CHAPTER 5 WWTP FACILITY PLANNING

5.1 PLANNING PRINCIPLE

5.1.1 HYDRAULIC / ORGANIC LOADING OF FACILITIES

For the plant facility design, hydraulic and organic loads to the facilities are determined based on the maximum daily wastewater flow of 115,000 m^3/day or 1.332 m^3/sec. The preliminary and primary treatment facilities are checked for the wet weather flow conditions.

All piping and channels are designed to carry the maximum hourly flows, but for the preliminary and primary treatment facilities the hydraulic condition of wet weather flow is considered. The incoming pressure sewer of 1,200 mm diameter will relieve the wastewater to the influent conduit ahead of the WWTP.

5.1.2 FACILITY PLANNING

Flow Division Control: The plant facility design provides for flow division control facilities to insure organic and hydraulic loading control to various process units. Flow division should be measured using flow measurement devices to assure uniform loading of all unit processes and operations.

Unit Bypasses: A minimum of two units in the liquid treatment process train is to be provided for all unit processes and operations in the plant. The bypass design will facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

Pipe Cleaning and Maintenance: Fittings, valves, and other appurtenances should be provided for pipes subject to clogging, to facilitate proper cleaning through mechanical cleaning or flushing. Pipes subject to clogging, such as pipes carrying sludge, shall be lined with a material that creates a smooth and non-adhering surface, thereby reducing clogging and resistance to flow.

Construction Materials: The materials of construction and equipment shall be resistant to hydrogen sulfide and other corrosive gases, greases, oils, chemicals, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action, and consequent corrosion.

Grading and Landscaping: The plant site should be graded and landscaped upon completion of the plant. Concrete or asphalt paved walkways should be provided for access to all units. Steep slopes should be avoided to prevent erosion.

Plant Outfall Lines: The Braila WWTP outfall sewers will be located and designed to discharge the effluent to the Danube River through in a manner not to impair the beneficial uses of the receiving stream, providing for:

- Free fall or submerged discharge at the site; and
- Limited or complete dispersion of discharge across stream to minimize impact on aquatic life movement, and growth in the immediate reaches of the receiving stream.

The outfall structure will be so protected against the effects of floodwater, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage. The outfall line may have a safe and convenient access, preferably using a manhole, so that a sample of the effluent can be obtained at a point after the final treatment process, and before discharge to or mixing with the receiving waters.

Plant Site: The WWTP site of about 16-hectare area owned by the City is located at the left bank of the Danube River. The land is relatively flat and low-lying with ground surface elevations ranging from 2.5 m to 3.5 m above M.W.L. The surrounding areas of the plant site are agricultural land at present and in foreseeable future, and no residences exist within a distance of 2km from the site. There is a sufficient land space surrounding the site for the possible future expansion of the plant facilities.

The elevation of the Danube River protection bank close to the site is at about 10 m above M.W.L. The ground elevations of the surrounding natural grounds are almost same as the site.

The treatment plant structures and all related equipment shall be protected from physical damage preferably by the 100-year flood. According to the record of the Danube River water surface elevations, the 100-year or 1 % probability of occurrence is 7.86 m above M.W.L. whereas that for multi-yearly elevation is 3.91 m above M.W.L. The plant site surface elevation ranges from 5.2 to 5.6 m above M.W.L., which are lower than the 100-year flood river water surface elevation. The average ground elevation of the site or, at least around the major structures, is to be higher than 7.9 m above M.W.L.

Site Access: Access to the site can be made through the major road, running from west toward east along the Danube River. From the major road, access road of 6 m wide is to be provided.

Emergency Power Facilities: The plant shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures, including provision of at least two independent sources of power, such as feeders, grid, etc., to the plant, or power generators. Auxiliary power for minimum aeration of the activated sludge is required to protect downstream uses, in addition to such facilities as wastewater pumps, building lighting, chlorine contact tanks, etc.

Plant Sanitary System: An adequate supply of potable water under pressure shall be provided for use in the laboratory and for general cleanliness around the plant. Potable water from the municipal supply will be used directly at points above grade for hot and cold supplies in lavatory, water closet, laboratory sink (with vacuum breaker), shower, drinking fountain, eye wash fountain, and safety shower; unless a positive break at the property line is required.

Hot water for any of the above units shall not be taken directly from a boiler or piping used for supplying hot water to a sludge heat exchanger or digester heating unit. Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

Flow Measurement: Appropriate flow measuring equipment should be provided after the preliminary treatment facility to continuously indicate, totalize and record volume of wastewater entering the plant in a unit time. Other flow measuring equipment are to be provided to the major component facilities to measure liquid and sludge.

Plant Bypass: The WWTP design calls for accepting the wet weather flow of 3.241 m^3/sec. Flows in excess of this rate may be bypassed to the Danube River at the intermediate pumping station. In the flow bypass structure a broad-crested weir will be set at a calculated hydraulic grade line elevation, which will accomplish this maximum hydraulic plant loading limitation.

The plant bypass should also be constructed at the location ahead of the WWTP. Since the wastewater will be sent to the plant through wastewater lift pumping stations, the frequency of the flow exceeding 3.241 m^3/sec. is expected to be extremely low.

Laboratory: The WWTP shall include a laboratory for making the necessary analytical determinations and operating control tests. The laboratory size, bench space, equipment and supplies shall be such that it can perform analytical work for all self-monitoring parameters required by discharge permits and the process control necessary for good management of each treatment process included in the design.

5.2 PROCESS DESIGN

5.2.1 PRELIMINARY TREATMENT

The process units and structures associated with the preliminary treatment are the influent gates, screens (coarse/ fine), aerated grit removal, and flow measurement.

(1) Influent Gates

At the entrance to the plant, influent gates are provided ahead of the screening facility to control or bypass the influent flows as required. The geometry of the gates is as follows:

Number of gates:	:	2 units
Type:	:	Sluice gate (manually operated)
Gate size:	:	1.2 × 1.2 m

(2) Screens

Coarse Screens: Manually cleaned coarse screening facilities will be provided ahead of the fine screens. The criteria for the coarse screens are:

Number of screens	:	2 units
Channel width	:	1.6 m
Clear bar spacing	:	100 mm
Slope from vertical	:	60 degrees

Screenings Disposal: As a minimum, screenings must be disposed of daily. All collected screenings will be dumped to one (1) common belt conveyor and sent to a hopper for storage, then, dumped into a truck for hauling it to a sanitary landfill.

(3) Influent Pumping Station

In the pumping station provision shall be made to facilitate easy removing of pumps, motors and other auxiliary equipment. Suitable safe means of access should be designed to the dry well of the pumping station, including stairways, handrails and gratings where necessary.

For the pump room floor below the ground surface, mechanical ventilation is provided, so arranged as to independently ventilate the dry well. The wet-wells will be open and no mechanical ventilator will be provided.

Pump Equipment and Operation Control: Totally eight (8) units of pump are planned, four (4) pumps each for the wastewater and stormwater pumping, including two (2) standby. In case of emergency, the engine driven pump will be used. The pump sizes, numbers and capacities of the wastewater pumps are as follows:

No.1 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 450 mm
Pump discharge capacity	: 25 m^3/min
Total dynamic head	: 11 m
Number of pump unit	: 4 units
Motor output	: 70 kW

No.2 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 600 mm
Pump discharge capacity	: 50 m^3/min
Total dynamic head	: 11 m
Number of pump units	: 2 units (1 standby)

Motor output	: 132 kW

No.3 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Number of pumps	: 2 units (1 standby)
Pump diameter	: 600 mm
Pump discharge capacity	: 50 m^3/min
Pump total dynamic head	: 11 m
Engine output	: 198 ps

Piping and Valves: Suction, discharge and header piping in the station are sized to handle the flows adequately. Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit. To the discharge pipeline, electric motor-operated butterfly valves and the check valves should be installed to ensure the operation of each pump.

Hoisting Equipment: An overhead bridge traveling crane should be provided in the motor room for handling of equipment and materials which cannot be lifted readily or removed from the station by manual labor.

Piping and Valves: Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit.

Hoisting Equipment: An overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials.

(4) Aerated Grit Removal

Grit Chamber: Grit settled by aeration at the bottom of the grit chambers is removed by grit lifting pumps with trolley to grit separation channels. The grit in sand separation channels will be sent through screw conveyors to grit hoppers for storage and final disposal.

Configuration: The grit removal of the wastewater will be accomplished in four (4) trains, one blower each comprising two (2) grit chambers, as shown below:

Number of units	:	4 channels
Width	:	3 m (including 1.4 m for oil separator)
Length	:	22 m
Depth	:	2.35 (side depth) to 3.05 m
Blowers	:	5 units (one-standby) x 15 m^3/min.
Influent gates	:	4 units, 800 mm x 800 mm
Effluent gates	:	4 units, 600mm x 600 mm
Grit hopper	:	1 unit
Grit removers	:	2 × sand pump, grit lifting device
Grit screw conveyors	:	2 units

Air Supply: For the total tank length of 88 m, air supply rate is 58 m^3/min. Five units (one-standby) of blowers, each with an air supply rate of 15 m^3/min., will be provided. It is important to have almost equal static head losses for all of the process aeration requirements so that air can be supplied under one common air supply pressure zone.

Grit Removal: The grit water pumps convey the grit mixed with water to the grit separator. The removed grit is conveyed by the grit separator screw conveyors into hoppers for final disposal.

5.2.2 PRIMARY TREATMENT

Primary treatment consists of gravity liquid/solid separation in circular clarifiers. Two (2) clusters of the clarifiers, each consisting of clarifier modules of four (4) units, thus totally eight (8) clarifiers will be provided.

(1) Flow Distribution

The wastewater, after passing through the Parshall flume, flows down to the distribution chambers located at the center of each cluster of four (4) primary clarifiers, then is distributed to each individual clarifier.

(2) Primary Clarifiers

Hydraulic Loading and Area Requirements: The hydraulic loading rate for the clarifiers is 35 m^3/m^2/day at the maximum daily design flow of 1.332 m^3/sec. The clarifier geometry is as follows:

Surface loading (at maximum daily flow)	: 35 m^3/m^2/day
Design flow rate	: 115,000 m^3/day (= 1.332 m^3/sec)
Surface area of each clarifier	: 484 m^2
Clarifier diameter	: 35 m
Effective water depth	: 2 m
Number of clarifiers	: 4 basins

Primary Sludge Production: The primary and excess sludge production (when excess sludge is returned to the primary tanks) for the daily average flow rate is 1,345 m^3/day or 0.9 m^3/min. The quantity of sludge, primary plus excess sludge from the average flow is as follows:

Sludge volume	:	1,345 m^3/day
TSS	:	26,890 kg/day
Solids concentration	:	2.0 %

Scum Management: Scum is removed from the clarifier surface by a rotating scum removal mechanism to a scum pit located near the tanks and is then pumped to a scum drum screen for scum removal.

Controls: Clarifier is manually controlled, but scum and sludge pumps will be operated either automatically or manually. The clarifiers will be provided with a torque limit control and an alarm system. All the sludge from the biological stage is pumped to the sludge drum screen and then to the digesters.

5.2.3 BIOLOGICAL TREATMENT

Biological treatment consists of aeration tanks and final clarifiers.

(1) Aeration Tanks

The design parameters for this process component are established as follows:

Design inflow rate	: 115,000 m^3/day or 1.332 m^3/sec
Average inflow BOD_5 concentration	: 195 mg/l
Total BOD_5	: 15,698 kg/day
F/M	: 0.3 kg BOD_5/kg MLVSS/d
MLSS	: 1,667 mg/l
Hydraulic detention time	: 7.3 hours at maximum daily flow
Recycle capability	: 50 % of maximum daily flow.
Liquid depth	: 5.5 m
Aeration system	: Bubble diffusers
BOD removal efficiency	: 89.5 % (combined with clarifiers)

The reactor geometry is summarized as follows:

Tank width	: 5.5 m

Liquid depth	:	5.5 m
Tank length	:	76 m
Number of tanks	:	16 units
Effective tank volume	:	35,264 m^3

The air requirement for the reactor tanks is calculated on the basis of 0.0904 x Q (kg O_2/day). The air distribution system is designed to have the ability to respond to changes in air demand. The air delivery system will consist of air diffusers. A minimum dissolved oxygen concentration of 1.5 mg/l will be maintained in the tanks.

(2) Final Clarifiers

The hydraulic loading rate for the clarifiers is 23 m^3/m^2/day at the maximum daily flow rate of 1.332 m^3/sec. The final clarifier geometry and sludge production are as follows:

Surface loading (at Q max.)	: 23 m^3/m^2/day
Design inflow rate	: 1.332 m^3/sec
Tank surface area	: 1,424 m^2
Clarifier diameter	: 45 m
Sidewater depth	: 3.5m
Number of clarifiers	: 4 units
Total SS	: 13.76 ton/day
Sludge concentration	: 0.5 %
Sludge volume	: 2,752 m^3/day

The excess sludge withdrawal handling will be accomplished either directly from the secondary clarifiers or through the primary clarifiers.

Return Sludge Pumps: The pump capacity is determined based on the maximum 100 % sludge return ratio of the reactor tank inflows. The pump design parameters are as follows:

No.1 pumps

Pump type	:	Centrifugal non-clog sludge pump
Pump diameter	:	250 mm
Capacity	:	6 m^3/min.
TDH	:	10 m
Number of pumps	:	4 units
Motor output	:	22 kW

No.2 Pumps

Pump type	:	Centrifugal non-clog sludge pump
Pump diameter	:	250 mm
Capacity	:	8 m^3/min.
TDH	:	10 m
Number of pumps	:	7 units (5 units for additional 50% return sludge)
Motor output	:	30 kW

Excess Sludge Pumps: The excess sludge of 5,859 m^3/day or 41 m^3/min will be sent either directly or through the primary clarifiers to the sludge thickeners. The criteria for the pump equipment include:

Pump type	:	Centrifugal non-clog sludge pump
Pump diameter	:	100 mm
Capacity	:	1.1 m^3/min.
TDH	:	10 m
Number of pumps	:	6 sets (including 2-standby)
Motor output	:	3.7 kW

Controls: Clarifier operation will be manually controlled, whereas sludge pumps will be controlled either automatically or manually. The sludge pumping from the secondary clarifiers is made based on manually measuring the sludge blanket height.

(3) Chlorine Contact Tanks

Chlorination System: The disinfection capacity shall is sufficient to produce an effluent that will meet the coliform bacteria limits specified by the standards for that installation at all time(e.g. total coliform bacteria and fecal coliform bacteria numbers are 1 million and 10,000 MPN/100 ml, respectively). The solution chlorine disinfection system consists of contact tank, chlorination equipment, housing and storage, and ancillary services, as shown in the following:

Design flow rate (Max.daily)	:	115,000 m^3/day
Design chlorine contact time	:	15 minutes
Hydraulic maximum flow rate	:	280,000 m^3/day (wet weather flow)
Capacity of chlorine feed system	:	8 mg/l at the weather flow rate
Hypochlorite feeding rate	:	19 l/min.
Hypochlorite storage capacity	:	2 x 20 m^3 (8 days)

Duplicate disinfection systems will be provided. Where only two units are installed, each will be capable of feeding the expected maximum dosage rate.

Tank Geometry: The chlorine contact tank will be of reinforced concrete longitudinal baffled basin, which will have a large effective length-to-width ratio. The contact tank geometry is summarized below:

Number of tank units	:	1
Channel width	:	4 m
Channel depth	:	4 m
Channel effective depth	:	3 m
Channel length	:	100 m
Tank effective volume	:	2,448 m^3
Effective water depth	:	3 m

Equipment: The installed capacity of a chlorine feed system will be sufficient to provide a dosage of 3 mg/l and 8 mg/l at the maximum daily flow and the wet weather flow, respectively. The feed equipment consists of the following:

Solution storage tank

Type	:	FRP cylinder type
Internal diameter	:	2,800 mm
Height	:	3,900 mm
Tank capacity	:	20 m^3
Number of tanks	:	2 units

No.1 feed pumps

Type	:	Diaphragm pump
Discharge capacity	:	3 l/min.
Number of pumps	:	2 units

No.2 feed pumps

Type	:	Diaphragm pump
Discharge capacity	:	13 l/min.
Number of pumps	:	2 units (one standby)

Forced, mechanical ventilation is to be installed, which will provide one complete air change per minute when the room is occupied. Adequate provisions will be made to insure that one complete air change per minute is provided when the room is occupied.

(4) Effluent Pumping Station

The effluent pumping station structure is in principle the same as the influent pumping station, comprising dry- and wet-wells.

Pump Equipment and Operation Control: Totally eight units of pump are planned, four pumps each for the wastewater and stormwater, including two-standby. In case of emergency, the engine driven pump will be used. The pump sizes, numbers and capacities of the wastewater pumps are as follows:

No.1 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 450 mm
Pump discharge capacity	: 25 m^3/min
TDH	: 5 m
Number of pump unit	: 4 units
Motor output	: 32 kW

No.2 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Pump diameter	: 600 mm
Pump discharge capacity	: 50 m^3/min
TDH	: 5 m
Number of pump units	: 2 units(1 standby)
Motor output	: 60 kW

No.3 Pump Units

Type of pumps	: Vertical centrifugal mixed flow pump
Number of pumps	: 2 units (1 standby)
Pump diameter	: 600 mm
Pump discharge capacity	: 50 m^3/min
Pump total dynamic head	: 5 m
Engine output	: 90 ps

Piping and Valves: Valves are to be provided on the suction and discharge side of each pump to allow proper maintenance of the unit.

Hoisting Equipment: An overhead bridge traveling crane will be provided in the motor room for handling of equipment and materials.

5.2.4 Sludge Management

(1) Gravity Sludge Thickeners

Design Basis: Equipment and piping must be designed to deliver sufficient dilution water to gravity thickeners. Hydraulic loading to produce overflow rates of 16~33 m^3/m^2/day will be maintained to prevent septicity. The loading rates and resulting solids concentration for gravity thickening, and tank geometry are as follows:

Average sludge production volume	: 3,895 m^3/day
Sludge withdrawal rate	: 615 m^3/day
Input sludge solids	: 26.89 t/day
SS loads	: 60 kg/m^2/day
Tank shape	: Circular

Number of tanks	: 4 units
Internal diameter	: 12 m
Sidewater depth	: 4 m
Total tank surface area	: 452 m^2
Thickening mechanism	: Rotating type scraper supported by center column with pickets

Equipment Features: Heavy-duty scrapers capable of withstanding extra heavy torque loads should be provided. The thickener mechanism may be provided with pickets to help facilitate the release of water from the sludge. The drive mechanisms will be attached with a skimmer.

Sludge Pumps: The pump capacity is so determined that the pumps can send the thickened sludge within 8 hours. Specifications of the equipment are as follows:

Type	:	Sludge pump with suction screw
Number of pumps	:	3 sets (one standby)
Diameter	:	100 mm
Discharge capacity	:	1.2 m^3/min.
TDH	:	20 m
Motor output	:	15 kW

Drum Screen: Prior to pumping the primary or secondary excess sludge to the sludge thickeners, the sludge will be screened by a revolving drum screen for the removal of coarse materials. The specifications of the drum screen are as follows:

Type	:	Rotary drum screen
Number of screen	:	1 set
Screen openings	:	4mm
Screening capacity	:	2 m^3/min.
Motor output	:	0.4 kW

Controls: Sludge pumps will be operated using on/off pump controls and timers. The sludge blanket height will be determined manually.

(2) Anaerobic Digestion Tanks

Digestion Process: Active digestion, concentration and storage will undergo in four (4) single stage anaerobic digestion tanks. There will be two (2) clusters each consisting of two (2) digestion tanks. Mechanical mixing system, heating and gas collection systems will be provided in each of the tanks.

Thickened sludge in the sludge thickeners will be pumped to the digestion tanks. The digested sludge will be drawn by gravity to the storage tanks in the sludge dewatering building.

Design Basis: The digestion tank capacity is determined based on the following factors:

Input sludge solids	:	21.51 t/day
Sludge input	:	615 m^3/day
Sludge output	:	466 m^3/day
Temperature to be maintained in the digesters	:	35 ℃
Solid detention time	:	20 days
The degree and extent of mixing in the digesters	:	Moderately mix
Required total tank capacity	:	14,013 m^3

Tank Geometry: The tank shape will be high vertical cylinder with conical floors. The total number of anaerobic digestion tanks required is four (4) tanks in two (2) clusters, with the same capacity and configuration. Tank dimensions are:

Tank shape	:	Single stage, high vertical cylinder with conical floor

Tank capacity	:	3,503 m^3
Tank diameter	:	15.0 m
Tank effective water depth	:	26.0 m

Tank Operation: Sludge mixing systems should be mechanical recirculation type. The mixing system shall be designed such that routine maintenance can be performed without taking the digester out of service.

(3) Sludge Gas System

Gas Collection, Piping and Appurtenances: All portions of the gas system, including the space above the tank liquor, storage facilities and piping, shall be so designed that under normal operating conditions, including sludge withdrawal, the gas shall be maintained under positive pressure. All safety equipment shall be provided where gas is produced. Pressure and vacuum relief valves, flame traps, gas detectors, and automatic safety shut off valves, shall be provided.

Gas Utilization Equipment: Gas-fired boilers for heating digesters will be located in a separate room not directly connected to the digester gallery. Gas lines to these units will be provided with flame traps. Gas piping will be of adequate diameter for gas flow rate and will slope to condensate traps at low points.

Digester Heating: Digesters will be constructed above ground water level and suitably insulated to minimize heat loss.

Sludge will be heated by circulating the sludge through external heaters. Piping may be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions should be made in the layout of the piping and valving to facilitate cleaning of these lines.

The boiler should be provided with suitable automatic controls to maintain the boiler temperature at a fixed rate, to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, or excessive temperatures.

Safety: Local and national safety requirements must be reviewed and complied with. Those requirements take precedence over the requirements stated herein, if more stringent, and should be incorporated in the design.

(4) Gas Holders

The total daily gas production is estimated to be 10,999 m^3. The gas holders will have the minimum gas storage capacity of 8-hour gas production. The geometry of the gasholders is as follows:

Type	:	Dry seal gas holder (membrane seal type)
Number of units	:	2
Diameter	:	12.6 m
Height	:	13.3 m
Capacity	:	1,000 m^3

(5) Belt Filter Press Sludge Dewatering

The daily digested sludge of 801 m^3 is drawn by gravity into the storage tanks located in the dewatering building. The digested sludge production rate and the required dewatering equipment are:

Total digested sludge production	:	466 m^3/day

Total sludge solids	:	13.98 t/day
Dewatering equipment type	:	Belt filter press
Yields per unit length	:	130 kg/m/hr.
Filter width	:	3 m
Daily operation time	:	6 hours
Working days per week	:	5 days
Solids load per hour	:	3,263 kg/hr.
Required filter press equipment	:	8 units

The sludge from the storage tank is pumped to the coagulation tank of the dewatering equipment (belt filter press) by sludge feed pumps. Polymer solution is mixed and then pumped into the coagulation tank of the belt filter press. The filtrate, together with belt filter cleansing wastewater, is returned to the process wastewater storage tanks by gravity and then pumped to the preliminary facility by process wastes return pumps..

(6) Process Wastewater Return Pump Facilities

The process wastewater return pump system is to return the process wastes (*i.e.* building wastewater, digester supernatant, belt press filtrate and scum filtrate) to the screen inlet chamber for further treatment.

5.3 ELECTRICAL, INSTRUMENTATION AND CONTROL FACILITIES

5.3.1 ELECTRIC POWER FACILITY

(1) General

The basic power distribution system can best be described as a secondary single selective system. One electric power line shall be received at the main substation. Another separated line should be planned as a stand-by use in the future.

The received power will be stepped down by the two main transformers and connected to the 380 V bus line. Each transformer shall have a capacity for all loads in the treatment plant by the year 2010.

The 380 V will be stepped down to auxiliary power distribution voltage (lighting and receptacles, etc.) by transformers that are installed at required locations.

The protective relay system shall be considered for proper protection of the electrical equipment in adequate/proper manner. Extensive zone protection will be considered for the parallel operation of the generator with utility power.

(2) Power Requirements of the WWTP:

The WWTP mechanical equipment requires the maximum electric power supply of 2,050 kW, excluding standby equipment. The electric power requirements by the process are as summarized in the following:

(3) Power Generator

An emergency electric power generator of minimum 500 kW capacity is to be provided. The generator is driven by a diesel engine and will be used as the minimum plant electric power source when the power supply is suspended. In order to attain the intent of the above design concept, the generator power line should be connected to the 380 V bus line which is charged by the utility supplied power.

(4) D.C. Power Supply

Uninterruptible D.C. power is supplied to breaker control circuit and an emergency lighting facility. Consequently, interruptible A.C. power supply for instrumentation and PC system is converted from D.C. by means of an inverted unit.

A sealed lead-acid stationary battery set shall be selected for this purpose due to its excellent quality features. The capacity of the battery set shall be designed by the required current and 30 minutes discharge time.

Each building within the plant will have its own independent uninterruptible power source unit for better and more effective utilization of the filtered/undistorted power source.

(5) Motor Control Facility

Power feeder to the motors and wiring to the controlling equipment are accomplished through motor control center and relay cubicles. The motor control center and the relay cubicles are divided into individual facility center and relay cubicles such as one set for clarifiers and another for scum screen area.

Each motor must be operated manually from the control station to be located adjacent to the equipment. The control panel will be equipped with switches for operation status indication and meters as required.

Major control sequence is to be accomplished through the relay cubicle as required for each mechanical equipment. The sub-monitoring panel is to be provided in the room for the purpose of detailed monitoring and back-up operation.

Type of cables/wiring to be utilized, conductor sizes, cable routing/layout and arrangement methods, etc. shall be determined appropriately throughout the detailed design stage.

5.3.2 INSTRUMENTATION

(1) Design Basis

Instrumentation is an important tool of the wastewater treatment plant because it insures an easy and proper operation and maintenance of such facilities.

The equipment should be selected carefully considering its purpose, reliability, locations and costs. They should meet the specific functional needs of the particular equipment with special attention directed toward operation requirements.

(2) Supervisory Control and Data Acquisition System

The system can best be described as a local, independent, process control network with supervisory, central, monitoring station consisting of hard graphic indication (MIMIC) panels and soft monitoring/control station consisting of graphic screens, keyboards, printers, etc. The basic design of the system will be classified as follows:

- Local instrumentation/control station;
- Local process control units (Programmable logic controllers);
- Hard graphic/MIMIC panel;
- Redundant data highway;
- Host computer system and real time data storage;
- Historical data retrieval
- Workstations

5.4 MAJOR PLANT BUILDINGS AND UTILITY SERVICES

5.4.1 GENERAL LAYOUT

Administrative building will consist of several main areas comprising the control room, laboratory, conference room, administrative personnel area, etc.

The workers area should include workshop, storage rooms, restrooms, and a cafeteria for workers. The workshop should be related directly to the service road of the lot to permit easy transport of materials and machinery to be repaired.

The service road will be joined through a gate to the entrance for visitors and parking area that may be open for emergency purposes.

5.4.2 ARCHITECTURAL WORKS

The uncovered preliminary facilities could be a source of odors, and as such, trees should be planted alongside the plant fence to help minimize odors. A landscape design is conceived for the whole lot. There should be trees and grasses wherever they do not disturb wastewater treatment processes.

Administrative Building: Office room may have the capacity of 20 persons with air conditioning system. In addition to the space for laboratory, this area may also include restroom and storage room, with air conditioning, natural and artificial light, and necessary desks and water analysis equipment. Control and electrical equipment room may have air conditioning and ventilation system.

Workers Room: This area consists of restroom for operation and maintenance workers with showers and lockers. This room is also raised 30 cm from the ground level.

Depot/Workshop: This room will be for small and big parts of the plant equipment, roof with metallic structure, brick walls, natural light and fans for ventilation.

Generator Room: Main electrical building shall have a floor level raised 30-cm from the planned ground elevation to avoid possible flooding. The building should face a road to permit the flow of machinery. Mechanical ventilation system shall be provided.

5.4.3 GENERAL CRITERIA FOR THE STRUCTURAL DESIGN

Foundations: The soil study performed under the Study included a sub-surface survey of the plant site and surrounding areas. A total of four soil test borings, each 30 m deep, were performed within the site in addition to the neighboring area.

The floor levels of the various component buildings of the plant will be installed at a minimum level of 30 cm above the site finished mean grade level of 7.9 m above mean Black Sea water level (M.W.L).

Structures: The main structures of the plant are cylindrical and rectangular tanks in shape; pipes with large diameters; pumping facilities, and buildings for the administration, operation and maintenance purposes.

The area is located in a zone of seismic risk. According to the Regulation P100/1992, the area is located in a D-degree seismic area. Determination of seismic loads shall be in accordance with the Regulations, local codes or other accepted standards. Each type and size of structures shall be individually designed depending on its own conditions assigning the factors of security established by the standards.

Design: The basic material for the construction of the plant structures will be the conventional reinforced concrete structures. Long span beams may be applied to the structures, which may be of post-tensioned with high resistance-cables. The structure design shall follow the Romanian National Standards STAS 4273/83 or equivalent international standards and publications.

Materials: All materials to be considered for the structural and architectural designs shall be subject to the relevant in the Romanian Standards, or other equivalent international specifications.

5.4.4 Principal Plant Facilities

Grading and Landscaping : Grading will slope away from structures to the open channels or box culverts. Landscaping includes grass for the area around the roads, structures and buildings. Trees and shrubs will be all along the fence of the site limits. The use of small trees around roads and buildings help to give a human scale to the project because structures are usually high.

Site Security: The site must be closed with a chain link fence or other appropriate means. The entrances will have a gate with hardware locks to have them closed when necessary.

Guardrails: For walkways located in hazardous areas of the structures, guardrails must be used. Guardrails shall be painted with safety colors of yellow and black.

Lighting: There shall be exterior lighting all-over the site, along roads, near the structures and along the edge of the surrounding of fence.

Lifesavers: There shall be one lifesaver at each deep and uncovered structure such as clarifiers and anaerobic ponds.

Site Signs: A sign identifying the project and the owner should be put at the entrances of the site. A sign system for orientation within the plant, as well as a color code for elements of the buildings will be provided

5.4.5 Layout of Facilities

Figure II.5.1 shows the layout of facilities in the wastewater treatment plant and *Figure II.5.2* shows that hydraulic profile of Braila WWTP. List of main facilities is shown in *Table II.5.1*.

Table II.5.1 Main Equipment of Braila WWTP

Item	Specification
Screen and Pump	Influent gate 1.0 m × 1.0 m × 4 units (including 2 units for rain) Coarse screen B1.6 m × H2.0 m × 2 units Fine screen B1.6 m × H2.0 m × 2 units Pumps ϕ450, Q=25 m^3/min, TDH=5 m, Mp=70 kW, 4 pumps ϕ600, Q=50 m^3/min, TDH=5 m, Mp=132 kW, 2 pumps ϕ600, Q=50 m^3/min, TDH=5 m, Mp=198 ps, 2 pumps
Grit chamber/ Oil separator	B 3m × L 22m × 4 channel
Parshall flume	306 - 12,380 m^3/h × 2 units
Primary Sedimentation Tank	ϕ35 m effective depth 2.0 m × 4 tanks
Aeration Tank	B 5.5m × H 5.5m × L 76m × 16 tanks (For advanced treatment : B 5.5m × H 5.5m × L 67m × 16 tanks)
Final Sedimentation Tank	ϕ45 m effective depth 3.5 m × 4 tanks (For advanced treatment : ϕ40 m effective depth 3.5 m × 4 tanks)
Chlorination Chamber	B 4.0m × H 4.0m × L 100m (Chlorination time 15 min)
Sludge Thickener	Inside diameter 12 m × H 4 m × 4 tanks
Sludge Digester	Inside diameter 15 m × H 26 m, V = 3,503 m^3 × 4 tanks
Gas Holder	Inside diameter 13 m × H 13.57 m, V = 1,000 m^3 × 2 tanks
Dewatering Equipment	130kg/m hr, B = 3 m × 8 units (building 32 m × 20 m)
Blower Equipment	Multi stage turbo blower ϕ350 / ϕ300, 80 m^3/hr × 4 (building 26 m × 13 m)
Administration Building	30 m × 40 m = 1,200 m^2

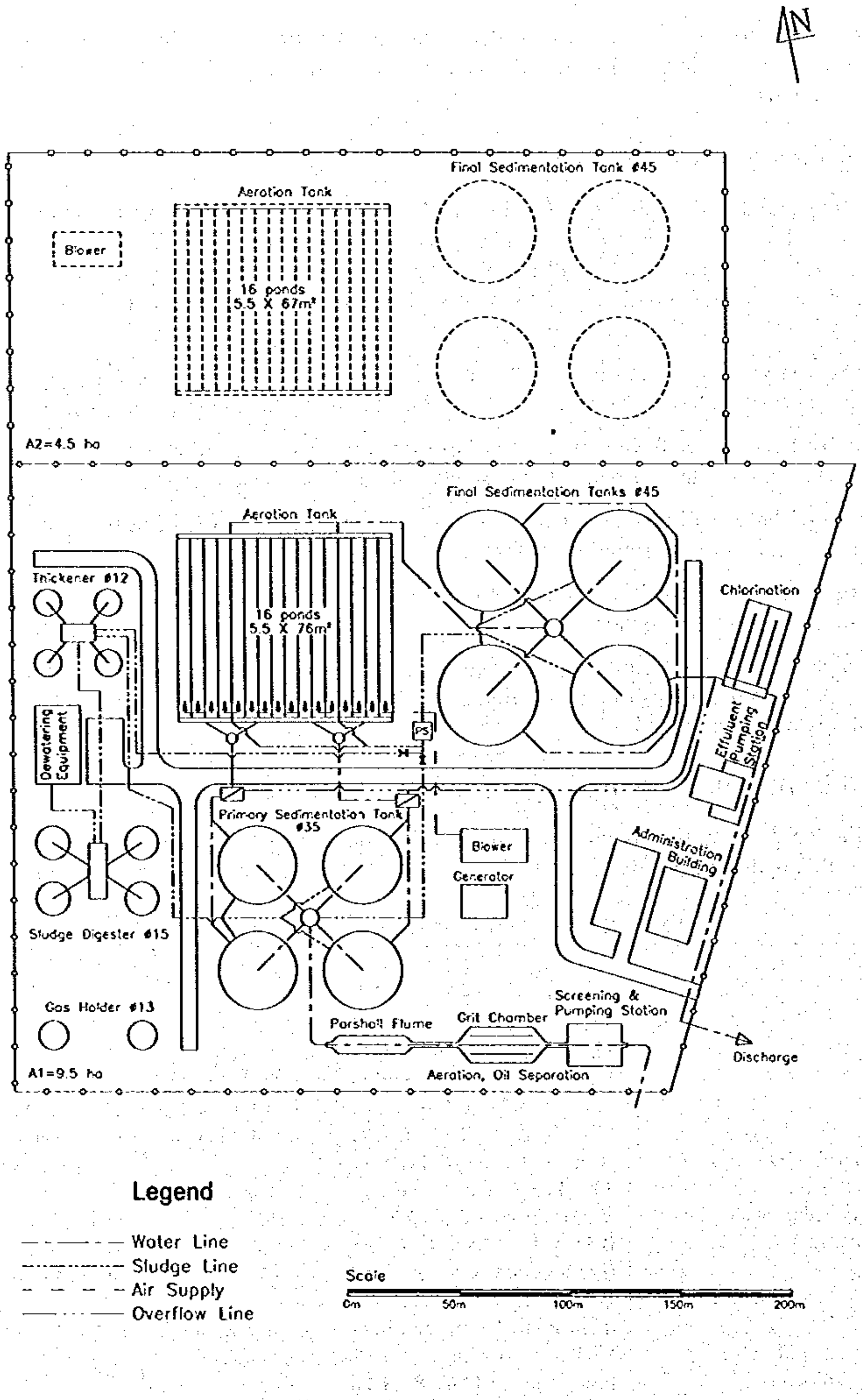

Figure II.5.1	Layout of Plan of Braila WWTP

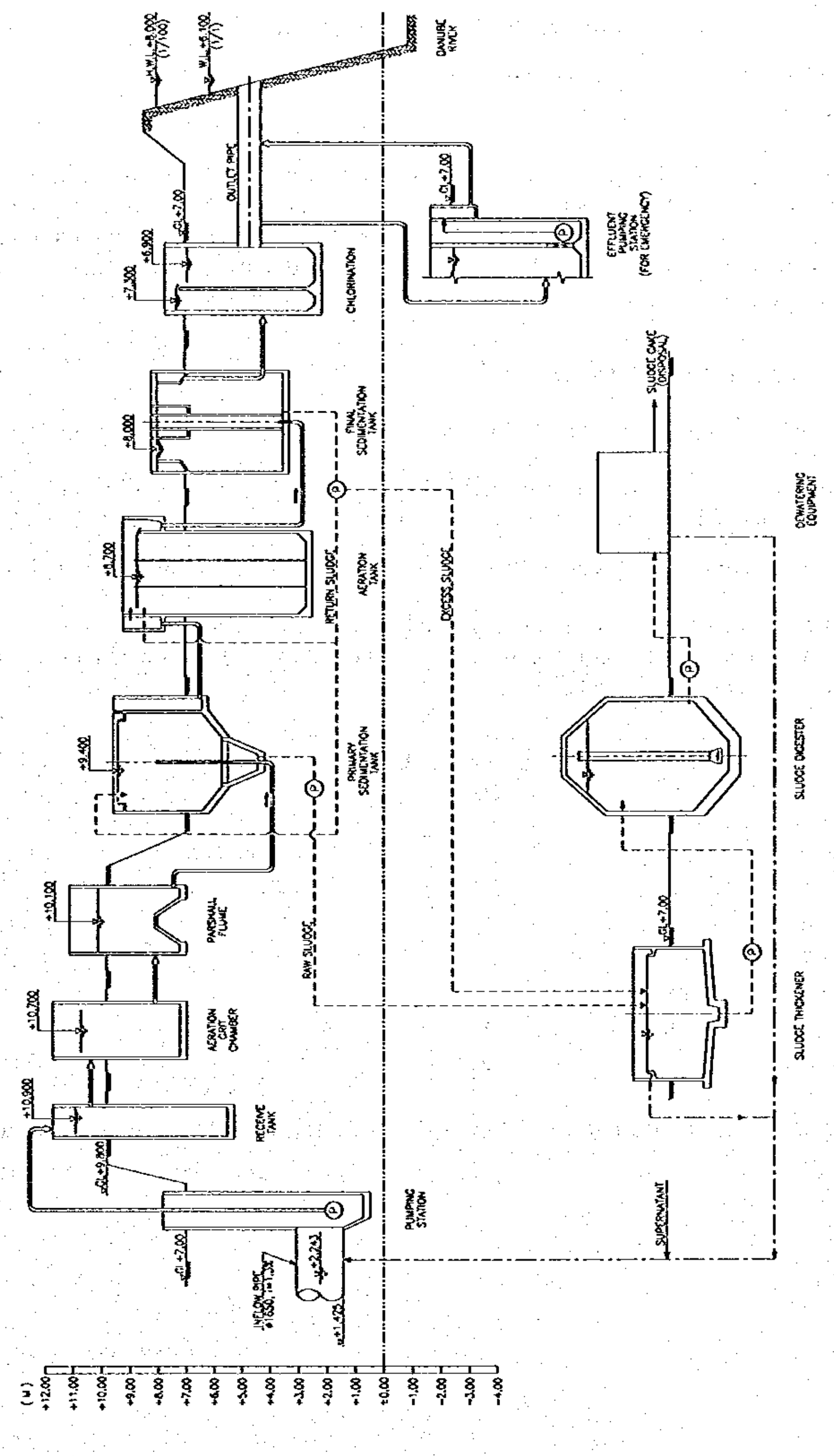

Figure II.5.2	Hydraulic Plofile of Braila WWTP

5.5 CONSTRUCTION PLAN

5.5.1 GENERAL

Major Facilities to be constructed the Project are as follows:

- Interceptor sewer, manhole and CSO
- Wastewater treatment plant

Construction works for above facilities, in general, will be executed by ordinary construction and equipment installation methods using equipment readily available in Braila and/or Romania. In addition, since construction site for the proposed facilities are located within or around Braila City, there would be neither difficulty to transport materials and equipment nor difficulty in obtaining utility services for construction works such as water and electricity.

5.5.2 CONSTRUCTION PLAN

The construction plan for the project is prepared based on the following considerations:

- Annual working days are estimated at 225 days based on the rainfall records in the past five (5) years and holidays in Romania. Daily working hour is assumed to be eight (8) hours.
- Construction machines are fully utilized for the smooth and economical implementation.

Required construction periods are estimated based on the construction volume and ordinary scale of inputs with the considerations mentioned above. Construction plan for the Braila project is presented in *Figure II.5.3*.

	Period (Year)	1st year 2000	2nd year 2001	3rd year 2002	4th year 2003	5th year 2004
Wastewater Treatment Plant						
Influent Pumping Station	1.5					
Wastewater Treatment Process	2.5					
Sludge Treatment Process	2					
Discharge Pumping Station	1.5					
Power Receiving Facility	1					
Administration Building	1					
Interceptor	2					

Figure II.5.3 Construction Plan and Sequence of Works for the Braila Project

CHAPTER 6 OPERATION AND MAINTENANCE PLAN

6.1 DESCRIPTION OF OPERATION AND MAINTENANCE WORKS

Following figure shows necessary operation and maintenance works in WWTP.

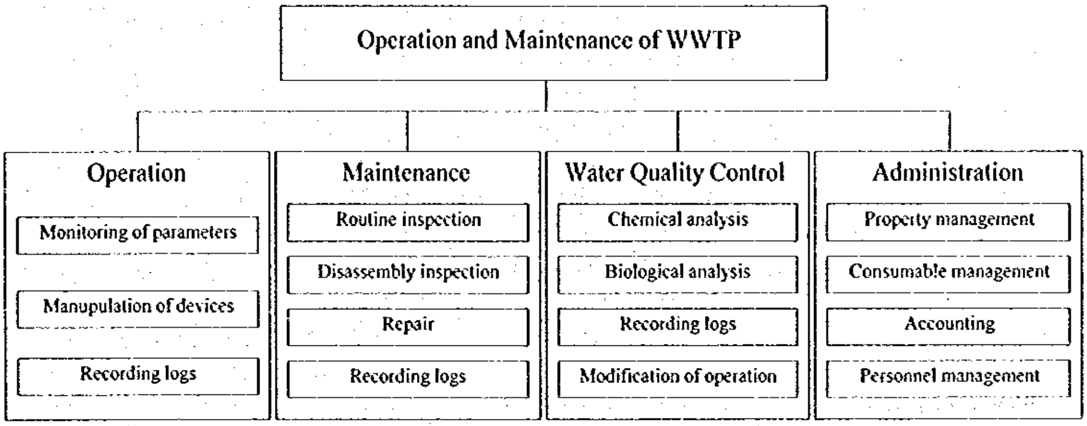

Figure II.6.1 Necessary Operation and Maintenance Work

The works are composed of operation of treatment processes for wastewater and sludge, maintenance work, water quality control, and administrative work.

6.1.1 TREATMENT PROCESS OPERATION

Process operation consists of monitoring of parameters and manipulation of devices such as gates, valves and pumps. The characteristics of these two activities are quite different. Manipulation of devices may be required only several times a day at most, on the contrary, monitoring will be required continuously. Thus, introduction of centralized automatic monitoring system greatly contributes to reduce number of operation staff. Furthermore, automatic monitoring is technically far easier and more reliable than automatic operation. These are the reasons why centralized monitoring system is applied in the proposed WWTP, though the automatic operation system is not introduced.

Tables II.6.1 to *II.6.3* show operation parameters monitored by central control system.

Table II.6.1 General Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Electrical facilities (including receiving equipment)	Voltage, electric current, electric power, electric power consumption
	Power factor, frequency, temperature of transformer
Others	Atmospheric temperature, humidity, pressure, rainfall
	Direction of the wind, wind velocity, strength of rainfall

Table II.6.2 Wastewater Treatment Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Grit chamber and oil separator	Inflow gates opening
	Inflow water level and volume (incoming flow), pH
	Water level of pre-screen and post screen
	Intake air flow, supplied air flow and pressure of blower
Pumping station	Water level at wet well
	Supplied water flow
	Effluent water level
	Valve opening
	Bearing temperature of pump and motor
Primary sedimentation tank	Receiving water level
	Underflow sludge volume
Aeration tank	Gate opening
	Receiving water level
	Air volume
Blower equipment	Intake air flow of blower
	Supplied air flow and pressure of blower
	Bearing temperature of blower and motor
Final sedimentation tank	Receiving water level
	Underflow sludge volume
	Excess sludge volume
	Water level of sludge sedimentation pond
Chlorine contact tank	Hypo-chlorite dosage volume
	Receiving water level
Discharge pipe	Discharge water volume
	Water level of river

Table II.6.3 Sludge Treatment Operation Parameters Monitored by Central Control System

Operation Process	Monitoring parameter
Sludge thickener	Inflow sludge volume
	Water level of tank
	Sludge-liquid interface
	Underflow sludge volume
Sludge digester	Inflow sludge volume
	Water level of tank
	Digested sludge transportation volume
	Under flow digested sludge volume
	Supernatant volume
	Outbreak sludge-digestion gas volume
	Digestion tank temperature
	pH
Dewatering equipment	Inflow sludge volume
	Sludge cake volume
Gas holder	Storage volume
	Gas holder level
	Add temperature combustion gas volume
	Excess combustion gas volume

6.1.2 MAINTENANCE WORK

Routine and disassembly inspections are essential to keep proper function of devices. *Table II.6.4* summarizes necessary maintenance work in general.

Table II.6.4 Necessary Maintenance Work

Frequency	Work content
Daily	Check appearance, unusual vibration and sound
	Check condition of lubricants
Monthly	Check gland packing wear and leakage around seals
	Check and, if necessary, replenish lubricants
	Check tension and wear of chains
Yearly	Replace lubricants and gland packing
	Tighten bolts
	Check operation of electric and mechanical devices
	Check operation of protective devices
	Dry up tanks/reservoirs and check submerged devices
Every 1 – 4 years	Overhaul, paint or greasing devices

Results of inspections and any maintenance activities should be recorded in daily or monthly logs. Maintenance staff should request necessary spare parts and consumables so that administrative staff can properly manage them.

6.1.3 WATER QUALITY CONTROL

Water quality control is one of the essential parts of WWTP operation. Operation parameters should be determined by the results of water quality analysis. Analysis items and sampling frequency of each sampling point is summarized below:

Table II.6.5 Analysis Items and Sampling Frequency of Each Sampling Point

Sampling points	Analysis items	Sampling frequency
Inflow channel	Appearance, Odor, Water temperature, Turbidity, pH	Daily or at the time of inspection
	SS, COD	Weekly
	BOD, NH_4-N	Monthly
Aeration tank	Appearance, Odor, Water temperature, Turbidity, pH	Daily or at the time of inspection
	MLSS	Weekly
	Microorganism	Monthly
Outlet of final sedimentation tank	Appearance, Turbidity, pH	Daily or at the time of inspection
	SS, COD, NH_4-N, NO_3-N	Weekly
	BOD	Monthly
Outlet of WWTP	Appearance, Turbidity, pH, Chlorine residual	Daily or at the time of inspection
	SS, COD	Weekly
	BOD, NH_4-N, NO_3-N	Monthly

Source: Japan Sewage Works Association, "Guidelines for Planning, Design and Operation and Maintenance for Small Scale Treatment Works." 1996.

6.1.4 Administrative Work

WWTP forms a self-complete organization and needs administrative staff for management of properties and consumable goods, budgeting and accounting, and personnel management. In addition, security guards, building janitors, and cleaning persons are also included in administrative staff.

6.2 EQUIPMENT FOR OPERATION AND MAINTENANCE

In addition to ordinary maintenance equipment such as welding machine or turning machine, at least the following laboratory equipment is necessary for laboratory:

- Temperature/pH/conductivity meters
- DO meters
- COD apparatus
- Turbidity meter
- Low power and high power microscopes
- Digital balances
- Drying ovens
- Incubators
- Laboratory flocculation apparatus
- TOC analyzer
- Hot plate stirrers
- Digestion apparatus
- Laboratory centrifuge
- Vacuum pumps with blower facility
- Evaporation equipment (water bathes, etc.)
- Distillation equipment and rotary film evaporator
- Fume cupboards with ventilation equipment
- Extensive range of laboratory ware
- Continuous still and deionizer units
- Miscellaneous instruments and spares

CHAPTER 7 ORGANIZATION PLAN

7.1 PRINCIPLES OF THE ORGANIZATION PLAN

The organization plan in the Study is made in line with the following principles.

- A current sewerage operating body, R.A. APTERCOL will undertake the operation and maintenance of facilities constructed by the proposed project.
- The WWTP section will be established in R.A. APTERCOL as a responsible body of WWTP.
- Scope of the organization plan is limited within the personnel related to the operation and maintenance of facilities constructed by the proposed project. The plan does not aim to modify current structure of R.A. APTERCOL.
- Since the administrative staff of the WWTP section will deal with most part of administrative work related to WWTP, increment of indirect division personnel out of the WWTP section is not envisaged.

7.2 REQUIRED PERSONNEL FOR THE WWTP SECTION

The wastewater treatment process runs for 24 hours continuously. Thus, the operation personnel for the process will work in three shifts. The chief of each shift should be an engineer in order to improve supervision capacity and plant operation control. The personnel for the final sludge disposal site are not included here, because neither construction nor operation and maintenance of the disposal site are within project scope. Following factors are also taken into consideration to estimate the number of required personnel.

- The WWTP should be self-sufficient from the laboratory viewpoint, for the control of treatment processes, research and development processes.
- Though the maintenance personnel will work during daytime in principle, the electric technician should stay for 24 hours continuously taking into account that failures in the electrical area are the most common in general.
- For day/night shift tasks, four persons will share one job. Each of three persons will work for either 8 hours or 12 hours a day, and the additional one will serve as replacement so that the other three may rest one day a week.

Under the section chief who is responsible for all the activities relating to operation and maintenance of WWTP, the following management personnel is deployed:

- Operation supervisor
- Maintenance chief responsible for all maintenance staff
- Laboratory chief responsible for water quality control, especially for sampling and analysis
- Administrative chief responsible

The number of required personnel is shown in *Table II.7.1*.

Table II.7.1 Personnel Requirements for the WWTP Section

Position	Total number	Day shift	Day/night shift
0. Section chief	1	1	-
Subtotal of Item 0	1	1	-
1. Operation			
Chief	1	1	-
Operator (engineer)	1	1	-
Equipment operator	4	-	4
Auxiliary staff	4	-	4
Subtotal of Item 1	10	2	8
2. Maintenance			
Chief	1	1	-
Supervisor	1	1	-
Mechanic I (senior)	1	1	-
Mechanic II (assistant)	1	1	-
Turner	1	1	-
Auxiliary shop staff	1	1	-
Maintenance	1	1	-
Auxiliary staff (mechanical)	3	3	-
Instrumentation chief	1	1	-
Instrumentation technician	1	1	-
Electrician (senior)	5	1	4
Auxiliary staff (electrical)	1	1	-
General concrete works	1	1	-
Subtotal of Item 2	19	15	4
3. Water Quality Control			
Chief	1	1	-
Chemist	1	1	-
Microbiologist	1	1	-
Sampling auxiliary staff	1	1	-
Subtotal of Item 3	4	4	-
4. Administration			
Chief	1	1	-
Administration assistant	1	1	-
Auxiliary staff	1	1	-
Secretary	1	1	-
Driver	1	1	-
Janitor	1	1	-
Cleaning staff	1	1	-
Gardener	1	1	-
Security guard	4	-	4
Subtotal of Item 4	11	7	4
Total	46	30	16

7.3 OTHER PERSONNEL INCREMENT

The proposed facilities in the Braila feasibility study in addition to the WWTP are as follows:

- 2,997 m of gravitational sewer pipes with 22 manholes
- 3 CSO regulartors

To cope with an increase of work volume due to the above facilities, additional four (4) maintenance persons, or one (1) shift, in the water distribution and sewerage section, is proposed for operation and maintenance of those facilities.

CHAPTER 8 COST ESTIMATE

8.1 BASIS OF COST ESTIMATE

The project cost consists of construction cost, equipment cost, engineering service cost, government administration cost, and physical contingency. The project cost is estimated under the following conditions.

- All base costs are expressed under the economic conditions that prevailed in June 1999.
- The exchange rates of currencies are US$1 = ROL 15,756 = ¥122, Euro1 = ROL 16,539 and DM1 = ROL 8,364.
- Equipment cost for WWTP is classified into foreign and local currency portions and rates of them are 70 % and 30 % respectively.
- Engineering service cost is including all services for detailed design, tendering assistance and construction supervision. The cost is assumed at 10% of the construction cost.
- Government administration cost is costs that should be prepared by government and/or executing agency (*e.g.* cost for personnel and organization for the project management, cost for commission for external loan, etc.). The cost is assumed at 2 % of the construction cost.
- All percentages mentioned above are assumed from former example of the same kind of projects.
- Physical contingency allowance is assumed to be 10% of the total of construction, equipment, engineering service, and government administration cost.
- Price escalation is not counted.

8.2 CONSTRUCTION COST

The construction cost consists of followings.

- Mobilization and demobilization cost (5% of main works)
- Cost for preparatory works (5% of main works)
- Cost for main works (direct cost and indirect cost)
- Cost for miscellaneous works (10% of main works)

The direct cost for main works (cost for civil work, mechanical/electrical equipment cost, mechanical/electrical equipment installation cost, and construction cost for administration building) are estimated based on the results of preliminary engineering design. Both indirect costs of site expenses and, overhead and profit are estimated at 10% of main works.

The cost for civil and architectural work is estimated by multiplying the quantity of works by unit construction costs. However, since there are no published standard market price list for mechanical/electrical equipment for wastewater treatment, the appropriate price of equipment are determined by obtained quotation from manufacturers that have experience in Romania and/or neighboring countries.

8.3 PROJECT COST

Estimated total project cost is about ROL 837,376 million, and its breakdown is shown in *Table II.8.1.* Of the total project cost, ROL 268,416 million or 32% is foreign currency portion, and remaining ROL 568,960 million or 68% is local currency portion.

Table II.8.1 Project Cost for Braila Project

	Item	Cost	Foreign currency	Local currency
I	**Construction Cost**	679,688	234,431	445,257
	Mobilization and Demobilization	24,275	0	24,275
	Preparatory Works	24,275	0	24,275
	Main Works	485,491	234,431	251,060
	Wastewater Treatment Plant	466,596	234,431	232,164
	Influent Pumping Station	46,819	25,665	21,154
	Wastewater Treatment Process	216,059	104,008	112,051
	Sludge Treatment Process	141,373	78,719	62,654
	Discharge Pumping Station	48,266	25,665	22,601
	Site Finalization	7,633	0	7,633
	Power Receiving Facility	232	0	232
	Administration Building	6,216	375	5,841
	Interceptor	18,895	0	18,895
	Miscellaneous Works	48,549	0	48,549
	Site Expenses	48,549	0	48,549
	Overhead and Profit	48,549	0	48,549
II	**Engineering Service Cost**	67,969	33,984	33,984
III	**Government Administration Cost**	13,594	0	13,594
IV	**Contingency**	76,125	0	76,125
V	**Project Cost**	837,376	268,416	568,960

(Unit: million ROL)

8.4 OPERATION AND MAINTENANCE (O/M) COST

Major portions of O/M cost of the WWTP are electric power charge for the equipment and cost for personnel. The O/M cost for the Braila project is estimated at ROL 9,296 million as shown in *Table II.8.2.*

Table II.8.2 Operation and Maintenance Cost for Braila Project

Item	Unit	Unit price	Quantity	Total (million ROL)
Personnel	ROL/month/ person (average)	2,000,000	50	1,200
Electricity	ROL/kwh	500	1,124	4,854
Chemical	ROL/kg	5,000	894,000	447
Excess Sludge Disposal	ROL/m³	20,000	297,990	1,490
Repairing	0.5% of Mechanical cost		23,000	460
Others	10% of above			845
Total				9,296

CHAPTER 9 IMPLEMENTATION PROGRAM

9.1 IMPLEMENTATION SCHEDULE

The project will be completed within five (5) years from 2000. Pre-construction stage of one (1) year is assumed for the detailed design period and tender process followed by four (4) years' construction works.

Proposed implementation schedule is presented in *Figure II.9.1*.

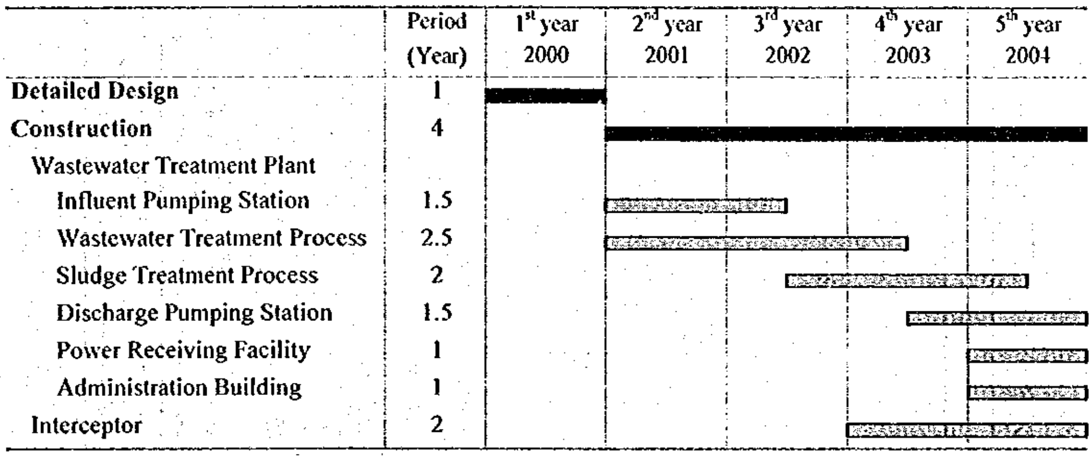

Figure II.9.1 Implementation Schedule of Braila WWTP Project

9.2 DISBURSEMENT SCHEDULE

Proposed annual cost disbursement schedule of the Braila WWTP project during entire project period is shown in *Table II.9.1*.

Table II.9.1 Disbursement Schedule of Braila WWTP Project

		Total	2000	2001	2002	2003	2004
Detailed Design	Total	33,984	33,984				
	FC	16,992	16,992				
	LC	16,992	16,992				
Construction		679,688		131,314	187,460	207,404	153,510
Mobilization and Demobilization		24,275		12,137			12,137
WWTP Construction							
Influent Pumping Station	Total	46,819		22,657	24,161	0	0
	FC	25,665		8,555	17,110	0	0
	LC	21,154		14,102	7,051	0	0
Wastewater Treatment Process	Total	216,059		65,622	86,424	64,013	0
	FC	104,008		20,802	41,603	41,603	0
	LC	112,051		44,820	44,820	22,410	0
Sludge Treatment Process	Total	141,373		0	28,275	56,549	56,549
	FC	78,719		0	15,744	31,488	31,488
	LC	62,654		0	12,531	25,061	25,061
Discharge Pumping Station	Total	48,266		0	0	23,622	24,643
	FC	25,665		0	0	8,555	17,110
	LC	22,601		0	0	15,067	7,534
Site Finalization	Total	7,633		0	0	0	7,633
	FC	0		0	0	0	0
	LC	7,633		0	0	0	7,633
Power Receiving Facility	Total	232		0	0	0	232
	FC	0		0	0	0	0
	LC	232		0	0	0	232
Administration Building	Total	6,216		0	0	0	6,216
	FC	375		0	0	0	375
	LC	5,841		0	0	0	5,841
Interceptor Construction	Total	18,895		0	0	9,448	9,448
	FC	0		0	0	0	0
	LC	18,895		0	0	9,448	9,448
Other Costs	Total	169,922		30,898	48,601	53,771	36,652
	FC	0		0	0	0	0
	LC	169,922		30,898	48,601	53,771	36,652
Construction Supervision	Total	33,984		8,496	8,496	8,496	8,496
	FC	16,992		4,248	4,248	4,248	4,248
	LC	16,992		4,248	4,248	4,248	4,248
Government Administration		13,594		2,626	3,749	4,148	3,070
Contingency		76,125	3,398	14,244	19,971	22,005	16,508
O/M Cost	Total	819,750					
	FC	600,000					
	LC	219,750					
Total Disbursement		1,657,126	37,383	156,681	219,676	242,052	181,584
FC		868,416	16,992	33,605	78,705	85,894	53,221
LC		788,710	20,391	123,076	140,971	156,159	128,363

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
O/M Cost	Total	8,790	8,790	8,790	8,790	8,790	8,790	8,790	208,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	208,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	208,790	8,790
	FC								200,000								200,000								200,000	
	LC	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790
Total Disbursement		8,790	8,790	8,790	8,790	8,790	8,790	8,790	208,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	208,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	208,790	8,790
FC		0	0	0	0	0	0	0	200,000	0	0	0	0	0	0	0	200,000	0	0	0	0	0	0	0	200,000	0
LC		8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790	8,790

CHAPTER 10 FINANCIAL PLAN AND ANALYSIS

10.1 GENERAL

The construction of the WWTP requires huge amount of investment cost which is far beyond the city's affordability. Consequently, soft loan or grant schemes of international financial sources should be introduced to realize the construction. It is quite usual that an application of those schemes require certain portion of the investment cost to be covered by own sources, which would be an evidence of self-assistance efforts of the recipient. In general, the ratio of this self-financed portion is 20 to 40 %, which varies according to the international financial sources.

The problem is that even the amount of the self-financed portion of the investment cost will be far beyond the financial capacity of Braila City. It means that during the construction period of the WWTP a considerable part of the self-financed portion should be procured by a subsidy from the state, or by private sector loans. The Study strongly recommends the former solution because of the following reasons.

- Beneficiaries of direct benefit of the project are rather inhabitants downstream of the recipient watercourse than users of sewerage who have already enjoyed the service.
- The recipient watercourse of treated wastewater is the Danube River. The Danube is an international river and the Danube Delta, which is located at the most downstream of the Danube, is listed in the World Natural Heritages. The state should share the responsibility to prevent such international natural resources from degradation.
- The construction is necessary to comply with the relevant EU directives. This compliance will contribute to Romania's EU membership accession, which is one of political goals of the state. Thus, the state is also one of the beneficiaries of the project.

It seems practically and theoretically reasonable to solve the above problem by applying the state subsidy. In this financial plan, the financial arrangement after the start of plant operation will be intensively discussed.

10.2 EXTERNAL FINANCIAL SOURCES

As mentioned in Chapter 2 of Part I, there are three external financial sources which may be applicable to the project as shown in the table below.

Table II.10.1 Assumed Financing Terms for Possible External Financial Sources

Financial Organs	Financing Ratio (%)	Loan/Grant	Interest Rate (%)	Repayment Period (Years)	Grace Period (Years)
EBRD	70	Loan	6.5	15	3
ISPA	75	Grant	-	-	-
JBIC	70	Loan	2.7	30	10

Supposing, EBRD, ISPA, or JBIC agreed to finance the project, the terms and conditions would be like in the table. However, they are nothing other than an example or assumption. It is necessary to make quantitative assumptions regarding financing to evaluate financial feasibility of the project. In the case of EBRD, financing ratio depends on the circumstances and interest rate fluctuates in parallel with LIBOR (London Inter-bank Offered Rate).

10.3 APPROACHES TO PREPARE FINANCIAL PLAN

10.3.1 FRAME OF FINANCIAL PLAN

The financial plan was studied based on the operational structure of the sewerage service explained in Chapter 2 of Part I. In brief, R.A. APTERCOL renders operation and maintenance of the sewerage service based on a concession contract with Braila City. Braila City procures necessary investment cost and pays principal and interest of loans, if any. The city owns facilities including WWTP, and depreciates them.

(1) Account of R.A. APTERCOL

R.A. APTERCOL will collect the sewerage charges, bear the operation and maintenance cost, and pay the lease fee to the city. Financial indicators of R.A. APTERCOL were set as follows.

- Cumulative working capital, as an indicator of company's sustainability
- Profit rate, as an indicator of possibility of privatization

The cumulative working capital means summation of working capitals of precedent years. Unless the value falls minus, the company can escape from insolvency.

In this financial plan, the profit rate is defined as the rate of average profit after tax to average revenue over the project period. A certain level of profit rate may be required to drive a private sector's investment will in the privatization.

(2) City's Sewerage Service Account

This financial plan introduced a concept of city's sewerage service account in order to examine a financial burden of the city accrued by the project, though it was not clear for the concept to be materialized.

The city's sewerage service account will receive a lease fee, depreciate the facilities including the WWTP, and pay principal and interest of loans, if any. If the lease fee can not cover the total amount of depreciation cost and payment of principal and interest of loans, the account needs subsidies from the city's general account budget.

(3) Financial Capacity of the City

Following two (2) financial indicators of the city's general account are very important for realization of the project.

- The ratio of an annual payment of principal and interest to a current revenue of each year
- The ratio of subsidy to the sewerage service account to a current revenue of each year

The former is one of the major criteria for obtaining the state guarantee for external loans. If the ratio in any year will exceed 20 %, the ministry of finance will not agree to issue the state guarantee.

The latter shows whether the required subsidy is within the city's affordability.

10.3.2 MAJOR PRECONDITIONS AND ASSUMPTIONS

Following preconditions and assumptions were applied in the financial plan.

- The financial plan deals with only the cost and the revenue accrued by the project.
- Currency unit is ROL and the value of ROL is expressed as the June 1999 prices.
- Projection period is 30 years since the start of project implementation.
- Target year is 2010. From 2010 on the values of variables related to revenues and O & M cost are assumed to keep the 2010 level.
- Implementation period is 5 years from 2000 to 2004.
- 38 % of profit before tax is levied as a corporate tax.

Depreciation period is assumed as follows.

Table II.10.2 Depreciation Period

Item	Mechanical equipment	Civil works and sewer pipes
Depreciation period	8 years	40 years

10.4 REVENUE

10.4.1 ESTIMATION METHOD

The revenue of R.A. APTERCOL consists of collected domestic and non-domestic sewerage charges. In this financial plan, both charges were estimated based on following assumptions.

- The tariff of each charge is set as a unit price per m^3.
- The unit price of domestic sewerage charge is determined based on the proportion to average household income.
- The unit price of non-domestic sewerage charge is determined in proportion to that of domestic charge.

Based on the above assumptions, the unit prices and revenue of R.A. APTERCOL were calculated as follows.

- $UP_d = X \times Income / Q_d / H_{serv}$
- $UP_{nd} = b \times UP_d$
- Annual Revenue = $(UP_d \times Q_d + UP_{nd} \times Q_{nd}) \times$ Charge Collection Rate

where,

UP_d: unit price of domestic sewerage charge,
UP_{nd}: unit price of non-domestic sewerage charge,
X: ratio of domestic charge to household income,
b: coefficient,
$Income$: average annual household income,
Q_d: quantity of domestic sewerage per year,
Q_{nd}: quantity of non-domestic sewerage per year, and
H_{serv}: number of sewerage served household.

In above equations, all independent variables and coefficients except X were estimated as mentioned in following sub-sections. Subsequently, the revenue of R.A. APTERCOL can be estimated when the variable X is given.

10.4.2 SERVED POPULATION

As mentioned in the chapter 3, the sewerage served population in 2010 was estimated 221,600. It was assumed that the present population increases linearly until 2010 and ever since remains 221,600. In addition, the household size was assumed to be constant at present value of 3.3 persons/household.

The numbers of served population and served household were estimated as follows.

Table II.10.3 Number of Served Population and Household

Year	2005	2006	2007	2008	2009	2010	from 2011
Served population	210,204	212,483	214,763	217,042	219,321	221,600	221,600
Served household	63,698	64,389	65,080	65,770	66,461	67,152	67,152

10.4.3 QUANTITY OF WASTEWATER

Similar to the served population, the quantity of wastewater was assumed to increase linearly from the present value to the estimated value in 2010, and since ever to remain at the level in 2010. Non-domestic wastewater is composed of commercial, institutional and industrial ones.

The estimated quantities of domestic and non-domestic wastewater are as follows.

Table II.10.4 Quantity of Domestic and Non-domestic Wastewater

(Unit : 1,000 m^3/year)

Year	2005	2006	2007	2008	2009	2010	from 2011
Domestic	18,507	18,795	19,085	19,376	19,670	19,966	19,966
Non-domestic	13,659	13,919	14,179	14,441	14,702	14,965	14,965

The coefficient *b*, the ratio of non-domestic sewerage charge to domestic one, was estimated 1.94 based on the values in 1998 and 1999.

10.4.4 HOUSEHOLD INCOME

The average monthly household income was estimated at ROL 1,643,600 as of 1999 based on the result of the people's awareness survey conducted in this study. It was assumed to grow 3 % per year until 2010, and to remain the level of 2010 whereafter. The annual household income was calculated by multiplying the monthly value with 12.

The estimated average annual household income is as follows.

Table II.10.5 Average Annual Household Income

(Unit : 1,000 ROL/year)

Year	2005	2006	2007	2008	2009	2010	from 2011
Annual Household Income	23,551	24,257	24,985	25,734	26,506	27,302	27,302

10.4.5 COLLECTION RATE

The charge collection rate was assumed to linearly increase from 58% in 1999 to 95% in 2010, then remain 95% ever since.

The collection rate of sewerage charge was estimated as follows.

Table II.10.6 Sewerage Charge Collection Rate

Year	2005	2006	2007	2008	2009	2010	from 2011
Collection Rate	78.2 %	81.5 %	84.9 %	88.3 %	91.6 %	95.0 %	95.0 %

10.5 PREPARATION OF ALTERNATIVES

10.5.1 External Financial Sources

Following four (4) alternatives of external financial sources were analyzed.

- Alternative I: EBRD covers 70 % of the total investment cost.
- Alternative II: EBRD covers 50 % of the total investment cost, and ISPA does 50% of that.
- Alternative III: EBRD covers 30 % of the total investment cost, and ISPA does 70%of that.
- Alternative IV: JBIC covers 70 % of the total investment cost.

10.5.2 Level of Lease Fee

Following two (2) alternatives of lease fee level were analyzed.

- Alternative A: 100 % of repayment of principal and interest, and depreciation cost
- Alternative B: 50 % of repayment of principal and interest, and depreciation cost

The alternative A is equivalent to be the case in which all the cost related to the construction and large scale rehabilitation will be borne by the users. Under the alternative B, the Braila City should absorb 50 % of the cost related to the construction and large scale rehabilitation.

10.5.3 Level of Sewerage Charge

The people's awareness survey conducted in this study revealed that the average household's monthly willingness to pay for sewerage services was ROL 13,015 as of 1999, equivalent to 0.80 % of the average monthly household income. On the other hand, the World Bank recommends 2.00 % of a household income as the affordability limit for sewerage charge. The adequate level of the charge seems between the former and the latter.

Currently, the monthly sewerage charge per household is equivalent to 0.44 % of the income. According to the preconditions and assumptions mentioned before, this portion was deducted from the revenue of this financial plan. It means that the following charge levels are increment values of sewerage service charge.

Following three (3) alternatives of sewerage charge level were analyzed.

- Alternative 1: Minimum level. 0.36 % (= 0.80 % – 0.44 %) of the income
- Alternative 2: Mean level. 0.96 % of the income
- Alternative 3: Maximum level. 1.56 % (= 2.00 % – 0.44 %) of the income

10.5.4 Prepared Alternative Cases

In total 24 alternative cases, which were combination of the abovementioned alternatives, were analyzed. The case code was assigned like 'Case IA1', 'Case IIIB2', and so on. For example, Case IA1 means a combination of the alternative I for external financial sources, the alternative A for lease fee, and the alternative 1 for sewerage service charge.

10.6 PROPOSED FINANCIAL PLAN

10.6.1 RESULT OF ALTERNATIVE STUDY

The financial statements were prepared for the abovementioned 24 alternative cases. The structure of applied financial statements is as follows.

Table II.10.7 Structure of Applied Financial Statements

R.A. APTERCOL account	
Revenue	A
Operation and maintenance cost	B
Lease fee	C
Profit before tax	D = A – B – C
Corporate tax	E = D × 0.38
Profit after tax	F = D – E
Working capital	G = F
Cumulative working capital	H = Σ G
City's sewerage service account	
Revenue from lease fee	I = C
Depreciation	J
Payment of interest	K
Profit	L = I – J – K
Loan	M
Subsidy from general budget	N
Depreciation	O = I
Sources	P = L+M+N+O
Investment cost	Q
Payment of principal	R
Applications	S = Q + R
Working capital	T = P – S
Cumulative working capital	U = Σ T
City's general account	
City general revenue	V
Corporate tax from R.A. APTERCOL	W = E
Revenue from lease fee	X = I
Total current revenue	Y = V + W + X
Subsidy	Z = N
Subsidy ratio	AA = Z/Y
Repayment ratio	AB = (K + R)/Y

The result of the alternative study is shown in *Table II.10.8*. Major findings are as follows.

- It is not possible for R.A. APTERCOL to run the service with the minimum level of sewerage service charge.
- If Braila City can shoulder 50 % of repayment and depreciation, R.A. APTERCOL can run the service with the mean level of sewerage service charge, except the Case IIB2.
- If more than 50 % of the investment cost is covered by ISPA, the maximum charge level enables R.A. APTERCOL to render a sustainable WWTP operation even with the lease fee covering 100 % of repayment and depreciation.

Table II.10.8 Result of Financial Alternative Study for Braila WWTP Project

Case I: EBRD 70%			R.A. APTERCOL		Braila City	
Lease fee	Sewerage charge level	Case code	Sustainability	Profit rate	Repayment criterion	Max subsidy ratio
100% of depreciation and repayment	Minimum (0.36 % of income)	Case IA1	×	-432.0%	× (ave. 24.4%)	
	Mean (0.96 % of income)	Case IA2	×	-99.5%	× (ave. 24.4%)	
	Maximum (1.56 % of income)	Case IA3	×	-22.8%	× (ave. 24.4%)	
50% of depreciation and repayment	Minimum (0.36 % of income)	Case IB1	×	-195.8%	× (ave. 27.9%)	36.2%
	Mean (0.96 % of income)	Case IB2	×	-10.9%	× (ave. 27.9%)	36.2%
	Maximum (1.56 % of income)	Case IB3	○	19.7%	× (ave. 27.2%)	35.6%

Case II: EBRD 50% + ISPA 50%			R.A. APTERCOL		Braila City	
Lease fee	Sewerage charge level	Case code	Sustainability	Profit rate	Repayment criterion	Max subsidy ratio
100% of depreciation and repayment	Minimum (0.36 % of income)	Case IIA1	×	-353.2%	× (ave. 18.2%)	
	Mean (0.96 % of income)	Case IIA2	×	-69.9%	× (ave. 18.2%)	
	Maximum (1.56 % of income)	Case IIA3	×	-4.6%	× (ave. 18.2%)	
50% of depreciation and repayment	Minimum (0.36 % of income)	Case IIB1	×	-156.4%	× (ave. 20.4%)	28.4%
	Mean (0.96 % of income)	Case IIB2	×	1.4%	× (ave. 20.4%)	28.4%
	Maximum (1.56 % of income)	Case IIB3	○	25.3%	× (ave. 19.7%)	27.7%

Case III: EBRD 30% + ISPA 70%			R.A. APTERCOL		Braila City	
Lease fee	Sewerage charge level	Case code	Sustainability	Profit rate	Repayment criterion	Max subsidy ratio
100% of depreciation and repayment	Minimum (0.36 % of income)	Case IIIA1	×	-274.3%	○	
	Mean (0.96 % of income)	Case IIIA2	×	-40.4%	○	
	Maximum (1.56 % of income)	Case IIIA3	○	8.0%	○	
50% of depreciation and repayment	Minimum (0.36 % of income)	Case IIIB1	×	-117.0%	○	20.3%
	Mean (0.96 % of income)	Case IIIB2	○	11.3%	○	20.3%
	Maximum (1.56 % of income)	Case IIIB3	○	31.0%	○	19.5%

Case IV: JBIC 70%			R.A. APTERCOL		Braila City	
Lease fee	Sewerage charge level	Case code	Sustainability	Profit rate	Repayment criterion	Max subsidy ratio
100% of depreciation and repayment	Minimum (0.36 % of income)	Case IVA1	×	-394.2%	○	
	Mean (0.96 % of income)	Case IVA2	×	-85.4%	○	
	Maximum (1.56 % of income)	Case IVA3	×	-17.0%	○	
50% of depreciation and repayment	Minimum (0.36 % of income)	Case IVB1	×	-176.9%	△ (ave. 17.9%)	16.1%
	Mean (0.96 % of income)	Case IVB2	×	-6.9%	△ (ave. 17.9%)	16.1%
	Maximum (1.56 % of income)	Case IVB3	○	22.4%	○	15.6%

Legend :
○ = Meet the requirement, △= Slightly fail to meet the requirement, × = Not satisfy the requirement.
Sustainability : Cummulative working capital in any year > 0
Profit rate : Ratio of an average profit after tax to an average revenue over the project period
Repayment criterion : Total repayment of each year should be less than 20% of current revenue of the city (ave. means average of the ratio over the project peri
Subsidy ratio : Ratio of subsidy (depreciation + repayment - lease fee) to current revenue of the city

- If more than 50 % of the investment cost is covered by EBRD, the ratio of the repayment to the city's current revenue will exceed 20 %, which may jeopardize an issuance of the state guarantee for the loan.
- The maximum ratio of the city's subsidy to the city's current revenue is dominated by the external financial source. The higher interest rate and shorter repayment period of EBRD make it difficult for the City to subsidize R.A. APTERCOL.

10.6.2 PROPOSED FINANCIAL PLAN

Accessibility to the external financial sources of each city council highly depends on the Government's policy and the policy of the external financial sources. Those policies also vary time to time. If the study proposes a financial plan with fixing a financial source and a city council fails to access to the proposed financial source, the proposed financial plan does not work any longer. Thus, it would not be realistic to propose a financial plan with a fixed financial source.

Therefore, the study proposes the financial plans by the financial arrangements discussed in the previous section. In the preparation of the financial plans, following general rules were set out:

- To secure a sustainability of a private company, the lease fee and sewerage charge level are set out so as to keep the cumulative working capital being over zero in any year.
- To secure the progress of the privatization, the lease fee and sewerage charge level are set out so as to generate a profit more than 5 %.
- As far as the case does not require an exemption of the repayment criteria, the lease fee is set at 50%. This reflects an idea that users paying all the costs including the investment costs is a grinding charge system as beneficiary of the wastewater treatment are not limited to the users.
- In case where the exemption is required, the 100 % lease fee is adopted to show efforts of the user side to convince the state to apply the exemption.
- Satisfying above rules, a sewerage charge is set at a milder level.

The proposed financial plan for each financial arrangement is summarized in *Table II.10.9*. Since the repayment period of the EBRD loan is rather short and its interest is high, the annual repayment exceeds the repayment criteria, except Case III. Therefore, utilization of EBRD loan would require exemption of the repayment criteria.

Table II.10.9 Proposed Financial Plan

Case	Financial arrangement	Lease fee	Sewerage charge	Remarks
I	70% EBRD + 30% Self-financing	50% of depreciation and repayment	Maximum level (1.56 % of income)	Over repayment criteria
II	50% EBRD + 50% ISPA	50% of depreciation and repayment	Maximum level (1.56 % of income)	Over repayment criteria
III	30% EBRD + 70% ISPA	50% of depreciation and repayment	Mean level (0.96 % of income)	
IV	70% JBIC + 30% Self-financing	50% of depreciation and repayment	Maximum level (1.56 % of income)	

10.6.3 FINANCIAL ANALYSIS BY CONVENTIONAL METHOD

The proposed financial plans were prepared to be feasible from the viewpoints of financial sustainability and privatization possibility of R.A. APTERCOL, financial capacity of the city's budget, and the applicability of the state guarantee for external loans. For the preparation of feasible financial plan, profit and loss statements and cash flow statements were prepared for alternative cases. This method makes financial analysis more realistic and more detail.

Conventional method of financial analysis requires only the revenue and expenditure of the project. For the comparative purpose, FIRR (Financial Internal Rate of Return), which is one of indicators of conventional financial analysis, was calculated.

The revenue of the project is collected sewerage charges, which vary according to a level of the sewerage charge. FIRR was calculated with the maximum and the mean levels of the charge.

As a result, FIRRs are not available at either the mean level or the maximum level of sewerage charge.

The result reveals the difficulty in implementing sewerage services with full financial independence. In other words, it shows the necessity of a certain level of financial assistance from public sector such as a subsidy for construction cost.

CHAPTER 11 ENVIRONMENTAL IMPACT ASSESSMENT

11.1 OBJECTIVES

A preliminary Environmental Impact Assessment (EIA) has been conducted under the Study based on the Romanian regulations.

The objectives of the EIA are as follows:

- To review the existing environmental conditions in EIA study area;
- To assess environmental impacts of the proposed projects; and
- To propose countermeasures for mitigating impacts and environmental monitoring plan.

The existing environmental conditions in/around the project site and the evaluation of impacts due to the proposed project are summarized in *Table II.11.1*. The countermeasures for mitigating and environmental monitoring plan are recommended in *Table II.11.2*.

11.2 NATURAL/ENVIRONMENTAL IMPACTS

Water Quality Improvement: Poor wastewater disposal practices are one of the major causes of pollution in the region. The disposal of raw wastewaters to the Danube River and reliance on on-site wastewater disposals have resulted in pollutant loads in the waterways and the Danube River. Improvement in the quality of water in the Danube River will reduce the level of pollutants significantly, including heavy metals and other hazardous materials. Because of the expected reduction of the major pollutant loads from the sewerage system, the public living conditions, as well as fauna and flora in the area, will be improved.

Topography, Geology and Hydrological Impacts: Construction of the WWTP and relating facilities may not affect adversely to natural conditions of the surrounding areas. Topographic and geological changes due to the construction works will be minimal, and may not cause significant adverse impacts to the surrounding areas.

Temporary Hazards: Although during the construction stages, some limited areas near the construction sites or along the major roads may be affected by dusts, noise or vibrations to some extent, but these can be prevented by careful controlling measures.

11.3 ECONOMIC AND SOCIAL IMPACTS

As summarized in *Table II.11.1*, each of environmental parameters has been assessed and evaluated from the viewpoints of economic, socio-economic, physical-chemical, ecological, and aesthetic aspects.

Domestic Users: Residential areas will be served by a combination of interceptors and sewerage. This, in combination with the collection and treatment of industrial wastewater, will reduce the amount of pollutants flowing into the waterways and finally to the Danube River. The major benefits for residents will be a reduction in noxious odors and, if combined with improvement of public health, a reduction in water-related disease.

Industrial Users: An improved wastewater system will result in reduced overall costs for factories in comparison to onsite treatment, although it will mean higher operating costs for factories that are currently spending inadequate amounts on treatment or have no treatment facility at all. Factories and commercial operations will also be required to pay for the costs of their connection to the sewers. Overall, however, operating costs are likely to comprise a relatively small proportion of factory turnover.

Negative Impacts: Although every effort has been and will be made for the planning, design and construction of an optimum system, and proper methods and schedules for the construction works of the project facilities, it may not be possible to completely eliminate the impacts due to the project implementation. Such residual or unavoidable impacts in the future, although not significant, may include as follows.

- Increase in traffic volume along the roads connecting the new WWTP,
- Increase of demand for electricity of WWTP operation, and
- Loss of agricultural production due to conversion of the agricultural lands to the new WWTP site.

11.4 OVERALL REMARKS

As shown in *Table II.11.1*, the assessment has resulted that the overall project appears to be well planned to achieve maximum benefits for the local people, which will surely enhance socio-economics and quality-of-life values of the region.

The assessment results can be summarized as follows:

- The proposed project as a whole has positive environmental impacts in the area's water environment and the public health of the residents in the City through the improved service standards for the wastewater management;
- Construction or improvement activities for sewers, pumping stations and wastewater treatment plant throughout the project area may cause nuisances to the residents, but such hazards could be limited by giving careful considerations on the methods of construction and proper management of the sewerage system; and
- Connection of the wastewater currently being discharged to the public waterways to the sewer system will significantly improve the water quality in the Danube River;
- The beneficial effects of the project outweigh the adverse effects; and
- As certain items in the preliminary EIA need to be further clarified from engineering viewpoints, further studies will be made on the extent of impacts, mitigation and remedial measures, including the impacts possibly caused by the construction, operation and maintenance works of the WWTP and related facilities.

Table II.11.1 Existing Condition and Evaluation of Impacts by Proposed Project in Braila (1/2)

Item	Survey Results	Evaluation of Impacts
1. Economic Activities	The proposed WWTP site (around 16 ha) now is used as agricultural field. The production losses caused by the proposed WWTP construction is estimated to be about 47 million Lei or 3,000 US $ per year, and can be negligible.	O
2. Public Health Condition	The results of wastewater characteristics survey at existing outfall revealed that the number of total Coliform Group in raw wastewater, which now is discharged directly into Danube River, is about 2.4×10^6 no./100ml to 2.4×10^3 no./100ml. While the number of total Coliform Group in Danube River (1 km downstream from the outfall of proposed WWTP) is 2.8×10^3 no./100ml to 3.5×10^3 no./100ml, which exceeded the standard (1×10^2 no./100ml, STAS 12585/1987) of water for swimming purposes. According to the F/S Study after WWTP being put into operation the existing outfall will be closed and wastewater will be collected and treated at WWTP. The number of total Coliform Group in WWTP effluent will be meet the standard (1×10^6 no./100ml, NTPA 001) of wastewater discharged in water resources. Hence, during WWTP operation stage the public health condition will be improved certainly.	O
3. Waste	According to the City's estimate, the existing solid waste disposal site is capable of receiving the present level of solid wastes until 2002. A construction plan of new solid waste disposal site is now under consideration, which will be provided with polyethylene liners at the bottom. The collected leachate will be brought with trucks to the public wastewater system for the final treatment. The results of wastewater characteristics of leachate from SWDS in Braila indicated that the concentrations of the organic substances (BOD_5: 3,824 mg/l, COD_{Mn}: 7,742 mg/l), NH_4-N (592 mg/l) and oil (528 mg/l) have exceeded the standard (NTPA 002/1997) of wastewater discharged into municipal sewage system substantially. Meanwhile, the number of total Coliform Group in the leachate is also relative high (3.5×10^3 no./100ml). All of these may contribute a negative impact on groundwater. Therefore, it is necessary to complete the new solid waste disposal site that will be properly designed and managed from the environmental viewpoint before Braila WWTP is put into operation, taking into account the groundwater pollution problem and the volume of excess sludge (63 m^3/d or 13 t/d) generated from WWTP.	△
4. Hazards (Risk)	Based on the results of geological survey, a careful aseismatic structure design will be considered in the planning and design of the wastewater treatment facilities.	O
5. Topography and Geology	Based on the results of geological survey, a careful aseismatic structure design will be considered in the planning and design of the wastewater treatment facilities.	O
6. Groundwater	The results of groundwater survey in/around the solid waste disposal site indicated that the number of Coliform Group ranged from 1.6×10^2 no./100ml (upstream) to 2.4×10^4 no./100ml (downstream), which already exceeded the standard (under 10 no./100ml, STAS 1342/1991) for drinking water. Hence some countermeasures for protecting groundwater from pollution should be considered.	△
7. Hydrological Situation	The effluent flow of WWTP is insignificant comparing with the flow of Danube River, so the effects of effluent on hydrological situation of the River are negligible. In addition, the pollutant diffusion and dilution characteristics are analyzed using "MIKE 11" model, the calculation results indicated that complete mixing is achieved at a distance of 2 km downstream of WWTP outfall in all cases studied here.	O
8. Fauna and Flora	Now the raw wastewater is discharged directly into Danube River, after the WWTP being put into operation, there will be no change about flow rate. In addition, as mentioned in Water Pollution Item the pollutants load will be reduced substantially. Therefore, it is expected that the living conditions of fauna and flora will be improved by implementing the Project.	O

Table II.11.1 Existing Condition and Evaluation of Impacts by Proposed Project in Braila (2/2)

Item	Survey Results	Evaluation of Impacts
9. Water Pollution	The results of industrial wastewater survey revealed that the concentrations of toxic materials, which may effect biological process for wastewater treatment, are under the standard of NTPA 002/1997. This can leads the conclusion that industrial wastewater will don't contribute a significant impact on WWTP influent characteristics. According to the F/S Study 4,651 tons of BOD_5 and 5,509 tons of SS per year (2010) will be no more discharged into Danube River, so the impacts on the water quality during WWTP operation will be a positive one. Moreover, 715 tons of BOD_5 and 930 tons of SS per year (2010) will be discharged into Danube River with WWTP effluent. Based on the results of simulation the maximum concentrations of BOD_5 and SS at downstream of complete mixing section (about 2 km downstream from the outfall of proposed WWTP) will be under the Maximum Allowable Concentration (MAC) of first quality category in STAS 4706/1998 (surface water quality).	O
10. Soil Contamination	According to the analysis results of soil (WWTP site, solid waste disposal site and agricultural field) and sludge generated in existing WWTP of Roman and Constanta, the heavy-metal concentrations in soil samples and sludge samples are under the Romania Standard. This creates a possibility to utilize excess sludge in agriculture.	O
11. Offensive Odor	The survey results revealed that the concentrations of H_2S (0 mg/m^3), NH_3 (0.105 mg/m^3) and odor level (Level 1) on the WWTP boundary fence are under Romania Standard 12574/1987 (H_2S: 0.015 mg/m^3, NH_3: 0.3 mg/m^3 and odor level: Level 5). The results of existing WWTP survey in Constanta are presented as following: Item / WWTP boundary fence / 150 m from WWTP boundary fence H_2S / 0.35mg/m^3 / 0.033 mg/m^3 NH_3 / 0.3mg/m^3 / 0.10 mg/m^3 Odor Level / 4 / 3 Finally it is evaluated that the offensive odor levels at adjacent areas to the WWTP site would generally be within acceptable levels, considering the facts that the nearest human settlement is located at more than 300 m from WWTP.	O

O: nothing or negligible
△: not serious or minor

Table II.11.2 Countermeasures for Mitigating and Environmental Monitoring Plan in Braila

Impact Item	Countermeasure
1. Groundwater and Waste	A new solid waste disposal site is necessary to be completed before Braila WWTP is put into operation, taking into account the volume of excess sludge (63 m^3/d or 13 t/d) generated from WWTP. Groundwater insulation-type landfill disposal plant is recommended to protect groundwater from polluting. In this case it is recommended to install the leachate collecting system and to discharge leachate after to be treated, especially disinfection treatment. The groundwater quality (at least Cl^-, COD_{Mn}, Coliform Group and typical heavy metals) should be checked 2 to 4 times per year in order to understand the change of groundwater quality. With the background that an increase in agricultural utilization and incineration and a reduction of landfill for sewage sludge is forecast, it will be recommended to consider incineration or the utilization of sewage sludge in agriculture. In this case the load limiting values of EU Sewage Sludge Directive can be applied as alternative to sewage sludge limiting values in order to maintain the soil limiting values of heavy metals. The characteristics (Cd, Cr, Cu, Pb, Hg, Ni and Zn) of dewatered sludge from WWTP should be checked at least 4 times per year.
2. Water Pollution and Public Health Condition	It is recommended to establish a monitoring system to check the water quality of Danube River at main swimming area, intake for water supply as well as the downstream reach from WWTP outfall. The detail plan (such as monitoring point, analysis items and sampling frequency etc.) should be made in cooperation with the Braila Municipality.

CHAPTER 12 PROJECT EVALUATION

12.1 TECHNICAL FEASIBILITY

At present Braila City has no functional wastewater treatment plant system. Most of the households and communities in the City rely on the sewerage system, whereas many of the large-scale industries operate pretreatment or complete treatment facilities before discharging industrial wastewaters to either public sewerage system or directly to public waterways.

The existing combined sewerage system is utilized for collection of domestic, commercial, institutional and industrial wastewaters, and during wet weather stormwater runoffs. All the collected raw wastewaters discharged either by gravity or pumping stations to the Danube River through outfalls of four major and eight other small collectors, is a major pollutant source to the river water. Under circumstances, there is an urgent need to implement a comprehensive wastewater collection and treatment system plan to alleviate the worsening environmental situation in the area.

The elaborated wastewater management strategy plan is based on the maximum use of the existing combined sewers and new interceptor sewers proposed along the Danube River left bank, which will involve collection of the wastewater and stormwater inflows. The activated sludge treatment plant is planned to treat all the collected wastewater flows up to the level of secondary process. During wet weathers, up to two times the dry weather wastewater flows, commingled with stormwater, will be conveyed to the treatment plant to receive treatment.

The proposed Project forms the least-cost long-term strategy plan up to 2010, and will serve the total population of 216,600 in the built-up urban districts, collecting and treating up to the maximum daily flow of 115,000 m^3/day wastewater, which include industrial wastewater of 29,200 m^3/day.

Upon completion of the wastewater system project, the estimated organic loads of 13,100 kg/day BOD and 15,540 kg/day SS, would be reduced by more than 90 percent or 11,789 kg/day and 13,986 kg/day respectively, which would otherwise be discharged directly to the Danube River.

The reduction of the level of the polluted water reaching the Danube River will improve the quality of environment and life for those living near the waterways and the River. Improving the disposal of industrial and domestic wastewater will also contribute to improvement in the beneficial uses from the waterways, such as freshwater fisheries and aquaculture, water transport and use of water for irrigation and industrial purpose.

12.2 ECONOMIC FEASIBILITY

12.2.1 ECONOMIC BENEFITS

In general, expected benefits of wastewater management projects are as follows.

- Sanitary improvement by eliminating untreated wastewater from roadside ditches
- Additional water uses due to water quality improvement of sewage recipient watercourse
- Amenity improvement due to water quality improvement of sewage recipient watercourse

In the Study, however, it is difficult to expect these benefits. First, sewer networks have been installed in the Study Area and there are no sanitary problems caused by wastewater. Second, flow quantity of Danube River downstream reach is so huge that expected positive impact of the Project could not result in additional water use.

A positive impact of the Project is supposed to be contribution to nature conservation and environmental protection of Danube Delta. Therefore, the study adopted a method to estimate the project benefits by a value of the positive impact to the nature conservation.

To estimate the value of the impact, questionnaire surveys were conducted in ten cities in Romania. The surveys asked the people about their willingness to pay (WTP) for the implementation of policies to contribute to the protection of the Danube Delta. The obtained WTP can be considered to represent the value of the positive impact, that is project benefits.

The economic benefits of the project are estimated as follows.

Table II.12.1 Estimated Economic Benefits

	Annual distribution	Total distribution
Economic benefit	325,529 million ROL	1,627,646 million ROL

12.2.2 Economic Analysis

Based on the economic benefits calculated above and the cost estimated hereunder, economic analysis was performed.

Preconditions and assumptions applied are as follows:

- Currency unit is ROL and the value of ROL is expressed at the June 1999 prices.
- Project Life: 30 years since the start of project implementation.
- Target Year: 2010. From 2010 on the values of O & M cost variables are assumed to keep the 2010 level.
- Implementation Period: 5 years 2000 to 2004.
- OCC (Opportunity Cost of Capital): 10%.
- Conversion factor: 98.4% to capital cost (initial and replacement cost) taking account of customs duty for foreign components.

The economic costs, which comprises of three types of costs, were determined as follows:

Table II.12.2 Economic Costs

Initial Cost						Replacement Cost	O & M Costs
2000	2001	2002	2003	2004	Total		
36,785	154,174	216,161	238,179	178,679	823,978	196,800	8,790

(Unit: million ROL)

Economic criteria, EIRR (Economic Internal Rate of Return), NPV (Net Present Value) and B/C (Benefit Cost ratio) were calculated as shown in *Table II.12.3.*

Table II.12.3 Calculated Economic Indicators

NPV (million ROL)	B/C	EIRR (%)
26,168	1.03	11.6

Results of the sensitivity analysis are as shown in *Table II.12.4.*

Table II.12.4 Result of Sensitivity Analysis

Conditions	EIRR (%)	NPV (million Lei)	B/C
Costs: +20%	NA	- 137,167	0.86
Costs: +10%, Benefits: -10%	NA	- 139,784	0.84
Benefits: -20%	NA	- 142,401	0.83

12.2.3 EVALUATION

For the base conditions, the project is judged economically feasible, while the results of the sensitivity analysis indicate it vulnerable. Considering nature of the project, that is, it does not have direct benefits, the study judges the project economically feasible.

12.3 FINANCIAL FEASIBILITY

The study proposed the financial plans that make the operation of the projects financially feasible, on condition of a certain level of subsidy to the investment costs. This is because that financial affordability of the users and the city council have not become yet high enough to pay all the investment costs for the wastewater treatment plant. Therefore, conventional financial analysis, in which a total of the investment costs and operation costs, despite that some portions of the investment costs to be subsided, is compared to the revenue, a total of sewerage charge collected, did not indicate the financial feasibility.

However, the proposed financial plans showed financial soundness and operational sustainability of the private company and the city council. Therefore, the study judged that the project is financially feasible on condition of the provision of subsidy.

12.4 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The Preliminary EIA has resulted that the overall project appears to be well planned to achieve maximum benefits for the local people, which will surely enhance socio-economics and quality-of-life values of the region, thus it is judged the project is environmentally feasible.

The assessment results can be summarized as follows:

- The proposed project as a whole has positive environmental impacts in the area's water environment and the public health of the residents in the City through the improved service standards for the wastewater management;
- Construction or improvement activities for sewers, pumping stations and wastewater treatment plant throughout the project area may cause nuisances to the residents, but such hazards could be limited by giving careful considerations on the methods of construction and proper management of the sewerage system; and
- Connection of the wastewater currently being discharged to the public waterways to the sewer system will significantly improve the water quality in the Danube River;
- The beneficial effects of the project outweigh the adverse effects; and
- As certain items in the preliminary EIA need to be further clarified from engineering viewpoints, further studies will be made on the extent of impacts, mitigation and remedial measures, including the impacts possibly caused by the construction, operation and maintenance works of the WWTP and related facilities.

CHAPTER 13 CONCLUSION AND RECOMMENDATION

13.1 CONCLUSION

The study proposed the construction of the WWTP together with the installation of interceptors necessary to convey wastewater from existing sewered areas to the proposed WWTP. The proposed wastewater treatment employs a conventional activated sludge method, which is one of the basic biological treatments, and could treat the wastewater currently discharged into the Danube River without treatment, to the water quality levels to meet the international requirements, except T-N and T-P.

The feasibility study brought out the technical, economic, and environmental feasibility of the proposed projects, however, the Study revealed financial difficulty in the implementation of the projects. The initial investment cost for the construction of the wastewater is too heavy financial burden for the present city's financial conditions. Therefore, the Study evaluated the financial feasibility, premising the following financial and institutional supports from the state:

- Acceptance of the utilization of state guaranteed external loans.
- Exceptional provision for the aforementioned repayment criterion.
- Application of special subsidy to sewerage development projects

These supports seem to run counter to the spirit of the recent legislative reform that encourages financial independence of local public works from the state. It would be a quite right direction to expand the autonomy of local municipalities and to entrust local public works to the local municipalities' initiative as much as possible.

On the other hand, the state faces to necessity of the development of the wastewater treatment in the country to meet the EU Directives as the EU applicant country, and is internationally responsible for the development of the wastewater treatment along the Danube River. The development of the wastewater treatment could be one of the higher priority policies of the state. As revealed in the Study, the development of the wastewater treatment is too heavy financial burden for the local municipalities of which economy has not grown up enough. If the development is left in the local municipalities' initiative without any guidance and supports by the state, no considerable progress would be expected.

As long as the affordability of the local municipalities remains not enough to develop their wastewater treatment by themselves, the state should take the initiative in order to realize the state policy. Therefore, the Study considered it justifiable to provide the support as tools of the state initiative for the wastewater treatment development, despite of the sprit of the legislative reform.

13.2 RECOMMENDATION TO THE CITY COUNCIL

The Study concluded that the construction of the wastewater treatment plant is feasible. While the state support is essential, the city council should take the first action to realize the project.

The first action would be to take a decision of the implementation of the project. As mentioned above, the project would cause a heavy financial burden and would limit the implementation of other new projects. Every effort to squeeze out the self-financing sources should be done. Process and results of the efforts could be one of means to convince the state to provide the supports. While it is a matter of fact that the project would not work out without the state supports, it should be reminded that the project is not started by the state support but by the city council's initiative.

The Study proposed several options of financial plans by the financial arrangements. Availability of the foreign financial sources depends on the policy of the both recipient country and financing agency. To start seeking for possible finical source will be one of the city council's initiatives. It is suggested that ISPA fund may be the most preferable as it is a grant. The Study provided the city councils with information necessary for the application of such financial sources.

13.3 RECOMMENDATION TO THE STATE

As long as Romania is the EU applicant country, the state should take an initiative to develop the wastewater system in the country. The Study considers that the state supports in terms of financial and institutional assistance are essential for the city council to implement the proposed project, comparing required project costs and the city council's financial capability.

The state is required to provide an arrangement for the state guaranteed external sources, because terms of external loans without the state guarantee are far exceed the city councils' affordability. Also, the state is required to provide exceptions of repayment criterion that is one of conditions for the state guarantee external loans. As explained in the financial plan in this report, the Study proposed a sustainable financial plan that proves capability of a operation company to pay lease fee, which covers all repayment amount and depreciation, to a city council. The Study considers that it is possible to exempt the repayment criterion on security of the financial plan.

Furthermore, the state should provide a subsidy that supplements a self-financing portion of the investment cost. Even if the city council can utilize the state guaranteed external loan, most of the city councils would have a great difficulty in procuring the self-financing portion. A source of such subsidy may be very limited in the state budget. Therefore, the state should have a plan to prioritize city councils for the sewerage development. The proposed subsidy could work as a tool for the state to exert the initiative for the sewerage development. The seven (7) cities in the study area are to have higher priority in the development plan because of their location, which is along the Danube River.