APPENDIX-9 GEOLOGICAL SURVEY

A geological survey was conducted to prepare basic information on the soil conditions, which are necessary to investigate the type of foundation and temporally work for planning of waste-water treatment plant and related facilities.

The geological survey consists of borings at the potential sites of the proposed wastewater treatment plant, and in-situ test and laboratory test to examine the soil characteristics. Contents of the survey are as follows:

Boring (depth: 10m)	2 sites
Boring (depth: 20m)	4 sites
Boring (depth: 30m)	1 site
Standard Penetration Test	7 boring sites
Physical Test at Laboratory (Specific gravity, Liquid/Plastic Limit and Grain Size)	6 samples
Unconfined compression test at Lab.	6 samples
Consolidation test at Lab.	6 samples

A report of the geological survey, which was prepared by the contractor "SETA S.A.", is attached hereinafter, and the contents of the report consists of location maps of sampling points, geological results, dynamic penetration test, analytical results of laboratory and result of consolidation test.

SETA S.A. SOCIETATE DE ECOLOGIE ªI TEHNOLOGIE A APEI

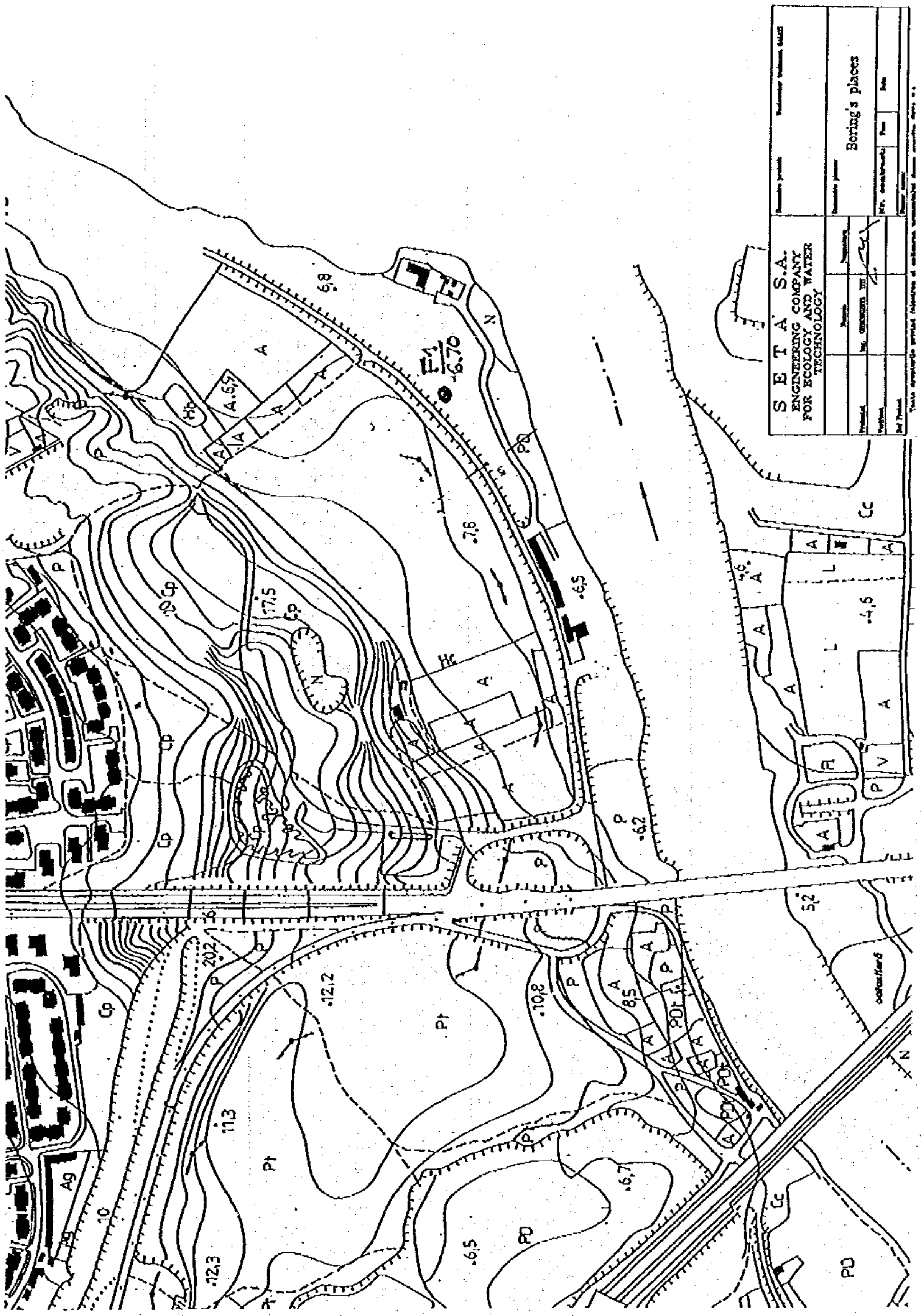
SEDIUL: str. Tudor Arghezi, nr.21 Sector 2, 70132, Bucure¿ti - J 40/4771/1995 - Cod fiscal R 7470611
Tel/fax: 211.32.20 ; 211.41.77; E-mail : Error! Reference source not found.

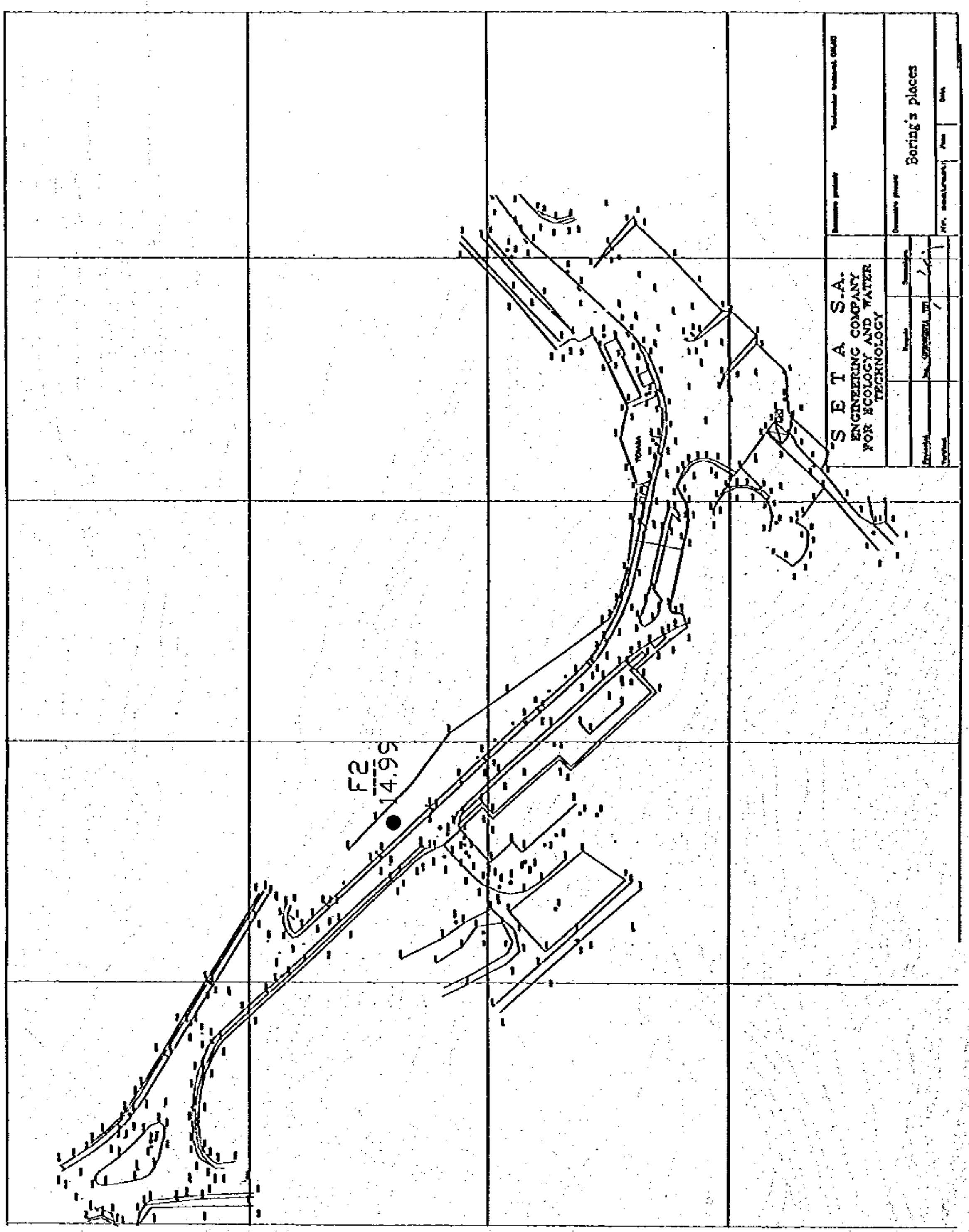
GEOLOGICAL SURVEY

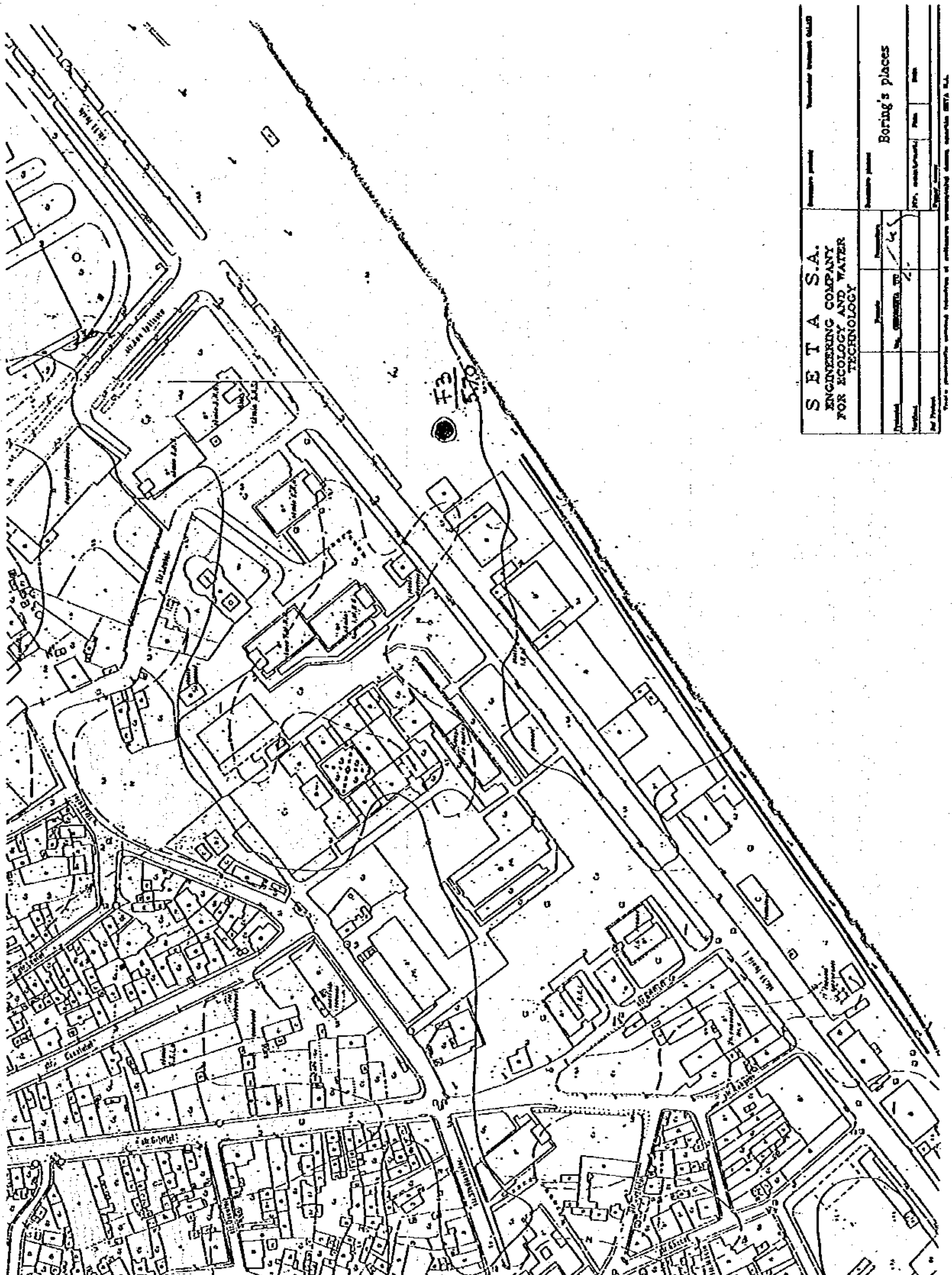
Subject : THE FEASIBILITY STUDY ON WASTEWATER TREATMENT

Locality : GALATI

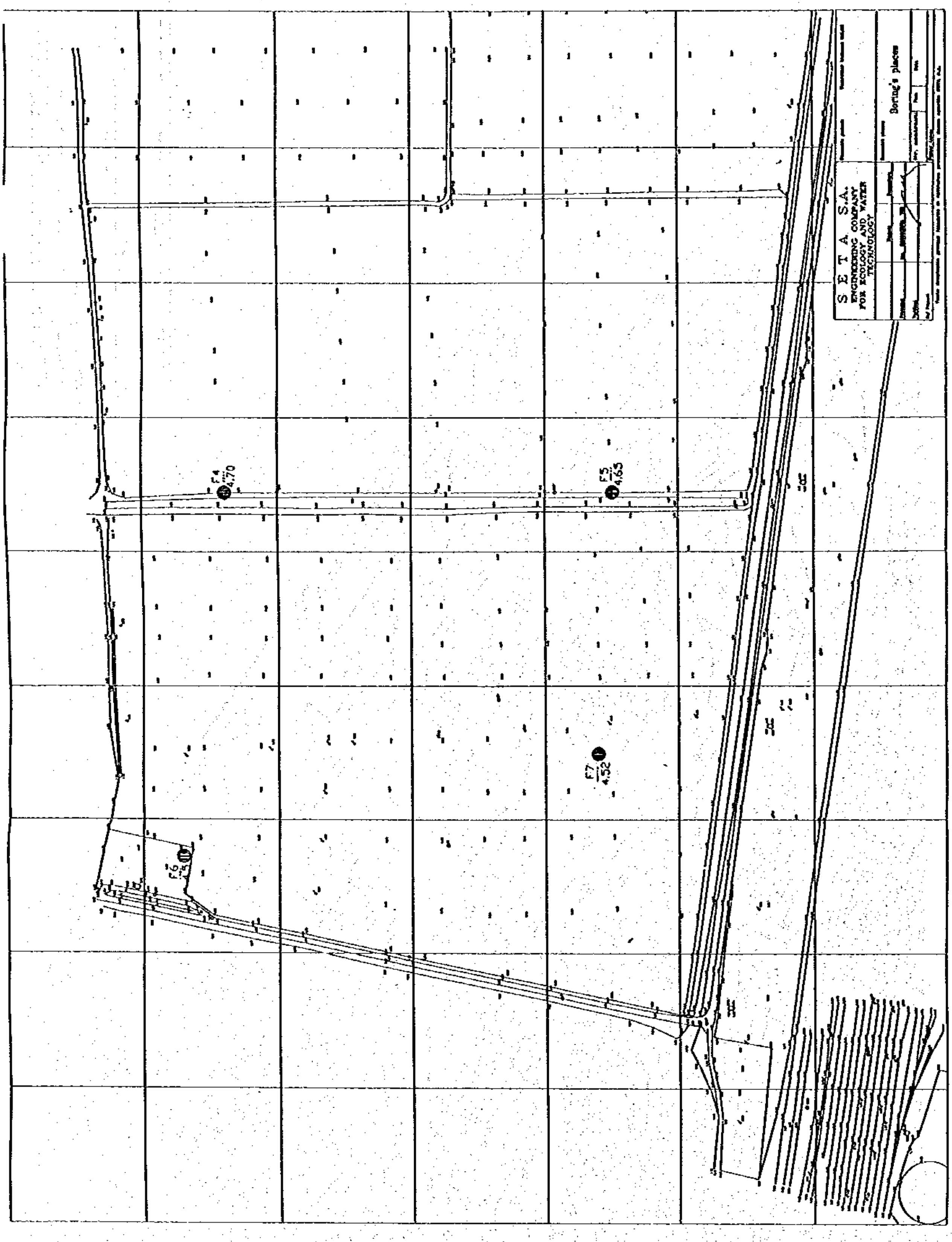
To : JAPAN INTERNATIONAL COOPERATION AGENCY


S E T A S.A.
ENGINEERING COMPANY
FOR ECOLOGY AND WATER
TECHNOLOGY
Boring's places


F2
14.99
S E T A S.A.
ENGINEERING COMPANY
FOR ECOLOGY AND WATER
TECHNOLOGY
Boring's places



F3
S.A.
S E T A S.A.
ENGINEERING COMPANY FOR ECOLOGY AND WATER TECHNOLOGY
Boring's places


F4
4.70
F5
4.65
F6
F7
4.52
S E T A S.A.
ENGINEERING COMPANY
FOR ECOLOGY AND WATER
TECHNOLOGY
Boring's places

SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F.1 : 6.70 rBS

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
	0.80	0.80		Vegetable soil	1	21
NH: 2.15				Grey or yellow clayish silt, consistent plastic	2	18
	3.20	2.40			3	19
				Yellow fine, immerged sand, with medium compaction	4	26
	4.80	1.60			5	24
	6.50	1.70		Grey, consistent plastic clay, with broken shells	6	24
				Grey clayish silt, soft plastic	7	18
					8	19
					9	21
	9.50	3.00			10	18
					11	19
					12	21
				Grey sandy clayish silt, soft plastic to consistent plastic, with shells end thin sandy lenses	13	20
					14	22
					15	21
					16	23
	17.20	7.70			17	28
					18	27
	20.00	2.80		Grey fine-medium, immerged sand with medium compaction	19	27
					20	28

DRAFTED:
Eng. T. Gheorghiță

SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F2 : 14.99 rBS

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
NH: -	0.80	0.80		Vegetable soil	1	50
				Yellow clayish silt, strong to soft plastic begeted by wind 's action. Between 1-5 m depth, with broken briks interlayers.	2	50
					3	50
					4	50
					5	50
					6	50
					7	47
					8	16
					9	7
	10.00	9.20			10	2

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SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F3 : 5.70 rBS

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
				Unhomogeneous filling	1	
NH: 1.90					2	
	2.80	2.80			3	19
					4	18
				Grey, clayish silt soft plastic, with shells	5	18
					6	17
					7	18
	7.50	4.70			8	19
	8.60	1.10		Grey , soft plastic clay	9	27
	10.00	1.40		Grey - yellow, immerged, fine- medium sand	10	29

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SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F 4 : 4.70 rBS

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
	1.20	1.20		Yellow silty sand, with strong compaction	1	33
NH: 2.00				Yellow or grey, consistent plastic clay, with shells and snails	2	27
					3	28
					4	25
					5	30
					6	31
					7	31
					8	22
	9.40	8.20			9	19
				Grey, silty sand, soft plastic	10	18
	11.60	2.20			11	18
				Grey, consistent plastic clay, with thin sandy lenses	12	20
	13.50	1.90			13	20
				Grey silty clay, consistent plasticc to soft plastic	14	21
					15	22
					16	23
					17	21
	18.10	4.60			18	21
				Grey, consistent plastic clay	19	24
	20.00	1.90			20	23

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SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F5 : 4.65 rBS

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
					1	50
NH: 2.10				Yellow - grey sandy clayish silt sturdly plastic to consistent plastic	2	36
	3.30	3.30			3	33
					4	27
					5	29
					6	30
				Grey consistent plastic clay, with snails. Between 11.8 - 12.4 m depth, grey sandy clayish silt, soft plastic.	7	31
					8	26
					9	20
					10	20
					11	21
					12	22
					13	34
	14.20	10.9			14	35
					15	20
	16.70	2.50		Grey clayish sand, consistent plastic	16	22
					17	26
				Grey. silty clay, consistent plastic	18	24
	19.10	2.40			19	26
	20.00	0.90		Grey sandy clayish silt, consistent plastic	20	27

DRAFTED:
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SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F6 : 4.50 rBS

Mark of the underground water (m)	Marks to 0.00 borehole (m)	Bigness of the layer (m)	Layers structure	THE NAME OF LAYER
NH: 1.80	0.60	0.60		Vegetable soil
	3.50	2.90		Yellow - red sandy silt, sturdly plastic
	4.80	1.30		Yellow - grey clayish silt, consistent plastic
	13.40	8.60		Grey, consistent plastic clay, with snails and shells. Between 8.8 - 9.4 m depth, grey silty sand, consistent plastic
	18.60	5.20		Grey silty sand or fine-medium sand, immerged strong compaction, with shells
	20.00	1.40		Grey, consistent plastic clay.

Depth (m)	Dynamic penetration SPT (shocks)
1	47
2	49
3	50
4	36
5	28
6	28
7	22
8	22
9	21
10	26
11	27
12	28
13	28
14	33
15	29
16	35
17	35
18	35
19	32
20	30

DRAFTED:
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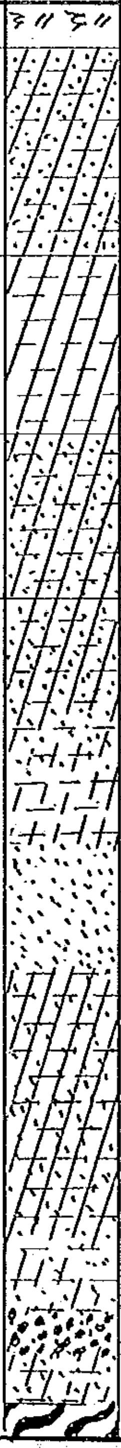
SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F 7 : 4.50 rBS

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
	0.50	0.50		Vegetable soil	1	7
NH: 2.20	3.80	3.30		Grey, sandy clayish silt, soft plastic, with vegetable remainings	2	8
					3	12
					4	20
	6.50	2.70		Grey, clayish silt, with shells, soft plastic to consistent plastic	5	12
					6	10
	9.00	3.50		Grey and brown sandy clayish silt, consistent plastic, with vegetable remainings. Between 8.0-8.5 m depth, black or brown peat	7	12
					8	10
					9	12
				Grey, sandy clayish silt alternanting with clayish silty sand, consistent plastic, with shells and snails.Between 12.8-14.5 m depth, grey, fine-medium sand, flowing.plastic. Between 20.0-20.5 m depth, gravel add sand, with shells. Between 21.6-22.0 m depth, black peat. Between 24.0-30.0 m depth, thin, silty clay lenses.	10	9
					11	15
					12	7
					13	8
					14	18
					15	20
					16	28
					17	24
					18	16
					19	17
					20	15
					21	18
					22	27

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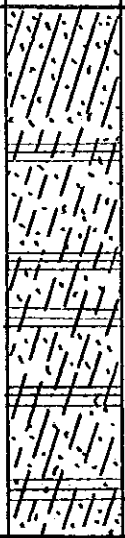
SETA SA BUCURESTI

Comanda:Wastewater treatment
Working place: Galati
Date: August 1999

GEOTEHNICAL RESULTS BOREHOLE Nr. F 7

Mark of the underground water	Marks to 0.00 borehole	Bigness of the layer	Layers structure	THE NAME OF LAYER	Depth	Dynamic penetration SPT
m	m	m			m	shocks
					23	21
					24	25
					25	20
					26	22
					27	23
					28	25
					29	25
	30.00	21.0			30	28

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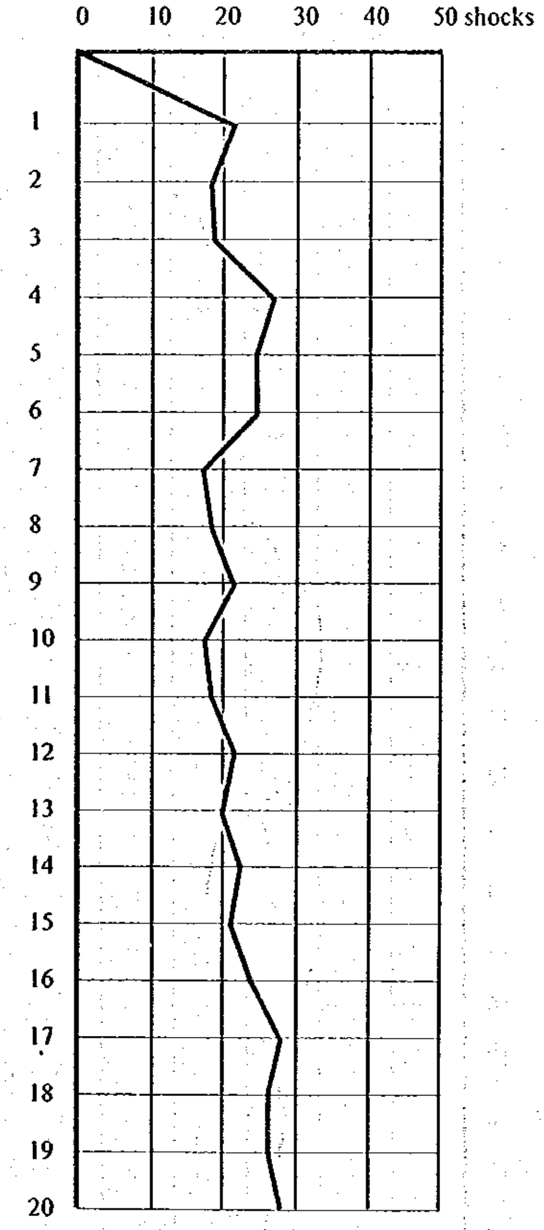
SETA SA BUCURESTI

Comand:Wastewater treatment
Working place: Galati
Date: August 1999

Dynamic penetration test

F 1



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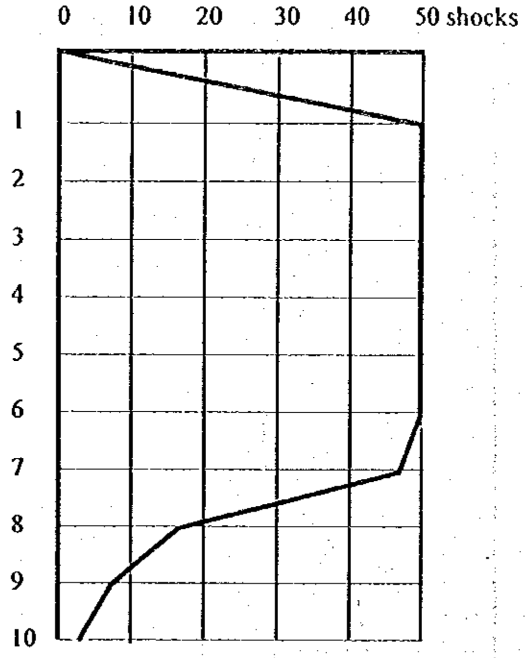
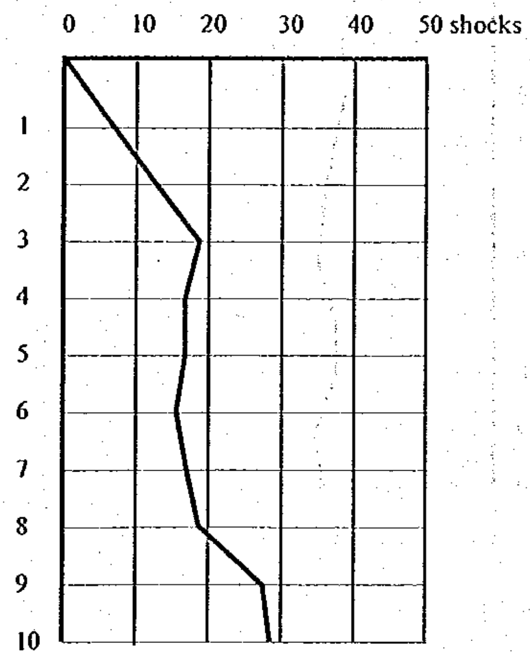


F 3



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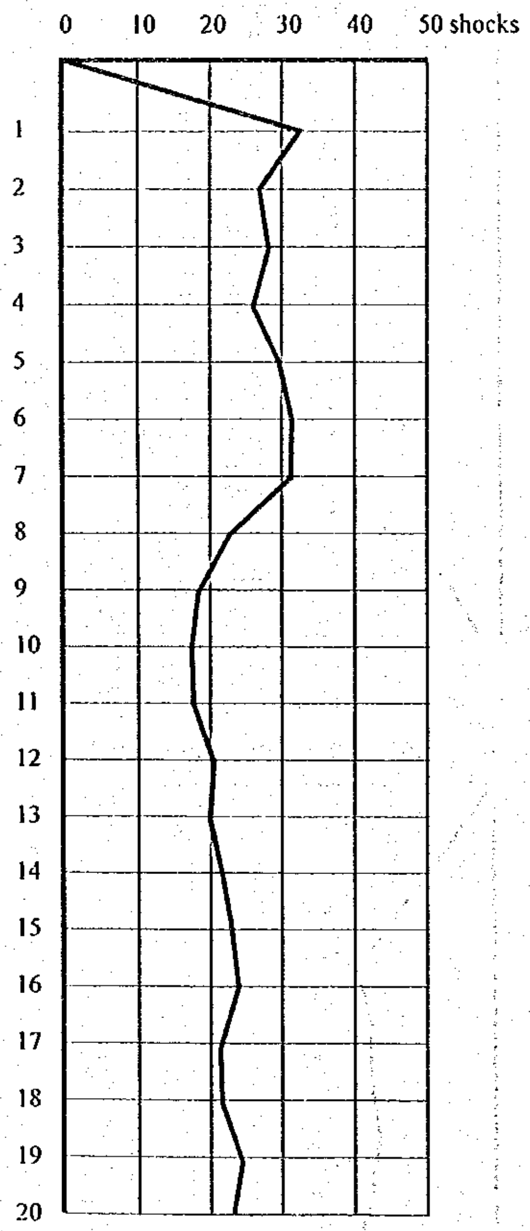
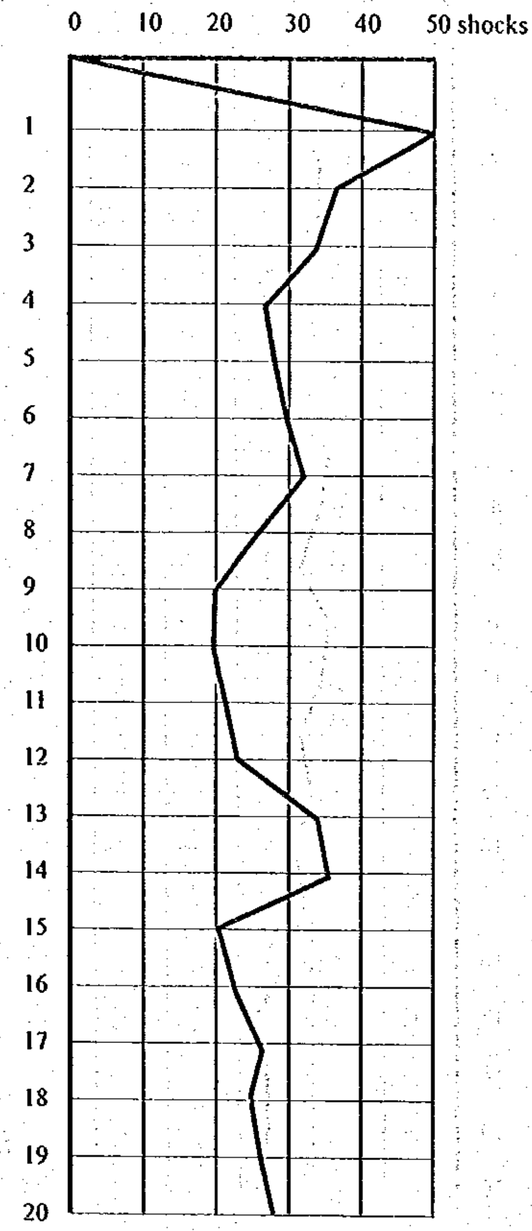
Comand: Wastewater treatment
Working place: Galati
Date: August 1999

Dynamic penetration test

F 4



F 5



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Eng.. T. Gheorghita

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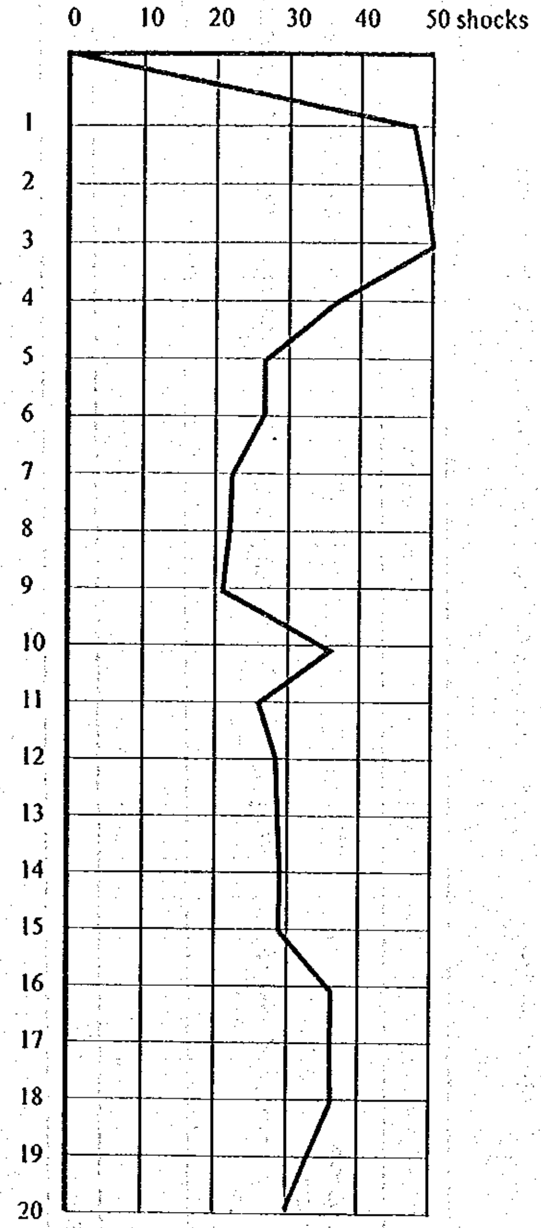
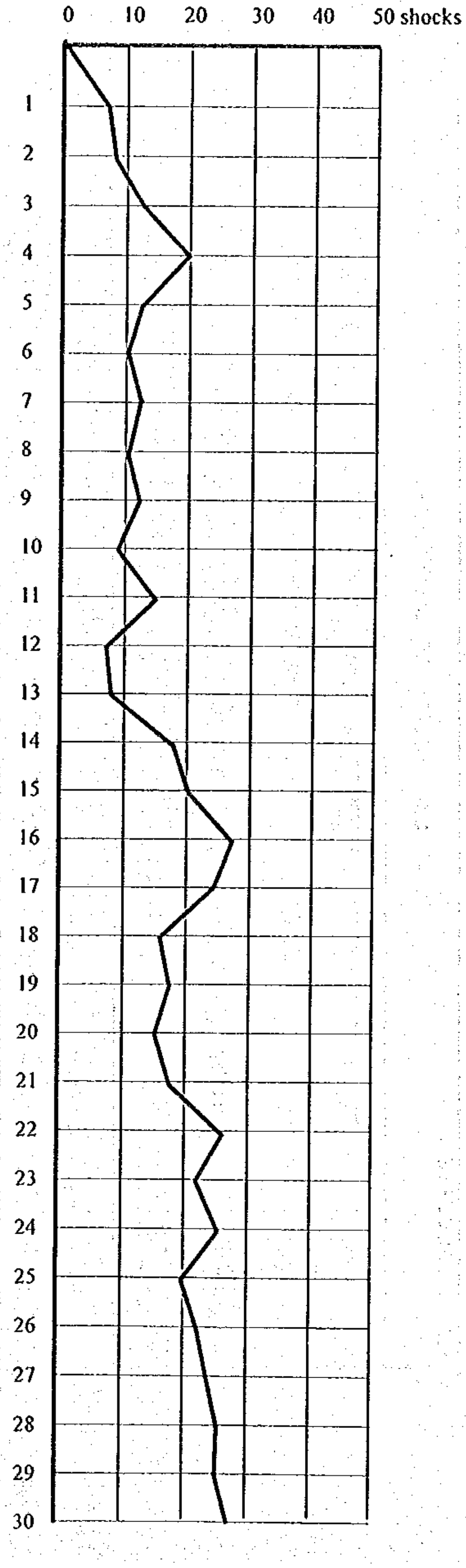
Comand: Wastewater treatment
Working place: Galati
Date: August 1999

Dynamic penetration test

F 6



F 7



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Eng.. T. Gheorghita

AH-9-17

SETA SA BUCURESTI

Comanda: Wastewater treatment
Working place: Galaţi
Date : August 1999

ANALYSIS RESULTS OF LABORATORY

Drilling level 0.00	Layer thickness	Underground water depth	Layers	Name of layer	☐ Bottle ☐ Sleeve ☐ Monolith: No. samples	Depth	Granulometric components (d in mm): Clay	Dust	Fine sand	Medium sand	Great sand	Plasticity limits: Flow limit	Knead limit	Plasticity index	Humidity	Consistency index	Volume weigh	Dry volume weigh	Porosity	Pore index	Humidity level	Specific weigh	Consolidation: Pressure	Primary consolidation time	Primary consolidation coeficient	Specific supplementary compression by damping	Specific compresion	Resistance to cutting: Internal abrasion angle	Cohesion
	m	m		Drilling - no: 1/8"		m	<0.005	0.005 - 0.05	0.05 - 0.25	0.25 - 0.5	0.5 - 2.00	Wl %	Wp %	Ip %	W %	Ic	γ KN/m³	γd KN/m³	n %	e	S_r	γs KN/m³	σ KPa	t_{50}% s	c_v 10^{-4} cm²/s	C_α	K 10^{-7} cm/s	φ°	c KPa
				Grey, soft plastic silty clay																			200	176	9.1	0.001	34.5		
					1	15.0	39	47	14			48	17.1	30.9	35.3	0.29	18.1	13.3	49.8	1.00	0.97	26.6	300	490.5	3.0	0.0011	7.3	12.0	7
																							400	1070.7	1.3	0.0015	4.1		
				Drilling No: 2/8"																									
				yellow, consistent plastic clayish silt (loess)																			200	247.7	7.5	0.0038	10		
					1	6.0	21	66	13			29.8	14.1	15.7	19.7	0.64	19.2	16.0	38.8	0.63	0.83	26.2	300	515	3.6	0.0062	3.1	20	15
																							400	881	2.0	0.0003	1.6		

Elaboration: Eng. Ana Stefanescu .... Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

ANALYSIS RESULTS OF LABORATORY

Comanda: Wastewater treatment
Working place: : Galaţi
Date : August 1999

Drilling level 0.00	Layer thickness	Underground water depth	Layers	Name of layer	☐ Bottle ☐ Sleeve ☐ Monolith: No. samples	Depth	Granulometric components (d in mm): Clay	Dust	Fine sand	Medium sand	Great sand	Plasticity limits: Flow limit	Knead limit	Plasticity index	Humidity	Consistency index	Volume weigh	Dry volume weigh	Porosity	Pore index	Humidity level	Specific weigh	Consolidation: Pressure	Primary consolidation time	Primary consolidation coeficient	Specific supplementary compression by damping	Specific compresion	Resistance to cutting: Internal abrasion angle	Cohesion
	m	m		Drilling - no: 3/8"		m	<0.005	0.005 - 0.05	0.05 - 0.25	0.25 - 0.5	0.5 - 2.00	Wl %	Wp %	Ip %	W %	Ic	γ KN/m³	γd KN/m³	n %	e	Sr	γs KN/m³	σ KPa	t_{50}% s	c_v 10^{-4} cm²/s	C_e	K 10^{-7} cm/s	φ°	c KPa
																							200	286.8	4.41	0.0016	32.6		
				Grey, running clayish sandy silt	1	5.0	22	48	30						48.7	0	16.8	11.3	57	1.33	0.98	26.3	300	799	1.44	0.0022	6.0	5	4
																							400	2019	0.54	0.0016	1.5		
				Drilling No: 4/8"																									
																							200	214	7.8	0.0017	39		
				Grey, running plastic silty clay	1	15.0	26	56	18			40.8	17.5	23.3	36.6	0.18	18.1	13.2	49.4	0.98	1.00	26.2	300	515	3.1	0.0014	12.8	15	10
																							400	1124	1.36	0.0007	3.3		

Elaboration: Eng. Ana Stefanescu [signature] Verification: Eng. Titi Gheorghita [signature]

SETA SA BUCURESTI

Comanda: Wastewater treatment
Working place: Galaţi
Date : August 1999

ANALYSIS RESULTS OF LABORATORY

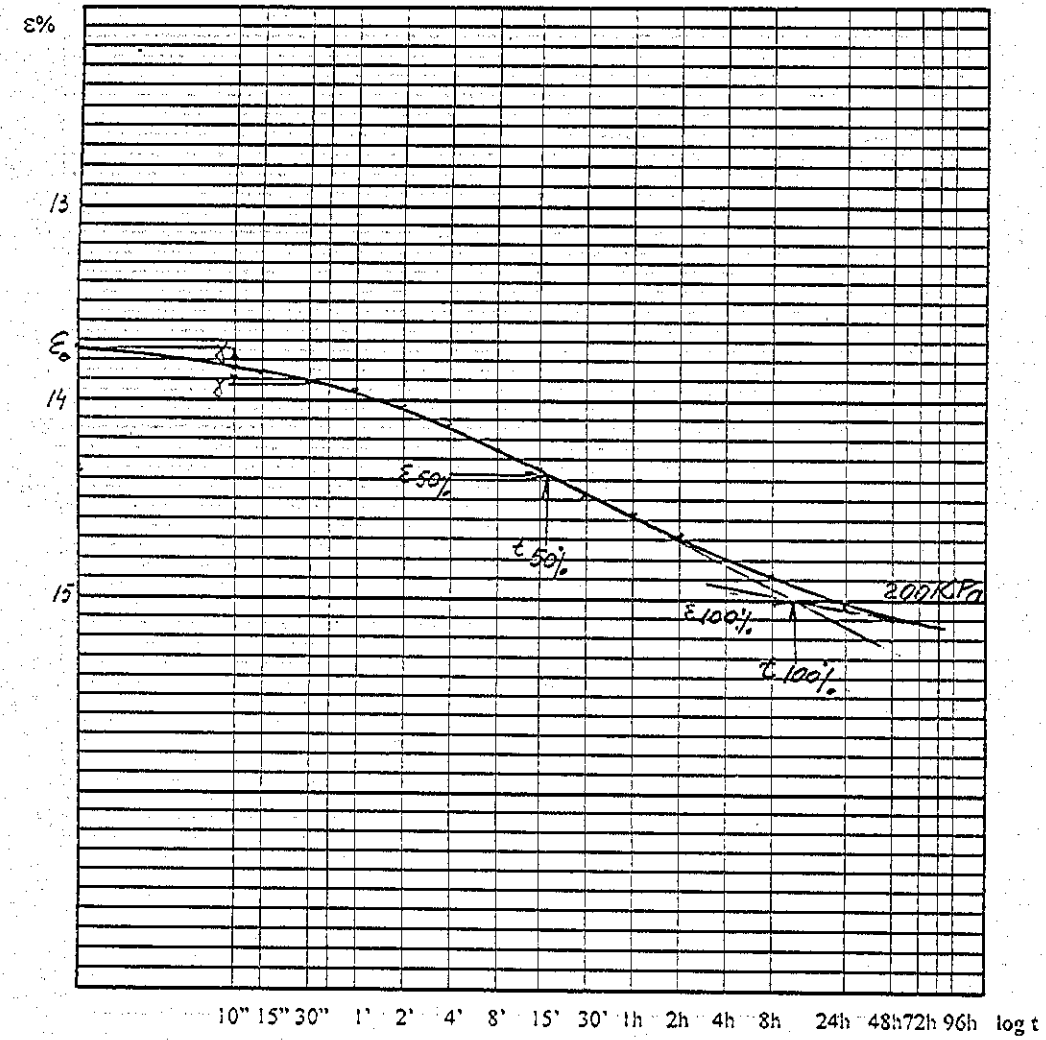
Drilling level 0.00	Layer thickness	Underground water depth	Layers	Name of layer	☐ Bottle ☐ Sleeve ☐ Monolith: No. samples	Depth	Granulometric components (d in mm): Clay	Dust	Fine sand	Medium sand	Great sand	Plasticity limits: Flow limit	Knead limit	Plasticity index	Humidity	Consistency index	Volume weigh	Dry volume weigh	Porosity	Pore index	Humidity level	Specific weigh	Consolidation: Pressure	Primary consolidation time	Primary consolidation coeficient	Specific supplementary compression by damping	Specific compresion	Resistance to cutting: Internal abrasion angle	Cohesion
	m	m		Drilling - no: 5/8"		m	<0.005	0.005 - 0.05	0.05 - 0.25	0.25 - 0.5	0.5 - 2.00	Wl %	Wp %	Ip %	W %	Ic	γ KN/m³	γd KN/m³	n %	e	S_r	γ_s KN/m³	σ KPa	t_{50}% s	c_v 10^{-4} cm²/s	C_α	K 10^{-7} cm/s	φ°	c KPa
				Grey, soft plastic fat cloy with snoils and shells	1	5,0	67	26	7			77,0	27,3	49,7	54,1	0,46	13,5	11,0	58,9	1,43	1,0	26,7	200	1019	1.5	0.0021	8.9	11	12.5
																							300	1366	1.03	0.0027	4.2		
																							400	2018	0.6	0.0029	0.8		
				Drilling-no: 6/8"																									
				Grey, soft plastic cloy with snoils and shells	1	5,0	47	38	15			66,5	24,6	41,9	47,6	0,45	17,6	11,9	55,1	1,23	1,0	26,6	200	690	2.2	0.0030	3.5	12,5	10.
																							300	971	1.44	0.0015	2.8		
																							400	1922.6	0.68	0.0017	1.0		

Elaboration: Eng. Ana Stefanescu

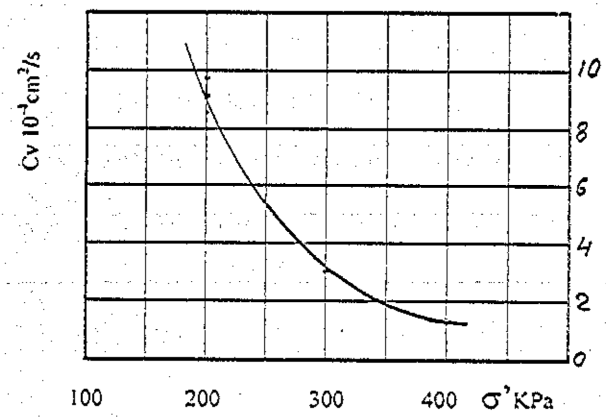
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F1/8"
Depth : 15.00 m.
Date: August 1999

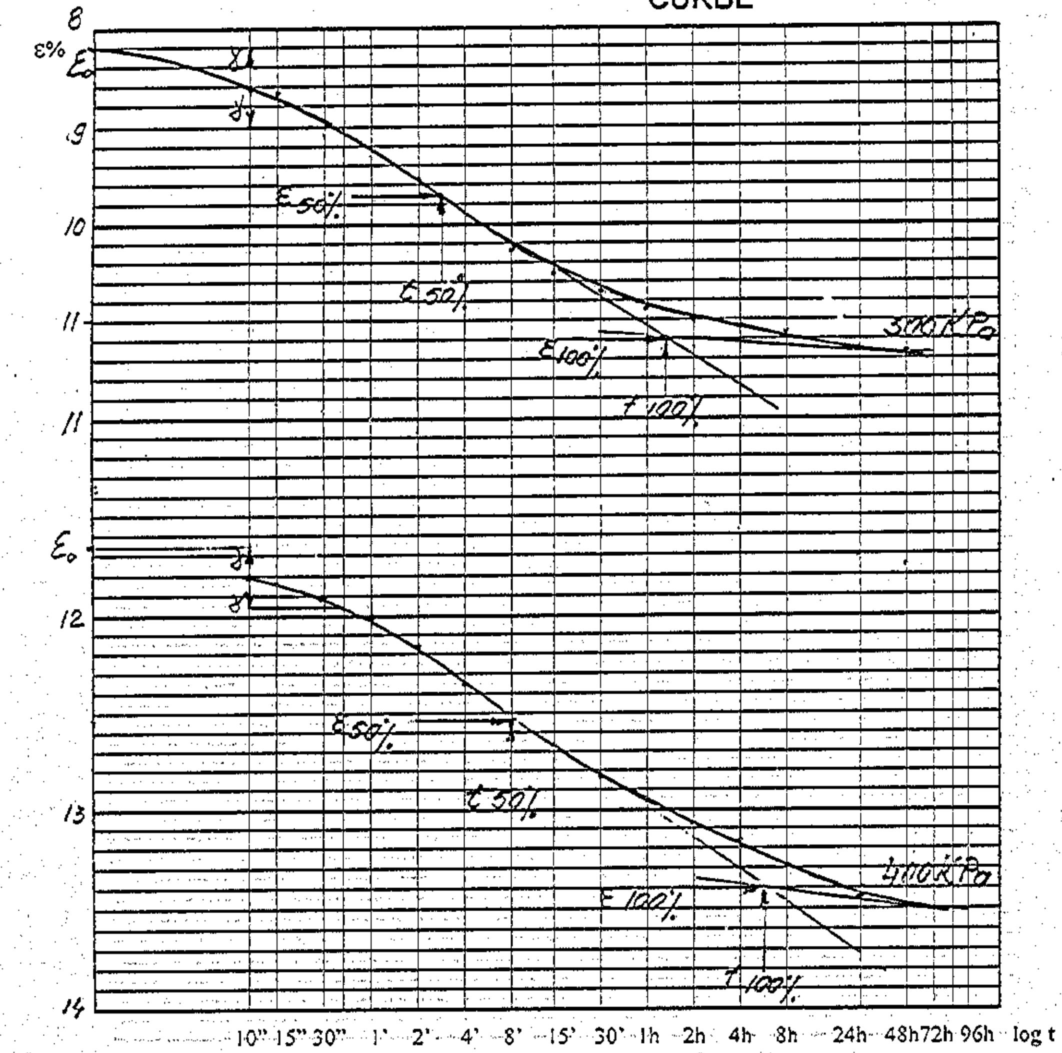


σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm²/s	c_α	K Cm/s
200	176	0.9022	$9,1\cdot10^{-4}$	0.0010.	$34.5\cdot10^{-7}$

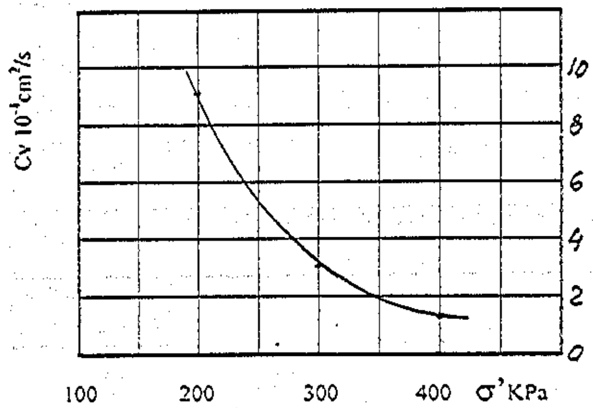
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F1/8"
Depth : 15.00 m
Date: August 1999



σ' KPa	t_{50}% sec	H_{50}% cm	c_v Cm²/s	c_α	K Cm/s
300	490.5	0.8747	$3.0 \cdot 10^{-4}$	0.0011	$7.3 \cdot 10^{-7}$
400	1070.7	0.8561	$1.3 \cdot 10^{-4}$	0.0015	$4.1 \cdot 10^{-7}$

Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

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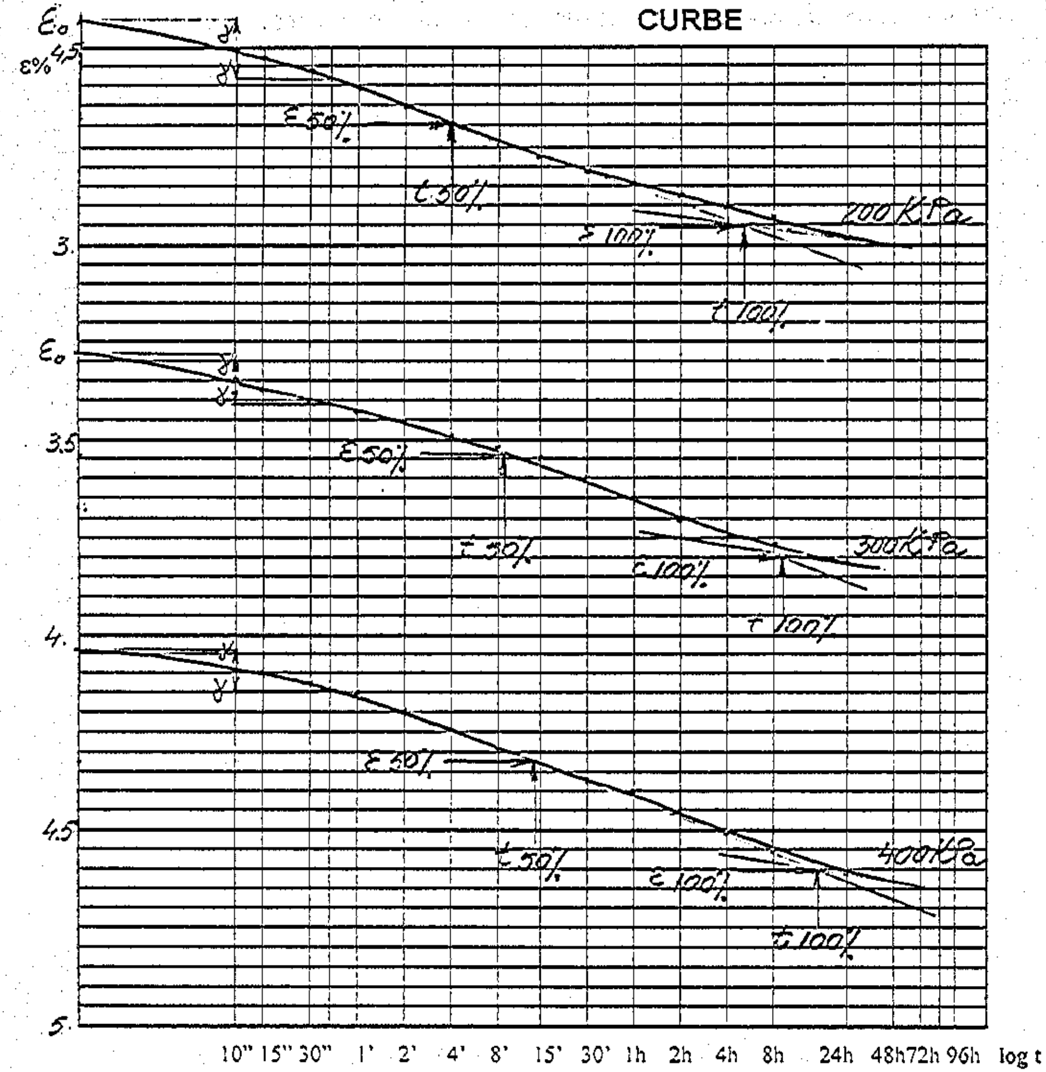
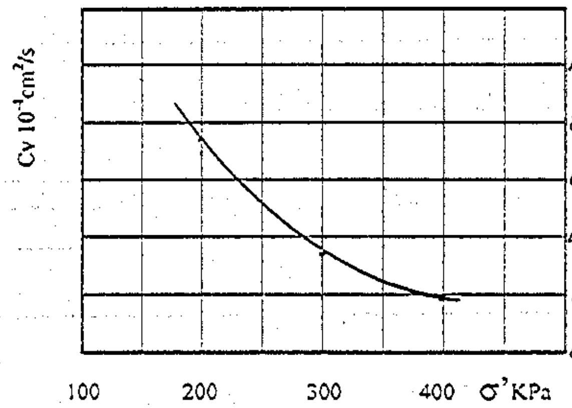
EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F2/8"
Depth : 600m
Date: August 1999

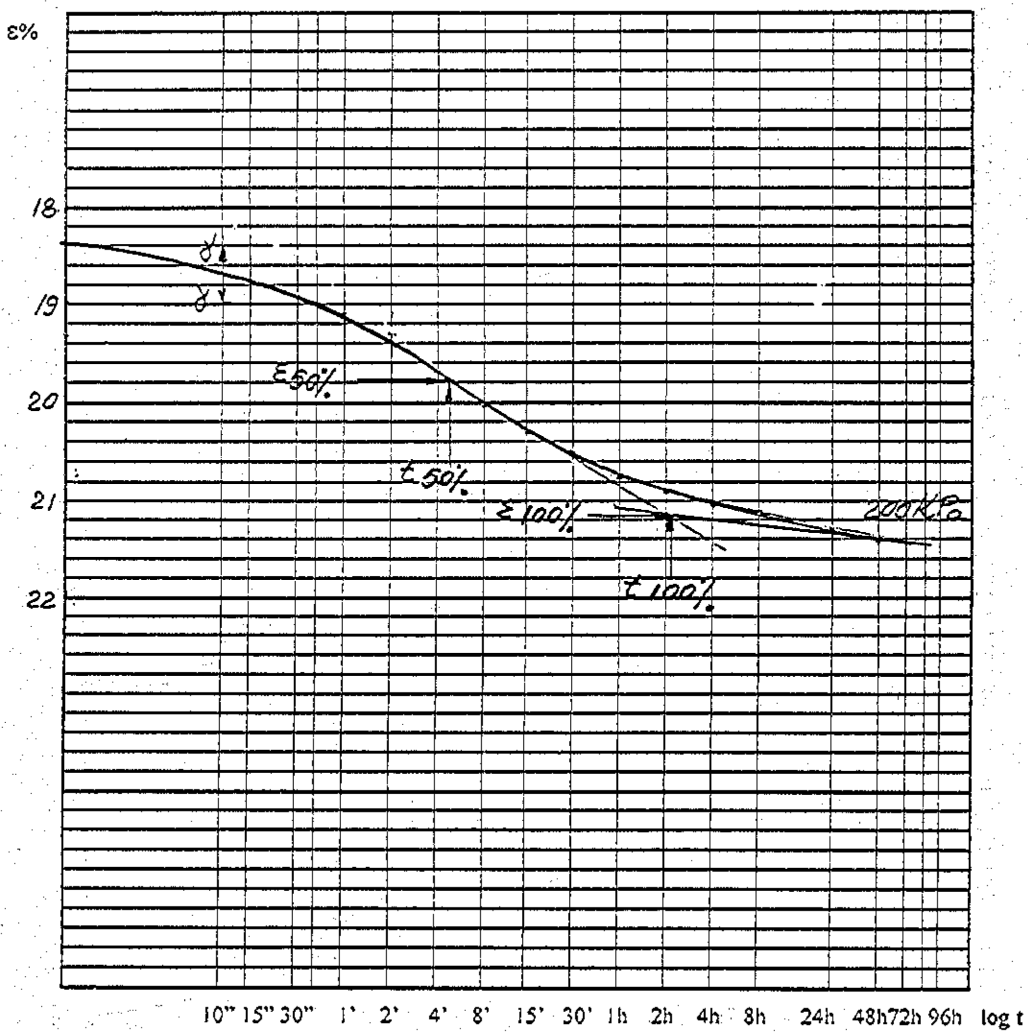


σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm²/s	c_α	K Cm/s
200	247.7	0.973	$7.5\cdot10^{-4}$	0.0038	$10.2\cdot10^{-7}$
300	515	0.9646	$3.6\cdot10^{-4}$	0.0062	$3.1\cdot10^{-7}$
400	881	0.9567	$2.0\cdot10^{-4}$	0.0005	$1.6\cdot10^{-7}$

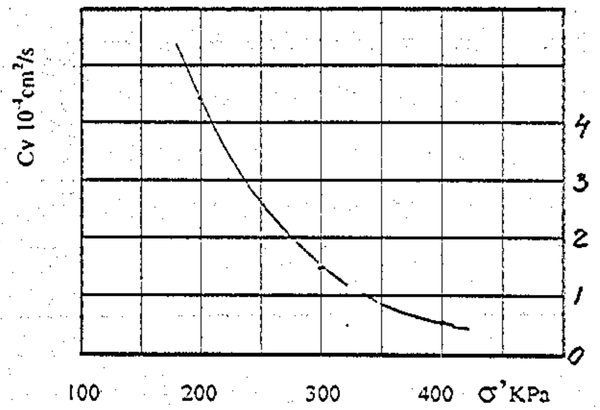
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F 3/8"
Depth : 5.00 m.
Date: August 1999

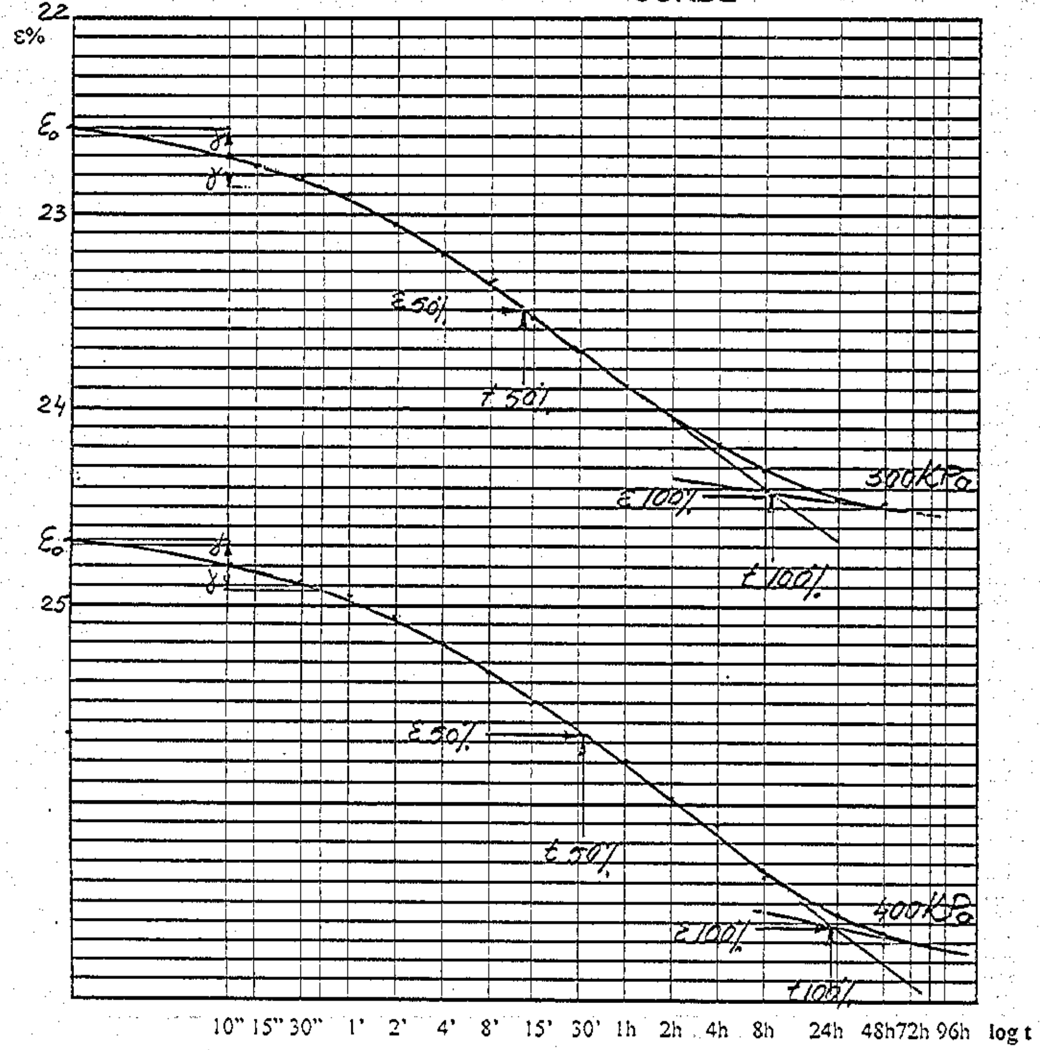


σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm²/s	c_α	K Cm/s
200	286.8	0.802	$4.41 \cdot 10^{-4}$	0.0016	$32.6 \cdot 10^{-7}$

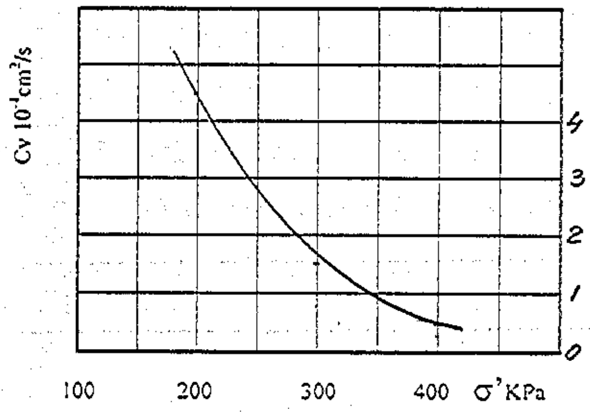
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F3/8"
Depth : 5.00m
Date: August 1999



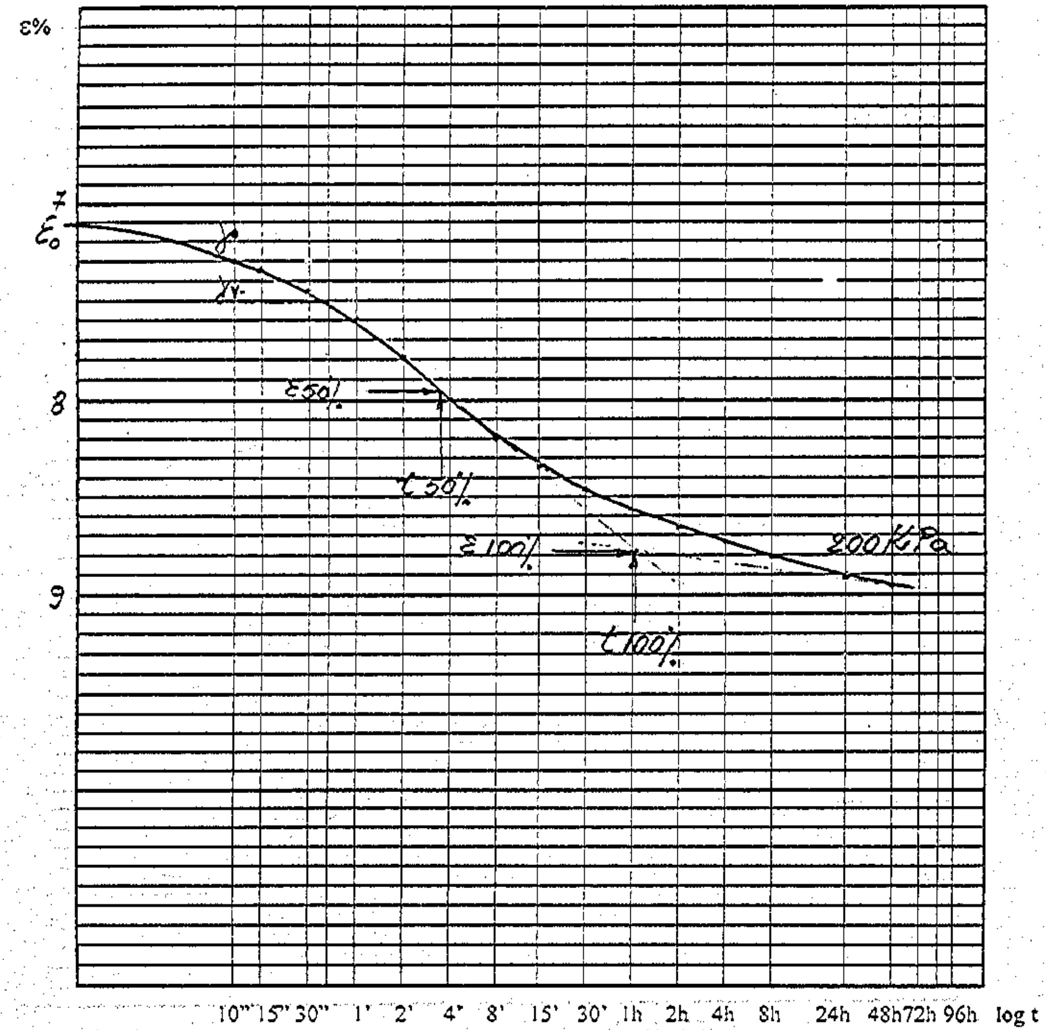
σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm²/s	c_α	K Cm/s
300	799	0.765	$1.44 \cdot 10^{-4}$	0.0022	$6.0 \cdot 10^{-7}$
400	2019	0.7434	$0.54 \cdot 10^{-4}$	0.0016	$1.5 \cdot 10^{-7}$

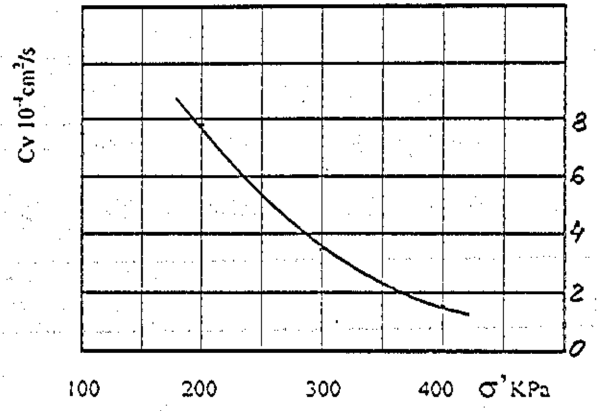
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE

Comanda: Wastewater treatment
Working place: Galati
Drilling : F4/8"
Depth : 5.00m.
Date: August 1999

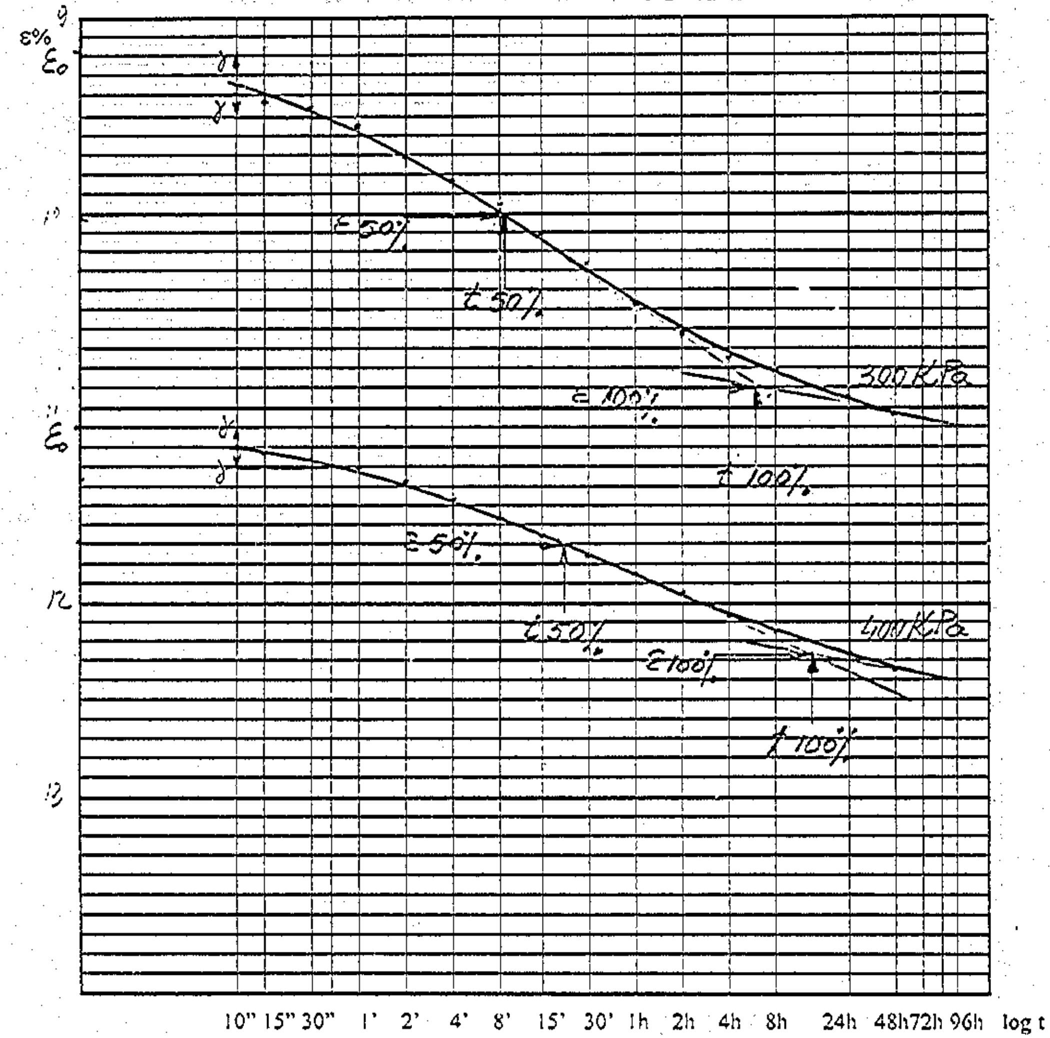




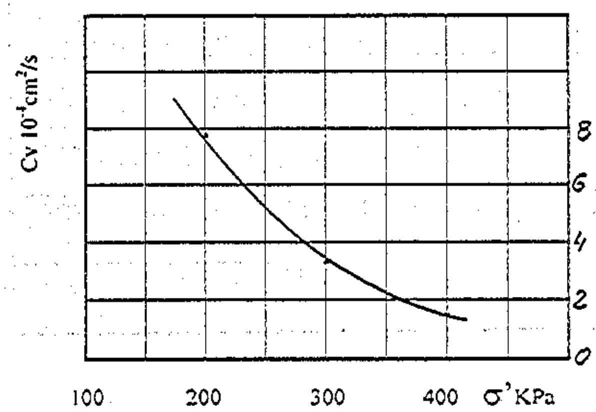
σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm²/s	c_α	K Cm/s
200	214	0.9204	$7.8\cdot10^{-4}$	0.0011	$39\cdot10^{-7}$

Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI **EDOMETRIC CONSOLIDATION CURBE**



Comanda: Wastewater treatment
Working place: Galati
Drilling : F4/8"
Depth : 5.00 m
Date: August 1999



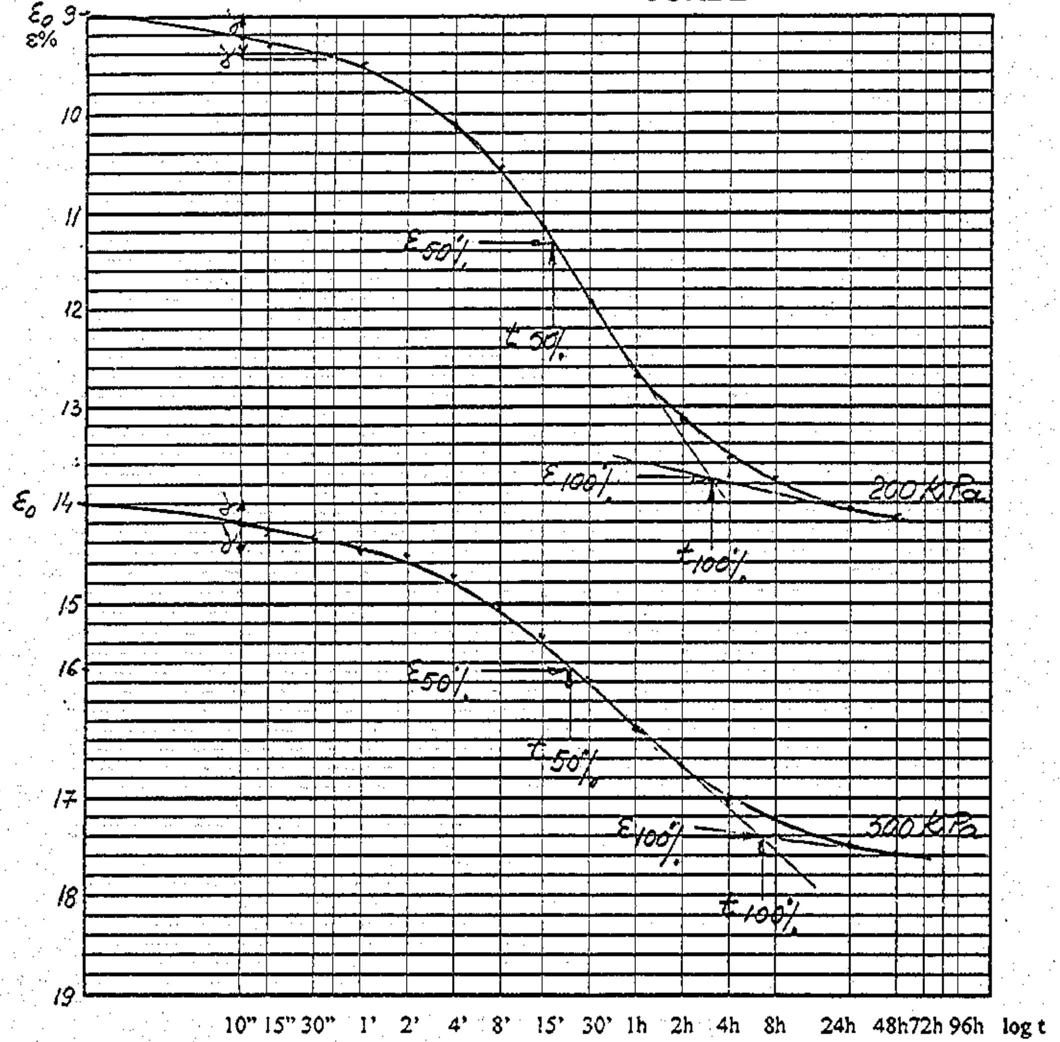
σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm²/s	c_α	K Cm/s
300	515	0.8999	$3.1 \cdot 10^{-4}$	0.0014	$12.8 \cdot 10^{-7}$
400	1124	0.853	$1.36 \cdot 10^{-4}$	0.0007	$3.3 \cdot 10^{-7}$

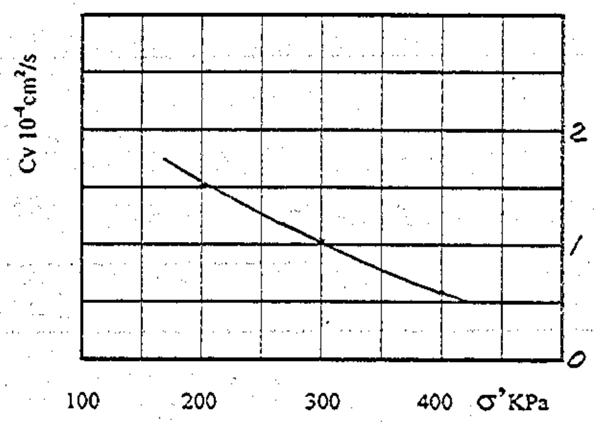
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE

Comanda: Wastewater treatment
Working place: Galati
Drilling : F5/8"
Depth : 500 m
Date: August 1999



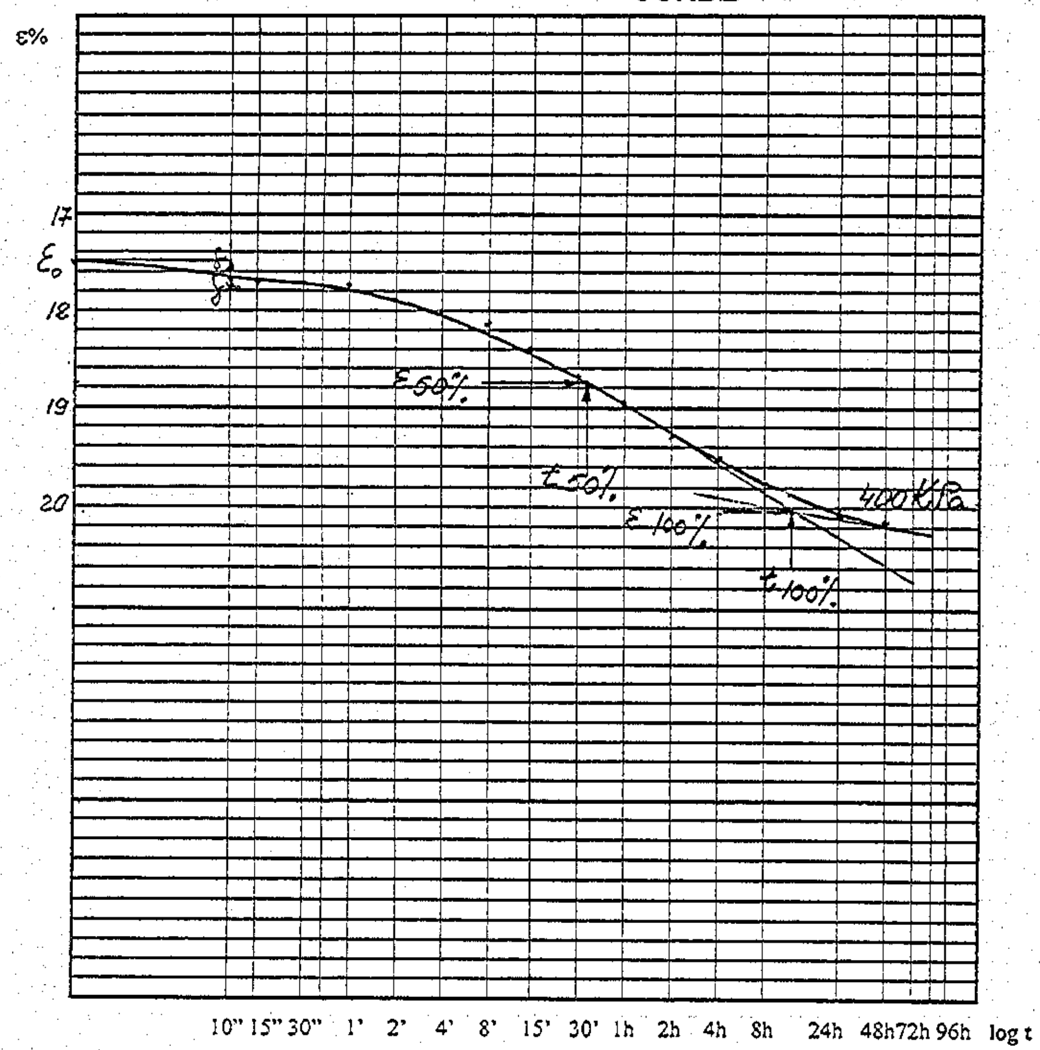


σ' KPa	t_{50}% sec	H_{50}% cm	c_v Cm²/s	c_α	K Cm/s
200	1019	0.8862	$1,5 \cdot 10^{-4}$	0.0021	$8.9 \cdot 10^{-7}$
300	1366	0.8432	$1,03 \cdot 10^{-4}$	0.00211	$4,2 \cdot 10^{-7}$

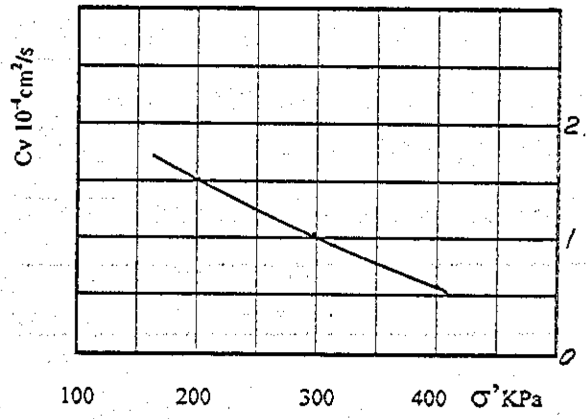
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F5/8"
Depth : 5.00m
Date: August 1999



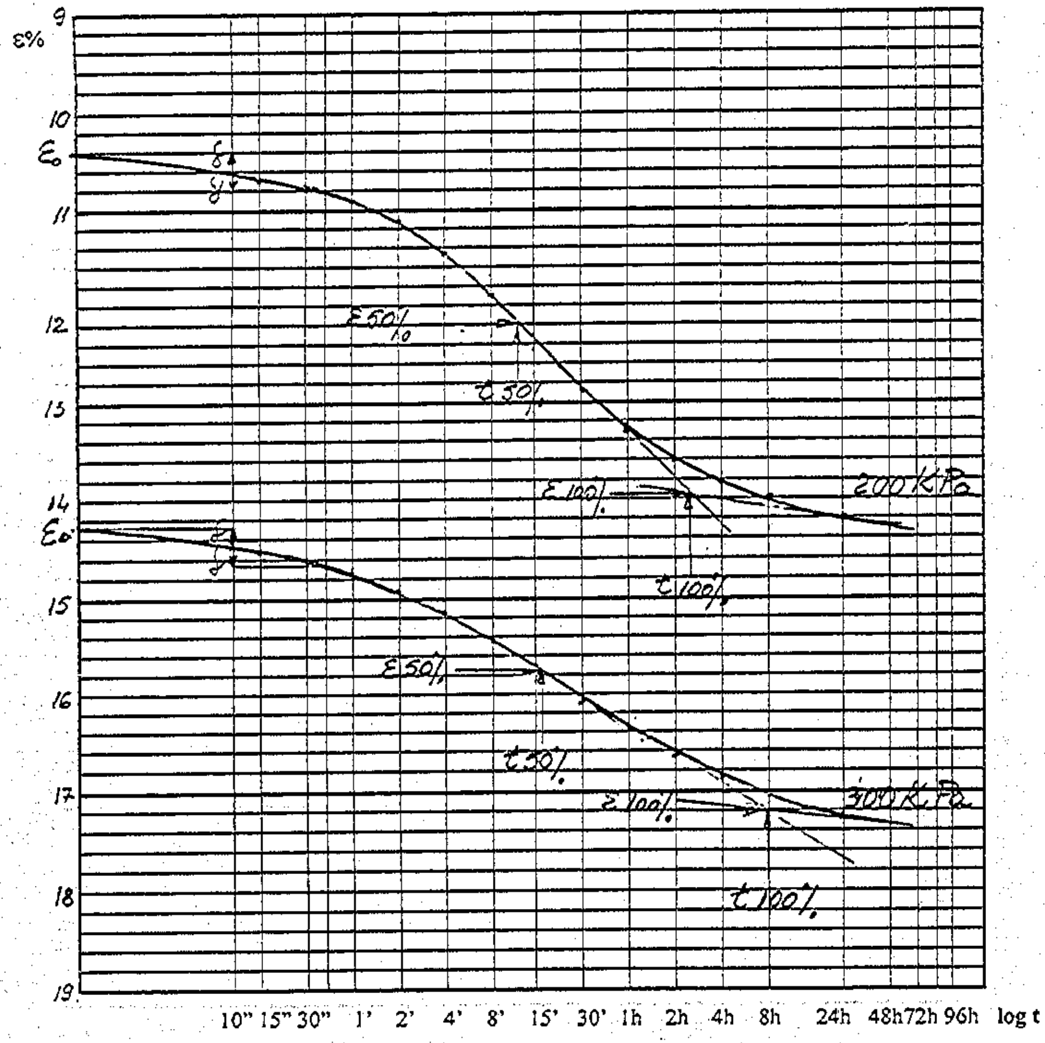
σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm^2/s	c_α	K Cm/s
400	2018	0.8131	$0.6 \cdot 10^{-4}$	0.0029	$0.8 \cdot 10^{-7}$

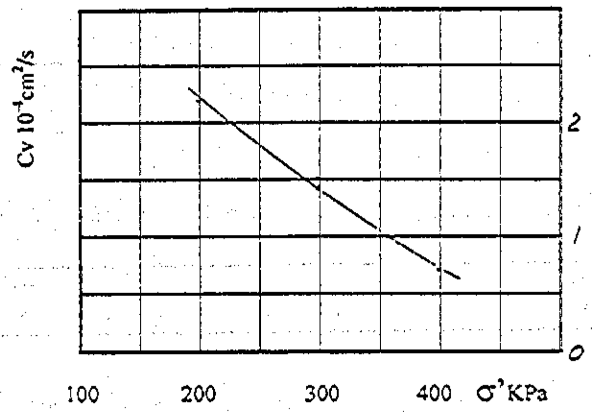
Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI

EDOMETRIC CONSOLIDATION CURBE

Comanda: Wastewater treatment
Working place: Galati
Drilling : F6/8"
Depth : 5,00 m.
Date: August 1999

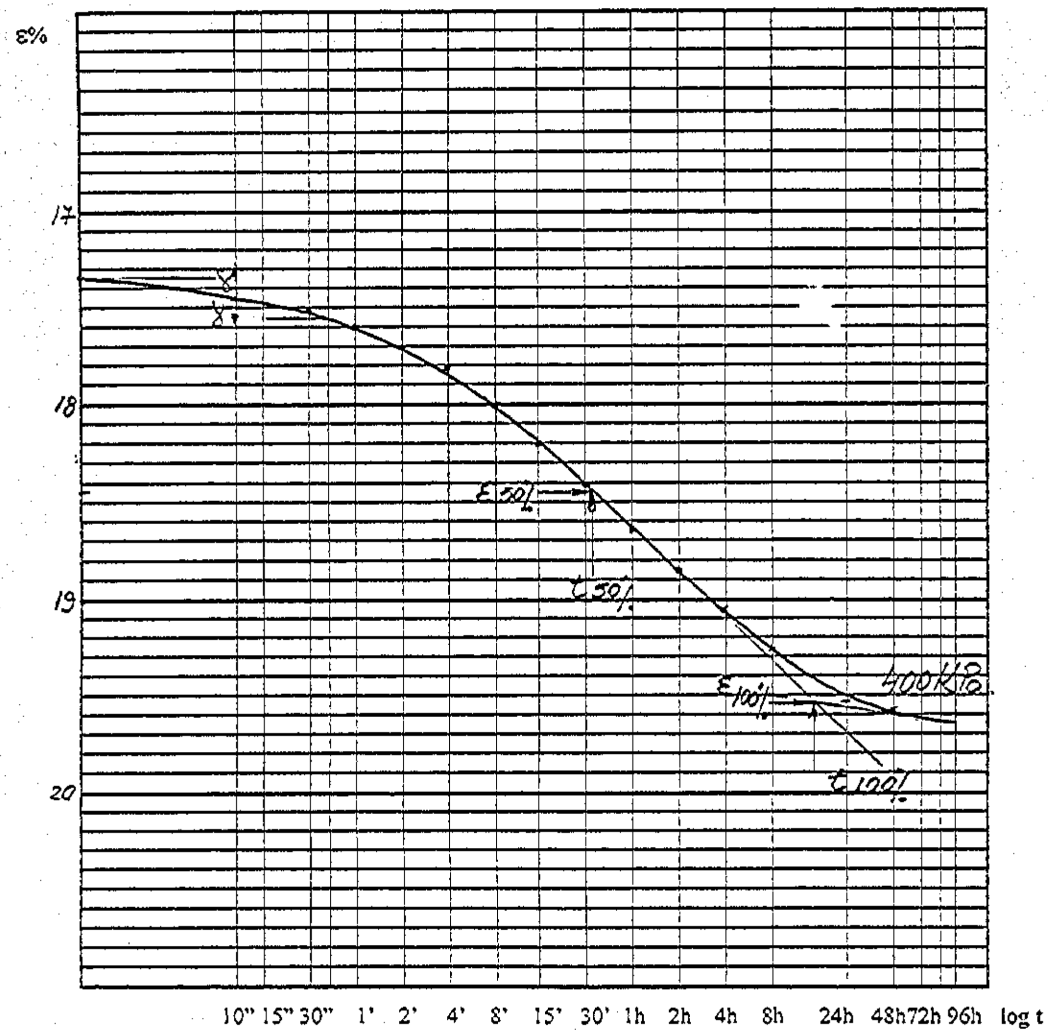




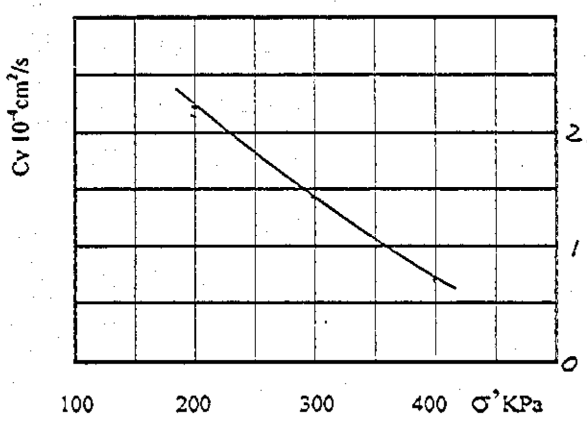
σ' KPa	t_{50}% sec	H_{50}% cm	c_v Cm²/s	c_α	K Cm/s
200	690	0,878	$2.2\cdot10^{-4}$	0,0030	$3.5\cdot10^{-7}$
300	971	0.8425	$1.44\cdot10^{-4}$	0.0015	$2.8\cdot10^{-7}$

Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

SETA SA BUCURESTI — EDOMETRIC CONSOLIDATION CURBE



Comanda: Wastewater treatment
Working place: Galati
Drilling : F6/8"
Depth : 5.00m.
Date: August 1999



σ' KPa	$t_{50\%}$ sec	$H_{50\%}$ cm	c_v Cm^2/s	c_α	K Cm/s
400	1922.6	0.8156	$0.68 \cdot 10^{-4}$	0.0017.	$1.8 \cdot 10^{-7}$

Elaboration: Eng. Ana Stefanescu
Verification: Eng. Titi Gheorghita

PART AII-3: FEASIBILITY STUDY FOR BRAILA WWTP PROJECT

APPENDIX-1

PLANNING BASIS FOR BRAILA WWTP

1. PROCESS TO DETERMINE THE DESIGN BASIS

The following design basis for the Braila WWTP is reviewed and updated:

- Population

  Total Administrative Population

  Service Population of Public Water Supply and Sewerage Systems

- Design Flow

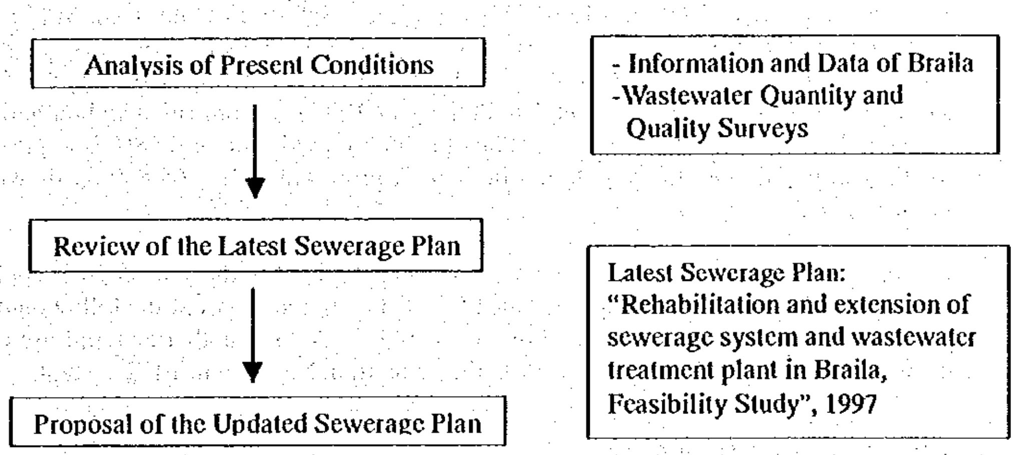
Wastewater Generation, Average Daily Flow, Maximum Daily Flow, Maximum Hourly Flow, and Wet Weather Flow

- Wastewater Characteristics

  Wastewater Pollutant Loads

  Design Influent Quality for the WWTP

Under the following process shown in the following figure, the design basis is reviewed and updated. First, the present situations are analyzed based on the data and information provided by the Braila city, the public water company "RA APTERCOL Braila", and related organizations. Results of wastewater quantity and quality surveys are also used to understand the present conditions of wastewater generation and pollutant loads. Second, the design basis proposed in the latest sewerage plan will be reviewed. The latest plan is "Rehabilitation and extension of sewerage system and wastewater treatment plant in Braila, Feasibility Study", prepared by RA PRODOMUS Design Institute Braila in 1997, hereinafter referred to as "the 1997 F/S". Finally, the design basis for this F/S is updated and proposed.



Process to Update The Design Basis

2. POPULATION

2.1 ADMINISTRATIVE POPULATION

The administrative population of Braila city is 234,763 in 1998, based on the data available from the bureau of statistics in Braila. *Figure AII.1.1* shows the population data from 1985 to 1998 obtained from the bureau of statistics. It indicates that there are two growth patterns before and after the year of 1992. Before 1992, the population was increased with high annual growth rate of 1.04%, but after 1992, the population was once decreased about 15,500 in 1992 (because workers at factories left the city and returned to their home land when their premises (lands) were returned to their original owner from the government), and since 1992 the population has been nearly constant about 235,000.

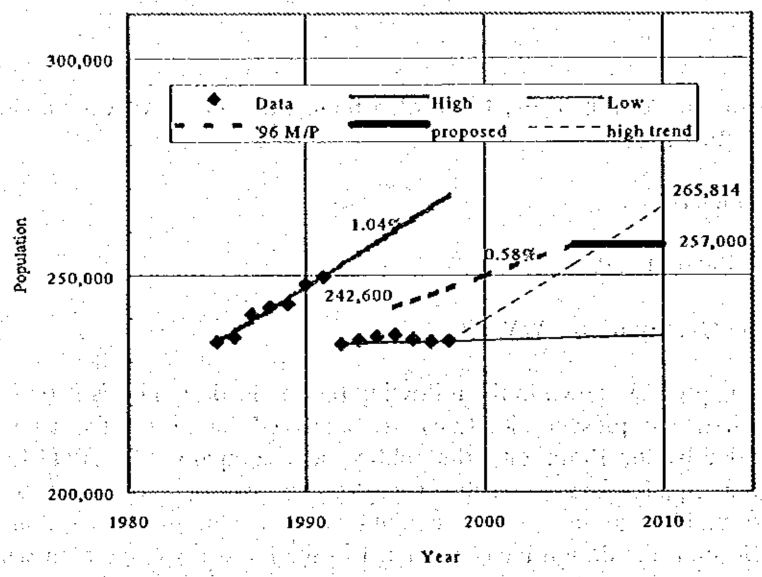


Figure AII.1.1 Population Projection for Braila City

According to a study on population projection for the Master Plan of General Urban Planning prepared in 1996 by PRODOMUS (hereafter referred as "the 1996 M/P"), the future population was projected 257,000 in the year 2005. This projection is based on the population data of 242,600 in the year 1995, with the annual growth rate of 0.58% from 1995 to 2005. The population data in the year 1995 was confirmed and authorized by the police department in Braila. When the high growth rate of 0.58% is applied to the present population, the population in 2010 is projected to be 265,800 as shown in *Figure AII.1.1*.

It is proposed that the administrative population of 257,000 in the year 2010 is applied the same as that in 2005 projected for the 96 M/P, taking into account the following two points. First, the projected population of 257,000 in 2005 is authorized and used for the urban planning. Second, since 1992 the population has been nearly constant.

2.2 SERVICE POPULATION

The water company "RA APTERCOL" provides the water supply and sewerage services. *Table AII.1.1* shows the present water supply conditions based on the recent three months records. The number of service population is based on the registered number of the users union. Because the number of service population, category 4, whose water measured by individual meters is not identified, the number is estimated as follows.

The recent three months data of the water supplied through 2,337 meters is 583 m^3/d, the water volume per unit meter is 250 L/unit/day. When the per capita water consumption is assumed 200 lpcd, the service population can be estimated about 3,000. Thus, the total service population is estimated about 204,200. Since all citizens has an access to the water supply system, i.e. the service population shall be 234,763, about 30,600 of population is not included in the table.

Table AII.1.1 Registered Service Population of the Public Water Supply

Category (Norm)	Per Capita Water Consump -tion (lcd)	Present Water Supply Service Population*(as of 1998)			***Metered Water Supplied Volume (m^3/d)	Estimated Unit Water Consumption
		Metered	Non-metered	Total		
1	65	-	13,362	13,362	-	-
2	110	-	37,051	37,051	-	-
3	170	-	4,072	4,072	-	-
4	295	(**3,000)	27	(3,027)	583	250 L/unit/d
5	380	146,693	-	146,693	40,556	277 lcd
		(149,693)	54,512	(204,205)		

Note: * indicates the data is based on the registered number of users
** shows the estimated value based on the assumption that the per capita water consumption is 200 lpcd. The water volume of 583 m3/d delivered through 2,337 meters is divided the per capita consumption of 200 lpcd.
*** shows the water volume metered recent three months, data source: RA APTERCOL

Table AII.1.2 shows a summary of the planned service population of water supply and sewerage systems. In the 1997 F/S, the service population for each category of water supply is not considered but only the total administrative population in the year 2050 is taken into account. The service population in the year 2010, proposed for the design basis for the Braila WWTP under this JICA Study, is based on the present service population estimated for futher study on the 1996 M/P. All the population of categories 3, 4, and 5 does not have access to the public sewer networks. The present sewerage service population is estimated by ratios of the area of sewered to the total area. The detailed calculation is shown in *Table AII.1.3*.

Table AII.1.2 Estimated Service Population based on a further study for the 1996 M/P

Category (Norm)	Per Capita Water Consump-tion (lcd)	Present Service Population* as of 1998		Service Population in the year 2050 (1997 F/S)	Service Populationin the year 2010 (Proposed)
		Water Supply	Sewerage		
1	65	7,533	-	-	
2	110	27,963	-	-	
3	170	7,152	**3,480	-	Table AII.1.4
4	295	42,197	**41,750	-	Table AII.1.4
5	380	149,918	**149,020	-	Table AII.1.4
Total		234,763	**194,250	275,000	Table AII.1.4
Administrative pop.		234,763		275,000	257,000

Note: * data is based on the General Urban Planning, "Plan de urbanism general (PUG)
** ** shows the estimated values based on the area ratio of sewered area to total area. Please refer to Table AII.1.3 in detail.

We propose three scenarios for the sewerage service development, taking into account of the present status of sewer networks development:

Scenario A-1: No expansion of the present sewer networks in the urban area, but expansion to sub-urban (peri-urban) area, this is the plan based on the urban planning.

Scenario A-2: Expansion of sewer networks in the urban area and the sub-urban (peri-urban) area, by which the sewerage services are provided to all users of category 3, 4, and 5.

Scenario B : Expansion of water distribution networks and sewer networks to improve the services to all category users.

The proposed service population for each scenario is shown in *Table AII.1.4*, for comparison the present sewerage service population is also presented.

Table AII.1.4 Proposed Sewerage Service Population in 2010

Category (Norm)	Per Capita Water Consumption (lpcd)	Present Service Population* (as of 1998)		Sewerage Service Population in the year 2010 (Proposed)		
		Water Supply	Sewerage	Scenario A-1	Scenario A-2	Scenario B
1	65	7,533	-	-	-	-
2	110	27,963	-	-	-	-
3	170	7,152	**3,480	3,600	7,200	31,500
4	295	42,197	**41,750	64,400	64,400	64,400
5	380	149,918	**149,020	150,000	150,000	150,000
Total		234,763	**194,250	218,000	221,600	245,900
Administrative Pop.		234,763		257,000		

Note: * data is based on the General Urban Planning, "Plan de urbanism general (PUG)

3. DESIGN FLOW

3.1 INTRODUCTION

The sewerage system of the Braila city is combined, thus the collectors installed in the city convey both wastewater and storm-water and finally discharge to the Danube River. The wastewater shall be intercepted and conveyed by interceptors and finally treated at a wastewater treatment plant.

To make a design of the required interceptors and wastewater treatment plant, it is necessary to determine the wastewater flows at dry weather conditions and the intercepted flows at wet weather conditions. The intercepted flow is generally a few times as large as the maximum hourly flow at dry weather conditions. In Romanian practice, two times as large as the maximum hourly flow at dry weather conditions is used to determined the intercepted flow. Thus, in the following discussion, the dry weather flows are studied and determined.

As the design wastewater flows at dry weather conditions, the following flows shall be determined: Average Daily Flow, Maximum Daily Flow, and Maximum Hourly Flow.

The Average Daily Flow will be used as the basis for the estimation of pollutant loads, sludge volume generation, and O/M requirements etc. The Maximum Daily Flow will be used for the design of wastewater treatment units. The Maximum Hourly Flow will be used for the design of interceptors and pipes and channels in wastewater treatment plant.

In order to estimate the present wastewater generation and to determine the design flows for necessary interceptors, pumping stations and wastewater treatment plant, the following Romanian Standards are used in principle, STAS 1343 (Water Supply – Determination of water supply volumes) and STAS 1846-90 (Sewerage – Calculation of the wastewater flow). Because the standard methods are judged to be appropriate for a planning purpose. Regarding a per capita water consumption is reviewed in the following section briefly.

3.2 Design Flows in the 1997 F/S

In the 1997 F/S, the design flow is determined on the basis of the water production of the public water supply system as follows:

The production capacity of maximum hourly flow: 2,000 L/s.

The production capacity of maximum daily flow: 1,800 L/s (=2,000 / 1.1)

The wastewater generation of maximum daily flow : 1,500 L/s (=1,800 x 0.8)

The wastewater generation of maximum hourly flow: 1,650 L/s (=1,500 x 1.1)

The intercepted wastewater flow at wet weather conditions: 3,300 L/s (=2 x 1,650)

Based on the information above, it is not easy to evaluate the design flow is appropriate, in other words, the scale of scheme.

3.3 Domestic, Commercial and Institutional Wastewater

3.3.1 Wastewater Generation

Table AII.1.5 shows a summary of the estimated present domestic, commercial and institutional wastewater generation using the data of General Urban Planning. The consumers of categories 3, 4, and 5 have access to the public sewerage system. The total wastewater generation is estimated about 71,700 m^3/d, and the amount of 61,900 m^3/d is collected by the public sewerage system, i.e. about 86% of the wastewater generated are collected by the existing sewerage system. The wastewater generation is calculated as 80% of water demand at water source (intake volume). *Table AII.1.5* also shows that the ratio of water consumption to wastewater generation is about 100 : 97.

Table AII.1.5 Present Wastewater Generation except Industrial Wastewater (Estimated)

Category (Norm)	Per Capita Water Consumption (lpcd)	Present Service Population (Table AII.1.2)	Present Sewerage Service Population (Table AII.1.2)	Water Consumption (m^3/d)	Water Demand at Source ** (m^3/d)	Wastewater Generation *** (m^3/d)	Wastewater Collected (m^3/d)
1	65	7,533	-	490	592	474	-
2	110	27,963	-	3,076	3,716	2,973	-
3*)	170	7,152	3,480	1,216	1,469	1,175	571
4*)	295	42,197	41,750	12,448	15,037	12,030	11,903
5*)	380	149,918	149,020	56,969	68,819	55,055	49,351
Total		234,763	194,250	74,199	89,633	71,707	61,825

Note: * : the category includes sewerage services
** : Water Demand at Source = Kp x Ks x Water Consumption, where, Ks=1.05, Kp=1.15, Kp x Ks=1.208
*** : Wastewater Generation = Kw x Water Demand at Source, where Kw=0.8

Table AII.1.6 shows the present water supply conditions based on the estimation of RA APTERCOL. Totally 92,000 m^3/d of water is supplied to the consumers through the distribution networks. The domestic water demand estimated in *Table AII.1.5* is satisfied with the present production.

Table AII.1.6 Present Water Supply Conditions as of 1998

	Yearly (m^3/year)	Daily (m^3/d)	Remarks
Water Intake Volume			
Surface Water	43,105,495	118,100	
Groundwater	9,917,444	27,200	
Total	53,022,939	145,300	89,700(Table AII.1.5)
Water Treatment Loss	7,953,441	21,800	
Water to the Distribution Network	45,069,498	123,500	
Unaccounted-for Water	11,546,666	31,700	
Accounted-for Water	33,522,832	91,800	74,200(Table AII.1.5)

Data Source: RA APTERCOL

The Per capita water consumption for domestic, commercial and institutional purposes in the standards is reviewed briefly in the followings:

The per capita water consumption for each category already contains domestic, commercial and institutional water consumption as shown in *Table AII.1.7*. The domestic water consumption rate is reasonable for the design basis, taking into account the living standard and easy access to the surface water source, the Danube River. A ratio of commercial and institutional water consumption to domestic water consumption is set about 21% to 40% for consumers of house connections. The ratios are appropriate for the level of urban development of the city. The standards also give some allowance to add some commercial and institutional water consumption up to 15 or 25% depending on local conditions and population size of municipalities.

Table AII.1.7 Per Capita Consumption of Domestic, Public and Commercial Water (STAS 1343)

Category No.	Classification	Domestic Consumption q_s (lcd)	Public and Commercial Consumption q_p (lcd)	Total q (lcd)	q_p to q_s Ratio
1	Water distributed through street taps	40	25	65	0.625
2	Water distributed through yard taps	80	30	110	0.375
3	Houses with plumbing and sewer pipes	140	30	170	0.214
4	Houses with plumbing and sewers, with in-house water heating system	210	85	295	0.405
5	Houses with plumbing and sewers, with provisions of central water heating	280	100	380	0.357

Note: The value of q_p can be increased depending local conditions, but not exceeds the followings by the size of the city;

- up to 15% for cities ranging in population from 300,000 to 1,000,000

- up to 25% for cities having the population more than 1,000,000

3.3.2 WASTEWATER TO BE COLLECTED BY SEWERAGE SYSTEM

Table AII.1.8 shows the average flows of domestic, commercial and institutional wastewaters to be generated and to be collected by the public sewerage system in the year 2010.

Table AII.1.8 Average Daily Flow of Wastewater in the year 2010 (Scenario A-1)

Category (Norm)	Per Capita Water Demand (lpcd)	Generation Service Population	Generation Average Flow (m^3/d)	Sewerage Service Population	Sewerage Average Flow (m^3/d)	Sewerage Service Population Coverage
1	65	7,500	472	0	0	
2	110	27,900	2,966	0	0	
3	170	7,200	1,183	3,600	591	50%
4	295	64,400	18,360	64,400	18,360	100%
5	380	150,000	55,085	150,000	55,085	100%
Total		257,000	78,066	218,000	74,036	85%

Note: To estimate the wastewater generation, the following coefficient is used:
Water Demand at Source = Kp x Ks x Water Consumption, where, Ks=1.05, Kp=1.15, Kp x Ks=1.208
Wastewater Generation = Kw x Water Demand at Source, where Kw=0.8

Table AII.1.8 (continued) Average Daily Flow of Wastewater in the year 2010 (Scenario A-2)

Category (Norm)	Per Capita Water Demand (lpcd)	Generation		Sewerage		Sewerage Service Population Coverage
		Service Population	Average Flow (m^3/d)	Service Population	Average Flow (m^3/d)	
1	65	7,500	472	0	0	
2	110	27,900	2,966	0	0	
3	170	7,200	1,183	7,200	1,183	100%
4	295	64,400	18,360	64,400	18,360	100%
5	380	150,000	55,085	150,000	55,085	100%
Total		257,000	78,066	221,600	74,628	86%

Table AII.1.8 (continued) Average Daily Flow of Wastewater in the year 2010 (Scenario B)

Category (Norm)	Per Capita Water Demand (lpcd)	Generation		Sewerage		Sewerage Service Population Coverage
		Service Population	Average Flow (m^3/d)	Service Population	Average Flow (m^3/d)	
1	65	3,000	189	0	0	
2	110	8,100	861	0	0	
3	170	31,500	5,175	31,500	5,175	100%
4	295	64,400	18,360	64,400	18,360	100%
5	380	150,000	55,085	150,000	55,085	100%
Total		257,000	79,670	245,900	78,620	96%

Maximum Daily Flow and Maximum Hourly Flow of the domestic, commercial and institutional wastewaters are calculated with using the coefficients set forth in the Romanian Standard (STAS 1343/1) as follows. The results of calculation are summarized in *Table AII.1.9.*

Table AII.1.9 Design Flows for the Domestic, Commercial and Institutional Wastewater, Scenario A-1

Wastewater Flow	Design Flow : JICA Study		Coefficient	Remarks
	(m^3/d)	(L/s)	STAS 1343/1	
Average Daily Flow	74,036 => 74,100	860	-	
Maximum Daily Flow	82,418 => 82,500	950	1.10* to 1.20*	
Maximum Hourly Flow	94,779 => 94,800	1,100	1.15	

Note: * indicates that the coefficient for each category 3, 4, and 5 is 1.20, 1.15 and 1.10, respectively.

Table AII.1.9 Design Flows for the Domestic, Commercial and Institutional Wastewater, Scenario A-2 (continued)

Wastewater Flow	Design Flow : JICA Study		Coefficient	
	(m³/d)	(L/s)	STAS 1343/1	
Average Daily Flow	74,628 => 74,700	870	-	
Maximum Daily Flow	83,128 => 83,200	960	1.10* to 1.20*	
Maximum Hourly Flow	95,595 => 95,600	1,110	1.15	

Note: * indicates that the coefficient for each categories 3, 4, and 5 is 1.20, 1.15 and 1.10, respectively.

Table AII.1.9 Design Flows for the Domestic, Commercial and Institutional Wastewater, Scenario B

Wastewater Flow	Design Flow : JICA Study		Coefficient	Remarks
	(m³/d)	(L/s)	STAS 1343/1	
Average Daily Flow	78,620 => 78,700	910	-	
Maximum Daily Flow	87,918 => 88,000	1,020	1.10* to 1.20*	
Maximum Hourly Flow	101,105 => 101,100	1,170	1.15	

Note: * indicates that the coefficient for each categories 3, 4, and 5 is 1.20, 1.15 and 1.10, respectively.

3.4 INDUSTRIAL WASTEWATER

3.4.1 PRESENT CONDITIONS

According to information provided by the Braila City, the industrial wastewater from major industries is about 16,000 m³/d as shown in *Table AII.1.10.* These industrial wastewaters are independently pre-treated at the sources to the degrees acceptable to the public sewers or directly disposed off to the nearby drains, ponds, or rivers.

Table AII.1.10 Industrial Wastewater Discharging from Major Industries

Industry	Daily Discharge (m³/d)	Remarks
Slaughter House	443	
Brewery	2,680	
Wood Industry	4,050	
Metal Industry	3,750	
Shipbuilding Industry	1,250	
Engineering	3,835	
Total	16,008	

Note) data source: Braila City

A questionnaire survey for major manufactures and companies is conducted by JICA

Study Team with the assistance of RA APTERCOL. About 12 companies replied to the questionnaire and the results are summarized in *Table AII.1.11*. It shows that the total industrial wastewater is 11,800 m³/d, in which the amount of 5,200 m³/d is discharged through the public sewers, and the remained 6,600 m³/d is discharged to the Danube River directly.

3.4.2 Wastewater to be Received by the Sewerage System

As it is shown in *Table AII.1.10* and *Table AII.1.11*, the present amount of industrial wastewater discharging from major industries is about 12,000 to 16,000 m³/d.

To determine the amount of industrial wastewater to be received by the public sewerage system, the following assumptions are taken into consideration.

First, the present industrial wastewater is about 16,000 m³/d. Second, the industrial wastewater discharging from the listed factories shown in Table 11 is defined as the point source origin. The point source wastewater of 12,000 m³/d is received and treated by the public sewerage system. Third, the remained 4,000 m³/d of industrial wastewater is defined as the non-point source origin, mainly discharging from small factories. Fourth, the future amount of industrial wastewater to be received by public sewerage system becomes 30% higher than the present one. These are summarized in *Table AII.1.12*.

Table AII.1.12 Design Average Daily Flow of Industrial Wastewater

unit: m³/d

Industrial Wastewater	Present (1998)	Proposed for the year 2010	Remarks
Point Source	12,000	16,000	1.3 times higher than the present one
Non-point Source	4,000	5,000	1.3 times higher than the present one
Total	16,000	21,000	1.3 times higher than the present one

The following flow variation coefficients are proposed, taking into account the scale of the manufactures and companies.

Table AII.1.13 Flow Variation Coefficients Set For Industrial Wastewater

Industrial Wastewater source	Average Daily	Maximum Daily	Maximum Hourly	Remarks
Point Source	0.75	1.00	1.25	Medium to small scale
Non-point Source	0.67	1.00	2.00	Small scale

The design flows of maximum daily and maximum hourly flows are calculated using the above flow variation coefficients and the results are summarized in the table below.

Table AII.1.14 Summary of Design Flow of Industrial Wastewater

Industrial Wastewater	Ave. Daily (m^3/d)	Max. Daily (m^3/d)	Max. Hourly (m^3/d)	Remarks
Point Source	16,000	21,300	26,600	0.75:1.00:1.25
Non-point Source	5,000	7,500	15,000	0.67:1.00:2.00
Total	21,000	28,800	41,600	

3.5 GROUNDWATER INFILTRATION

The most of urban area of the city has been developed in hilly area, the groundwater infiltration may be negligible small. Based on the information of the length of existing sewers installed under the groundwater table, the amount of groundwater infiltration is estimated about 2,250 m^3/d as follows:

- Total length of sewers installed: 227 km
- Unit groundwater infiltration: 0.5 to 1.0 L/s/km of sewers installed (Romanian Standards)
- Length of sewers installed under the groundwater table: 26 km
- Groundwater Infiltration: 26 km x 1.0 L/s/km = 26 L/s => 2,250 m^3/d

Therefore, the groundwater infiltration of 2,300 m^3/d is applied for the sewerage plan.

3.6 SUMMARY OF DESIGN WASTEWATER FLOW

In summary, the design flows of domestic, commercial, institutional and industrial wastewater is combined and summarized in the table below. The figure of each category of wastewater is rounded at thousands.

Table AII.1.15 Summary of the Design Flow, Scenario A-1

unit: m^3/d

Wastewater	Average Daily	Maximum Daily	Maximum Hourly	Wet Weather	Remarks
Domestic, commercial and Institutional Wastes	74,100 => **74,000**	82,500 => **83,000**	94,800 => **95,000**		
Industrial Wastes Point Source Non-point Source Sub-total	 16,000 5,000 21,000 => **21,000**	 21,300 7,500 28,800 => **29,000**	 26,600 15,000 41,600 => **42,000**		
Groundwater Infiltration	2,300 => **2,000**	2,300 => **2,000**	2,300 => **2,000**		
Total	97,400 => **97,000**	113,600 => **114,000**	138,700 => **139,000**	277,400 => **278,000**	

Table AII.1.15 (continued) Summary of the Design Flow, Scenario A-2

unit: m³/d

Wastewater	Average Daily	Maximum Daily	Maximum Hourly	Wet Weather	Remarks
Domestic, commercial and Institutional Wastes	74,700 => 75,000	83,200 => 84,000	95,600 => 96,000		
Industrial Wastes Point Source Non-point Source Sub-total	 16,000 5,000 21,000 => 21,000	 21,300 7,500 28,800 => 29,000	 26,600 15,000 41,600 => 42,000		
Groundwater Infiltration	2,300 => 2,000	2,300 => 2,000	2,300 => 2,000		
Total	98,000 => 98,000	114,300 => 115,000	139,500 => 140,000	279,000 => 280,000	

Table AII.1.15 (continued) Summary of the Design Flow, Scenario B

unit: m³/d

Wastewater	Average Daily	Maximum Daily	Maximum Hourly	Wet Weather	Remarks
Domestic, commercial and Institutional Wastes	78,700 => 79,000	88,000 => 88,000	101,100 => 111,000		
Industrial Wastes Point Source Non-point Source Sub-total	 16,000 5,000 21,000 => 21,000	 21,300 7,500 28,800 => 29,000	 26,600 15,000 41,600 => 42,000		
Groundwater Infiltration	2,300 => 2,000	2,300 => 2,000	2,300 => 2,000		
Total	102,000 => 102,000	119,100 => 119,000	145,000 => 145,000	290,000 => 290,000	

3.7 Proposed Design Flows for Braila WWTP

It is proposed that the following design flows are to be applied for the F/S study on the Braila WWTP.

Table AII.1.16 Summary of the Design Flow, Scenario A-2

unit: m^3/d

Wastewater	Average Daily	Maximum Daily	Maximum Hourly	Wet Weather	Remarks
Domestic, commercial and Institutional Wastes	74,700 => **75,000**	83,200 => **84,000**	95,600 => **96,000**		
Industrial Wastes Point Source Non-point Source Sub-total	 16,000 5,000 21,000 => **21,000**	 21,300 7,500 28,800 => **29,000**	 26,600 15,000 41,600 => **42,000**		
Groundwater Infiltration	2,300 => **2,000**	2,300 => **2,000**	2,300 => **2,000**		
Total	98,000 => **98,000**	114,300 => **115,000**	139,500 => **140,000**	279,000 => **280,000**	

Table AII.1.17 shows the design flows proposed for JICA Study to compare with the one in 1997 F/S.

It shows that the maximum hourly flow and the wet weather flow proposed are approximately equal to the flows proposed in 1997 F/S.

Table AII.1.17 Comparison of Design Flows

Design Flows	This Study (m^3/d)	This Study (L/s)	1997 F/S (m^3/d)	1997 F/S (L/s)	Remarks
Average Daily	98,000	1,135	-	N.A.	
Maximum Daily	115,000	1,330	(129,600)	1,500	11% reduced
Maximum Hourly	140,000	1,620	(142,560)	1,650	
Wet Weather	280,000	3,240	(285,120)	3,300	

Note: The design flows proposed in the 1997 F/S are expressed as Liter per second (L/s).

4. WASTEWATER CHARACTERISTICS

4.1 Present Wastewater Characteristics

Table AII.1.18 shows the average monthly wastewater quality monitored at each collector. The concentration of BOD_5 and SS ranges from 31 to 162 mg/L and 53 to 408 mg/L, respectively.

Table AII.1.18 Monthly Average Quality of Wastewater in Major Outfalls (1996 to 98)

ID No.	Name of Collector	BOD_5 (mg/L)	SS (mg/L)	Remarks
1	Braila Sud	38 to 158	53 to 276	
2	Germany	31 to 135	139 to 408	
3	Cezar Petrescu	38 to 162	107 to 257	
4	Targoviste	38 to 137	119 to 295	

Note: Data was obtained from Braila City (or RA APTERCOL)

A wastewater quality survey was conducted by JICA Study Team during February to March in 1999. The samples were taken at two sites: one is a manhole at Buzau street and another one is the outfall of Germany. The resulted four water quality parameters: BOD_5, SS, T-N, and T-P are presented in *Table AII.1.19* and *Figures AII.1.2 and AII.1.3*. Those concentrations are varied as shown in the figures, a weighed average concentration for each parameter was calculated and presented in *Table AII.1.19*. The BOD_5 concentration has the same magnitude as those in *Table AII.1.18*.

Table AII.1.19 Results of Wastewater Quality Surveys (24 hours, one sample every 3 hours)

Parameters	Manhole at Buzau st. Range	Manhole at Buzau st. Weighted Average	Germany Range	Germany Weighted Average	Remarks
BOD_5 conc. (mg/L)	30 - 147	94	25 - 98	68	*31 to 162
SS conc. (mg/L)	45 - 126	94	23 - 85	62	*53 to 408
T-N conc. (mg/L)	8.8 - 20.3	15.4	11.9 - 22.4	17.4	
T-P conc. (mg/L)	0.52 - 2.44	1.64	0.50 - 3.79	2.06	

Note: * the average concentration of BOD_5 and SS shown in *Table 18* is presented.

The pollutant loads discharged to the Danube were estimated and summarized in *Table AII.1.20*.

Table AII.1.20 Estimated Pollutant Loads based on Wastewater Quantity and Quality Surveys

Sampling Location	Average Flow (m^3/d)	Weighted Average Concentration (mg/L)				Pollutant Loads (kg/d)				Remarks
		BOD_5	SS	T-N	T-P	BOD_5	SS	T-N	T-P	
The manhole	2,664	94	94	15.4	1.64	250	250	41.0	4.37	
Germany	52,008	68	62	17.4	2.06	3,537	3,224	904.9	107.1	

Because residential area is the predominant in the service area of the sewer of manhole at Buzau street and any factories are not identified in the area, the samples are typical examples of domestic wastewater. While in the service area of Germany, there are flats, offices, restaurants, factories, thus the wastewater is a mixture of domestic, commercial, institutional and industrial wastewater. Therefore, the wastewater measured at the manhole at Buzau street is domestic origin, the measured flow rate and calculated pollutant loads are used to calculate the per capita wastewater generation and unit pollutant loads. The results are summarized in *Table AII.1.21.* The per capita wastewater generation is 266 L/capita/day (lpcd). According to the norm (Romanian Standards, STAS 1343, referred to *Table AII.1.7*), the domestic water consumption is 280 lpcd from the users of the category 5, mostly living in flats, the estimated per capita wastewater generation is the same level as the norm. The unit pollutant loads are 25 g/capita/d as of BOD_5 , 25g/capita/d as of SS, 4.1g/capita/d as of T-N and 0.44g/capita/d as T-P.

Table AII.1.21 Estimated Per Capita Unit Loads and Generation Rate of Domestic Wastewater

	Manhole at Buzau street	Remarks
Average Flow (m^3/d)	2,664	
Service Population *	10,000	
Per Capita Wastewater Generation (lcd)	266	
Loads (kg/d)		
BOD_5	250	
SS	250	
Total Nitrogen (T-N)	41.0	
Total Phosphorus (T-P)	4.37	
Per Capita Unit Loads (g/capita/d)		
BOD_5	25	
SS	25	
Total Nitrogen (T-N)	4.1	
Total Phosphorus (T-P)	0.44	

Note: * shows that the service population is based on the information provided by RA APTERCOL

4.1.2 INDUSTRIAL WASTEWATER

Table AII.1.22 shows industrial wastewater characteristics measured for 12 manufacturers and companies in 1998. The quality data of BOD_5 and SS were mainly obtained from RA APTERCOL, combined with the information obtained through a questionnaire survey conducted by JICA Study Team with cooperation of RA APTERCOL.

Based on the information of flow and quality (pollutant loads), the overall average concentration of BOD_5 and SS is about 105 and 480 mg/L, respectively.

4.2 DESIGN INFLUENT QUALITY

4.2.1 INTRODUCTION

Design wastewater quality is used as the basis for evaluation of effects of wastewater treatment as well as for making design of wastewater treatment facilities. As for the design wastewater quality, influent quality and treated quality shall be determined. The latter quality, treated water quality is regulated by the Romanian Effluent Standards, as shown in *Table AII.1.23.* The detailed discussion on the treated wastewater quality for the design will be conducted in later opportunities when we will discuss wastewater treatment methods and propose an appropriate wastewater treatment method.

Table AII.1.23 Major Effluent Quality Standards to Public Receiving Water Bodies.

No.	Quality Parameters	Units	Max. Admissible	Methods of Analysis
A. Physical Parameters				
1.	Temperature	°C	30°C	-
B. Chemical Parameters				
2.	Hydrogen ion concentration (pH) For Danube River	Unit pH	6.5 – 8.5 6.5 – 9.0	STAS 8619/3-90
3.	Total Suspended Solids	mg/dm^3	60.0	STAS 6953-81
4.	Biochemical Oxygen Demand (BOD_5)	mg/dm^3	20.0	STAS 6560-82
5.	Chemical Oxygen Demand (COD-Mn)	mg/dm^3	40.0	STAS 9887-74
6.	Chemical Oxygen Demand (COD-Cr)	mg/dm^3	70.0	STAS 6954-82
7.	Ammonium Nitrogen (NH_4^+-N)	mg/dm^3	2.0	STAS 8683-70
8.	Total Nitrogen (N)	mg/dm^3	10.0	STAS 7312-83
9.	Nitrates (NO_3^-)	mg/dm^3	25.0	STAS 8900/1-71
10.	Nitrites (NO_2^-)	mg/dm^3	1.0	STAS 8900/2-71
11.	Sulfides (as H_2S)	mg/dm^3	0.1	STAS 7510-66
12.	Sulphites (SO_3^{2-})	mg/dm^3	1.0	STAS 7661-89
13.	Phenols (C_6H_5OH)	mg/dm^3	0.05	STAS 7167-92
14.	Oil and Fats	mg/dm^3	5.0	STAS 7587-66
16.	Phosphates (PO_4^{3-})	mg/dm^3	4.0	STAS 10064-75
17.	Total phosphorus (P)	mg/dm^3	1.0	STAS 10064-75
C. Bacteriological Parameters				
42.	Total coliform (MPN)	Nr/100 cm^3	1 mil	STAS 3001-91
43.	Fecal coliform (MPN)	Nr/100 cm^3	10,000	STAS 3001-91
44.	Fecal streptococci (MPN)	Nr/100 cm^3	5,000	STAS 3001-91

Source: ORDER No. 730/1997, Norms for establishing the limits of pollutants in the wastewater before to be discharged into water resources, NTPA 001/1997

4.2.2 Design Influent Quality in the 1997 F/S

In 1997 F/S, the design influent quality is set at 150 mg/L as of BOD_5 and 250 mg/L as of SS. The quality was determined taken into account the present conditions based on surveys results. Unfortunately, no information available to know how to determine the design influent quality.

4.2.3 Design Influent Quality

In the followings, we will discuss the design influent quality, especially BOD_5, SS, T-N, and T-P. The design figures will be determined take into consideration the present wastewater concentrations, present pollutant loads, and future increments of pollutant loads, and data and information available from some references.

(1) Domestic, Commercial and Institutional Wastewater

The per capita unit loads of domestic wastewater is as follows. But it should be noted that the per capita loads can only be used for domestic wastewater.

Table AII.1.24 Estimated Per Capita Unit Loads

Wastewater Parameter	Per Capita Unit Loads (g/capita/d)	Remarks
BOD_5	25	
SS	25	
Total Nitrogen (T-N)	4.1	
Total Phosphorus (T-P)	0.44	

The resulted per capita loads are used to predict the future wastewater quality as shown in the following *Table AII.1.25*. The table shows an example of the Scenario A-2. In the table, the per capita loads is used for the present domestic wastewater. The per capita unit loads for commercial and institutional wastewater is assumed 30% of the domestic one as the same as the flows. Total per capita units loads are increased from 10% to 50% from the present level.

Table AII.1.25 Estimated BOD_5 and SS Concentration in Domestic, Commercial and Institutional Wastewater based on Per Capita Loads, Scenario A-2

Per Capita Loads (g/capita/d)			Loads**	Influent Quality**	Remarks
Domestic	Commercial and Institutional *	Total	(kg/d)	(mg/L)	
25.0	7.5	32.5	7,202	96	Present Level***
27.5	8.3	35.8	7,933	106	10% increase
30.0	9.0	39.0	8,642	116	20% increase
32.5	9.8	42.3	9,374	125	30% increase
35.0	10.5	45.5	10,083	135	40% increase
37.5	11.3	48.8	10,814	145	50% increase

Note: * : The per capita loads of commercial and institutional wastewater is assumed 30% of that of domestic wastewater
**: The planned service population is 221,600 and the design average flow is 74,700 m^3/d
***: Domestic Per Capita Load is at present level

Taking into consideration the survey results from other cities, the following per capita unit loads is used to estimate the influent quality of domestic, commercial and public wastewater. It is assumed that the increase of the per capita loads is assumed to be about 30% within the target year. The influent quality is calculated as shown in *Table AII.1.26*.

Table AII.1.26 The Design Influent Quality of Domestic, Commercial, and Institutional Wastewater, Scenario A-2

Quality Parameter	Planned Service Population	Per Capita Loads (g/capita/d)	Loads (kg/d)	Design Average Flow (m^3/d)	Influent Quality (mg/L)	Remarks
BOD_5	221,600	44	9,750	74,700	131	
SS		51	11,302		150	
T-N		7.7	1,706		23	
T-P		1.01	224		3.0	

Note: The Domestic wastewater includes commercial and institutional wastewater.

(2) Industrial Wastewater

The listed 12 factories are categorized by their products and the present industrial wastewater discharges by product categories are summarized as shown in *Table 27*.

Table AII.1.27 Present Industrial Wastewater Discharges by Product Category

Category	Present Discharge Flow (m^3/d)	Share (%)	Remarks
Food Processing	3,389	28.8	Meat products, dairy products, Canned fish, Canned vegetable, Fruit etc.
Beverage	873	7.4	Beer
Machinery	4,500	38.2	Construction Machine, Ship building
Metal Products	2,115	17.9	Nail, Steel wire
Furniture	680	5.8	Furniture, matches
Others	231	2.0	Service industries
Total	12,348	100.0	

The share of each category for the target year is assumed to be the same as the present one, the design discharge flow to the sewerage system is set as shown in *Table AII.1.28*. The design discharge flow is calculated by the design flow of 16,000 m^3/d multiplied with the share of each category.

Table AII.1.28 Design Industrial Wastewater Discharge Flow by Categorized Factories

Category	Share (%)	Design Discharge Flow (m^3/d)	Remarks
Food Processing	29.0	4,640	
Beverage	7.0	1,120	
Machinery	38.0	6,080	
Metal Products	18.0	2,880	
Furniture	6.0	960	
Others	2.0	320	
Total	100.0	16,000	Design Average Flow

For the design purpose, the industrial wastewater quality to be discharged by each category is set as shown in *Table AII.1.29.* The quality is set taking into account the present data available, the maximum permissible level set forth in the National Effluent Quality Standards for the Wastewater Discharge to Public Wastewater Systems as shown in *Table AII.1.30,* and some typical values for each category in references.

Table AII.1.29 Design Industrial Wastewater Characteristics Classified by Product Category

Category	Quality Parameters (mg/L)				Remarks
	BOD_5	SS	T-N	T-P	
Food Processing	300	300	40	10	
Beverage	300	300	30	10	
Machinery	100	200	15	3	
Metal Product	80	100	10	5	
Furniture	100	200	20	3	
Others	100	200	5	1	

The maximum permissible concentrations of BOD_5 and SS are set at 300 mg/L as the same as the national effluent quality standards for the wastewater discharge to public wastewater systems as shown in *Table AII.1.30.* However, regarding the concentration of total nitrogen and total phosphorus, the national effluent standards are not applied. Because the national standards do not provide any maximum permissible concentration of total nitrogen but that of ammonium nitrogen of 30 mg/L and provide that of total phosphorus of 5.0 mg/L.

Table AII.1.30 Major Permissible Effluent Quality Standards for the Wastewater Discharged into Public Wastewater Systems

No.	Quality Parameter	Units	Permissible Values	Methods of Analysis
1.	Temperature	°C	40°C	-
2.	Hydrogen ion concentration (pH)	-	6.5 – 8.5	STAS 8619/3-90
3.	Suspended Solids	mg/dm^3	300	STAS 6953-81
4.	BOD_5	mg/dm^3	300	STAS 6560-82
5.	COD-Cr	mg/dm^3	500	STAS 6954-82
6.	Ammonium Nitrogen (NH_4^+-N)	mg/dm^3	30	STAS 8683-70
7.	Total Phosphorus (as P)	mg/dm^3	5.0	STAS 10064-75

Source: Norms regarding the discharge conditions of wastewater into sewerage, NTPA 002/1997

The design loads from the listed 12 companies are estimated as shown in *Table AII.1.31*; the design discharge flows multiplied with the concentrations. The average concentration is estimated, total loads are divided with the total flow: BOD_5 of 168 mg/L, SS of 218 mg/L, T-N of 22 mg/L, and T-P of 5.8 mg/L.

Table AII.1.31 Design Quality of Industrial Wastewater by Categorized Factories

Category	Design Flow (m^3/d)	Concentration (mg/L)		Loads (kg/d)		Remarks
		BOD_5	SS	BOD_5	SS	
Food Processing	4,640	300	300	1,392	1,392	
Beverage	1,120	300	300	336	336	
Machinery	6,080	100	200	608	1,216	
Metal Products	2,880	80	100	230	288	
Furniture	960	100	200	96	192	
Others	320	100	200	32	64	
Total	**16,000**			**2,694**	**3,488**	
Average Concentration (mg/L)		**168**	**218**			

Table AII.1.31 Design Quality of Industrial Wastewater by Categorized Factories (Continued)

Category	Design Flow (m^3/d)	Concentration (mg/L)		Loads (kg/d)		Remarks
		T-N	T-P	T-N	T-P	
Food Processing	4,640	40	10	186	46.4	
Beverage	1,120	30	10	34	11.2	
Machinery	6,080	15	3	91	18.2	
Metal Products	2,880	10	5	29	14.4	
Furniture	960	2	3	2	2.9	
Others	320	5	1	2	0.3	
Total	**16,000**			**344**	**93.4**	
Average Concentration (mg/L)		**22**	**5.8**			

The design quality of overall industrial wastewater is estimated as shown in *Table 32*. In the table, the design quality of industrial wastewater originated from non-point source is assumed to be the same as the domestic, commercial and institutional wastewater, i.e. BOD_5 of 131 mg/L, SS of 150 mg/L, T-N of 23 mg/L, and T-P of 3.0 mg/L. The design quality of overall industrial wastewater is estimated as follows: BOD_5 of 159 mg/L, SS of 201 mg/L, T-N of 22 mg/L, and T-P of 5.0 mg/L.

Table AII.1.32 Design Quality of Industrial Wastewater

Source	Design Flow (m^3/d)	Concentration (mg/L)		Loads (kg/d)		Remarks
		BOD_5	SS	BOD_5	SS	
Point Source	16,000	168	218	2,694	3,488	
No-point Source	5,000	131	150	655	750	
Total	**21,000**			**3,349**	**4,238**	
Average Concentration (mg/L)		**159**	**201**			

Table AII.1.32 Design Quality of Industrial Wastewater (Continued)

Source	Design Flow (m^3/d)	Concentration (mg/l)		Loads (kg/d)	
		T-N	T-P	T-N	T-P
Point Source	16,000	22	5.8	344	93.4
No-point Source	5,000	23	3.0	115	15.0
Total	21,000			459	108.4
Average Concentration (mg/L)		22	5.0		

Combine the design quality of domestic, commercial, and institutional wastewater shown in *Table AII.1.26* with that of industrial wastewater discharged to the public sewerage system shown in *Table AII.1.32,* the overall influent quality to the wastewater treatment plant is estimated as shown in *Table AII.1.33.*

Table AII.1.33 Design Influent Quality

Wastewater	Design Flow (m^3/d)	Loads (kg/d)		Concentration (mg/L)	
		BOD_5	SS	BOD_5	SS
Domestic, Commercial, and Institutional	74,700	9,750	11,302	131	150
Industrial	21,000	3,349	4,238	159	201
Groundwater Infiltration	2,300	0	0	0	0
Total	98,000	13,099	15,540		
Average Concentration (mg/L)				135	160

Table AII.1.33 Design Influent Quality (Continued)

Wastewater	Design Flow (m^3/d)	Loads (kg/d)		Concentration (mg/L)	
		T-N	T-P	T-N	T-P
Domestic, Commercial, and Institutional	74,700	1,706	224.0	23	3.0
Industrial	21,000	459	108.4	22	5.0
Groundwater Infiltration	2,300	0	0	0	0
Total	98,000	2,165	332.4		
Average Concentration (mg/L)				22	3.4

The design influent quality for Braila WWTP is determined, taking into consideration the calculation results shown in *Table AII.1.33* and that proposed in the 1997 F/S. The proposed design influent quality of BOD5 and SS in the 1997 is based on the results of series of quality surveys of wastewaters. Consequently, the following design influent quality is proposed for the design of Braila WWTP:

- BOD_5 concentration: 150 mg/L
- SS concentration: 180 mg/L
- T-N concentration: 25 mg/L, and
- T-P concentration: 4 mg/L