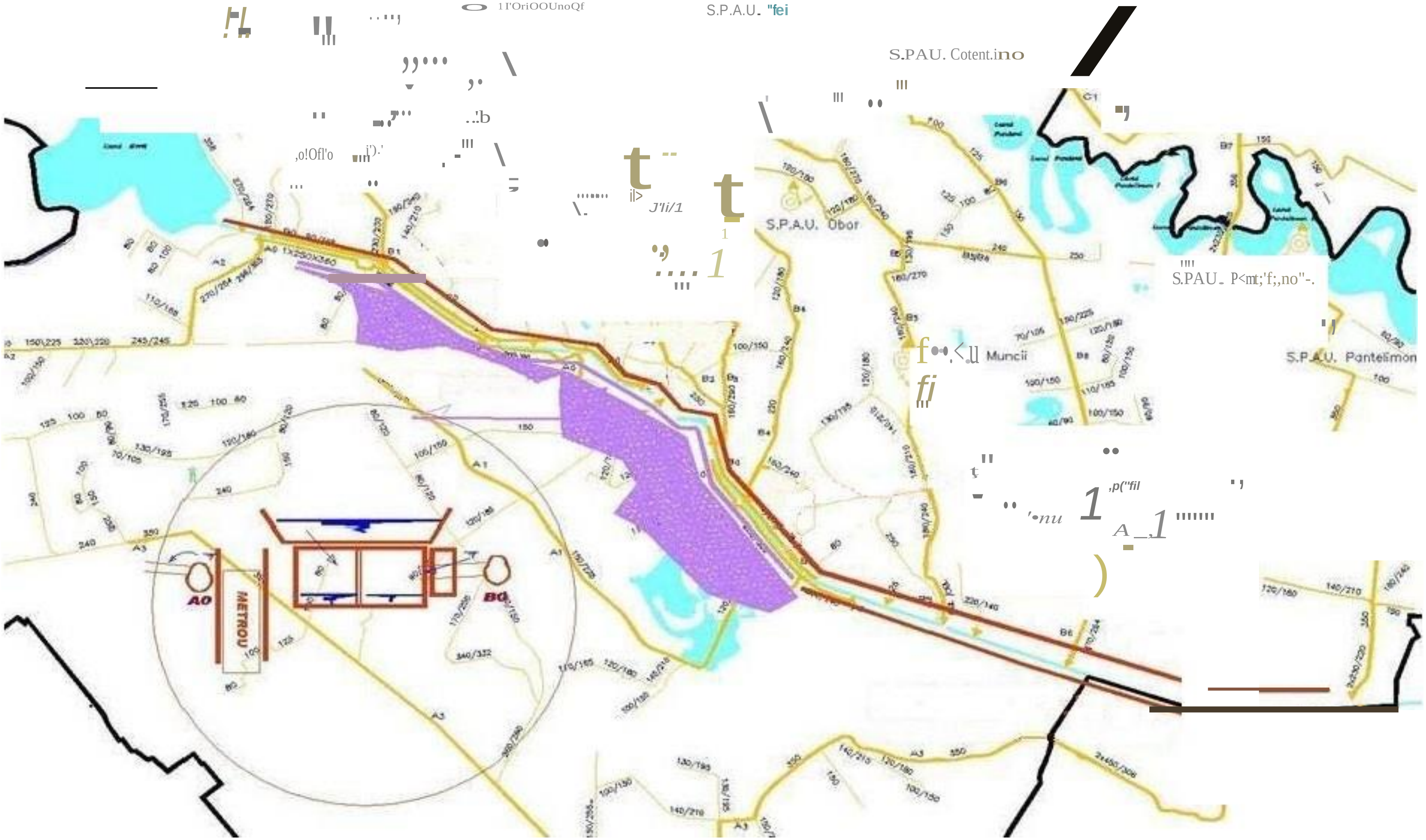


Figure 2.13 Infiltration areas

2.3 Specific data on the project

The discussed project is oriented to optimize the investment for the Glina treatment plant by reducing the dilution of wastewater in the sewerage system and to rehabilitate the sewerage structures that are supplying the plant.

The works included in this project have as purposes:

- Limiting the groundwater to enter in the Caseta
- Limiting the entrance of surface water in the sewer system, meaning river water from superior reach (Dambovita channel) and lakes water
- Ensuring the durability of the main structure – the Caseta - allowing the arrival of wastewater to Glina plant.

To achieve these purposes the following categories of works have been projected:

- Works on the main drain of the Caseta between Ciurel and Vitan
- Works for the sealing of the superior reach - Dambovita channel
- Works for improving the durability of the Caseta
- Rehabilitation of the collectors in the area of contact with the water table
- Elimination of the lakes water discharge into the sewage network.

These categories of works are detailed below, based on the ANB document “Supporting report regarding works to be performed in the sewerage system of Bucharest for Glina phase 2”. It is to mention that the feasibility studies are not yet available, being at this moment in the phase of bidding.

2.3.3 Works on the MAIN DRAIN of the Caseta between Ciurel and Vitan

Originally, the drainage of the Caseta was thought to achieve the following purposes:

- Avoiding the pressure of groundwater on the Caseta and maintaining its stability
- Guarantee the stability of the adjacent buildings by limiting the rise of the groundwater level
- Feed the Dambovita channel with clean water by pumping in it the water collected by the drain
- Ensure an appropriate flowing of the river Dambovita on the Bucharest territory despite of the new arrangement of the river bed and wastewater collection system.

The investigations recently made have revealed that the effectiveness of the main drain is not ensured because:

- the 3 pumping stations provided to discharge drained water into the upper reach do not work because these structures have not been fully completed;

- there is a direct link between the collectors entering in the Caseta and the main drain. The groundwater collected by the drain is entering in the Caseta by different ways. The estimated flow entering in the sewage from the drain is 1.26 m^3/s, which is around 25% of the total clean water infiltration estimated at the inlet to Glina plant.

The works planned in order to manage the above problems have the following objectives:

- Rehabilitation of the main drain (partially or totally) by acting on its connection points with collectors, the Caseta and on the access ways.
- Ensuring of functional and secure access to the Caseta and rehabilitation of the upper reach drain
- Rehabilitation of the pumping stations allowing discharging the drained water to the hydraulic knots of the upper reach (Dambovita channel).

Works planned on the main drain between Ciurel and Vitan

The works on the MAIN DRAIN between Ciurel and Vitan are planned to be achieved on around 10km. The components of these works are detailed below.

1. Allow and ensure the access to the drain. Dewatering of the structures.

- The access to the drain will be ensured from the upper slabs of Dambovita reach, by mean of an earth ramp allowing the mechanical devices handling and materials transport.

- The earth dam on the upper reach must be built for limiting the work section and allowing its dewatering. Such dams will be made to limit each work section, any time when needed.

2. Install a drain by-pass on the collectors entering the Caseta

- The implementation of drain by-pass shall be made from an opening in the slab of the upper reach. A dam placed on the collector B0 will allow dewatering by pumping.

- The collector will be demolished at the point of junction with the drain and the Caseta.

- The continuity of the main drain will be established by installing several pipes under the base of the collector. Further, the collector will be reconstructed.

- The rehabilitation of the collector up to the BO collector connection chamber implies:
    - correction of damages found – cracks, facings, profiles
    - implementing of a casing in order to create a hydraulic inlet on the Caseta.

- Construct the necessary embankments.

- Repairs to the cover slab at the upper reach level.

3. Rehabilitation of the main drain over 10 km

- The exact length of the main drain to be rehabilitated will be established according to the findings of an expertise to be performed.

- The sectors that will be rehabilitated will be limited by dams placed downstream and upstream in order to allow working in a waterproof environment.

- The works sequence is as follows:

- the sawing of the upper slab on 5 lm (in long) every 50 ml;
- cleaning of the entire drainage by removing of the sand clogging the drain
- cleaning of the holes allowing the water draining
- creating additional weep holes
- rehabilitation of the structure in such a way to assure inspection of the drain.

4. Rehabilitation of the pumping stations

This category of works included:

- Remediation of the access ways
- Replacement of the pumps
- Providing of a discharge pipe to the upper reach for the drained water
- Implementation of the safety equipment (ramps, steps, signalization)
- Installing electric automatic control devices
- Installing mechanical ventilation.

2.3.4 Works assuring the sealing of the SUPERIOR REACH - Dambovita canal

Originally, the project for construction of the Dambovita upper reach provided a sealed channel separating the surface water from the sewage and intended to achieve the following objectives:

- Create a clean water stream to cross the city instead of the old polluted river Dambovita
- Manage the clean water stream by mean of a system of valves and hydraulic knots ensuring the optimal flowing into the upper reach.

The investigations made have revealed the following issues:

- the water in the channel flows at a low speed causing water eutrophication and odour problems in summer

- the channel is leaking and the fresh water is entering the Caseta through:
    - the weak insulated joint points of the structure
    - the drainage system of the upper reach
    - the structural damages (cracks in the concrete riverbed).

The estimates show a possible infiltration flow of 0.93 m^3 /s in the main collector that means 18 % of the clean water found at the Glina inlet.

The works planned in order to manage the above issues have the following objectives:

- Cleaning the bottom of the channel
- Repairing damages and provide a new base layer on the bottom of the channel
- Sealing the bottom on the sections potentially leaking.

Works to be performed on the superior reach - Dambovita channel – on over 17 km

- Dewatering of the upper reach by sectors using dams and the existing overflows
- Cleaning the bottom of the channel, meaning removal of waste and sludge, washing the bottom and walls of the channel by using high pressure water
- Identification of structural damages and their treatment by passivation of the exposed steel and installing a structural concrete on the gaps found
- Application of a water-repellent cement mortar layer
- Assuring a tightness complying with the European standards.

2.3.3 Works for structural rehabilitation of the CASETA

The construction of the Caseta was made in order to:

- collect separately all wastewater generated by the Bucharest city
- underground transport of collected wastewater to the Glina plant.

Achieved between the years 1984 and 1988, the Caseta was constructed using prefabricated concrete elements.

Although the recognition of the bottom structure was not performed because the Caseta was not dewatered, the investigations made have revealed the following issues:

- The structure has not been completed. Formwork props remained in place being not extracted before the immersion of the structure
- The pre-slabs used as permanent formworks to support the upper slabs are in poor condition and sometimes fall inside the structure
- The Caseta walls have been penetrated to allow direct connection of the collectors
- Steel within the structure has been exposed in particular at the level of pre-slab support
- Occasionally, there are cracks in the concrete cladding on the peripheral walls where infiltrations were observed.

Except the above mentioned issues the Caseta structure seems to be in good shape and the concrete has not been affected by the H_2S release.

The works planned in order to manage the above issues have the following objectives:

- Stabilize the pre-slabs supporting the structure cover
- Rehabilitate the cracks and openings inside the structure
- Consolidate the structure by improving its lift and by filling the gaps around it.

Works to be performed on the Caseta

The works planned for the Caseta will be achieved on over 41km length and they will consist on the following phases and actions:

1. Rehabilitation of the Caseta

The works will include:

- Dewatering by pumping of the Caseta sectors delimitated by dams on every 1km
- Cleaning of the Caseta bottom
- Achieving of drills for injections (4 drills every 3 km)
- Low pressure (max. 2 to 3 bars) cement grout injection to fill the annular gaps of the slab supports

- Treatment of the identified structural damages by passivation of the exposed steel and application of structural concrete on the gaps found
- Stabilization of the pre-slabs by reinforcement with wire mesh anchoring and concrete projection
- Demolition and removal of the pre-slabs that can not be stabilized and filling the gaps in the remaining slabs supports
- The recovery of the hydraulic profiles, if necessary.

2. Rehabilitation of the access ways to the Caseta.

The works will include:

- Cleaning the access ways
- Repairing of the cracks and facing of the structure
- Providing and installing of safety equipment (handrail, steps, pads, signage)
- Rehabilitation of the upper reach drainage bypass by installing of a metal pipe.

2.3.4 Works for the SUBWAY DRAINAGE

The construction of the subway was made by using mould walls embedded in the sealed geological horizons. These walls have stopped the groundwater flowing to the riverbed and as a result the level of the groundwater rose substantially.

Originally, the subway project provided the construction of a peripheral drainage but it has not been completed. For this reason the water table is now in direct contact with the collectors that are draining it and are sending it into the Caseta.

The investigations made have revealed the following issues:

- The subway infrastructure contributes to the increase of the water table level
- There is no peripheral drainage juxtaposed with the subway infrastructure.

The rehabilitation of the subway drainage system is planned on a length of 8 km and will comprise 5 pumping stations. Works could be divided in 2 categories:

1. *Works for rehabilitation of the subway drainage including:*

- Construction of a drainage trench along the subway structure
- Installing a DN 400 drain at the level of -1m from the bottom of the sewage collectors
- Applying of a 20/40 gravel layer surrounded by a specific geo-textile as anti-clogging and anti-contaminant
- Construction of the required embankments
- Restoration of the site surface.

2. *Works for installing of 5 pumping stations including:*

- Construction of concrete pumping chambers (30 m^2) located at a depth of 5m
- Providing of access ways to pumping chambers
- Installation of pumps
- Implementing of discharge pipes up to the upper reach
- Provision of safety equipment (handrail, steps, access pad, signage, working platform, crane, etc)
- Installation of automatic control devices
- Providing of mechanical ventilation.

NOTE: All these works have to be made before the works for the collectors' remediation.

2.3.5 Rehabilitation of COLLECTORS in the area of contact with the water table

Before the construction of the subway line no 1 between Semanatoarea and Mihai Bravu the collectors were not inside the water table. As result of the subway construction the water table raised because of interrupting its way to the riverbed.

The investigations made have revealed the following issues:

- The collectors in areas located in the vicinity of the Metro line no 1, on a length of 35 km, are now located in the water table and are draining it.
- Many cellars belonging to buildings constructed in the area before the year 1980 are flooded
- The collectors are sometimes destabilized and collapse
- The collectors have no longer the needed hydraulic capacity to discharge storm water during heavy rains.

Estimations show a possible infiltration flow in the main collector of 1.47 m^3/s, which is equivalent to 28 % of the clear water flow found at the inlet of Glina Plant.

The works planned in order to manage the above issues have the following objectives:

- Assuring the water table lowering below the level of the collectors
- Partial rehabilitation of 35 km collectors in the affected area.

It is to NOTE that the works for rehabilitation of collectors mentioned below have to be achieved after the works for the subway drainage.

Works to be performed on 35 km collectors in the affected area.

1. Rehabilitation of non-visitable collectors

- Demolition of roads and execution of the required excavations
- Implementation of a new collectors next to the old ones
- Restoring the connections
- Filling of old collectors with cement or sand
- Restoration of the sites over the excavated trenches.

2. Rehabilitation of visitable collectors

- Dewatering of the collectors
- Cleaning and inspection of the collector's structure
- Drills for annular injections (3 drills every 3 ml) and filling them with a cement grout (100 kg cement, 200 kg sand, 2 kg bentonite for 1 m^3 of water)
- Repairing of structural damages using structural shotcrete or structural concrete
- Repairing of cracks and collector facings
- Restoration of connections
- Securing of the access ways

2.3.6 Works for LAKES WATER DISCHARGE in the superior reach

The investigations performed in the purpose of limiting the dilution of the sewage with so called "clean water" have revealed that the drainage of some lakes on the Bucharest territory is discharged into the sewage network.

The lakes whose drained waters are evacuated directly in the sewerage system are:
Titan lake, Tineretului lake, Carol lake.

All these lakes are in the southern part of the city and their drained water is discharged in the sewage collectors.

Estimates indicate a possible flow of 0.5 m^3 /s coming from the lakes in the main collector, meaning around 8% of the total clean water found at the inlet to the WWTP.

The planned works on this purpose are:

- Install water tanks (500m^3) downstream of the lakes drainage system
- Construct pumping plant
- Install pipes discharging lakes water in the upper reach of river Dambovita.

The works planned for managing the above issue have the as objective to limit the clean water discharged in the sewerage and the raise of hydraulic load on the Glina plant.

Chapter 3 ACHIEVEMENT AND FUNCTIONING OF THE OBJECTIVE

3.3 Duration of the proposed works executions

The proposed duration for execution of the planned works was declared 30 months, regardless the option to be implemented and they have to be totally finished at the end of the year 2015.

In case of achieving all the six described actions the time phasing and the works duration is proposed to be as follows:

- 1. Drainage of the subway between Ciurel and Vitan – 13 months
- 2. Simultaneously achieved: the drain of the Caseta, structural rehabilitation of the Caseta and sealing the upper tank between Ciurel and Vitan – 30 months
- 3. Sealing the upper tank from Vitan to Glina – 7 months
- 4. Structural rehabilitation of the Caseta between Vitan and Glina – 21 months.

Details on the planning of actions in case of the other considered options are presented in Chapter 8.

In this chapter it is to underline the fact that the works on the Caseta and Collectors will be directly related to the works for completion of the Phase 2 of the Glina WWTP and will be achieved in the same time**.**

For the moment two contracts for the elaboration of the feasibility studies for rehabilitation of the Caseta and Collectors and another contract for Technical Assistance to the project management are in the assigned phase.

3.4 Functioning time and program

After the finishing of the works for Caseta and Collectors rehabilitation, the durability of the sewerage system will be improved and it is supposed that the network will last more than 25 years, meaning the target year will be 2040**.**

During the functioning period the Caseta and Collectors will be working continuously - 24 hours per day and 365 days per year - without interruption other than revisions or repairing periods.

Chapter 4 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.4 Project area

The area covered by this Environmental Impact Assessment is the surface of Bucharest city. However, since several influences will be manifest beyond this limited area, as well as the influence of the surroundings will affect the sewerage functioning, a greater area is described as well. Therefore the total area of the Bucharest city has been described, as well as a part of the Arges river basin (in some cases).

4.5 Physical environment

4.2.1. Climate

Bucharest is located inside a temperate-continental climate with some excessive nuances belonging to the Romanian Plain (44º25' northern latitude and 26º05' eastern longitude). This type of climate is characterized by four seasons with specific features.

Summer is the warmest season, with average monthly temperatures of 20º-23ºC. The daily temperatures may reach also 35º-40º C. The precipitations totalize 190 mm and usually have torrential character. Following the advection of tropical air, often phenomena of drought and dryness occur.

Winter is characterized by average monthly temperatures between –2.7ºC and +0.2ºC. Daily values can reach –10 till -20ºC, especially under the influence of the eastern and northern air circulation. Sometimes there are rich snowfalls and snow storms, while other times there are warm days, due to the advections of Mediterranean air.

Spring is short, with thermal contrasts, even from one day to another. The average monthly temperatures vary between 5 and 17 ºC and the precipitations reach 150 mm.

Autumn tends to extend into the winter; sometimes it is relatively dry, with average monthly temperatures between 18 and 5.6 ºC.

Air temperature

The annual averages are over 11 ºC in the city and lower than 11°C in the outskirts. The influence of the city may be noticed on all climatic parameters and Bucharest is, from a thermal point of view, an urban "heat island" caused by the fuel burned in the city and the excessive heating of the concrete, asphalt, bricks surfaces.

Soil temperature and frost

The soil annual average temperature is 12.7°C and it is lowering from the center of the city to the outskirt. The January maximum soil temperature reaches average values under –3°C in the city and under –4°C outside it (Afumati). The July maximum temperature is over 28 °C in the city and lowers in the surrounding area (Afumati - 27.3 °C).

The date of the first frost is between November 3 and 5 in the city and between October 26 and 31 in the outskirts. The last frost happens between March 29 and April 1 - in the city, delaying in the outskirts of about two weeks later. The soil depth of freezing is of 0.7-0.9 m.

Air relative humidity and fog

Air relative humidity has annual average values of 74%, increasing to the outskirts (Afumati - 78.2%). Humidity less than 70%, characterize the summer months, especially July, while values of 85-90% are characterizing the winter months (i.e. December). The high humidity of the air is made obvious also by the phenomenon of fog. Annually, there are 40-50 foggy days, more frequently on the zones near the lakes and rivers. Sometime, the phenomenon of urban fog is produced over the whole Bucharest, due to the atmosphere pollution with smoke, soot, particles of dust and exhaust emissions, etc.

Precipitations

The highest average annual quantities fall over Bucharest, where the aerosols quantity is bigger (Filaret - 590.9mm) and are lower in the outskirts (Afumati 538.9 mm). During the year, there is a maximum of precipitations in June and minimum in February. During the summer, there are often downpours, sometimes accompanied by hailstone (occurring 1 – 3 times a year, in the average). It should be noticed that within the city the precipitations are distributed non-uniformly, occurring with local differences or only in some areas.

The average value of the snow cover thickness is between 00.0 and 9.6 cm. Higher values are noticed in the city, while lower values are noticed in the open field. The first snow occurs in November, while the last snow - end of March.

Wind regime

In Bucharest, the NE winds are prevalent (23.2 % at Afumati), followed by the SW winds (8.1 % at Afumati). The highest average annual speed (3.2 m/s at Afumati) is on the NE direction, followed by the E direction (3.2 m/s).

4.2.2. Topography, geology and soil

Topography. Theoretically, the center of Bucharest is intersected by the latitude of 44º25’50’’ N and the longitude 26º 4’50’’E. Bucharest and its outskirts are located over the Vlasia Plain, 60 km north of the River Danube.

The field represents the dominant form of the relief, followed by valleys and also the flood plains of Dambovita and Colentina rivers. The altitude decreases slowly from 110-100 m in the North-East to 50-60 m in the South-East, with slopes under 2%.

The rivers are not deep and the river beds are frequently marshy; the groundwater is at a low depth (3-5 m), so that in the rainy period a surplus of humidity occurs.

Surface geology consists of Quaternary sedimentary deposits made up of many distinct complexes (surface fill, upper sandy-clayey complex or Colentina gravel complex). The existing sewers are located at depths of up to 9 m below ground level and are likely to be bedded depending on their location in the surface fill or upper sandy-clayey complex.

On broad terms available data indicate that the surface geology is predominately as follows:

- Eastern sector of Bucharest: succession of clay and sand layers;
- Northern sector of Bucharest: predominately sandy soils;
- Elsewhere: predominately clayey-sand profile.

Bucharest is subject to intermittent *seismic activity*. The city is located some 140km to 170km from the Vrancea region (epicenter of many earthquakes) and is particularly vulnerable to earth movements due to the lack of hard geology in the area.

Soil. Due to the physical and geographical conditions, the municipality of Bucharest and its neighborhood are dominated by reddish-brown forest soils, to which associate many other types of soil such as argillo-iluvial, cambic chernozems, podzolized and gleyed soils, and alluvial soils. The cultivated reddish-brown soils of the Bucharest outskirts are in several evolution stages, being differentiated by the humus content and the color. The weakest organic soils are found only on Glina-Balaceanca terrace.

4.2.3 Ground water

Bucharest and the neighboring area have three categories of groundwater: the upper aquifer, the captive water located in the Fratesti gravel layers and the lower aquifer located deep under the Fratesti gravel.

- The upper aquifer is composed of coarse sands and gravels - alluvial deposits along the Damboviţa and Colentina River valleys. Due to its small depth below the soil surface it is highly vulnerable to pollution.
- The Fratesti layers, composed of coarse deposits separated by clay, having a thickness between 70-100 m, are now the main resource for groundwater supply.
- The lower aquifer is composed of fissured karstic limestone from the cretaceous and lower Jurassic period and can be found at around 600 m depth.

The Damboviţa and Colentina alluvial sand and gravels representing the upper aquifers are of particular interest to the studied sewerage system. The Damboviţa sands and gravels deposits are located only under the flood plain of the river Damboviţa. With a thickness of 2m to 11m and a slope from northwest to southeast, this aquifer lies at depths of 4m to 15m.

The Colentina strata can be found throughout the whole city. This aquifer is closer to the surface in the northwest (3m to 17m) and deeper to the south-east (up to 10m to 28m). The thickness of the aquifer is between 4 and 10m.

4.2.4 Surface water

The Bucharest Municipality is crossed by the Damboviţa and Colentina Rivers, which flow roughly parallel through the city from West to East. Bucharest and its surroundings are situated in the lower reaches of the Arges river basin.

The river Damboviţa is one of the principal tributaries of the river Arges and has a total length of 286 km and a catchment area of 2,824 km2.

Figure 4.1 Trajectory of the Dambovita and Colentina Rivers through Bucharest

The natural Dambovita River does not really exist on the Bucharest territory, being replaced by a dual system composed of the Casseta designed to receive wastewater from the sewerage system and an artificial 'river bed' which runs on top of the Casseta, containing clean water delivered over the dam of Lacul Morii (Morii Lake). This lake receives the water of Dambovita river upstream Bucharest. Lacul Morii was created in the 1980´s, in the western part of the city, in order to attenuate flows in the river Damboviţa and improve the protection against flooding.

Downstream Bucharest and until reaching the confluence with the river Arges, Dambovita has been transformed into a man-made straight channel, which at the present is carrying an important amount of untreated wastewater that finally enters into the Danube (60 km downstream).

The river Colentina is a tributary of Damboviţa. It has a total length of 80 km and a catchments area of 636km^2.

The flow regime of this river was also modified during the first half of the twentieth century by damming in order to form a number of lakes, part of them included in the city area (Baneasa, Herastrau, Floreasca, Tei, Plumbuita, Pantelimon, etc).The multi-annual average flow at Colacu section is of 0.63m^3/s.

On the Bucharest territory and downstream Bucharest the survey of the water quality performed by the “Apele Romane – Directia Bazinala Arges” indicates exceeding of the following quality indicators:

- organic dissolved biodegradable substances (expressed as BOD5)
- nutrients – N and P
- heavy metals.

As result of the high pollution degree hypertrophic accumulation of biomass are very frequent in the rivers as well in the lakes water.

4.2.5 Air quality

Within the project area there are an important number of air pollution sources - important roads, thermo-power plants, industrial platforms, as well as the commercial units (supermarkets and hypermarkets with intense traffic) and other activities. All these activities have an impact on the ambient air quality in Bucharest and the surrounding areas.

The intense traffic in the area results in emissions of sulphur dioxide, nitrogen oxides, benzene, carbon monoxide and fine dust. The emissions from the PROTAN factory activities and Ochiul Boului landfill mainly influence the air quality by unpleasant odours in the southern part of the area.

Except the pollution of the ambient air resulting of the human activities, the atmosphere is subject of a natural contamination, process in which the dust storms have an important role. Their impact is stronger in the absence of adequate vegetal cover. Further along the Dambovita River, odour can be considered as noticeable. This is also due to the so-called “dead arms” or stagnant waters, downstream the river.

The air quality is assessed based on the following Romanian regulations:

- Order 592/2002 for approval of the Norms establishing limit values, thresholds values and criteria and assessing methods for sulphur dioxide, nitrogen dioxide, nitrogen oxides and suspended particulates (PM_{10} and $PM_{2,5}$), lead, benzene, carbon monoxide and ozone in the ambient air.

- Order 1271/2008 for approval of the classification of localities within Bucharest agglomeration and Cluj, Dolj and Iasi counties in air lists following the provisions of the Order 745/2002 on defining agglomerations and classification of agglomerations and zones for air quality assessment in Romania.

Table 4.1 Limit Values (VL), Guiding Values (GV) and Alert Thresholds (AT) – in conformity with Order 592/2002

Limit Values (LV) and Guiding Values		Alert thresholds	Mediation period
NO_2	LV = 200 μg/m^3 – 18 exceedings admitted	400 μg/m^3 – during 3 consecutive hours in points that are representative for air quality on a surface of at least 100 km^2 or for the entire zone, agglomeration	1h
	LV = 40 μg/m^3		1 year
NOx	GV = 30 μg/m^3 – for protection of ecosystems in non-built zones		1 year
CO	LV = 10,000 μg/m^3		
SO_2	LV = 350 μg/m^3 – 24 exceedings accepted	AV = 500 μg/m^3 during 3 consecutive hours in points that are representative for air quality on a surface of at least 100 km^2 or for the entire zone or agglomeration	1 h
	LV = 125 μg/m^3		24 h
	LV = 20 μg/m^3		1 year
Suspended particulates PM 10	LV = 50 μg/m^3		24 h
	LV = 40 μg/m^3		1 year

Assessment of the air quality for Bucharest municipality and the surrounding areas representing the Bucharest agglomeration has been based – as required by Order 592/2002 - on the results of the air quality monitoring obtained from the monitoring stations, the emission inventories and modeling of dispersion in the atmosphere achieved by using meteorological data.

Lists containing the classification of Bucharest municipality and dwellings of Bucharest agglomeration in conformity with the provisions of Order 592/2002 are provided in the Order 1271/2008.

Table 4.2 Air pollution lists (Order 1271/14.10.2008) where Bucharest municipality and Bucharest agglomeration are mentioned

Poluant	Lists where Bucharest municipality is mentioned	Lists where Bucharest agglomeration (surrounding dwellings) is mentioned
NO_2	List 1	List 2.1 – dwellings: Popesti-Leordeni
		List 3.1.2 - dwellings: Afumati, Balotesti, Bragadiru, Chiajna, Chitila, Dobroesti, Glina, Jilava, Magurele, Mogosoaia, Otopeni, Pantelimon, Voluntari
PM_{10}	List 1	List 3.1.3 - dwellings: Afumati, Balotesti, Bragadiru, Chiajna, Chitila, Dobroesti, Glina, Jilava, Mogosoaia, Otopeni, Pantelimon, Popesti-Leordeni, Voluntari
CO	List 1	List 3 Sub-list 3.3.4 - dwellings: Afumati, Balotesti, Bragadiru, Chiajna, Chitila, Dobroesti, Glina, Jilava, Magurele, Mogosoaia, Otopeni, Pantelimon, Popesti-Leordeni, Voluntari
SO_2	List 3 Sub-list 3.1	List 3 Sub-list 3.3.1 - dwellings: Jilava, Magurele, Popesti-Leordeni
Pb	List 3 Sub-list 3.3	List 3 Sub-list 3.3.3 - dwellings: Afumati, Balotesti, Bragadiru, Chiajna, Chitila, Dobroesti, Glina, Jilava, Magurele, Mogosoaia, Otopeni, Pantelimon, Popesti-Leordeni, Voluntari
C_6H_6	List 3 Sub-list 3.3	List 3 Sub-list 3.2.5 – dwellings: Afumati, Balotesti, Bragadiru, Chiajna, Chitila, Dobroesti, Glina, Jilava, Magurele, Mogosoaia, Otopeni, Pantelimon, Popesti-Leordeni, Voluntari

Notes:

List 1 - Agglomerations and zones where the levels of concentrations of one or more pollutants are higher than the limit value plus the margin of tolerance or higher than the limit value in case of no margin of tolerance has been fixed**.**

List 2 - Agglomerations and zones where the levels of concentrations of one or more pollutants are between the limit value and the limit value plus the margin of tolerance.

List 3 Sub-list 3.1 - Agglomerations and zones where the levels of one or more pollutants are lower than the limit value, but situated between this one and the upper level of assessment

List 3 Sub-list 3.2 - Agglomerations and zones where the levels of one or more pollutants are lower than the limit value, but situated between the upper level of assessment and the lower level of assessment

List 3 Sub-list 3.3 - Agglomerations and zones where the levels of one or more pollutants are lower than the limit value, but do not exceed the lower level of assessment.

4.2.6 Noise

In the area of interest the main sources of noise is the traffic along the main streets due to:

- light and heavy vehicles (cars, trucks, busses, trolleybuses)
- trams and railway vehicles

Other noise sources are activities of some industrial and services/infrastructure maintenance companies and domestic activities.

The road inside the city are very crowded almost the whole day, supplemental nuisances resulting from stopping and acceleration of cars and also from horns of special vehicles as Police and Ambulances.

A detailed evaluation of noise level in Bucharest was made in year 2008 when the strategic noise map of Bucharest agglomeration was elaborated. This strategic noise map shows the limits between the areas with different noise levels comprised between 40 and 80 db (A).

The figure 4.2 presents the strategic noise map of Bucharest municipality. This map indicates the followings:

- the highest noise level - 70 – 80 dB(A) - is registered in the center of the city in some points along the main roads, both during the day and night period;

- high noise level of 65-70 dB (A) is also registered along the roads crossing Bucharest city or giving access to different quarters but only during the day period;

- the average level of noise in the area of Dambovita upper reach (Splaiul Independentei street) and main streets, which are parallel with the main collectors (13 Septembrie, Marasesti, Calea Vacaresti, Mihai Bravu, Pantelimon etc), is comprised between 65 – 70 dB(A) both, during the day and night period;

- even if high level is registered in the immediate vicinity of the main roads, the lateral zones of these roads registered a noise level of 50-55 db(A), while the peripheral zones register a noise level of 45-50 and sometimes even under 40 dB.

Considering the accepted values of noise (STAS 10009-88) the actual noise sources in the area do not generate excessive noise levels for the a big dwelled areas.

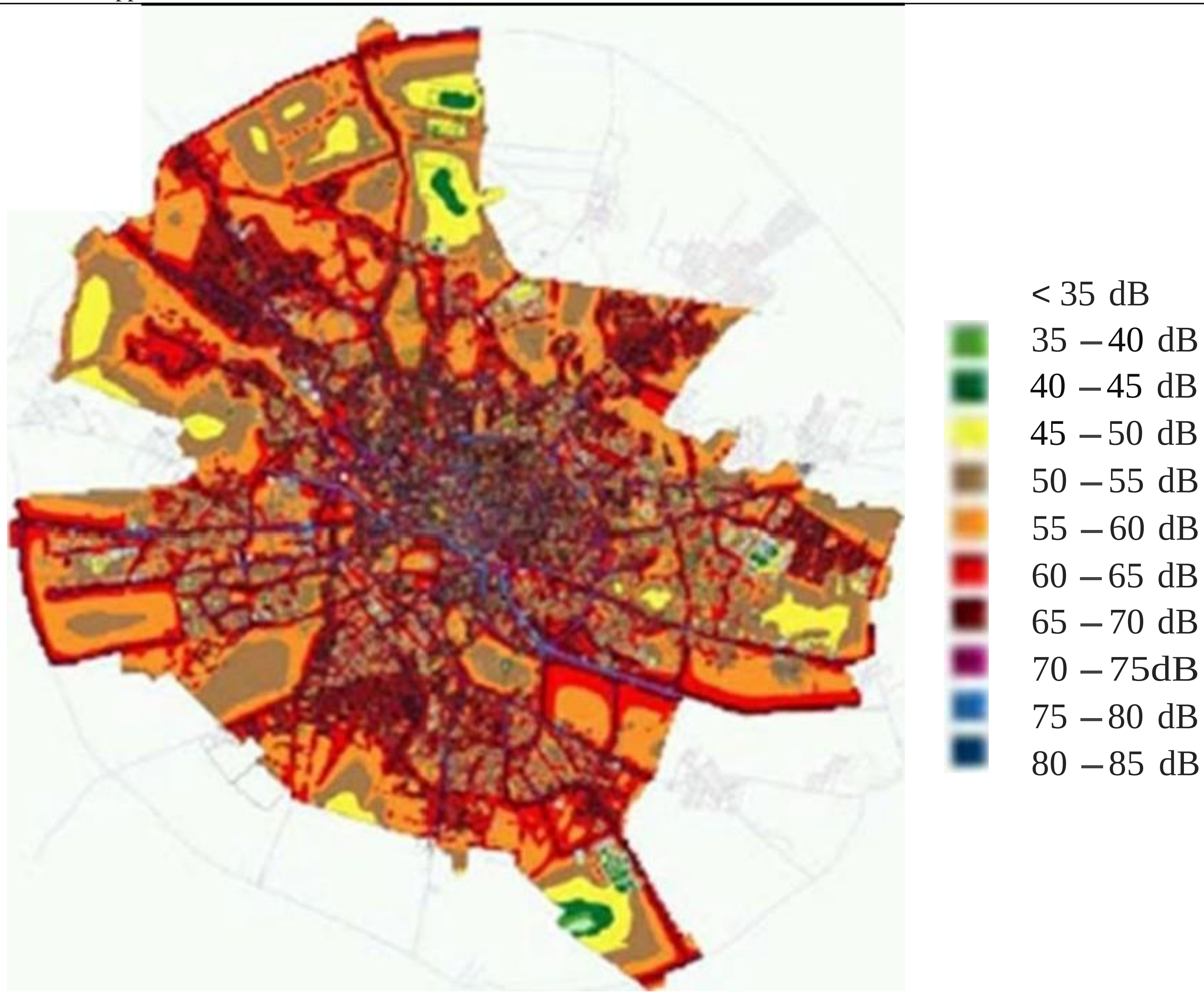


Figure 4.2 Bucharest noise map

4.6 Biological environment

Within the natural landscape, the vegetation has an important role, as it is one of the natural factors with a large economic and ecologic importance.

The vegetation of the area where Bucharest is located and in particular that of the surrounding areas include biocenoses of the inter-stream areas, hydrophilic areas and flood plain vegetation. Natural vegetal associations representing these biocenoses are visible only in the surrounding area of Bucharest, because inside the city the natural environment was replaced by an artificial one, in which only isolated elements of these biocenoses could be found.

4.3.1 Protected trees species

For the urban environment a special mention should be made for some exemplars of **protected trees** found in the Bucharest parks and streets. A part of protected trees are exotic species as:

- Magnolia tree (Magnolia grandifolia), brought from Japan, is one of the most widely represented protected tree; exemplars could be found in Cismigiu and Carol Parks, on the streets Berzei, Dragos Voda, Tepes Voda, Aurel Vlaicu and around the church Casin.
- Life tree or the Ginko tree (Gingo biloba) is originated from China and Japan and could be found especially in parks or household gardens.
- Tulipe tree (Liliodendron tulipifera) is originated from Nord America and is represented by 5 exemplars in Bucharest.
- Silk tree (Albizzia julibrissin), originated from Asia is well adapted to the climate of the southern part of Romania.
- Japanese acacia (Sophora japonica) could be found in Cismigiu Park but also on the streets as on the street Popa Soare.

Other part of protected trees is represented by exemplars of the following common species, protected because of their age, aspect and other qualities:

- White mulberry (Morus alba), brought by Greeks from China in the Mediterranean region for the silkworms rearing, is largely represented on the streets Popa Nan, Matei Basarab, Latina, General Berthelot,. Sachelarie and Alexandru Davila.
- Oak tree (Quercus robur) is reprezented by 9 imposing very old trees on the streets Badea Cartan, Horei, Olimpului and Principatele Unite, as well as in the Gradina Icoanei Park.
- Black pine (Pinus nigra) is growing in Romania in the Banat region; in Bucharest is present on the Dr. Staicovici street, but without nameplate
- Lime tree (Tilia tomentosa)is specific for warm climates and is very resistant to pollution ; one exquisite exemplar is found on the street Cositelor (sector 3), while others along the Splaiului Independentei street.
- Plane tree (Platanus acerifolia) is known as the most oxygen productive tree and for this reason is considered as very useful for the environment protection; in Bucharest some very nice protected exemplars are on the streets Legendei 2 and Splaiul Independentei.

4.3.2 NATURA 2000 sites and other natural protected areas around Bucharest.

The Natura 2000 Scroviştea site was nominated based on the Habitats EU Directive for the protection of natural habitats and wild fauna other than wild birds. The Scrovistea site is a remaining of the Codrii Vlasiei large forest that covered in the past all the Romanian Plain and contains a complex of lakes, ponds and forests.

The Natura 2000 Grădiştea-Căldăruşani-Dridu site was nominated based on the Birds EU Directive, for the 83 species of protected wild birds out of which 22 species are strictly protected at European level. In Ilfov county this site is reprezented by the lakes Căldăruşani and Balta Neagră, the water storage basins on the rivers Cociovaliştea and Vlăsia, that represent ideal places for nesting, refuge and food for wild birds, and the surrounding forests.

Near Bucharest, on the territory of Ilfov county, there are 3 protected natural areas of national interest: the forest Snagov, the lake Snagov and the forest Scrovistea that is superposed on the Natura 2000 Scroviştea site.

The Snagov forest is a national park having as purpose the protection and conservation of samples containing natural elements of special values. It contains many monumental oaks, ashs and limes**,** having strain diameter of 80-100 cm and hights of more than 30 meters.

The Lake Snagov, situated at 25-30 km of Bucharest, is a river „liman" on the Ialomiţa river; with a depth of 9 m it is the deeper lake in the Romanian Plain. On his shores, besides the reed and rush, one could find white and yellow lilies, as well as the indian lily recently acclimatizated. The fish fauna, very attractive for fishermen, is reach in species as bream, carp, perch, catfish, pike and roach.

Besides these protected areas in Ilfov county and in Bucharest there are many secular trees registered as natural monuments out of which two are on the territory of the Cernica monastery.

4.3.3 Other protected areas

Inside Bucharest there are a lot of areas protected as hystorical monuments registered on the List of the Ministry of Culture and dated from the Neolitic period till 20 years ago, 2279 being hystoric monuments – buildings, churches or statues from different periods. These construction, placed mainly in the hystoric center of the city, are have been declared as protected by the Decision 279/2000 of the General Council of the Bucharest Municipality.

Outside Bucharest, 5 km east and beyond the Colentina river catchment area, there is an architectural and a natural protected objective – the Cernica monastery and the Cernica Lake and forest. The monastery was built in the year 1608.

Chapter 5 POLLUTANT SOURCES and MEASURES FOR ENVIRONMENT PROTECTION

The environmental impact generated by the achievement of the works for rehabilitation of the Bucharest wastewater collection network will be determined by the pollutants emitted during the construction phase and during the operational phase.

In this chapter the pollutant emissions are described, as well as measures for their effects reduction, while in the next chapter the impact on the environment is assessed.

It is to mention as a characteristic of this project that the most polluting emissions and nuisances will be registered during the construction phase while the operation phase will benefit of positive changes. The project aims to reduce the existing nuisances generated by issues related to:

- the high level of the ground water
- the infiltration of clean water inside the sewage system

and to ensure the durability of the structure transporting the wastewater to the Glina WWTP.

5.2 Nuisances generated by planned works and reduction measures

Table 5.1 presents the works planned to be achieved on different components of the sewerage system and the nuisances or pollutant emissions supposed to be produced by these works. All these nuisances will be produced in the construction phase. In functioning phase no emissions related to the planned works are supposed to appear.

Quantitative estimations of nuisances are hardly to be given at this stage of works planning because of not knowing the extension of the works. The real extension of the works will be established after future investigations and detailed planning that will be subject of contracts to be assigned.

Table 5.2 presents the inventory of nuisances and the measures recommended to reduce or eliminate them. A more detailed description of nuisances and of proposed measures is provided in Chapter 6.

In Chapter 6 the impact forms on the environment components are detailed separately for the construction phase and the operation phase, by considering the effects of proposed minimization measures.

Table 5.1 Emissions and nuisances related to the works to be achieved for the Bucharest sewerage rehabilitation

Objective	Actions	Achieved by	Nuisances, emissions
Rehabilitation of the Main Drain between Ciurel and Vitan	*Ensure the access to the drain.* *Install a drain by-pass under the collector entering the Caseta* *Rehabilitation of the collector B0 at the point of discharge in the Caseta* *Rehabilitation of the main drain over 10 km and of the access ways to the drain*	- limiting the work section by dams on the upper reach; construct earthen ramps for handling mechanic equipment and materials - raising the slabs of the upper reach on 5 m in long - dewatering and cleaning the drain - blocking the connection of the collector B0 with the main drain and the Caseta - installing several pipes under the collector B0 entrance in the Caseta to enssure continuation of the drain - rehabilitation of the collector BO connection chamber to the Caseta, (correction of cracks, profiles, facings) - repairs to the cover slab of the upper reach level. - the sawing of the upper slabs on 5 lm (in long) every 50 ml; - cleaning of the entire drain by removing the sand clogging the drain - cleaning of the weeping holes allowing the water draining; - creating additional weep holes	- crowding the traffic by blocking a part of the nearby road (transport of earth waste, movement of mechanic devices) - nuisance for the landscape - wastewater - odour - emission of particulates and burning gases by vehicles and machinery movements - noise and vibrations - waste (fragments of tiles, concrete debris, sand and sludge from cleaning the drain and weep holes, metallic waste from the old pumps) - odour, emission of particulates and burning gases - noise and vibrations

	Rehabilitation of the pumping stations	- structural rehabilitation in order to assure safe drain inspection - Remediation of the access ways - Replacement of the pumps - Providing of a discharge pipe to the upper reach for the drained water pumped - Implementation of the safety equipment (ramps, steps, signalization) - Installing electric automatic control devices - Installing mechanical ventilation	- waste (fragments of tiles, concrete debris, sand and sludge from cleaning the drain and weep holes, metallic waste from the old pumps) - odour, emission of particulates and burning gases - noise and vibrations
Sealing of the SUPERIOR REACH - Dambovita canal on 17 km	- *Cleaning the bottom of the channel* - *Repairing damages and provide a new base layer on the bottom of the channel* - *Sealing the bottom on the sections potentially leaking*	- Dewatering of the upper reach by sectors limited by dams and the existing overflows - Cleaning the bottom of the channel, removing waste and sludge, washing the bottom and walls by using high pressure water - Identification of structural damages and their treatment by passivation of the exposed steel and installing a structural concrete on the gaps found - Application of a water-repellent cement mortar layer	- clean water from the upper reach work sector dewatering will be sent to the next upper reach sector, downstream the working site - domestic waste, sludge, sand collected from the bottom of the channel - wastewater (if possible sent to the Caseta) - odour, emission of particulates and burning gases - construction waste - noise

Structural rehabilitation of the CASETA	*1. Rehabilitation of the Caseta* . *Rehabilitation of the access ways to the Caseta*	- Dewatering by pumping of the Caseta sectors delimitated by dams - Cleaning of the Caseta bottom - Achieving of drills for injections (4 drills every 3 km), for stabilizing the pre-slabs supporting the cover - Low pressure (max. 2 to 3 bars) cement grout injection to fill the annular gaps of the slab supports - Treatment of the identified structural damages by passivation of the exposed steel and application of structural concrete on the gaps found - Stabilization of the pre-slabs by reinforcement with wire mesh anchoring and concrete projection - Demolition and removal of the pre-slabs that can not be stabilized and filling the gaps in the remaining slabs supports - Cleaning the access ways - Repairing of the cracks and facing of the structure - Installing of safety equipment (handrail, steps, pads, signage) - Rehabilitation of the upper reach drainage bypass by installing of a metal pipe.	- odour, wastewater - sludge and sand, construction debris left inside the Caseta - noise, vibrations - metallic waste, construction waste - noise - particulates – air pollution - construction waste, metallic waste - noise - crowding the traffic by blocking a part of the nearby road (transport of earth waste, machinery movement) - emission of particulates and burning gases by vehicles and machinery - noise - nuisance for the landscape - crowding the traffic - construction waste, earth, gravel,

Works for the SUBWAY DRAINAGE	*Works for rehabilitation of the subway drainage on a length of 8 km*	- Construction of a drainage trench along the subway structure - Installing a DN 400 drain at the level of -1m from the bottom of the sewage collectors - Applying of a 20/40 gravel layer surrounded by a specific geo-textile (anti-clogging and anti-contaminant) - Construction of embankments - Restoration of the site surface	- crowding the traffic - emission of particulates and burning gases by vehicles and machinery functioning - noise - construction waste, earth, gravel
	Works for installing of 5 pumping stations	- Construction of concrete pumping chambers (30 m^2) located at 5m depth and of access ways to them - Installation of pumps - Installing discharge pipes up to the upper reach - Providing safety equipment (handrail, steps, access pad, signage, working platform, crane) - Installation of automatic control devices and mechanical ventilation.	- crowding the traffic - emission of particulates and burning gases by vehicles and machinery functioning - noise - construction waste, earth, gravel
COLLECTORS rehabilitation on 35 km in the area of contact with the water table	*Rehabilitation of non-visitable collectors*	- Demolition of roads and execution of the required excavations - Installing of a new collectors next to the old ones; restore connections - Filling of the old collectors with cement or sand - Restoration of the sites over the excavated trenches.	- noise - construction waste, earth, gravel, sand - emission of particulates and burning gases by vehicles and machinery functioning - odour - landscape nuisances

	Rehabilitation of visitable collectors	- Dewatering of the collectors - Cleaning and inspection of the collector's structure - Drills for annular injections (3 drills every 3 ml) and filling them with a cement grout - Repairing of structural damages using structural shotcrete or structural concrete - Repairing of cracks and collector facings - Restoration of connections - Securing of the access ways	- wastewater from dewatering the collectors - waste from cleaning the collectors (solid waste, sand, sludge) - construction waste from drilling and injections, application of structural concrete, repairing the facings - air pollution - particulates, burning gases, odour - noise - landscape nuisances
Works for LAKES WATER DISCHARGE in the superior reach	- Install water tanks downstream of the lakes drainage system - Install pipes discharging lakes water into the upper reach of river Dambovita	- no details specified	Supposed nuisances: - traffic crowding - landscape nuisances - air pollution (particulates, burning gases) - noise - construction waste

Table 5.2 Description of pollutant emissions and nuisances and measures recommended for their reduction or elimination

Nuisances description	Measures recommended for reduction of nuisances
Crowding the traffic will be the result of: - working sites blocking a part of the nearby road - vehicles transporting materials and waste and of machinery used for activities in the working site The working sites will be placed mainly on the trajectory of the Caseta on a length of 17 km (in case of the upper reach rehabilitation) and on the collectors trajectory (on at least 35 km). The working sites will comprise not only the surface of the Caseta and of collectors, but also a part of the neighboring roads. Occupying a surface of the roads, the worksites will act as a bottle neck for the traffic already crowded in some areas. In addition, the works will require movement of of some mechanic machinery which sometimes are circulating at low speed (bulldozers, concrete trucks, shotcrete machine), as well as movement of vehicles transporting earth, waste or material.	- Planning the opening of different work sites, in order to prevent the appearance of many blocking points on the same route - Signalizing the working sites from enough long distances before to allow traffic deviation; - Limiting the area of the road included in the work site - Optimization of any transport or machinery movement and avoid parking on the route - Transport of earth, waste or material, as well as the movement of some mechanic machinery to be made during the not crowded hourly intervals of the day.
Emission of particulates and burning gases will result from vehicles and equipment circulation to/out or inside the worksite. Particulates are generated also by actions implying construction of the earth dams, demolition, and excavation (i.e. for the subway drain) or sawing the upper slabs, as well as the actions for restoration of sites. Repairing of structural damaging, cracks and facings are also actions producing particulates but because having large dimensions or being wet these particulates will settle not far from their generating sources.	- Optimization of transports and machinery movement inside the worksite; avoiding excessive functioning on the worksite of equipment using gasoline or diesel as energy source - Wetting the trajectory of vehicles and machinery inside the waste - Correct handling of pulverulent materials/waste
Odour will be produced in case of different actions involving opening, dewatering and cleaning of Caseta, main drain, collectors or access ways. Extraction and	- Implementation of a correct system of waste management within the worksite in order to

handling of clogging sand, construction waste or sludge is generating odours. Wastewater generated from cleaning or diversion of wastewater flow transported by collectors are also sources of unpleasant odours	maintain order and cleanliness - Separate collection and evacuation of waste, sludge and clogging sand - Wastewater resulted from cleaning the work sectors will be evacuated only in the Caseta
Wastewater will be generated from cleaning actions achieved inside the main drain, weep holes, access ways to the drain and to the Caseta or inside the upper reach bottom and walls	- Any type of wastewater resulted from cleaning the different work sectors or from rehabilitated collectors will be evacuated only in the Caseta
Nuisance for the landscape Any work place will constitute a nuisance for the landscape because of introducing disturbing elements such as demolished sidewalks, construction equipment / machinery, materials, wastes, etc., that are not an usually presence. These elements are sources of modifying the pedestrians and cars traffic and the circulation of clean water in the Dambovita upper channel, that are normal landscape components in the project area.	- The surface of the worksites will be limited to 1 km in length - Worksites have to be completely fenced and their surfaces have to be well organized (for example the opening of the upper reach will be made once on only 5 m length) - Worksites fencing have to be composed of panels covered by advertising posters or prints - Rapid restoration of the site surface at the end or works.
Noise and vibrations will be generated by the traffic of vehicles making different materials transport and functioning and movement of constructive equipment. There will be many noisy equipments acting on the sites such as: excavator, bulldozer, peak hammer, epuisment pumps, electricity generator, compressor, injection equipment, shotcrete machine and concrete mixer/truck. The noise generated by the functioning machinery will be added to the background noise produced by traffic and usual industrial and domestic activities	- The fencing of the working site have to be composed of noise absorbent panels - The equipments producing strong noise have to be placed any time when possible at the lowest level inside the site (i.e. on the bottom of the upper reach or of the open drain) to be shielded by the existing walls of the site - The equipments producing vibrations and noise have to be fixed on temporary supports

Waste will be represented especially by fragments of tiles/slabs, concrete and asphalt debris, fragments of replaced collector channel, formworks, props, facings, metallic waste from the old pumps, clogging sand and sludge from cleaning the main drain and weep holes, but also by soils and gravels. Most of the above mentioned wastes are recyclable materials, but there are some waste types needing special regime (sludge and clogging sand) because they are contaminated and generate odour.	- Separate collection of different types of waste - Specific regime applied to recyclable and non-recyclable waste: - evacuation of recyclable waste has to be made by companies specialized in recycling construction waste - disposal of sludge and clogging sand have to be sent to hazardous waste landfills - Handling and transport of hazardous waste will require measures for ensuring the safety of working personnel.
Energy / fuel consumption Most part of works will be made by equipments whose functioning is ensured by consumption of fuels – diesel or gasoline (excavator, bulldozer, concrete truck). Other equipments (epuisment pumps) are supplied by electricity produced by generators whose functioning is assured also by burning liquid fuel (gasoline or diesel). Whatever the form of energy is used, the consumption of energy is a nuisance for the environment because of being of consuming non renewable resources.	- Use of modern equipment with reduced energy consumption - Optimization of equipment functioning regime - Avoiding non-necessary functioning of equipment - Daily control of the energy and materials consumption

5.2 General measures for worksites organization in order to ensure work safety

The worksites will be organized as required by the following regulations:

- *Law no.319/ 2006 – on work safety and health*

- *Norms for application of the Law 319/2006 provisions*

- *Governmental Decision no. 300/02.03.2006 on minimal requirements for work safety and health on temporary or mobile worksites*

- *Specific Norms for work safety in the field of wastewater approved by Order 357/1995*.

The minimal requirements for worksites organization are asking for:

- Introducing restricted areas
- Indicating traffic roads inside and outside the worksite
- Assuring stability of surfaces/embankments/slopes/dams and equipments
- Providing natural of artificial lightening
- Providing ventilation of closed spaces
- Reducing personnel exposure to specific risks such as noise, atmosphere lacking oxygen or containing toxic or flammable substances
- Detection and fire fighting
- Providing first aid in case of accidents

A special attention has to be given to:

- Excavation machinery and vehicles for material evacuation
- Underground works and access ways to them
- Concrete or metallic construction, slabs, formworks, props and other prefabricated elements
- Installation for electricity distribution.

Chapter 6. IMPACT ON THE ENVIRONMENT

In this chapter the impact on the environment determined by the planned works and recommended protection measures are described.

6.1 Impact on water quality

6.1.1 Impact on surface water

The planned works are intended mainly to limit the clean water entering the sewerage system and diluting the influent discharged to the Glina WWTP and, in the same time, to ensure the durability of the Bucharest sewerage structure.

In order to achieve these objectives the works are oriented mainly on rehabilitation and completion of the sewage system components. The planned works are influencing the surface water of the river Dambovita, either by addressing directly to the upper reach of the Dambovita channel that is crossing Bucharest, or by discharging drained clean water in the upper reach.

In the first work category addressing directly to the upper reach one could mention:

- ► Works for sealing of the superior channel containing Dambovita clean waters
- ► Works on the main drain of the Caseta; these works, planned on a length of 10 km from Ciurel to Vitan, where the Caseta is going in parallel with the upper reach, will need access from the superior reach (that is the Dambovita channel)
- ► Works on the Caseta – to rehabilitate its structure and its connections with the collectors; the access in the work sectors will be also from the upper reach.

In the second category the following planned works could be mentioned:

- ► Subway drainage on 8 km length that will discharge cleanwater in the upper reach
- ► Discharge of lakes drainage system in the upper reach.

Impacts during construction phase

The first category of works is apparently the most impacting because:

- dams are to be constructed on the upper reach to delimitate the work sectors
- upper reach sectors limited by dams will be dewatered; the water of the river channel sectors will be diverted downstream the worksite by pipes
- slabs of the upper reach will be dislocated in order to give access to the drain or Caseta
- bypasses will be built for the water drained by the main drain and the subway drain to be discharged in the upper reach.

During construction, although spectacular, these works will not affect the quality of the surface water because, as the protection measures are specifying, no wastewater will be discharged in the upper reach. The water used for cleaning – around 300 l/s – will be sent only into the Caseta.

An important effect is that the planned works will reduce the investment cost on Glina WWTP, by the fact that phase 2 of this objective will be conceived on reduced hydraulic parameters.

Impact during operation
During operation it could be possible that the supplemental flow coming from underground to improve the quality of the upper reach water, because being cleaner after filtration by many earth layers, and consequently, the risks of eutrophication will diminish, too.

It is supposed that the effect of works will be noticeable on the flow amount in the upper reach that could increase theoretically with around $3m^3/s$. The supplemental flow will increase the water speed in the upper reach with favorable effects on water quality and the landscape.

As a result of infiltration reduction, the flow of wastewater brought by the Caseta to the Glina Plant will be reduced with around the same amount, while the plant influent will be more concentrated. Consequently, better conditions for the activated sludge development will be created and the efficiency of the treatment plant in removal of pollutant load will increase.

The lowering of the influent flow and the improvement of the Glina treatment process will lead to the discharge of a cleaner effluent, meaning less negative influence on the receptor. As a consequence an improvement of the water quality in river Dambovita downstream Bucharest is expected. This means an increased capacity of auto-purification of the river water and, subsequently, an increased abundance of life forms in river water and on the river banks. Improvement of the water quality of the river Arges is expected too, considering the contribution of Dambovita River to Arges pollution, and similarly a reduction of pollutants into Danube river.

Finally, it is to mention that of special importance is the economic effect on the Glina WWTP that consists in reduction of the operation costs.

6.1.2 Impact on Groundwater

As mentioned before, the construction of the Caseta and Subway line no 1 has increased the groundwater level, which rose in the Vitan zone from -69.12m to – 60.00m. On the right bank of the river there is no draining system related to the Subway, while the drainage of the left bank is not well functioning.

At present, in the area where the subway line is parallel with the Caseta, this one and the collectors are placed inside the groundwater layer and for this reason the clean water from the ground is entering in the sewerage system, by cracks and constructive defects.

Impact during construction
No disturbance of the geological structure is supposed to take place during works construction.

No change of the groundwater quality will be determined because no wastewater discharge will occur in the ground or on the soil during the works.

Impact during operation
The planned works are supposed to decrease the level of the groundwater and to discharge drained flows into the superior reach. As effect of the planned works a lowering of the groundwater level with 1-2 m is expected, respectively from the actual depth of -3… -7 m, till around -5 m from the land surface (this being the depth of the pumping stations on the left bank drainage system and of the Subway drain on the right bank).

The lowering of the shallow groundwater layer will have as main effect the reduction of clean water infiltration inside the sewage system components.

The subsequent effects are the reduction of the wastewater flow brought by the Caseta to the Glina Plant and the increased concentrations of BOD and N that will improve the efficiency of the treatment plant. On the other hand, the flow reduction will reduce the investment and operation costs for Glina plant.

The planned works will achieve also an improvement of the sewerage component efficiency and durability.

The rehabilitation of the collectors transport capacity will lead to the reduction of risks of flooding accidents for the metro galleries and buildings cellars during heavy rains, as well as assuring the integrity of the buildings in areas near the Dambovita channel.

No negative effects are expected on the water level inside the wells because wells in Bucharest area are reaching deeper groundwater layers which are supplied from long distances.

6.2 Impact determined by waste

Impact during construction
The types of waste supposed to result from the construction of the planned works are included in Table 6.1 where also the waste codes and the recommended disposal options are mentioned.

Table 6.1 Generated waste and recommended disposal options

Waste Types	Waste code	Recommended disposal option
Fragment of asphalt cover	17 03 02	recycling
Fragment of concrete, dislocated tiles	17 01 01	recycling
Metallic props	17 04 05	recycling
Formworks	17 02 01	recycling
Metallic waste	17 04 07	recycling
Clogging sand	17 05 02	disposal by landfilling
Sludge	19 08 99	disposal by landfilling
Debris of facings	17 07 01	disposal by landfilling
Mixed domestic waste extracted from the bottom of the superior reach	20 03 01	disposal by landfilling
Earth, grave, sand from digging the trench for the metro drain	20 02 02	recycling

The above mentioned waste results from:

- opening the access from the surface of upper reach to the main drain and Caseta,
- materials extracted from inside the main drain, the Caseta and upper reach bottom
- old equipment extracted from the access ways and former pumping stations
- repairing of the sewerage components and from the restoration of the site surface.

A quantitative estimation could not be made because the volumes of works are not detailed yet. It was roughly calculated that the amount of excavated material that will be used for fillings or sent to disposal is around 420,000m^3.

Most part of the possible generated waste is inert construction materials that could be recycled in the benefit of the environment. But a special attention has to be offered to the clogging sand and sludge for the reason of their possible contaminants content (pollutants or pathogenic germs) and potential of generating unpleasant odour.

Regardless of the impact on the environment, all waste has to be separately collected and stored before disposal or sending to recycling. Storage places have to be arranged in such a way not to allow spreading and spilling. If appropriate – recipients will be provided for better collection and transport.

Contracting services for waste management with specialized companies will ensure the correct treatment of generated waste.

Impact during operation
No waste are expected to be generated during operation phase, except those ordinary waste resulted from periodic cleaning of the upper reach and maintenance of the pumping stations or access ways.

6.3 Impact related to consumption of materials and energy

Impact during construction phase
Most part of works will use equipments whose functioning is based on consumption of fuels – diesel or gasoline (excavators, bulldozers, concrete trucks). Other equipments such as pumps, peak hammers will be supplied by electricity produced by generators whose functioning is assured also by burning liquid fuel (gasoline or diesel).

At this moment, the energy consumption expressed as fuel and electricity could not yet be estimated depending on many factors that will be highlighted by the feasibility studies.

The amount of materials that will be consumed was roughly estimated as being the followings:

Asphalt	51,000 m^2
Concrete	95,000 m^3
Water proofing materials	300,000 m^3
Enforcements	1153 tones.

As measure for reducing the impact of materials and energy consumption the following measures were recommended:

- Using modern equipments with reduced energy consumption
- Optimization of equipment functioning regime and materials consumption
- Avoiding non-necessary functioning of equipment or materials consumption
- Daily control of the energy/materials consumption.

Impact during operation
The consumption of energy during operation phase will be limited to the functioning of pumps that evacuate the drained water from the main drain or the subway drain. The amount of energy consumption will depend upon the types and capacity of pumps and the quantity of pumped water.

Materials consumption will be limited to those needed for maintenance of pumping stations and access ways and possible small remediation of the sewage network.

6.4 Impact on Soil

Impact during construction phase
The planned works will take place on sectors having a maximum length of 1 km and occupying surfaces of 400 m^2 of the Caseta and around 200 m^2 of the surrounding area.

Worksites will be organized mainly on surfaces covered by roads or occupied by the Dambovita channel and only outside the city there are chances worksites to comprise areas not covered by asphalt or concrete.

All worksites have to be fenced by reusable panels in order to limit the affected areas.

Uncovered or discovered soil surfaces could be accidentally polluted by waste, especially by sludge and clogging sand extracted from the Caseta and drains, if these waste are not correctly handled.

The proposed measures for waste separate collection and storage on dedicated and arranged places (or recipients) are intended to and could avoid soil pollution.

Other soil accidental pollution could occur with oils of fuel from the equipment repairing or supply on the sites, if not carefully handled. It is recommended that any repair of equipment on sites to be achieved – if possible – only on concrete or asphalt covered zones and all spills to be gathered by absorbent materials.

Impact during operation
No impact on soil is expected to happen during operation phase. Accidents could happen due to the incorrect waste management during repairing actions or by spilling of oils/fuels, but the probability of such events is very low.

6.5 Impact on air

Impact during construction
The **emission of particulates and burning gases** that will result from vehicles circulation to or out the worksite and from equipment functioning could generate impact on the air quality. Dust will be also produced by actions such as construction of the earth dams, demolitions, excavations (i.e. for the subway drain) or sawing the upper slabs, as well as the actions for restoration of sites.

Repairing the structural damaging, cracks and facings are also actions producing particulates but, because having large dimensions or being wet, these particulates settles not far from their generating sources, producing a negligible impact on the surrounding areas.

Measures as optimization of vehicles and machinery movement and wetting their trajectory inside the sites could substantially reduce the emissions of particulates in the air and the impact on the air quality. On the other hand the correct handling of pulverulent materials/waste will have the same positive effect.

Avoiding excessive functioning of equipment using gasoline or diesel as energy sources will reduce the emissions of burned gases.

Another form of impact on the air is **odour** that will be produced in case of actions involving opening, dewatering and cleaning of Caseta, main drain, or access ways to them. Extraction and handling of clogging sand, sludge or construction materials left inside the Caseta, as well as wastewater generated from cleaning could generate unpleasant odours. The mechanically cleaning of the upper reach is supposed to generate fewer odours because it will handle a mineralized and stabilized mass of sediments.

Reduction of the impact due to odours will be possible by:

- Separate collection and regular evacuation of waste, sludge and clogging sand
- Immediate evacuation into the Caseta of any wastewater resulted from cleaning the work sectors
- Implementation of a correct system of waste management within the worksite in order to maintain order and cleanliness.

It is expected that the above measures will reduce odour impact and make it supportable for the people living in the area or passing by.

Impact during operation
No impact on the air is expected to be generated during the operational phase.

6.6 Noise impact

Impact during construction
The noise of works on the sewage system will affect areas that are placed along the Caseta and upper reach (17 km), along different collectors (35 km), as well along the Metro line no 1 (8 km).

The character of noise generated will depend on the types of works performed and types of equipment used, some works (breaking asphalt cover or concrete slab) being more noisy than others (cleaning, repairing, facing). The same observation could be made in relation to the duration of the noise and vibrations, but it is to mention that these emissions will be not continuous and will last not for long time.

The noisiest equipments used on the sites will be peak hammers, pumps, electricity generators, compressors, and concrete mixer/trucks. It is expected that their noise emissions together with the background noise will not exceed 70-90 dB(A).

Similar noise level is reached in auto parking and some industrial premises but it is to mention that in our case, normally, it will be not superposed and continuous functioning of many noisy equipments. The noise generated by the planned works on the sewerage system could be compared with the noise generated by the maintenance works performed for other utilities such as the natural gas distribution or water supply.

The receptors affected by noise are the persons living or working in the area and the passersby, pedestrians or car passengers.

The recommended fencing of the working sites composed of noise absorbent panels will be more efficient in combination with the placement of the noisy equipment at the lowest level inside the site (i.e. on the bottom of the upper reach or of the open drain) in order to be supplementary shielded.

Another solution is to fix the equipment producing vibrations and noise on a temporary support, especially when this equipment will be used for a longer period or many times in the same location.

Supplementary, it will be very important to limit the working period during the day to the interval 9.00 -17.00 for not disturbing the resting period of the day.

The above measures recommended in order to reduce the impact of noise will be capable to reduce the level of noise at least with 20%.

Impact during operation
No impact due to noise is expected to be generated during the operational phase.

6.7 Impact on the landscape

Impact during construction
Any work place will constitute a nuisance for the landscape because of introducing disturbing elements such as dams, fencings, demolished items, construction equipment / machinery, materials, wastes, etc., that are not usually present in the zones. These elements are modifying the traffic regime on the roads and the water flowing in Dambovita upper channel, which are normal landscape components in the project areas. This impact on landscape is limited in space - because worksites are extended on maximum 1 km length of the Dambovita channel and in time. The total duration of planned works is 30 months, but each worksite will have a smaller duration.

For limiting the landscape impact during the worksites life special measures have to be provided such as:

- Worksites will be completely fenced and their surfaces have to be well organized (for example the opening of the upper reach will be made once on only 5 m length);
- Worksites fencing will be composed of panels covered by advertising posters or prints;

- The wheels of vehicles leaving the worksites will be washed at the exit gate in order not to soil the roads;
- At the end of works the site surface will be rapidly restored.

Impact during operation
No negative impact on the landscape due to planned works is expected to be generated during the operation phase. Instead, positive impact could be generated by the increased flow in the upper reach, which will increase the water circulation speed, respectively the water refreshing and will reduce the risks of eutrophication.

6.8 Impact on human health

Impact during construction phase
Human health could be impacted by some of the already described nuisances (air pollution, noise, crowded traffic, etc.). Reduction measures for these nuisances have been already presented. The safety of workers will be assured as required by the regulations in force.

Impact during operation
All above mentioned nuisances related to the worksites will disappear after the works ending, while the disease risks sources due to humid cellars and streets flooding during heavy rains will disappear.

Another benefic impact is the reduction of the risks for workers that are involved in survey and control of the sewerage system by using the access ways. The rehabilitated pumping stations and access ways will be provided with safety equipment such as steps, ramps, signalization, automatic control devices, and mechanical ventilation.

6.9 Impact on dwellings and other objectives

Impact during construction phase
The impact on dwellings determined by the planned works during the construction phase will consist in forms already mentioned – bottleneck in traffic, noise, disturbed landscape, etc., for which reduction measures have been already presented. All these negative impacts are limited in space and will last no longer than 30 months, considering the total duration of works.

Impact during operation
No negative impacts are expected during operation phase.

Instead, positive impacts are supposed to be registered consisting in:
- better collection of the wastewater; improved durability of the sewerage system
- reduction of risks of flooding roads and cellars during heavy rains
- elimination of risks for inhabitant health

- better functioning of the Glina wastewater treatment plant.

6.10. Socio-economic impact

Finally, it is to mention that of special importance is the economic effect on the Glina WWTP that consists in reduction of the investment and operation costs.

Chapter 7 GLOBAL EVALUATION OF THE PROJECT IMPACTS

In order to synthesize the elements presented in Chapter 6, the table 7.1 has been elaborated.

From the Table 7.1 one can conclude the followings:

a) most forms of the impact of the analyzed project are:

- significant (18 of 22)
- direct (17 of 22);
- positive (13 of 22)
- permanent (13 of 22)

a) only 9 forms of impact are negative, but they are temporary and will last not for long time ;

b) only 6 of the impact forms are cumulative;

c) 12 impact forms will appear in short term and out of them 9 negative impact forms will be not permanent, being manifest only during the construction phase.

Table 7. 1 Characterizing of identified impact forms related to the construction and operation of planned works

No	Identified impacts	Significance of impact		Nature of impact					Term of appearance		Duration of impact	
		Significant	Not-significant	Direct	Indirect	Pozitive	Negative	Cumulative	Short	Medium	Temporary	Permanent
	Impact on surface water											
1	Improving the quality of water in Dambovita upper reach, by mixing with clean groundwater, increasing speed circulation, reducing eutrophication risks	x		x		x			x			x
2	Improving of water quality in Dambovita river downstream Bucharest	x			x	x		x		x		x
3	Increasing the capacity of auto-purification of the river water, because of the better quality of the discharged effluent of the Glina WWTP	x			x	x		x		x		x
4	Increasing the abundance of life forms in river water	x			x	x		x		x		x
5	Improving of water quality in Arges River after the confluence with Dambovita	x			x	x		x		x		x
6	Reduction of pollutants sent to the Danube River	x			x	x		x		x		x
	Impact on groundwater											
7	Lowering the groundwater level around Caseta and main collectors	x		x		x				x		x
8	Reducing the groundwater infiltration in the sewerage system and subsequently reducing the wastewater dilution in the Caseta	x		x		x			x			x
	Impact due to waste											
9	Pollutant and pathogenic risks due to the sludge and clogging sand extracted from main drain and Caseta	x		x			x		x		x	
10	Unpleasant odours due to sludge and clogging sand extracted from drains and Caseta	x		x			x		x		x	

No	Identified impacts	Significance of impact		Nature of impact					Term of appearance		Duration of impact	
		Significant	Non-significant	Direct	Indirect	Pozitive	Negative	Cumulative	Short	Medium	Temporary	Permanent
	Impact on air											
11	Emission of particulates and burned gases from vehicles and equipment circulation		x	x			x	x	x		x	
12	Possible unpleasant odour emissions from sludge /sand extracted from main drain and Caseta		x	x			x		x		x	
	Impact on soil											
13	Discovered areas where worksites will be located		x	x			x		x		x	
14	Accidental pollution by waste or oil/fuel spills		x	x			x		x		x	
	Noise											
15	Noise produced by traffic of vehicles and functioning of equipment such as peak hammers, compressors, electricity generators, concrete trucks, large pumps	x		x			x		x		x	
	Consumption of resources											
16	Energy and construction materials consumption	x		x			x		x		x	
	Impact on human health											
17	Reducing the infectious risks due to flooded roads and cellars for people living in areas of Caseta and main collectors	x		x		x			x			x
	Landscape											
18	Appearance of worksites is a disturbing element for the local landscape	x		x			x		x		x	
	Impact on dwellings and other objectives											
19	Improved durability of the sewerage system.	x		x		x			x			x
20	Better wastewater collection, roads flooding reduction	x		x		x			x			x
21	Better functioning of the Glina WWTP	x		x		x			x			x
	Socio-economic effects											
22	Reduction of the investment and operation costs for Glina WWTP	x		x		x				x		x

Chapter 8 ENVIRONMENTAL CONTROL AND MONITORING

The monitoring program will be implemented in order to survey the impact of the planned works and the functioning of the sewerage system after its rehabilitation on the environment. Based on the monitoring results it will be possible to control the environment quality and, when necessary, to undertake additional measures for further reduction of negative impacts. The monitoring data will be used also to demonstrate the compliance with legislation and conditions imposed by the environmental permit and authorization. These data will be periodically reported to the interested authorities.

Aspects considered when scheduling the monitoring program are related to the identified impacts that:

- are important for the surroundings
- are measurable without excessive costs
- can be expressed by parameters
- can be mitigated or reduced.

The monitoring program contains:

- parameters or impact form
- proposed measurement frequency
- location of sampling points.

8.1 Monitoring program during the construction period

Table 8.1 Proposed Monitoring Program during the construction period

Environment component	Impact form or monitored parameter	Frequency	Monitoring location
Surface water	Flow in the upper reach	Continuously	Downstream worksites
Groundwater	Lowering of groundwater lever	Monthly	Worksites
Air	Air quality Particulates concentration	Continuously	Air monitoring stations in the vicinity of the worksites
Soil	Leakage or spills	Daily	Worksites
Waste	Quantities and disposal of construction waste and waste extracted from main drain, Caseta and access ways	Daily	Worksites
Natural resources	Consumption of materials and energy	Daily	Worksites
Noise	Level of noise in the areas surrounding the worksites	Weekly	Surrounding of the Worksites

8.2 Monitoring Program during the operation period

During operation period the Monitoring Program will be focused mainly on surface and ground water: main drain and subway drain functioning, groundwater pumping, integrity of the Caseta and main Collectors and water discharge from lakes.

Table 8.2 Proposed Monitoring Program during operation period

Environment component	Impact form or parameter	Frequency	Monitoring location
Surface Water	Flow measurement	Continuously	Upper reach points
	Quality of water in the upper reach (COD, BOD, suspended matters, N and P content, biota	at least 4 times/year or as required by the Water authorities	Upper reach points
Groundwater	Groundwater level	Weekly	Measurement points have to be established
	Flow of groundwater collected and discharged in the upper reach	Daily	Discharge points into the upper reach
	Quality of drained water (COD, BOD, N, P, suspended matters, etc.)	Monthly	Discharge points into the upper reach
Natural resources	Consumption of energy (i.e. for pumping ground water) and materials (i.e. spare pieces)	Monthly	Pumping stations on main drain and subway drain
Main drain and Subway drain	Integrity of the Main drain and Subway drain	2 times per year	Visiting points
	Checking for leakage	Weekly	Visiting points
Caseta and main Collectors	Integrity of the Caseta	Monthly	Visiting points
	Flow measurement	Continuously	Discharge point in Glina inlet
Discharge from lakes	Flow measurement	In relation to discharges	Discharge point in the upper reach

	Water quality ((COD, BOD, suspended matters, N, P, biota	In relation to discharges	Discharge point in the upper reach

Equipment for automat measurement of flow and sampling shall be installed.

All results of measurements will be registered and processed in order to offer an easy manner to verify the conformation with the conditions established by environmental permit or authorization.

Aspects related to the water control and monitoring

Points for measurement of water characteristics will be placed in points where representative data could be obtained. Measurement points and conditions will be established in common with the water authorities and EPA and included in the water and environmental authorizations.

The adequate functioning of the equipment for automat monitoring of water quality shall be verified by annual controls and test. Calibration of this equipment will be made by parallel measurements with reference methods, at least once by 3 years.

Aspects related to the waste quality control and monitoring

Monitoring and control of waste characteristics will be performed periodically in order to verify the appropriateness of the disposal solution.

Procedures and standards to be applied for classification and treatment of granular waste are provided within the **Ministerial Order 95/2005** on establishing criteria for acceptance of waste for landfilling and procedures for acceptance to each landfill classes – Section 3 – entitled “Methods for sampling and analyses”. The recommended standard is **SR EN 12457/1-4 – Lixiviation** – Test for verifying the conformity to lixiviation of granular waste and sludge.

The testing results will be compared with the criteria for conformation with the conditions for landfilling on different landfills classes included in Section 2 of the Order 95/2005 (pollutant values in leachate obtained in different lixiviation conditions meaning liquid/solid proportions).

Chapter 9 MAIN ALTERNATIVES STUDIED

The considered options for implementation of the works to be performed on the sewage system of Bucharest within the Phase 2 of the Glina project are the following:

Option 1 (HIR) - Achievement of all 10 mentioned actions within Table 2.2

Option 2 (IIR) – Achievement of 6actions included in Table 2.2 (excluding actions no 2, 7, 9, 10)

Option 3 (NIR) - Achievement of only structural rehabilitation of the Caseta (meaning actions 4 and 6).

The options analysis has revealed that the IIR option is the most advantageous from economic point of view and technically because it can assure a realistic design flow for Glina WWTP stage 2, correlated with an optimal functioning of the sewerage system, in the most acceptable cost conditions.

PART III

NON-TECHNICAL SUMMARY

NON TECHNICAL SUMMARY

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INTRODUCTION

The city of Bucharest, where around 2 millions inhabitants are living, has a combined system to collect domestic, industrial and storm water. The discharge of the Bucharest untreated wastewater was considered the main source of water quality degradation in Dambovita and Arges Rivers and also as one of the major sources of pollution of the Danube River.

To remediate this situation, an ISPA Measure "Bucharest Wastewater Treatment Plant Rehabilitation Stage 1" was promoted. Within the frame of this project, the stage 1 of the Glina WWTP development and the Feasibility Study for the development stage 2 of the same plant was included, as well as the elaboration of the Cohesion Fund Application. The Cohesion Fund Application will cover also the works for rehabilitation of the Bucharest sewerage system.

The project is correlated with the Framework Scheme for Arrangement of the Dambovita Hydrographical Basin and do not affect any existing or future objectives in the area.

The Beneficiary of the Project is the Municipality of Bucharest (MoB).

The Consultant, preparing the Feasibility Study (FS), the Environmental Impact Assessment (EIA) and finally the Cohesion Fund Application (CFA) is the Joint Venture Sweco International AB, Halcrow Group Ltd and Sogreah Consultants (SHS JV). The technical definition of infiltration reduction measures has been elaborated by Apa Nova Bucharest.

The elaborator of Environmental Impact Assessment (EIA) is the former SC Enviroassist srl, (actual SC Artelia Romania srl), registered within the National Register of environmental studies elaborators at the position no.198. The registration Certificate is valid till 13.04.2015.

The Environmental Impact Assessment study (EIA) refers to the whole Glina WWTP - Stage 2 project, which means:

- Glina WWTP treatment line no 2 including sludge incinerator
- Works for the Bucharest sewerage system rehabilitation.

Practically, the EIA report is composed of two parts:

- Part I: EIA of Glina WWTP stage 2 development including sludge incineration
- Part II: EIA of the works the Bucharest sewerage system rehabilitation.

The two parts of the EIA study are strongly correlated because the works for rehabilitation of the wastewater collection network have been proposed not only to improve the functioning and durability of the sewerage system but primary in order to optimize the costs for investment and operation of the whole Glina WWTP, aiming to limit the entrance of groundwater into components of the sewerage system. By reducing the flow and dilution of wastewater sent to the Glina WWTP it results a reduction of the investment cost of plant Phase 2 and of the functioning costs of the whole plant.

PART I

SUMMARY of EIA of the Glina WWTP stage 2 including the sludge incineration

DESCRIPTION OF THE PROJECT

Location of Project

Stage 2 of the Glina WWTP and the sludge incinerator will be constructed in direct connection to the existing WWTP phase 1, which is now in function. Glina WWTP is situated south-east of the Bucharest, on the right bank of Dambovita River, inside an area of the Glina commune designated within the General Urban Plan (PUG) as industrial zone and has the following vicinities:

- north - the Dambovita River canal and the formerly proposed Bucharest Inland Harbour
- east - pastures and other agricultural land
- south - the Glina Village residential area and the landfill "Ochiul Boului" to south-west
- west - a wholesale store for consumer goods, the pilot wastewater treatment plant, the PROTAN factory, while to **north-west** - the Thermo-Electric Power Plant.

Of the total surface of 114 ha, for the Glina WWTP stage 2 a surface of around 65 ha was reserved. The surface that will be occupied by constructions or installations is around 8.5 ha while the remaining unoccupied surface will be arranged as green land.

History of the project

The design of Glina WWTP was developed based on pilot plant studies carried out in the years 1970's. The initial design envisaged a WWTP next to Glina village, composed of three treatment lines for a 7.5 m^3/s flow each, containing primary settlement and conventional activated sludge basins. The construction works started in 1985, but was interrupted many times after 1990. Finally, the WWTP Stage 1 was put into operation in the first part of the year 2011.

The actual Stage 1 of the Glina WWTP was designed to treat a 10 m^3/s flow by mechanical and biological processes, based on parameters established in the year 2005. But because the influent pollutant concentration and the conditions imposed for the discharged effluent have been changed, it was agreed that the treatment capacity of the stage 1 to be reduced and a supplementary treatment for Phosphorus removal to be introduced. As a result, the Glina WWTP Stage 1 operational parameters have been changed as follows:

- 10 m^3/s to be treat in the primary mechanical phase, but only 5 m^3/s - in the secondary biological phase, including Phosphorus removal;
- the remaining 5 m^3/s mechanically treated to be diverted through the emergency by-pass to the river;
- the hydraulic capacity of all biological process units to remain 10 m^3/s.

In March 2011, the Contractor started to treat the wastewater in both the mechanical and biological stage. The performances obtained during June 2011 have shown compliance with the discharge conditions, indicating that the biological process works as intended by the design.

Design parameters for Glina WWTP stage 2

The design flow for the Glina stage 2 is the *maximum hourly dry weather flow* - MHDWF (maximum hourly flow during the day with the maximum daily dry weather flow from a certain period of time). This flow includes the peak day factor and the peak hour factor.

The design flow, established to be 11.9 m3/s, is the result of choosing the intermediate option for infiltration reduction within the sewerage system. The considered 3.43 m^3/s infiltration will be reduced by achieving 6 of the actions proposed for the sewerage system rehabilitation. The table below gives brief information about current (2010) and expected future load and concentrations (2040) in sewage coming to Glina WWTP.

Loads and concentrations in wastewater coming to Glina WWTP (influent)

Indicators	Units	2010	2040
Total organic load (BOD_5)	kg/d	80,750	100,000
Organic load - domestic customers	%	96	98
Organic load- from industry	%	2	1
Organic load – commerce, public services	%	2	1
BOD_5, influent	mg/l	80	140
Tot-N, influent	mg/l	24.3	40.6
Tot-P, influent	mg/l	1,08	6.3
SS, influent	mg/l	165	280
COD, influent	mg/l	253	420

The wastewater treatment process will comprise:

- the primary mechanical stage (coarse and fine screens, grit chambers, grease removal and primary sedimentation) designed to treat up to 2 times the MHDWF
- the secondary biological stage, based on activated return sludge combined with chemical precipitation for Phosphorus removal.

The component installations of the water line 2 are the followings:

Mechanical stage: 1 septic tank
4 Coarse screens
2 Inlet pumps
2 Fine screens
3 Grit chambers
9 Grease removal tanks
4 Primary sedimentation tanks

Biological stage: 12 Aeration tanks (8 AS +4 ARS)
48 Secondary sedimentation tanks.

The design of stage 2 is oriented to solve part of deficiencies identified after putting in function the Stage 1, due to lack of needed equipment, respectively:

- Grease removal
- Flow measurement after mechanical stage
- Odour minimization measures.

The other deficiencies are or will be solved by construction remediation.

The treated effluent should comply with the Romanian standard NTPA 001 – 011, which transposes the Urban Wastewater Treatment Directive 91/271/EEC, meaning:

BOD5	25 mg/l,
COD	125 mg/l,
SS	35 mg/l,
total P	1 mg/l,
total N	10 mg/l).

The plant efficiency for water pollutants removal shall be between 70% and 90 %.

Sludge treatment will be made by thickening, anaerobic digestion, dewatering by centrifugation and finally disposed of by incineration. The new sludge line components are:

5+2 Belt thickening presses for primary sludge
2 storage tanks for surplus activated sludge (SAS buffer tanks)
5 Gravity belt thickeners of surplus biological sludge
2 Raw thickened sludge mixing tank (mixing buffer tank);
1 Digested sludge storage tank (emergency storage tanks);
5+1 Centrifuges for digested sludge dewatering;
Sludge incineration plant

The amount of sludge sent to anaerobic digestion will be 3,291 m^3/d. The digested sludge will be dewatered, from this process resulting an amount of 481 m^3/d dewatered sludge with a 67% water content (33% dry solids).

The dewatered sludge will be disposed of by incineration, process of which an ash amount of 79.6 t/day will result.

The selection of incineration as sludge disposal solution was based on the following arguments:

1). The **use as fertiliser,** meaning a recycling of N, P and organic matters content by application on agricultural lands, on derelict areas for land reclamation, or on forestry land and soil production by composting or landfill coverage is not possible for many reasons but mainly because the concentration of heavy metals in Glina sludge is to high for any such uses (EC Directive 86/278/EEC) and the improvement of the sludge quality would be possible by significant changes in the economic pattern of the area and only in long time.

2) **Landfilling** cannot be considered sustainable in the future firstly because of the limitations imposed by the Directive 1991/31 EC related to disposal of organic waste.

Secondly, as in case of land application sludge, landfilling needs measures for limiting environmental impact on groundwater and the costs of a sound handling and transport of around 481 m^3/day or 163,700 m^3/year (water content of 67%) will be very high.

Because both, the land application and landfilling have limitations and high uncertainties these options are not only undesirable, but even inapplicable in case of Glina plant.

3) The incineration quality of being able to substantially reduce the amount of residues to be disposed is of extreme importance for a very large plant as Glina WWTP. This quality outweighs all disadvantages when compared with other options.

Incineration was from the beginning more or less established as the final sludge handling option for Glina WWTP, justified by the following aspects specific to other options:

- Negative influences on the environment (spreading toxics, bad odour, noise)
- Health reasons for the citizens in Bucharest and surrounding municipalities.

The **incineration process** configuration was chosen taking into account the best available techniques (BAT) for sewage sludge incineration, which is considered to be:

- *fluidized bed technology* - because of the higher combustion efficiency and lower flue-gas volumes resulting from such system;
- *drying of the sewage sludge by using heat recovered from inside the incinerator* to the extent that additional combustion support fuel is not required for the normal operation of the installation (normal operation excludes start-up, shut-down and the occasional use of support fuels for maintaining combustion temperatures).

Comparison between BAT provisions and Glina incinerator process

BAT provisions for sludge incineration	**Glina incinerator process configuration**
Fluidized bed technology	Combustion into a fluidized bed, having high burning efficiency and generating lower flue-gas volumes
Drying of the sludge by using heat recovered from inside the incinerator	Drying of sludge by using the heat recovered from the incineration process, in order to avoid the need of additional fuels for normal operation
Occasional use of support fuels for maintaining combustion temperatures	Auxiliary burners for start–up and shut-down to maintain the needed combustion temperature
Burning temperature - 850ºC.	Burning temperature - 850ºC.
Retention time in the combustion chamber of minimum 2 seconds	Minimum 2 seconds retention time in the combustion chamber in the presence of at least 6% after the final injection of combustion air.

The sewage sludge with a moisture content of 67% will be fed into the fluidized bed furnace where it is burned at a temperature of 850ºC.

The flue gases leaving the furnace will pass over heating surfaces in which steam for the dryer is generated and the combustion air for the fluidized bed is heated. The flue gases leaving the boiler are then cleaned into a flue gas cleaning system, comprising an **electrostatic precipitator (ESP**), where heavy metals will be removed and a **bag filter**, where **activated carbon and sodium bicarbonate ($NaHCO_3$)** is injected, in order to retain mercury and organic compounds, before the flue gas is exhausted to atmosphere through the stack.

Compared to wet systems, the proposed dry removal system is less expensive, both in terms of capital cost as well as in operating cost. The dry system is also less complex since **no wastewater handling is required**.

It was assumed that 10% of the solids discharged from the system are removed as bottom ash from the furnace, whilst 68% and respectively 22% are removed in the ESP (electrostatic precipitator) and bag filter.

METHODOLOGY FOR DETERMINING ENVIRONMENTAL IMPACTS

The main environmental impacts considering the project nature could happen on water and air.

The methodology used for evaluation of the possible impacts determined by the Glina plant on the **surface water** has considered the water body, respectively the effects on the ecological potential and chemical status of the heavily modified water body downstream Glina in comparison to the environmental objectives.

The methodology used for evaluating the impact on the **air quality** was based on modeling the dispersion of the pollutants resulted from sludge incineration, taking into account the imposed air quality in Glina area.

In case of the other components of the environment the assessment was based on the effects of the measures proposed for abatement of impacts possibly related to the plant activity.

IMPACT ASSESSMENT

Impact on surface water

The water body **Dambovita upstream APA NOVA (GLINA) discharge – Confluence with ARGES River,** which is an heavily modified water body, is characterized by:

- *a moderate ecological potential*
- *other than a good chemical status.*

Reaching the environmental objectives for this water body, which are *a good ecological potential and a good chemical status*, means improvement of the actual situation that is possible only in case of finalizing the Glina WWTP. The good functioning of this plant will reduce the water pollutants with around 118,200 kg/d as BOD; 252,000 t/d as suspended solids, 31,500 kg/d as total Nitrogen and 5,450 kg/d as total Phosphorus.

Finalising the construction of Glina WWTP will eliminate the main cause of the actual precarious situation of this water body and will lead to a substantial improvement of Dambovita water quality downstream Bucharest and, subsequently, an improvement of water quality in Arges River and reduction of pollutants brought into the Danube River.

The improvement of water quality in Dambovita River will have direct effects such as:

- increasing the capacity of auto-purification of the river water
- increasing the biologic and genetic biodiversity (as vegetation, birds, mammals)
- rincreasing the abundance of life forms in river water and on the river banks
- reduction of some nuisances (odours, floating refuse, unpleasant water colour)
- progressive reduction of groundwater pollution and prevention of its further pollution.

The above favourable effects will lead to the extension of some water and land uses by:

- development of irrigations and extension of the cultivated lands
- appearance of new industrial uses, especially small scale industries, but not only;
- new opportunities for recreation activities along the river;
- possible extension of dwelled areas.

The new or extended water and land uses will have beneficial socio-economic effects on the area expressed as:

- growth of agricultural and industrial production
- more working places and local stabilising of the rural population
- increasing of the properties value
- better life standards for inhabitants.

Impact on Groundwater

The **construction** of several elements of the WWTP stage 2 implies soil excavation (for piping and foundations) and *lowering of the groundwater level.* Lowering of groundwater table could generate disagreements to the nearby households using wells for water supply, but this negative impact will have low amplitude, will be temporary and will last not for long time.

Another form of impact on the groundwater could be generated by *accidental spillage of chemicals and fuel* used during construction. To avoid such situation these materials will be stored in closed tanks, vessels or drums placed separately inside the storehouse. The storage area will be equipped with impermeable concrete floor having channels for spillage retaining and removing in order to avoid soil and groundwater pollution.

The level of the groundwater will not be affected by the **operation** of the WWTP stage 2. *No losses of wastewater from plant installations* are possible because all technological basins will be waterproof. In order to prevent pollution of groundwater all structures will be constructed using impermeable concrete and the waterproof degree of structures will be tested and restored (if the case) before the functioning start-up.

Similarly to the construction phase, during the functioning phase the groundwater can be polluted by *spillage of chemicals, sludge or fuels*. To avoid such accidents the storage of containers containing chemicals or other materials will be organized in dedicated spaces inside buildings, having concrete floors and spillage collection channels. In case of spillage occurrence, the spilled material will be safely removed.

In conclusion, *no impact on groundwater is expected* during finalizing and operation of Glina WWTP stage II.

Impact on Soil

During the **construction** of the plant several components *the soil has to be excavated* and the resulted materials have to be removed from the area. In order to avoid any impact and assure recycling, the fertile soil will be separately deposited on the site in order to be reused for land remediation in places where such actions are needed. The ground rocks will be evacuated from the site and landfilled. Specialized companies that are managing non-hazardous waste landfills or construction waste landfills will be contracted for disposal of this material.

The soil and ground rocks could also be polluted during construction by *accidental spillage* of chemicals and fuels. Therefore chemicals will be stored in closed vessels or drums, placed separately, inside the storehouses equipped with impermeable concrete floors provided with channels for collection of spillage and contaminated rain resulting from fire-fighting operations. Fuels will be stored in dedicated underground tanks within the Fuel Supply Station that will be constructed observing measures for work safety and environmental protection.

During the **functioning phase** no excavations will normally occur. The land surface that remains unoccupied by installations/buildings will be *covered with grass* and even ornamental plants. Accidents generated by *spillage of chemicals and fuels* will be still possible and for avoiding such risks the already mentioned security measures will be taken.

The *appropriate waste management* will avoid any pollution due to them. Disposal of technological waste will be made by incineration, recycling or landfilling. Incineration will be made locally, while contracts with authorized companies will be negotiated for landfilling and recycling of domestic waste and some of the technological waste.

In conclusion, no impact on soil is expected as result of the construction and operation of stage II of Glina WWTP, if normally operated.

Impact on Air

The general impact on air during **construction phase** could be produced by emissions of dust particulates, gases/vapors and odours.

Construction of WWTP stage 2 will not generate specific odours, gases and vapors, but some combustion gases and dust emissions may occur from car traffic and excavations. From environmental point of view and considering the sensitive receptor, which is the Glina village, traffic gases and dust emissions from construction activity are not capable to modify the general quality of the air in the area, due to the small surface occupied by constructions compared with the surface that will remain free of constructions (8.5 ha out of 65ha).

During the **functioning of WWTP stage 2** air emissions will arise from: water treatment processes happening in open air, combustion of biogas and sludge incineration. Two types of impact forms could be discussed as caused by these emissions: odours and effects on air quality.

Impact of emissions from water treatment processes

Normally, from plant components having large uncovered surfaces (i.e. aeration tanks, settlement tanks, etc.) no substantial emissions such as *CO2, CH4 and other gases* will occur. The emission of these gases especially occurs from the sludge digestion process, which takes place in completely closed digestion tanks and generated gases are collected in biogas reservoirs.

Odour emissions due to the content of H_2S and mercaptans in the wastewater could appear at the influent entrance in the WWTP and in the area of sludge thickeners. These compartments will be covered and the air will be purified before exhausting.

The disturbance of the local inhabitants will decrease compared with the situation without wastewater treatment plant. The arguments sustaining this estimation are the following:

- plant components causing strongest odours (i.e. the plant inlet) are located at the largest distances from the Glina village; these plant structures will be covered and the air will be treated before exhausting;
- odours at the plant inlet will be reduced also due to removal of materials deposited inside the sewage main collectors which are subject of fermentation causing odours;
- odour generated now by the untreated wastewater along the Dambovita River will disappear completely, the impact on the air quality being favorable for the inhabitants living downstream Glina WWTP.

In order to verify these estimations, during the first operation period of the plant stage 2, an odour monitoring study will be performed and supplementary abatement measures will be proposed if needed.

Impact of emissions from combustion of biogas in gas engines

The biogas burning in order to produce warm water and/or electricity will generate mainly CO_2 and, in minor quantities, some other gases such as NOx and SO_2, while emissions of particulates (soot and ash) will be negligible. Their contribution to the air pollution was included in the calculations of the background pollution within the dispersion study of the incinerator emissions.

In case of emergency or accidents (ex. malfunctioning of biogas burners) the combustible gases produced by anaerobic fermentation will feed a flare burning combustible gases in the open atmosphere. The flare is enough high to ensure good dispersion of burning gases.

Impact of emissions from sludge incineration

The Glina incinerator will be designed, equipped, built and operated in such a way that the emission limits, as have been set out by **IE Directive 2010/75/EU – Annex VI Part 3** will be not exceeded.

The dispersion study has concluded that a height of 30 m for the stack of Glina sludge incinerator is optimal to ensure the atmospheric dispersion of the pollutants emitted from the incineration process and to determine a low impact, not affecting the compliance with the limit/ target values/critical levels for the ambient air.

For the stack height of 30 m, in the dwelled areas with sensitive receptors to Nitrogen dioxide (NO_2), which is the most important pollutant generated by incinerator (because of the highest value of the ratio between the estimated emission and the appropriate value for air quality), there is no exceeding of the limit values, even in the case of the cumulative impact of incinerator operation and background levels, for any of the averaging periods.

For the stack height of 30 m, the maximum concentrations for the other analyzed pollutants (SO_2, PM10, PM2.5, CO, Pb, As, Cd, Ni, Hg and PAH) are well below the corresponding limit/target values for all the averaging periods in case of exclusive incinerator operation. In the same time, the limit values/ target values/ critical levels in the areas with sensitive receptors (i.e. localities situated in the area of maximum impact) will be not exceeded by the cumulative impact with the background levels generated by other emission sources.

Noise impact

The noise generated during the **construction phase** by the building activities on site and the traffic due to the transport of construction materials and waste is expected not to surpass the accepted level for industrial sites - 65 db(A). Being a temporary nuisance and taking into account the location of the new constructions within the site, it can be considered as not increasing the impact on the dwelled areas.

The traffic on roads in the surroundings of dwelled areas is a constant element of the environmental conditions and it is not expected to consistently change due to the new project construction. Traffic noise could still increase if transport (for landfilling or recycling) of dewatered sludge produced by the stage 1 will become a regular activity.

During the **operation phase,** noise generated by the traffic is not considered to become an issue for the local inhabitants, even if the number of cars transporting materials/personnel will increase, because a new access to the plant will be arranged opposite to the dwelled zone.

During the WWTP functioning period, another noise source will be the functioning of mechanical equipment, mainly blowers and large pumps. In order to reduce this noise all blowers and large pumps will be placed inside buildings and fixed on solid foundations capable to attenuate vibrations and noise. So, they will have small contribution to the noise level in the dwelled areas.

The flare burning combustible gases is of no significance as a noise source because it will be used only in case of emergency.

The described new noise sources will not generate an additional impact for the dwelled area and will not modify the existing noise levels that are comprised between the following values:
- 65-70 db(A) – along A2 highway, Bucharest ring-way and access road to Ochiul Boului landfill;
- 50-70 db(A) – inside the WWTP area
- 45-55 db(A) – in Glina and Popesti Leordeni villages, except the households situated near the main roads, where 60-65 db(A) is registered.

Impact related to the Consumption of Energy and Chemicals

Energy consumption
The construction of the WWTP stage 2 requires energy for the building activities on the site and elsewhere - for processing materials (i.e. concrete) that are used in the construction. The use of energy during the construction phase is not of major importance for the overall environmental impact of the WWTP when compared with the good effects of its activity.

No special chemicals will be used in the construction phase, except paints and ground coats. Consumption of these materials will not have a larger impact than in case of other buildings. All packaging waste resulted from such chemicals are to be correctly evacuated by the construction company, which will record on the consumed quantities.

During **operation phase** the use of energy in the form of electricity can be split in two components, respectively for the water line and for the sludge line.The electricity consumed by the *water line* is mainly for pumping and biological processes (aeration of activated sludge basins), the other plant components using comparatively small amounts of electricity. The energy consumption by the *sludge line* is mainly for sludge pumping, anaerobic digestion and sludge dewatering.

The Glina WWTP will not only consume electricity (total consumption by plant **- 98,480,000 kWh)**, it will also produce energy by conversion of biogas, steam reuse and outlet turbines. By using the energy generated by **anaerobic digestion, which is es timated to be 45,980,000 kW,** the net consumption will be of only **52,500,000 kWh.**

It results that even there will be a substantial consumption of energy within the Glina WWTP, the stage 2 project is offering different possibilities to reduce it, by recovery of energy, use of heat from biogas burning, use of steam (from incinerator) and possibly power generated by outlet turbines.

Chemicals use
Chemical use and consumption is specific to the functioning phase.

Basically, the *treatment of wastewater* does not require addition of chemicals, except the tertiary step for Phosphorus removal, where Ferric chloride (13.8% Fe) is used (22,500t/year).
The *sludge treatment* needs chemicals, possibly polymers for thickening and dewatering (400t/year). Also the incineration process uses some chemicals such as sodium bicarbonate (2,200t/year) and activated carbon (60t/year) for the retention of flue gas pollutants.

An uncertainty is related to the consumption of additional fuel for the start-up of incineration process. One can not say if significant supplemental fuel is necessary for starting incineration because at this stage the sludge calorific value is not really known. It is still certain that supplemental fuel will be used only during the start up of the process.

One can say that the consumption of chemicals for wastewater treatment and sludge disposal within Glina WWTP will be not significant as types and quantities and will not impact the environment by the hazardousness of the substances.

Impact on the landscape

During the **construction phase** a temporary impact on the landscape will be observed from the dwelled area – Glina village – that is located south of the plant, on a small hill. The impact will be related to the presence of building equipment and excavations for different basins. After the completion of the construction these visual nuisances will disappear. The visual impact is not considered to be significant because of its limited duration, the relatively small surface occupied by the stage 2 constructions and installations (8.5 ha out of the total surface of 65 ha) and the relative long distance to the village households.

During **operation phase**, since stage 1 of the WWTP structures has been already built, the additional visual impact of the stage 2 components will be not very obvious. The main visual impact is related to the sludge digesters that are very visible, but these structures are mainly part of the stage 1, already constructed. Most of the new structures to be built will be similar with some of the existing ones. The maximum height of these structures will be of around 10 – 15 meters above the ground level, except the incinerator that will be a higher construction having a stack of at least 30 meters height.

When completely constructed and the remaining free land will be covered by vegetation, the plant site could appear as a well organized space. It is recommended that trees, brushes and flowers to be planted on the alley borders and other trees rows to be planted in parallel to the fence surrounding the site, in order to form a vegetal curtain to hide partially the plant components. Finally, the Glina WWTP will be an objective with no negative impact on the surrounding landscape.

Impact on biological environment

The construction of the WWTP stage 2 new structures needs that their locations to be free of vegetation. The removal of vegetation will be limited to shrubs and grass because no trees are present on the site. This action will have a small negative effect on the fauna, since species such as rodents, lizards, rabbits, etc., living now on the site have to move away towards other locations.

After the completion of the WWTP the land unoccupied by constructions and installations will be covered by grass, while flowers and trees will be planted on the alleys border and parallel to the site fence. It is not expected that the animal species will return to the site when the completed WWTP will be in operation, but it would be possible a large number of birds (seagulls especially) to pass over the new water surfaces. Such situation, already observed during this study elaboration, is not a real negative effect.

Impact on human health

During the **construction phase** the contractor will have to elaborate and implement a Health and Safety Plan for people working on the site. The safety measures will be brought to attention of all personnel that will be obliged to respect them.

Wearing protective clothes and boots, safety helmets, protective glasses, ear plugs, etc. will reduce risks for human health, that are related to fire and explosions, asphyxiation, mechanical injuries and poisoning.

Hygiene facilities will be part of the site arrangement and will help for avoiding different diseases generated by pathogenic germs living in wastewater.

During the **operation phase** similar measures for health and safety will be imposed for plant workers. These measures will consider the potential risks specific to operation of WWTP that are not only fire and explosions, asphyxiation, mechanical injuries and poisoning, but also risks of falling in basins and underground installations. These parts will be clearly marked and only trained personnel will have access within risks places. For visitors such places will be accessible only under supervision. All measures will be included within the Safety and Health Action Plan that will be elaborated for the plant.

Supplementary to the specific measures described above, fencing, lighting, guarding and watching of the works and visitors will be provided anywhere it will be needed. During construction and operation all reasonable efforts will be taken to keep the site and works out of risks for individual persons. In such conditions the impact on human health and safety is insignificant.

Beside the above described risks for workers and visitors, it is to mention that for the inhabitants of the Glina Village, and people living downstream the plant, the risks related to the potential spread of infectious diseases will be substantially reduced, WWTP ensuring improved conditions for preserving human health.

Impact on dwellings

The impact on dwellings is expressed by the effects on groundwater deepness, air quality, noise level, land use and socio-economic aspects.

Water supply of households in the neighbouring dwellings is made now from underground resources. In the future all three villages of Glina commune will be connected to a centralized water supply and sewer system, but this action is planned to begin after ending the construction of WWTP stage 2.

During the construction of WWTP stage 2 phase, the *level of the groundwater* will be lowered due to the need of working in a dry environment. Lowering the groundwater table could generate disagreements to households still using wells. This negative form of impact is expected to have low amplitude and be temporary, lasting only a part of the construction period.

Construction of WWTP stage 2 will generate minor *dust emissions* from traffic and excavations. These emissions will not modify the general quality of the air in the area and especially in the Glina village, due to the large size of the location. During the functioning of WWTP *gaseous emissions* arising from the open air treatment processes, combustion of biogas and sludge incineration could theoretically influence the air quality, but the designed measures will avoid the possible negative effects.

Noise produced during the construction of WWTP stage 2 by the building activities and by the traffic related to the transport of construction materials and waste will not impede the life conditions in the neighboring dwellings. During the functioning period, main noise source will be the mechanical equipment (blowers and large pumps). The large surface of the site and the proposed measures for noise abatement will contribute to the reduction of any supplemental impact on dwellings due to noise, whose level inside Glina village will remain within the limits of 45-55 db(A).

The implementation of the Glina project stage 2 will have beneficial *socio-economic influences* on dwelled areas expressed by new job opportunities for local people, appearance of small scale companies, extension of the dwelled area, increasing of the properties value, all these effects leading finally to an improved life standard for the inhabitants.

Global evaluation of the project impacts

The synthesis of the described impacts forms indicates the followings:

a) most forms of the impact of the analyzed project are:
   - direct (14 of 22);
   - significant (16 of 22)
   - positive (17 of 22)
   - permanent (18 of 22).

a) only 6 forms of impact are negative;
b) almost half of the impact forms are cumulative and positive (11 of 22);
c) more than half of the impact forms will appear in medium time (12) while the other will appear in short time (10).

PROPOSED ENVIRONMENTAL MONITORING PROGRAM

Environment monitoring programs have been proposed both, for the construction and the operation periods in order to survey the impact of the Glina WWTP. Based on the monitoring results it will be possible **to control the environment quality** and, when necessary, to undertake additional measures for further reduction of negative impacts.

The monitoring data will be used also **to demonstrate the compliance with legislation** and conditions imposed by the environmental permit and authorization.

Characterization /classification of identified impact forms related to the construction and operation of Glina WWTP stage II

Identified impacts	Significance of impact		Nature of impact					Term of appearance		Duration of impact	
	Significant	Not-significant	Direct	Indirect	Pozitive	Negative	Cumulative	Short	Medium	Temporary	Permanent
Impact on surface water Improving of water quality in Dambovita river downstream Bucharest	**x**		**x**		**x**			x			**x**
Increasing the capacity of auto-purification of the river water	**x**			x	**x**		x		x		**x**
Increasing the biodiversity (vegetation, fishes, reptiles, birds, mammals);	**x**			x	**x**		x		x		**x**
Increasing the abundance of life forms in river water and on the river banks;	**x**			x	**x**		x		x		**x**
Improving the area general perception due to reduction of floating refuse and unpleasant water colour	**x**		**x**		**x**			x			**x**
Increasing of the fishing activity		x		x	**x**				x		**x**
New recreation activities along the river	**x**			x	**x**		x		x		**x**
Development of irrigations and extension of the cultivated lands	**x**			x	**x**				x	x	
Appearance of new companies, especially small scale industries, on the river banks;	**x**			x	**x**		x		x	x	
Improving of water quality in Arges River after the confluence with Dambovita	**x**		**x**		**x**		x		x		**x**
Reduction of pollutants brought into the Danube River	**x**		**x**		**x**				x		**x**

Identified impacts	**Significance of impact**		**Nature of impact**					**Term of appearance**		**Duration of impact**	
	Significant	**Non-significant**	**Direct**	**Indirect**	**Pozitive**	**Negative**	**Cumulative**	**Short**	**Medium**	**Temporary**	**Permanent**
Impact on groundwater **L**owering of level		x				x		x		x	
Impact on air Disappearance of odour generated by the untreated wastewater	**x**		**x**		**x**		x	x			**x**
Sludge incineration and biogas burning will generate CO2, NOx, SO_2 and particulates		x	**x**			x		x			**x**
Noise Noise produced by more traffic and equipment such as blowers and large pumps		x	**x**			x		x			**x**
Consumption of resources Energy and chemicals consumption	**x**		**x**			x		x			**x**
Lanscape Local appearance of new constructions, green spaces and tree curtains surrounding the site. Improvement the landscape along the river	**x**		**x**		**x**		x	x			**x**
Impact on fauna Effects on the fauna, since several species have to move away their habitat. Sea-gulls invasion.		x	**x**			x		x			**x**
Impact on human health Reducing the risks of infectious diseases for people living in the plant surroundings and downstream	**x**		**x**		**x**			x			**x**
Impact on dwellings and other objectives Possible extension of dwelled areas;		x	**x**		**x**		x		x		**x**
Increasing the properties value due to the improvement of the general perception of the area	**x**		**x**		**x**		x		x	x	
Socio-economic effects More working places; increased income for local inhabitants; improved life standards	**x**		**x**		**x**		x		x		**x**

PART II

EIA of the works the Bucharest sewerage system rehabilitation.

DESCRIPTION OF THE PROJECT

Bucharest Municipality has a combined sewerage system, collecting both rainwater and wastewater,s that extends throughout the developed area of the city and surrounding dwelling areas. The sewer network receives domestic wastewater from approximately 95 % of the Bucharest population (1,925,000 inhabitants), wastewater from neighboring communities, industrial wastewater and surface water runoff during storm events. Collected wastewater is transported south-east of Bucharest, to the Glina wastewater treatment plant (WWTP) from where, after treatment, it is discharged into the River Damboviţa.

In relation to the Stage 2 of Glina WWTP development, technical solutions and works for rehabilitation of the wastewater collection network have been proposed in order to optimize the costs for investment and operation of the Glina WWTP stage 2 and the functioning of the sewerage system. These solutions and works are aimed to:

- limiting the entrance of groundwater and other undesired waters into components of the sewerage system, in order to reduce the flow and dilution of wastewater sent to the Glina WWTP,

- ensuring a good functioning and durability of the main structures bringing wastewater to Glina WWTP – the Caseta and main collectors.

The Feasibility Studies for Glina WWTP Stage 2 and studies for rehabilitation of Caseta and main Collectors, as well as the corresponding EIA reports, will serve for the elaboration of the Cohesion Fund Application.

Project location and object

The Project area will be Bucharest, while the project object is Bucharest sewerage system.

Following completion of the investments, the sewerage service will be significantly improved and more close to the target of providing a piped sewerage system to all chosen surrounding areas, by 2015. The neighbouring communities, recommended to be connected with the Bucharest system are: Glina, Popesti-Leordini, Jilava, Chiajna, Chitila, Mogosoaia, Buftea, Voluntari, Dobroesti and Pantelimon.

Without intervention, the incidence of flooding from the system is likely to increase in the future due to the expansion of the system to serve 100% of the resident population, the continued development of the Municipality and connection of sewerage systems of neighbouring communities.

The Caseta was designed to collect wastewater brought by main collectors, by crossing Bucharest from the western part (near lacul Morii) towards east, on a distance of 17.8 km, and to bring it to Glina Wastewater Treatment Plant. The Caseta trajectory is going under the Dambovita channel on 10 km, till the Vitan bridge, where it deviates and goes 3 km along the north shore (left shore), till after the Popesti overflow, where it under-crosses the river and continues the final 4 km, till Glina, along the south shore (right shore).

The existing sewage system is approximately 2,561 km in length (1,772 km collectors plus 789 km connections). Before the construction of the Caseta the wastewater was collected by mean of 2 main collectors – A0 and B0 - placed on both sides of the river Dambovita. Today there are 12 main collectors that have fragmented the old main collectors A0 and B0 in their route to the Caseta. The sewerage system operates predominately by gravity with 13 minor pumping stations serving local low-lying areas.

The identified problems related to the Caseta and main Collectors that influence the Glina WWTP design and functioning are the followings:

i) *Infiltrations*
ii) Deposition of sediments
iii) Lakes water discharge in the sewage system

Infiltrations

Significant entrance of clean water, by infiltration and clean water discharge, has been identified inside the Caseta, as a result of the following factors:

- Groundwater discharges in the Caseta from the main **drain which is n ot connected to the river channel (superior reach)** and due to the **non-functioning of the pumping stations** (Eroilor, Opera si Mihai Bravu)

- Infiltrations at the **intersection points** between the Caseta main drain and collectors or inspection tunnels and at **the juncti on points of collectors with the Ca seta.** In these points the groundwater is flowing around the pipes and is penetrating the drain walls because of sealing lacking or because of pipes incorrect placement

- Infiltrations of groundwater due to **illegal or unknown connections**

- Entrance of clean water through the **non-waterproof joint points of the Ca seta ceiling components** and through the **cracks in the riverbed.**

Deposition of sediments and other materials

The sediments and sludge accumulated inside the Caseta together with debris resulted from ceiling crumbling and construction materials not removed after ending the building are making difficult the water transport especially when the flow is small.

Lakes water discharge in the sewage system

The outlet of the drainage systems of lakes Titan, Tineretului and Carol are discharged directly in the sewage network and the discharged water is sent in the Caseta.

Quantitative details on the infiltrations and reduction objectives

As resulted from the ANB measurements (2009-2010) **the total amount** of infiltration and other undesired water arriving in the Caseta is **5.36 m^3/s,** out of which **infiltration flow** was found to be **4.66 m^3/s**, while the flow of **other undesired waters - 0.71 m^3/s.**

Origins of infiltration and other undesired flows and proposed reduction actions

Action No.	Origin	Nature of undesired water	Reason for reduction	Action to reduce undesired water	Flow m^3/s
1	Infiltration from water network leakage	Infiltration	To reduce infiltration	Leakage control of water supply network	0.44
2	Drainage from industries	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.11
3	Drainage from lakes	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.50
4	Infiltration from Dambovita river	Infiltration	Caseta structural rehabilitation	Waterproofing on 17 km, 60 m width	0.93
5	Infiltration from groundwater (part linked to high level of groundwater table)	Infiltration	To reduce infiltration	Reinstatement of subway drainage system to lower the ground water table	1.38
6	Infiltration from groundwater (part due to structural sewers conditions)	Infiltration	Network structural rehabilitation	Rehabilitation of 36 km sewers	0.10
7	Metro drainage	Other undesired water	To reduce other undesired water	Disconnection from Caseta and connection to Dambovita channel	0.09
8	Infiltration from Caseta left drain in city centre (10 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	1.26
9	Infiltration from Caseta left drain downstream city centre (7 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	0.27
10	Infiltration from Caseta right drain downstream city centre (7 km)	Infiltration	To reduce infiltration	Rehabilitation of Caseta drain	0.27

Action No.	Origin	Nature of undesired water	Reason for reduction	Action to reduce undesired water	Flow m^3/s
	Total, infiltration (1, 4, 5, 6, 8, 9, 10)				**4.66**
	Total, other undesired water (2,3,7)				**0.71**
	Grand total (1-10)				**5.36**

Options for reducing the infiltration and other undesired water flows

A number of 3 options have been defined for reducing the infiltration into the Caseta:

- High infiltration reduction (**HIR**) – comprising 10 actions reducing the infiltration flow with 4.02 m^3/s of the total 5.36 m^3/s
- Intermediate infiltration reduction (**IIR**) – comprising 6 actions reducing the infiltration flow with 3.43 m^3/s
- No infiltration reduction (**NIR**) - but only 2 structural remediation actions, which could reduce the infiltration flow with 0.86 m^3/s of the total 5.36 m^3/s.

The options analysis has revealed that the **IIR option, which is the most advantageous** from economic and technical point of view, assures a realistic design flow for Glina WWTP stage 2, correlated with an optimal functioning of the sewerage system.

Specific data on the project

The proposed work categories have been detailed in the ANB document “Supporting report regarding works to be performed in the sewerage system of Bucharest for Glina phase 2”.

Works on the MAIN DRAIN of the Caseta between Ciurel and Vitan

- *Allowing and ensuring the access to the drain by dewatering of the structures*
- *Install a drain by-pass on the collectors entering the Caseta*
- *Rehabilitation of the main drain over 10 km and its pumping stations*

Earth dams on the upper reach will be built for limiting the consecutive work sections and allowing dewatering. Access to the drain will be ensured by mean of earth ramps for the transport and handling of mechanical devices and materials.

Works assuring the sealing of the SUPERIOR REACH - Dambovita channel

- *Cleaning the bottom of the channel*
- *Repairing damages and provide a new base layer on the bottom of the channel*
- *Sealing the bottom on the sections potentially leaking.*

Works for structural rehabilitation of the CASETA

- *Rehabilitation of the Caseta* (Cleaning the bottom; cement grout injection (4 drills every 3 km); passivation of the exposed steel and application of structural concrete on the gaps found; stabilization of the pre-slabs and removal of the pre-slabs that can not be stabilized)
- *Rehabilitation of the access ways to the Caseta.*

Works for the SUBWAY DRAINAGE

- *Rehabilitation of the subway drainage on a length of 8 km* (Installing a new drain - DN 400 - at the level of -1m from the bottom of the sewage collectors; applying of a 20/40 gravel layer surrounded by a specific geo-textile)
- *Installing of 5 pumping stations.*

Rehabilitation of COLLECTORS on 35 km in the affected area

- *Rehabilitation of non-visitable collectors* (Demolition of roads and excavations; putting new collectors next to the old ones; restoring the connections and the sites)
- *Rehabilitation of visitable collectors* (Repairing of structural damages using structural concrete; repairing of cracks and facings; securing the access ways)

Works for LAKES WATER DISCHARGE in the superior reach

- *Install water tanks (500m^3) downstream of the lakes drainage system*
- *Construct pumping plants*
- *Install pipes discharging lakes water in the upper reach of river Dambovita.*

The proposed duration for execution of the planned works was declared 30 months and, as the completion of the Glina WWTP Phase 2, they will be finished at the end of year 2015, offering an improved durability of the sewerage system for the next 25 years.

IMPACT ON THE ENVIRONMENT AND ABATEMENT MEASURES

A general characteristic of this project that the most polluting emissions and nuisances will be registered during the construction phase while the operation phase will benefit of positive changes.

Impact on Surface water

During the construction phase the works are mostly impacting by:

- dams to be constructed on the upper reach to delimitate the work sectors
- upper reach sectors limited by dams that will be dewatered, the water of the channel sectors being diverted downstream the worksite by pipes
- slabs of the upper reach will be dislocated to give access to the drain or Caseta
- bypasses built for the water drained by the main drain and the subway drain to be discharged in the upper reach.

Although spectacular, these construction works will not affect the quality of the surface water because no wastewater will be discharged in the upper reach. The water used for cleaning, around 300 l/s, will be sent only into the Caseta.

During the operation phase

The planned works are influencing the river Dambovita, either by discharging drained clean water in the upper reach or by the effects on the Glina WWTP.

Effects on the water in the Dambovita upper reach on the Bucharest territory

- the flow in the upper reach will increase with around 3 m^3/s and will speed the water movement in the channel ensuring a better refreshing
- the supplemental flow will improve the quality of the upper reach water and will diminish the risks of eutrophication.

Effects on the Glina WWTP

- the Glina WWTP *efficiency in pollutants removal will increase* due to better conditions for the activated sludge development (as flow and pollutants concentration); the discharge of a *cleaner effluent* means less negative influence on the receptor;
- as a consequence an *improvement of the water quality in river Dambovita* downstream Bucharest is expected. This means an *increased capacity of auto-purification* of the river water and, subsequently, an *increased abundance of life forms;*
- improvement *of the water quality of the river Arges* is expected too, considering the contribution of river Dambovita to Arges pollution and, similarly, a reduction of pollutants sent into the Danube.

Impact on Groundwater

The construction of the Caseta and Subway line no 1 has increased the groundwater level, which rose in the Vitan zone from - 69.12m to – 60.00m. On the right bank of the river there is no draining system related to the Subway, while the drainage of the left bank is not well functioning. At present, the Caseta and the collectors nearby the Caseta are placed inside the groundwater layer and for this reason the clean water from the ground is entering in the sewerage system, by cracks and constructive defects.

Impact during construction

- *No disturbance of the geological structure* will take place during work performance.
- *No change of the groundwater quality* will be determined because no wastewater discharge will occur in the ground or soil during the works and after their ending.

Impact during operation

- As effect of the planned works, *a lowering of the groundwater level with 1-2 m*, from the actual depth of -3… -7 m, till around -5 m (that is the depth of the pumping stations on the left bank and of the Subway drain on the right bank) is expected.
- The lowering of the shallow groundwater layer will have as main effect the *reduction of clean water infiltration* inside the sewage system components.
- The subsequent effects are the *reduction of the wastewater flow* brought to the Glina Plant and *improved treatment efficiency*.

Impact determined by Waste

Impact during construction

The planned works will generate construction waste that is of 2 categories considering their adequate disposal option:

- waste that could be recycled (fragments of asphalt, concrete tiles, metallic waste),
- waste that should be disposed of by landfilling (sludge, clogging sand, debris of facings, mixed domestic waste extracted from the bottom of the superior reach).

Most part of the generated waste is inert construction materials, which impact on the environment is not dangerous and could be recycled in the benefit of the environment. But a special attention has to be offered to the clogging sand and sludge for the reason of their possible contaminants content (pollutants or pathogenic germs) and potential of generating unpleasant odour.

Regardless of the impact on the environment, all waste has to be separately collected and stored before disposal or sending to recycling. Storage places and/or recipients (for transport) have to be provided in such a way not to allow spreading and spilling. Contracting services for waste management with specialized companies will ensure the correct treatment of generated waste.

Impact during operation

No waste are expected to be generated during operation phase, except those ordinary waste resulted from periodic cleaning of the upper reach and maintenance of the pumping stations or access ways.

Impact related to Consumption of Materials and Energy

Impact during construction phase

Most part of works will use equipments whose functioning is based on consumption of fuels – diesel or gasoline (excavators, bulldozers, concrete trucks) or electricity from generators whose functioning is assured by burning liquid fuel, too). At this moment, the energy consumption could not yet be estimated, depending on many factors.

The amount of materials that will be consumed is roughly estimated to 51,000 m^2 asphalt, 95,000 m^3 concrete, 300,000 m^3 water proofing materials, 1153 tones enforcements.

As measures for reducing the impact of materials and energy consumption the following were recommended:

- using modern equipment with reduced energy consumption
- optimization of equipment functioning regime and materials consumption
- daily control of the energy/materials consumption.

Impact during operation

The *consumption of energy* during operation will be limited to the functioning of pumps that evacuate the drained water from the main drain or the subway drain. The amount of energy consumption will depend upon the number, types and capacity of pumps and the quantity of pumped water. *Materials* consumption will be limited to those needed for maintenance and possible small remediation of the sewage network.

Impact on Soil

Impact during construction phase
The planned works will take place on sectors having a maximum length of 1 km and occupying surfaces of around 400 m^2 of the Caseta and 200 m^2 of the surrounding area. Worksites will be organized on surfaces covered by roads or occupied by the Dambovita channel and only outside the city worksites will comprise areas not covered by asphalt or concrete. It is recommended that all worksites will be fenced by reusable panels in order to limit the affected areas.

Uncovered or discovered soil surfaces could be accidentally polluted by waste especially by sludge and clogging sand extracted from the Caseta and drains. The proposed measures for waste separate collection and storage are intended to and could avoid soil pollution.

Soil accidental pollution could occur with oils or fuels from the equipment supply or repairing on the sites, if not carefully handled. It is recommended that any oil/fuel spill to be removed by using absorbent materials.

Impact during operation
No impact on soil is expected to happen during the operation phase. Accidents could happen due to the incorrect waste management during maintenance actions or by spilling of oils/fuels, but the probability of such events is very low.

Impact on Air

Impact during construction
The impact on air could be determined by the **emission of particulates and burning gases** that will result from vehicles and equipment functioning, construction of dams, excavations or sawing the upper slabs, as well as from actions for restoration of sites. Repairing of structural damaging, cracks and facings are also actions producing particulates but, because having large dimensions or being wet, these particulates settles not far from sources.

Measures as optimization of vehicles and machinery movement, wetting their trajectory inside the worksites and correct handling of powdery materials/waste could substantially reduce the emissions of **particulates** emissions in the air and the impact on the air quality. Avoiding excessive functioning of equipment using gasoline or diesel as energy source will reduce the emissions of **burned gases.**

Another form of impact on the air is **odour** that will appear from actions involving opening, dewatering and cleaning of Caseta, main drain, or access ways to them. Extraction and handling of clogging sand, sludge or construction materials left inside the Caseta, as well as wastewater generated from cleaning could generate unpleasant odours. The mechanically cleaning of the upper reach is supposed to generate fewer odours because of the higher degree of sediments stabilization.

Reduction of the impact due to odours will be possible by:

- Separate collection and rapid evacuation of waste, sludge and clogging sand
- Immediate evacuation into the Caseta of any wastewater resulted from cleaning.

It is expected that the above measures will reduce odour impact to a supportable level for the people living in the area or passing by.

Impact during operation

No impact on the air is expected to be generated during the operational phase. An improvement of the actual situation is expected as result of the improved hydraulic functioning of the Caseta and of the increased flow and water speed in the upper reach.

Noise impact

Impact during construction

The noise generated by works on the sewage system will affect areas that are placed on the length of the Caseta and upper reach (17 km), along different collectors (35 km), as well along the Metro line no 1 (8 km).

The character of noise generated will depend on the types of works performed and types of equipment used, some works (breaking asphalt cover or concrete slab) being more noisy than others (cleaning, repairing, facing). The noisiest equipment used on the worksites will be peak hammers, pumps, electricity generators, compressors, and concrete mixer/trucks. It is expected that their noise emissions overlapped on the background noise will not exceed 70-90 dB(A), especially due to the fact that there will be not simultaneous functioning of two or many noisy equipments.

Being not continuous, the noise generated by the planned works could be compared with the noise in some industrial premises or noise generated by the maintenance works performed for utilities such as the natural gas distribution or water supply.

The receptors affected by noise are the persons living or working in the area and the passersby, pedestrians or car passengers.

The recommended fencing of the worksites using noise absorbent panels will be more efficient in combination with the placement of the noisy equipment at the lowest level inside the site, on the bottom of the upper reach or open drain, in order to be supplementary shielded. Another recommendation is to fix the equipment producing vibrations and noise on a temporary support, when this equipment will be used many times in the same location.

The above measures recommended in order to reduce the impact of noise will be capable to reduce the level of noise at least with 20% for the receptors, which are persons living or working in the area and the passersby, pedestrians or car passengers. Supplementary, it will be very important to limit the working period during the day to the interval 9.00 -17.00.

Impact during operation
No impact due to noise is expected to be generated during the operational phase.

Impact on the Landscape

Impact during construction
Any workplace will constitute a nuisance for the landscape because of introducing disturbing elements such as fencings, dams, demolished items, machinery, wastes, etc., that are not usually present in the areas. These elements are modifying the traffic regime on the roads and the water flowing in the Dambovita upper channel, that are normal landscape components. The impact on landscape is limited in space - worksites are extended on maximum 1 km length of the Dambovita channel - and in time, the total works duration of being 30 months.

Limiting the landscape impact during the worksites life is assured by measures such as:
- Worksites have to be completely fenced with panels covered by advertising prints;
- Their surfaces have to be well organized (for example the opening of the upper reach will be made at once on only 5 m length);
- The wheels of vehicles leaving the worksites have to be washed not to soil the roads.

Impact during operation
No negative impact on the landscape due to planned works is expected to be generated during the operation phase. Instead, *positive impact* could be generated by the increased flow in the upper reach, which *will increase the water circulation speed*, respectively the water refreshing, and will *reduce the risks of eutrophication*.

Impact on Human Health

Impact during construction phase
Human health could be impacted by some of the already described nuisances (air pollution, noise, crowded traffic, etc.) for which reduction measures have been already presented. The safety of workers will be assured as required by the regulations in force.

Impact during operation
All above mentioned nuisances related to the worksites will disappear after the works ending, while the *disease risks sources* due to flooded cellars and streets flooding during heavy rains *will disappear*.

Another benefic impact is the *reduction of the risks for workers involved in survey and control of the sewerage system* that are using the access ways. The access ways to the rehabilitated pumping stations, drains and collectors will be provided with safety equipment - steps, ramps, signalization, automatic control devices and ventilation.

Impact on Dwellings and other objectives

Impact during construction phase
The impact on dwellings determined during the construction phase will consist in forms already mentioned – bottlenecks in traffic, noise, disturbed landscape, etc., for which reduction measures have been already presented. All these negative impacts are limited to the areas around the work sectors and will last no longer than 30 months, the total duration of works.

Impact during operation
No negative impacts are expected on dwellings or other objectives during operation phase. Instead, positive impacts are supposed to be registered, consisting in:

- better collection of the wastewater; improved durability of the sewerage system;
- reduction of risks of flooding roads and cellars during heavy rains;
- elimination of risks for inhabitant health;
- better functioning of the Glina wastewater treatment plant.

It is to mention that of special importance is the economic effect on the Glina WWTP that consists in reduction of the investment and operation costs reflected in the taxes to be paid.

Global evaluation of the project impacts

In order to synthesize the elements presented above one can conclude the followings:

a) most forms of the impact of the analyzed project are:

- significant (18 of 22)
- direct (17 of 22);
- positive and permanent (13 of 22).

b) only 9 forms of impact are negative;

c) the 13 positive impact forms will appear in short term and the 9 negative impact forms will be not permanent, being manifest only during the construction phase.

PROPOSED ENVIRONMENTAL MONITORING PROGRAM

The study has proposed a monitoring program to be implemented in order to survey the impact on the environment of the planned works, during their construction and the functioning of the sewerage system after its rehabilitation. Based on the monitoring results it will be possible to control the environment quality and, when necessary, to undertake additional measures for further reduction of negative impacts.

The monitoring program contains:

- parameters or impact form
- proposed measurement frequency
- proposed location of sampling points.

The monitoring data will be used also to demonstrate the compliance with legislation and conditions imposed by the environmental permit and authorization. These data will be periodically reported to the interested authorities.

Characterizing of identified impact forms related to the construction and operation of planned works

No	Identified impacts	Significance of impact		Nature of impact					Term of appearance		Duration of impact	
		Significant	Not-significant	Direct	Indirect	Pozitive	Negative	Cumulative	Short	Medium	Temporary	Permanent
	Impact on surface water											
1	Improving the quality of water in Dambovita upper reach, by mixing with clean groundwater, increasing speed circulation, reducing eutrophication risks	x		x		x			x			x
2	Improving of water quality in Dambovita river downstream Bucharest	x			x	x		x		x		x
3	Increasing the capacity of auto-purification of the river water, because of the better quality of the discharged effluent of the Glina WWTP	x			x	x		x		x		x
4	Increasing the abundance of life forms in river water	x			x	x		x		x		x
5	Improving of water quality in Arges River after the confluence with Dambovita	x			x	x		x		x		x
6	Reduction of pollutants sent to the Danube River	x			x	x		x		x		x
	Impact on groundwater											
7	Lowering the groundwater level around Caseta and main collectors	x		x		x				x		x
8	Reducing the groundwater infiltration in the sewerage system and subsequently reducing the wastewater dilution in the Caseta	x		x		x			x			x
	Impact due to waste											
9	Pollutant and pathogenic risks due to the sludge and clogging sand extracted from main drain and Caseta	x		x			x		x		x	
10	Unpleasant odours due to sludge and clogging sand extracted from drains and Caseta	x		x			x		x		x	

No	Identified impacts	Significance of impact		Nature of impact					Term of appearance		Duration of impact	
		Significant	Non-significant	Direct	Indirect	Pozitive	Negative	Cumulative	Short	Medium	Temporary	Permanent
	Impact on air											
11	Emission of particulates and burned gases from vehicles and equipment circulation		x	x		x		x	x		x	
12	Possible unpleasant odour emissions from sludge /sand extracted from main drain and Caseta		x	x		x			x		x	
	Impact on soil											
13	Discovered areas where worksites will be located		x	x		x			x		x	
14	Accidental pollution by waste or oil/fuel spills		x	x		x			x		x	
	Noise											
15	Noise produced by traffic of vehicles and functioning of equipment such as peak hammers, compressors, electricity generators, concrete trucks, large pumps	x		x		x			x		x	
	Consumption of resources											
16	Energy and construction materials consumption	x		x		x			x		x	
	Impact on human health											
17	Reducing the infectious risks due to flooded roads and cellars for people living in areas of Caseta and main collectors	x		x		x			x			x
	Landscape											
18	Appearance of worksites is a disturbing element for the local landscape	x		x		x			x		x	
	Impact on dwellings and other objectives											
19	Improved durability of the sewerage system.	x		x		x			x			x
20	Better wastewater collection, roads flooding reduction	x		x		x			x			x
21	Better functioning of the Glina WWTP	x		x		x			x			x
	Socio-economic effects											
22	Reduction of the investment and operation costs for Glina WWTP	x		x		x			x			x

PART IV

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

The EIA performed on the project for development of the stage 2 of Glina WWTP and the Bucharest sewerage system rehabilitation has demonstrated that this investment will substantially improve the quality of the environment.

The main environmental impacts resulting from the project nature will be on **water** – because it refers to the treatment of around 70% of river Dambovita flow - and on the **air** - because it proposes the construction of the first sludge incinerator in Romania.

1. Impact on water

● The Glina WWTP will be capable to treat mechanically and biologically a flow of 23.8 and 11.9 m3/s, respectively, of wastewater generated by a population of around 2.4 million, living in Bucharest and in the 10 surrounding localities.

● The good functioning of the Glina plant is conditioned by the structure and durability of the sewerage system that will be improved by the rehabilitation works that are proposed to be achieved in parallel with the completion of the treatment plant. These works are designed to reduce with $3.66m^3/s$ the entering of relatively clean water into the Caseta and main collectors and consequently the Glina inflow, respectively the hydraulic load of the plant. The planned works will influence not only the Glina WWTP functioning, but also the river Dambovita, by supplying the upper reach with the drained clean water.

The effects on the water in the Dambovita upper reach on the Bucharest territory will be favorable because:

- the flow in the upper reach will increase with at least 3-4 m^3/s and will speed the water movement in the channel ensuring a better refreshing and oxygenation
- thus, the supplemental flow will improve the quality of the upper reach water and will diminish the risks of eutrophication.

● The treatment at Glina WWTP of a flow representing 3/4 of the river Dambovita will result in eliminating considerable quantities of pollutants, estimated for the year 2040 to be around 118,200 kg/d as BOD; 252,000 t/d as suspended solids, 31,500 kg/d as total Nitrogen and 5,450 kg/d as total Phosphorus. The reduction of this amount of pollutants will lead to a *cleaner environment,* meaning:

- reduction of nuisances such as odours, floating refuse, unpleasant water colour
- increased capacity of auto-purification of the river water
- increased abundance of life forms in river water and on the river banks
- progressive reduction and prevention of groundwater pollution.

● The above favourable effects will lead to the *extension of some water and land uses* by development of irrigations and extension of the cultivated lands, new opportunities for recreation activities along the river and possible development of dwelled areas and small companies. These new or extended water and land uses will have *beneficial socio-economic effects* on the area expressed as growth of the income from agricultural and industrial production, more working places, increased value of the properties and better life standards for inhabitants.

● The works for Glina plant completion and for sewage system rehabilitation will not change the **quality of groundwater** because no wastewater discharge will occur in the ground or soil during the works and after their ending.

● As results of the planned works for the sewage system rehabilitation, *during operation phase a lowering of the groundwater level with 1-2 m*, from the actual depth of -3… -7 m, till around -5 m (that is the depth of the pumping stations on the left bank and of the Subway drain on the right bank) is expected.

• The lowering of the shallow groundwater layer will have as main effect the *reduction of clean water infiltration* inside the sewage system components.

• The subsequent effects will be the *reduction of the wastewater flow* brought to the Glina Plant and the *improved treatment efficiency.*

● The quality of groundwater will be subject of a monitoring program.

2. Sludge generation and processing

● The primary and secondary treatment of the wastewater will generate a considerable amount of sludge that will be processed by thickening, anaerobic digestion and dewatering. As result of these processes a sludge quantity of 476 m3/day (or 157,100 m3/year) with 67% water content has to be disposed of..

● Incineration was from the beginning of the project more or less established as the final sludge disposal option for Glina WWTP, justified by the following aspects that are specific to other options:

- Negative influences on the environment (spreading toxics, bad odour, noise);
- Health reasons for the citizens in Bucharest and surrounding municipalities.

The analysis of the available disposal options for Glina sludge disposal has underlined that both, the land application and landfilling have limitations and high uncertainties and for such reasons these options are not only undesirable, but even inapplicable as long term solutions. The incineration quality of being able to substantially reduce the amount of residues to be disposed is of extreme importance for a very large plant as Glina WWTP. This quality outweighs all disadvantages when compared with other options.

3. Impact on air

During the functioning of WWTP stage 2 air emissions will arise from water treatment processes happening in open air, combustion of biogas and sludge incineration. Two types of impact forms have been discussed as caused by these emissions: odours and effects on air quality.

- *Odour emissions* due to the content of H_2S and mercaptans in the wastewater usually are generated at the influent entrance in the treatment plants (screens, grit and sand removal) and from the open sludge tanks. The achievement of Glina stage 2 will significantly reduce such odours by covering the plant structures supposed to generate odours and by treating the air before exhausting.

Odours at the Glina plant inlet will be reduced also due to removal of materials deposited inside the Caseta and the sewage main collectors, which are subject of fermentation. As a result the discomfort of the Glina inhabitants will be significantly lower compared with the actual situation of Glina Stage 1 or with the former situation without wastewater treatment plant.

After the completion of Glina stage 2, the odour generated now by the untreated wastewater along the Dambovita River will disappear completely, the improvement of air quality being favorable for the inhabitants living downstream Glina WWTP.

- **Impact of emissions from sludge incineration**

The Glina incinerator will be designed, equipped, built and operated in such a way that the emission limits, as have been set out by **IE Directive 2010/75/EU – Annex VI, Part 3** will be not exceeded.

The dispersion study has concluded that a height of 30 m for the stack of Glina sludge incinerator is optimal to ensure the atmospheric dispersion of the pollutants emitted from the incineration process and to determine a low impact, not affecting the compliance with the limit/ target values/critical levels for the ambient air.

For the stack height of 30 m, in the dwelled areas with sensitive receptors to Nitrogen dioxide (NO_2), which is the most important pollutant generated by incinerator (because of the highest value of the ratio between the estimated emission and the appropriate value for air quality), there is no exceeding of the limit values, even in the case of the cumulative impact of incinerator operation and background levels, for any of the averaging periods.

For the stack height of 30 m, the maximum concentrations for the other analyzed pollutants (SO_2, PM10, PM2.5, CO, Pb, As, Cd, Ni, Hg and PAH) are well below the corresponding limit/target values for all the averaging periods in case of exclusive incinerator operation. In the same time, the limit values/ target values/ critical levels in the areas with sensitive receptors (i.e. localities situated in the area of maximum impact) will be not exceeded by the cumulative impact with the background levels generated by other emission sources.

4. Impact of energy consumption

The Glina WWTP will have **substantial energy consumption,** but the stage II project is offering different possibilities to reduce it, by recovery of biogas energy, reuse of heat and steam from incinerator and by producing power with the outlet turbines. By using the energy generated by these sources**,** the net energy consumption could be reduced with 40-50%.

5. Impact on dwelled areas, human health and welfare

- The works for rehabilitation of the Caseta and collectors will have a beneficial effect on the Bucharest citizen's life by **reduction of cellars and roads floodi ng and pollution** during strong rains. This effect will be the result of:
  - the increased transport capacity of the sewerage system due to elimination of materials left or accumulated in the Caseta and to the reduction of infiltration (at least with 3.4 m^3/s)
  - the capacity of the mechanical treatment, meaning that during heavy rain the plant will treat mechanically a flow of 23.8 m^3/s.

- The rehabilitation of Caseta and collectors and finalization of Glina WWTP will reduce the main risks related to the **potential spreading of infectious diseases** that is associated to sewage water. The role of such works in improving the conditions for preserving human health of inhabitants is well know and it will be assured for inhabitants of Bucharest, Glina village and of dwellings downstream the plant.

- The implementation of the Glina project stage 2 will have **beneficial socio-economic influences on dwelled areas** expressed by new job opportunities for local people, appearance of small scale companies, extension of the dwelled area, increasing of the properties value, all these effects leading finally to an improved life standard for the inhabitants.

- The construction works planned for rehabilitation of Caseta and main Collectors will have a temporary negative impact on the Bucharest quarters that are neighboring the works sectors by modifying the traffic regime on the roads and the water flowing in the

Dambovita upper channel, by noise and by the appearance of some landscape disturbing elements (such as fencings, dams, demolished items, machinery, wastes, etc.). This impact will be limited in space - worksites are extended on maximum 1 km length of the Dambovita channel - and in time, the total works duration being of 30 months.

6. Recommended measures for protection of soil and groundwater

Impact on the soil and groundwater could be generated by *accidental spillage of chemicals and fuel* used during construction or operation phase of Glina WWTP and sewage system rehabilitation. To avoid such situations it was recommended that these materials to be stored in closed tanks, vessels or drums placed separately inside the storehouses. The storage areas must have impermeable concrete floor with channels for spillage retention in order to avoid soil and groundwater pollution. Any accidental spill has to be collected and removed by using absorbent materials.

7. Recommended measures for waste management

- Consideration is to be given to any possibility of minimization of waste amount and harmfulness (as required by the Art. 53 of the IE Directive).

- The disposal of the Glina WWTP technological waste (ashes, fly ash and APC residues) has to be externalized by contracting this activity with specialized companies which are authorized to dispose of the non-hazardous and respectively hazardous waste. The screenings will be incinerated together with the sludge and the grit (sand) washed and reused.

- Prior to determining the routes for the disposal of these residues, appropriate tests shall be carried out to establish the physical and chemical characteristics and the polluting potential of residues. Those tests shall concern the total soluble fraction and the soluble fraction of heavy metals. Provisions of **Ministerial Order 95/2005** will be applied for establishing the waste characteristics.

- Supplemental treatment (i.e. solidification using cement, lime and other pozzolanic materials) is expected to be applied to some incineration waste in order to reduce the leachability of their heavy metals content. Intermediate storage and transport of dry residues in the form of dust have to take place in such a way as to prevent their dispersion in the environment.

A special attention has to be given to the clogging sand and sludge extracted from the sewerage system for the reason of their possible contaminants content (pollutants or pathogenic germs) and potential of generating unpleasant odour. Companies contracting the rehabilitation works of Caseta and Collectors have to demonstrate that they have solutions for safe disposal of extracted materials.

8. Recommended measures for landscape improvement

- For the Glina WWTP a vegetal curtain is proposed to be created to hide partially the plant components and to transform it into an objective with no negative impact on the surrounding landscape. For this purpose it was recommended that trees, brushes and flowers to be planted on the alley borders, while other trees rows to be planted in parallel to the fence surrounding the site.

- Minimization of the negative impact on the city landscape during the sewage rehabilitation works has to be assured by measures such as:
  - completely fencing the worksites with panels covered by advertising posters/ prints;
  - worksites surfaces have to be well organized (for example the opening of the upper reach will be made at once on only 5 m length);
  - attention to be given to not soil the roads and for this reason the wheels of vehicles will be washed before leaving the worksites.

9. Specific recommendations for environmental protection during works for sewerage system rehabilitation

- The recommended fencing of the worksites using **noise absorbent panels** will be more efficient in combination with the placement of the noisy equipment at the lowest level inside the site, for example on the bottom of the upper reach or open drain, in order to be supplementary shielded. Another recommendation is to fix the equipment producing vibrations and noise on a temporary support, when this equipment will be used for longer time in the same location.

- The impact on air determined by the **emission of particulates and burning gases** that will result from vehicles and equipment functioning, construction of dams, excavations or sawing the upper slabs, as well as from site restoration actions could be substantially reduced by measures as optimization of vehicles and machinery movement, wetting their trajectory inside the worksites and correct handling of powdery materials/waste.

- Works involving extraction and handling of clogging sand, sludge or construction materials left inside the Caseta, as well as wastewater generated from cleaning could generate unpleasant odours of low intensity but the discomfort generated to Bucharest inhabitants will be temporary and of short duration. Minimization of these **odours** will be possible by:
  - Separate collection and rapid evacuation of resulted waste, sludge and clogging sand
  - Immediate discharge into the Caseta of any wastewater resulted from cleaning.

It is expected that the above measures will reduce odour impact to a supportable level for the people living in the area or passing by.

As a final conclusion it is to underline that the project of Glina stage 2 involving the WWTP completion and the rehabilitation of the sewage system is beneficial from environmental point of view and of its favorable effects will benefit a significant number of inhabitants living in Bucharest and 10 neighboring localities.