4.3

PRELIMINARY DESIGN OF MUNICIPAL WASTEWATER TREATMENT WORKS

4.3 Preliminary Design of Municipal Wastewater Treatment Works

4.3.1 Wastewater Treatment Requirement

The municipal wastewater treatment requirements for the three priority project towns of Pazardjik, Dimitrovgrad and Stara Zagora are studied.

The criteria for preliminary design for planning wastewater treatment works at the three-(3) towns are planned as follows:

(1) Qualitative Requirements

It is essential for treating the Municipal Wastewater to satisfy the requirements of Standards of the EC Urban Wastewater Directive. The current Bulgarian River standard is also applied, but the requirement is far less onerous.

As applied to the treatment works for the towns under consideration, it is generally an effluent standard equal to or better than:

- BOD5 25 mg/l
- SS 35 mg/l

Normal physical and 'BOD5' removal treatment process are recommended. Nutrient removal is not considered here. They are not required under the EC Urban Wastewater Treatment Directive.

(2) Population to be served

The Municipal populations within the areas to be served at the 3 towns is as follows:

TABLE 4.3.1 ULTIMATE POPULATION TO BE SERVED

Location	Census Figures In 1992	Growth Rate to year 2015 %	2015
Pazardjik	80,921	20%	97,100
Dragor	1,433	15%	
Jvaylo	3,345	15%	3,848
Dobrovnitza	1,526	15%	
Mokrishte	2,188	15%	
Glavinitza	2,733	15%	
Mirantzi	686	15%	
TOTAL			100,948
Dimitrovgrad	45,573	20%	54,688
Tchernokonevo	3,172	20%	
Vulkan	840	18%	
Marino	2,389	18%	
Mlada Gvadia I	505	18%	
Mlada Gvardia II	1,670	26%	
TOTAL			54,688
Stara Zagora	149,666	10%	164,600
	Estimate:		
Bogomilovo	1,383	5%	
Zora	5,622	10%	
K. Gantchevo	5,174	10%	
TOTAL			164,600

NB: For consistency of presentation, the population projections are based on the 1992 Census data and the general growth rates forecast. These should be re-appraised at the detailed design stage: especially at Stara Zagora where recent migration into the town may be cause for revision (The town reports a 1998 population of 172,181)

4.3.2 Recommended Treatment Works Needs in the Foreseeable Future (To 2015)

It is pointed out that there are many unknown factors in the actual conditions and behavior of the existing combined sewer systems.

We are recommending, however, in view of current regional economic constraints, that the three (3) towns base on their works sizes ONLY for their immediate needs: It is recommended that no further investments would be made in the sewer system expansion before execution of adequate rehabilitation of the existing sewer system. Otherwise, there is a risk of ineffectual investment.

Therefore the preliminary designs (and costs) have based on treatment facilities sized only sufficient for:

- Treatment provided for the urban areas at present connected to the main town sewer system
- Exclusion of all industrial effluents (diversion and/or treatment separated from the Municipal Works)
- Assuming 'space' for the expansion needed when the town is able to fund its full system expansion plans and after rehabilitation.

The 'Wastewater Treatment Works' designs developed for the Feasibility Study are summarized in Table 4.3.2 & 4.3.3

Practically speaking, there is a possibility that the industrial wastewater with similar quality of domestic wastewater from medium and small size industries in the service area of the proposed municipal WWTPs might be discharged into sewerage networks. In this case, the design wastewater volume with medium and small size industries will be about 1 to 4 % larger than the design wastewater volume without industries. This difference can be judged at very small and will not affect the size of the proposed three WWTPs.

However, in the case of inclusion of the industrial wastewater from medium and small size industries, it is essential that the wastewater quality is similar to the quality of domestic wastewater and that at least pre-treatment should be conducted before discharging into sewers. Furthermore, large industries, as well as industries with different wastewater quality from domestic wastewater should treat their wastewater by themselves to meet the requirement of effluent standard.

4.3.3 Sludge Disposal

Sludge disposal is an essential part of the Municipal Wastewater Treatment Operational Program.

At the planning stage the economics and practicalities of the treatment works sludge separation, treatment, transit and disposal can have a profound influence on the towns' wastewater policy and treatment requirements, e.g., certain industrial discharges may render the wastewater sludge difficult to separate out, costly to treat and even very costly to dispose of.

Current Bulgarian wastewater planning seems to assume that all Municipal sludge can be 'landfilled' without full consideration of options such as forcing pre-treatment of toxic discharges, and the obvious solution of disposal to agricultural land or other recycling opportunities. Disposal to a modern properly organized landfill is expensive and the current movement for 'privatizing' Bulgarian landfills will inevitably force the Municipalities to avoid land fill costs and seek 'recycling' solutions, e.g., Ensure toxic are eliminated and dispose to land.

In Western Europe the gradual introduction of the various EC Directives has meant that around 55 % of all the Municipal sludge is at present disposed of to agriculture and forecasts are that this will have to increase to at least 70 % with the current planning Horizons.

Particular Consideration has to be given to the extent and type of treatment required 'stabilizing' the sludge and rendering it sufficiently 'safe' for agricultural re-use:

It is emphasized that no general rule can be applied, and that each 'town case' must be individually considered during the detailed design period. The end result may well be for each particular Municipality to set its own 'disposal & sludge treatment strategy' and for the wastewater treatment works designers to select the proper treatment process and sludge processing accordingly.

The Wastewater Treatment by-products to be disposed-of comprise:

A. Screenings, Fats and Oils & the heavier grits collected in the initial 'mechanical' stages of the treatment works

- These are generally collected in Skips at the site and are generally satisfactorily disposed to land fill or by burying at an approved site

B. The settled sludge and biological sludge from the Mainstream Process Units.

- The sludge treatment objectives at all 3 sites are to ensure that it is suitable for disposal to agricultural lands (Thermophillic Digestion of Activated Sludge or Stabilization within the process, e.g., In the extended aeration process) or by aging in 'open topped' digesters.
- Treatment works laboratory facilities are included in the facilities envisaged (but 'local': supply) to enable a degree of 'control' to be made over the quality and disposal process.

4.3.4 Treatment Works Sites Available

Treatment works sites are available for all three-treatment works: Bulgarian EIA's. Formal Planning Permission and Discharge Consents are in place for all three.

Although topographic and some geotechnical and environmental data was available on these sites, the JICA Study have independently carried out.

- A ground survey,
- a geo-technical drilling and sampling program,
- an environmental review of the impacts by the projects at the Treatment Works Sites

The results of the works have been satisfactory and used as the basis of our considerations.

4.3.5 Design Criteria

The design criterion used for the preliminary design is set out in Table 4.3.2.

It is emphasized that these criteria are preliminary in nature and are established in order to:

- Clarify and explain the basis of the assumptions,
- Facilitate the development of the possible preliminary designs to suit the technical requirements,
- Enable the technical feasibility to be considered,
- Establish the base from which the project planning can proceed.

These criteria should be updated in any subsequent design.

Particular Environmental Design Issues in respect of the Pazardjik Site:

During our environmental appraisal, we identified two issues, which are at variance with the Town's existing plans: These are identified below and the appropriate measures to comply with our appraisal are included in our preliminary designs.

They are:

- As it approaches the site, the partially complete Pazardjik collector comprises a large, poorly built oversized concrete tube dominating the landscape. It is an unfortunate eyesore and obstruction to the environment. It should be demolished and replaced by an underground symphonic arrangement.
- The Discharge Consent is for the Luda Yana River, a relatively small tributary of the Maritza River. We recommend that the discharge be made to the Maritza River itself, where a more satisfactory dilution will be obtainable.

4.3.6 Preliminary WWTW Proposals

Preliminary designs of our WWTP study proposals are developed for the 3 towns, working generally based on the principals of the Master Plan. They are summarized below:

Pazardjik

Conventional Activated Sludge Treatment with Screening, Grit & Oil Separation, Primary Settlement, Aeration, Final Settlement and discharge to the Maritza River.
Thermophillic Sludge Digestion.

Dimitrovgrad

Two alternatives have been considered:

A. Conventional Activated Sludge processes comprising Conventional Activated Sludge Treatment: Screening, Grit & Oil Separation, Primary Settlement, Aeration, Final Settlement and discharge to the Maritza River

Simple Sludge Treatment: Cold Digestion

B. Extended Aeration Process: Comprising Screening, Grit & Oil Separation, Recirculating Aeration tank, Settlement and discharge to the Maritza River

Table 4.3.3 evaluates these two options: The latter is recommended (less costly: simpler to operate and maintain).

Stara Zagora

Conventional activated Sludge Treatment with Screening, Grit & Oil Separation, Primary Settlement, Aeration, Final Settlement and discharge to the Bedechka River.
Thermophillic Sludge Digestion.

In illustration of these preliminary designs and confirmation at the technical feasibility of the concept, we have developed preliminary designs, hydraulic gradients, process diagrams, plans, sections and the outline sizing proposals necessary to properly explore the feasibility of the treatment

These are shown:

Drawing	Pazardjik	Dimitrovgrad	Stara Zagora
Layout Plan	Fig 4.3.1	Fig 4.3.2	Fig 4.3.3
Process Diagrams	Fig 4.3.4	Fig 4.3.4	Fig 4.3.4
Process Gradient	Fig 4.3.5	Fig 4.3.5	Fig 4.3.5
Collector Gradient	Fig 4.3.6		

4.3.7 Existing Municipal Wastewater Situation & Planning Approach

Here we examine the existing Municipal Wastewater Service Area at each of the three 'Priority Project' towns: Dimitrovgrad, Pazardjik and Stara Zagora.

In doing so we set out the respective long term plans for serving the Municipality and we look at the town's plans for all its sewerage & treatment. The 'nominal' design horizon is 2015.

In accordance with standard practice, we 'allow' for further growth (beyond 2015). The treatment plant developments studied herein are only those considered feasible for immediate development: Although the first priority for the towns is to treat their existing sewage the second is clearly to invest in the rehabilitation of their existing sewer systems before expanding them.

Our planning studies have been very much influenced by two key factors:

1. The need seen to separate out industrial wastewater from the 'equation': As explained in the Master Plan, the concept is that all industries should provide its own Treatment in due course. Accordingly, parallel 'industrial' treatment plant capacity or other solution (pre treatment etc) needs to be found. The established 'industries' are simply too 'massive' to be funded from the municipal purse and for the wastewater catered for in the Municipal plants.

2. The most urgent need to rehabilitate the sewers, track down and cut down 'unaccounted' for wastewater system inflows/'infiltration', and minimize 'exfiltration'.

This is because we have found that the existing wastewater is comprised of some 70% 'non -sewage' waster (groundwater or wastewater): There is also strong evidence that not all the

sewerage collected reaches the final collector: We think the larger city systems are badly leaking. Accordingly we are only recommending that, in the first stage, the 3 towns' treatment works only be sized for the existing 'Municipal Effluent. (i.e. the Immediately Connected Areas and *excluding the respective Industrial Estate Wastewater)*

The present municipal wastewater situation is reviewed below. Figures 4.3.1, 4.3.2 & 4.3.3 show the respective Municipal Wastewater System Service Areas at each town.

1. Pazardjik (See Fig. 4.2.10).
    - Fig. 4.3.1 shows the existing sewer service area lying on the north bank of the Maritza River with a population of 80,912. At present, some 72,829 of the town's inhabitants are connected to the sewer system. The Municipality has immediate plans to connect its Ivaylo District: A further 3,345 existing persons.
    - The Main Town Industrial Areas are principally on the south bank and are not yet connected to the main sewerage system.
    - Construction of a Wastewater Scheme for the Town's Joint Industrial & Municipal Wastewater was started in the late 1970s, but a lack of funds forced a suspension of work by 1990.
    - The main town collector was partially completed at that time, an industrial collector brought across the Maritza River terminating at an existing Industrial Wastewater Pump Station.
    - Serving the edges of the urban Area, 3 Municipal wastewater pump stations were completed and these all are combined with the town's gravity collectors to feed the treatment site in an open channel.
    - At the treatment works site itself, a start has been made with the interconnecting services, some 'site' works, the administration buildings and the drying beds. Of these facilities, some residual value lies in the drying beds and the collector system. The remaining structures are a liability. The main

collector itself has been built as an obstruction above ground for some 1.0 km and hence dominates the region.

- At present the municipal wastewater is collectable at a common point shown on the drawing where it can gravitate to the TW Site.
- A Treated Water Discharge Permit was issued for a discharge into the Luda Yana River from the site. The discharge must not cause the river to exceed Category III after mixing.

2. Dimitrovgrad (see Fig. 4.2.11)

- The present service area is shown in the Fig. 4.3.2 has an estimated as 46,000. Within this area, the town reports a full connection rate. A potential does exist for connection of the outlying villages shown on the north side of the Maritza River but the town has currently no firm plan for the sewerage for these communities (A 1992 population of 8,576).
- A municipal sewage collector and a joint municipal/industrial treatment works were designed in the early 1970s. A start was made with the treatment works, but the construction stopped around 1986, generally at 'tank' foundation level. None of the partially completed treatment facilities have any current 'worth'
- The main town collector and the terminal pump station have still to be built.
- A Treated Water Discharge Permit was issued on 1/01/1992 for a discharge into the Maritza River from the site. Under regulation No 7, the discharge must not cause the river to exceed Category III after mixing.

3. Stara Zagora (See Fig. 4.2.12)

- The Stara Zagora Wastewater town municipal service area is shown in Fig. 4.3.3. Of the present total urban population of 172,181 some 158,421 are at present connected to the sewer system and 13,168 still to be 'connected'.
- Adjacent to the main service area there are the 3 outlying developments of Bogomilovo, Zora and Kosta Ganchevo which have still to be connected to the main town system. These outlying populations total 12,179.

- The Main Industrial Area itself lies to the South East of the City and 'straddles' the existing Municipal Collectors
- A treatment plant site has been acquired some 1.5 Km SW of the town on the Bedechka River. The main town collector feeds to the site in an open channel carrying an ADF which we measured and estimate at some 80,000 cu. m / day. The present total collectable municipal wastewater (September 1998) is estimated at some 106,000 cu. m per day. The balance overflowing within the system into a storm water outlet.
- Although a discharge permit for a Treatment Works was granted in 1979, the site suitability has only just been confirmed following a recent land-use change EIA.
- A Treated Water Discharge Permit was issued on 13/01/1979 for a discharge into the Bedechka River from the site. The discharge must not cause the river to exceed Category III after mixing.

4.3.8 Existing Wastewater Characteristics

Existing data on the joint towns' wastewater collected is sparse. For Treatment Works design purposes correlated flow and quality data is needed. Relevant historical based on 24-hour sampling & flow measurement data in the municipal collectors is summarized in the following table.

The data represent round the clock data as recorded on the days sampled. Populations are best estimates of the situation using 1992 census data: The exact population counts on the sample dates are not available.

TABLE 4.3.4 EXISTING MUNICIPAL WASTEWATER CHARACTERISTICS

Town	Contributing Population	Estimated Existing Dry Weather Flow from the Connected Area (Cu m/ day)	Corresponding DWF BODs
Pazardjik Nov 1996	~83,325	31,067	2,889 kg/day 93 mg/l 35 mg/capita/d
Dimitrovgrad 1996/1997 Nov '92- Feb. '93	~46000 45,573	No convincing data base available 14,285	2,878 kg/day 2,371 kg/day 166 mg/l 52 mg/capita/d
Stara Zagora Oct 1997	~152,600*	105,936	11,335 kg/day 107 mg/l 74 mg/capita/d*

Note: 1998 Populations at Stara Zagora may be higher

4.3.9 Existing Industrial Discharges

There are no estimates available of Industrial Discharges at the dates the effluents were sampled. However based on our own survey of the present industrial discharge within the present WW service area we find:

TABLE 4.3.5 INDUSTRIAL WASTEWATER IN THE MUNICIPAL SEWERAGE

Town	Main Contributors	Estimated DWF Cu m / day	Estimated Average Industrial BOD Connected (Kg/day)
Pazardjik	'Electronic' 'Food Processing' 'Somat'	2,279	131
Dimitrovgrad	'Rakovski'	1,200	180
Stara Zagora	22 Factories incl.: Zagorka Brewery Gali Zagoretz Food Processors Bisa Olivia Etc.	20,485	4,780

4.3.10 Diurnal Wastewater Flow & Quality Patterns

The '24 hour' historical data collected have been 'plotted' in Fig. 4.3.10.

The charts in this figure confirm serious wastewater situation at all 3 towns.

Plotting the recorded BOD and flow rates show significant unexplained wastewater night flows in all 3 towns. We note:

- *At Pazardjik* unexplained inflows of at least 900 cu m/hour: Some 21,600 cu m per day or 70% of the total flows: Equivalent to some 30 l/c/day.

- *At Dimitrovgrad* unexplained flows varying from a November figure of around 450 cu m/hour to a February figure of 300 cu m/hour, i.e. Some 50% to 75% of the total and an Equivalent of 16 to 24 liters /c/d
- *At Stara Zagora* an unexplained sewer flows of some 3,000 cu m per hour into the sewers at night. Approx. 72,000 cu m per day representing some 68% of the total daily flow at the date measured, equivalent to 45 liters/c/day

4.3.11 Comments on the Existing Situation

Within the broad accuracy of these indicative figures, we note the following points:

1. Indications are that all 3 towns have a serious 'excess water' problem in their existing sewer system.
2. The 'domestic' wastewater element is heavily dilute: Normal municipal sewage is over 200 mg/l: In the 3 Bulgarian towns around 70% of the wastewater is 'infiltration' or possibly even excessive 'water wastage'
3. The 'industrial' elements of both Pazardjik & Dimitrovgrad are relatively insignificant in terms of their Quantitative & 'BOD' discharges.
4. The Stara Zagora Industrial wastewater (already connected) however represents a significant portion of the total wastewater.
5. There is an 'unexplained' loss of Domestic 'BOD': e.g. Bulgarian wastewater historically averages out at some 54 grams of BOD_5 per person per day. Note:

    - Diurnal migration to the industrial estate may explain the position at Pazardjik but not so at Stara Zagora
    - 'Exfiltration' losses seem the more plausible explanation.

In summary:

- we find that there is a very serious sewerage 'infiltration'/'exfiltration' problem at all 3 towns

- whereas the data available is sufficient for preliminary design purposes, the *Wastewater Quantity & Quality 'Books'* does not balance. there are too many unknowns to come to reliable conclusions upon which to base a detailed design.
- In view of the shortfall of information, we are recommending that the detailed design stage includes a thorough investigation of the reasons why the sewerage system is as it is. In the meantime, the respective water companies should undertake proper data collection of the sewerage characteristics (monthly 24-hour Flow & quality penetrative & investigative data collection throughout their systems).

4.3.12 Full Scope of the Wastewater Requirement at Each of the Towns

The full scope (and costs) of all Wastewater system development work needed at the towns cannot be finalized until the detailed design stage: Especially in relation to the elimination of sewer exfiltration & infiltration.

The 'Scope' and extent of the 'Treatment Project' at the treatment works site is however definable within the constraints outlined above.
For present planning and costing purposes, it is envisaged that the 'Scope' of the work needed be identified and split as follows

Project Preparation & Capital Works' at The Treatment Works Site:

- For potential funding by an IFI
- All Design Work as outlined in the table below
- The Capital Works needed to deliver Municipal Wastewater to the Site, i.e. the Works' collectors.
- The Capital Works within the Works Site (unless referred to below)

Necessary Supporting Local Provisions, Design & Implementation

- The following assumed funded from 'Local' resources
- Supporting services during the Sewer Investigations (design stage)

- Follow up sewer design and implementation targeted specifically at controlling overflows and reducing excessive infiltration/exfiltration.
- All necessary capital works out with the municipal treatment works boundary, excluding the main collector and including the access roadways, HV power supply, water supply, Mobile Plant, Furnishings and Laboratory equipment.
- Ensuring Major Industrial Discharges do not reach the Municipal Treatment Works Site.

The following summarizes the related requirements:

TABLE 4.3.6 SUMMARY OF REQUIREMENTS

Task	*Pazardjik*	*Dimitrovgrad*	*Stara Zagora*
Design Stage	Initial Survey of Main Collectors. CCTV Survey of a sewerage system pilot area. Design of replacement collector and overflow Review/update treatment works requirements	Initial Survey of Main Collectors. CCTV Survey of all main sewerage collectors. Review/update treatment works requirements	Initial Survey of Main Collectors. CCTV Survey of a sewerage system pilot area. Review/update treatment works requirements
Foreign Costs	Detailed Design of Treatment Works	Detailed Design of Treatment Works	Detailed Design of Treatment Works
	Preparation of Bidding Documents	Preparation of Bidding Documents	Preparation of Bidding Documents
	Construction Supervision	Construction Supervision	Construction Supervision
Essential Sewer System Work	Commence a major program of progressive sewer rehabilitation & replacement Divert South Bank	Commence a major program of progressive sewer rehabilitation & replacement	Commence a major program of progressive sewer rehabilitation & replacement Enforce control of

Local Costs	Industrial wastewater elsewhere		Industrial effluents reaching the River system Provide interceptors to separate out major industrial discharges from the Municipal Wastewater
Identified major wastewater system investments. *Local Costs*	Sewer system storm water overflow required outside the treatment works boundary. Three sewer system pumping stations to be re-equipped to handle DWF rates of flow: Storm pumps to be provided with variable speed controls. Construct any necessary storm water holding tanks. Complete house and outlying village connection program Improve Access roadway to the TW Site Provide Power and water to the TW Site	Sewer system storm water overflow required outside the treatment works boundary. Improve Access roadway to the TW Site Provide Power and water to the TW Site	Re-route existing major sewerage system overflow to contain municipal WW within the existing sewerage system. Construct any necessary storm water holding tanks Complete house and outlying village connection program New access roadway to the TW Site Provide Power and water to the TW Site
Treatment and process Facilities within the works site	Variable capacity inlet lift pumps Conventional Activated Sludge	Variable capacity inlet lift pumps Extended Aeration Treatment Process	Storm water overflow Variable Capacity Inlet lift pumps

Envisaged as Funded by Arrangement with an IFI	Treatment Process Thermophillic Sludge Digestion & press Drying Beds Discharge facilities to the River Maritza	Sludge holding facilities & press Drying Beds Discharge facilities to the River Maritza	Conventional Activated Sludge Treatment Process Thermophillic Sludge Digestion & press Drying Beds Discharge facilities to the River Bedechka
Provide Equipment *Local Costs*	Vehicles Mobile Plant for Sludge Disposal O & M Equipment Laboratory Equipment	Vehicles Mobile Plant for Sludge Disposal O & M Equipment Laboratory Equipment	Vehicles Mobile Plant for Sludge Disposal O & M Equipment Laboratory Equipment Trade effluent inspection equipment

4.3.13 Conclusions and Recommendations: Feasibility of the WWT Works

1. We find that, at all the three towns, the development of Wastewater Treatment Facilities is technically feasible.
2. The respective Municipalities & Water Companies have several technical matters to address in their sewerage systems. Especially that of rectifying infiltration/exfiltration problems in their sewer systems: As this we recommend that investigation of all three town's sewers is included as a key part of the project work
3. The larger towns with developed industry, especially Stara Zagora, should not (and cannot afford to) allow untreated industrial wastewater to penetrate their municipal wastewater without at least full pre-treatment: We consider that ideally, the industrial wastewater should be separated out & independently treated.

4. The priority is to be given to providing treatment plants as sized 'minimum for present situation only', that space be provided for expansion and that no further investment is made in the sewer system extensions until the system rehabilitation is complete or is nearing completion.

TABLE 4.3.2 DESIGN CRITERIA FOR WWTP AND RELATED FACILITIES

Town	Pazardjik	Dimitirovgrad	StaraZagora	Notes
Design Population	97,000	61,000	165,000	
Design PE	97,000	61,000	165,000	
Total daily average flow	29,400 m3/day	18,800 m3/day	49,400 m3/day	250 l/person·day
Peak dry weather flow: Qdwf	45,600 m3/day	30,200 m3/day	73,800 m3/day	
Peak wet weather flow: Qwwf(2*Qdwf)	91,200 m3/day	60,400 m3/day	147,600 m3/day	
BOD load	5,240 kg/day	3,300 kg/day	8,890 kg/day	54 g/person·day
SS load	6,310 kg/day	3,980 kg/day	10,700 kg/day	65 g/person·day
Related facilities				
main collector	new φ1.3 L= 2,640	existing φ1.0	existing 2.0*2.0	
over flow chamber	new biginning point of new main collector	existing end of existing main collector	new inside WWTP	
WWTP				
site area	10.8 ha	6.4 ha	11.4 ha	
process	conventional activated sludge process	extended aeration process	conventional activated sludge process	
WWTP main facilities				
screening , grit removal	○	○	○	coarse&fine
oil removal	○	○	○	
primary sedimentation tanks	○		○	hydraulic surface load 50 m3/m2·day
aeration tanks	○	○	○	HRT 9hrs (CAS) HRT 24hrs (ExA)
final sedimentation tanks	○	○	○	hydraulic surface load 20 m3/m2·day (CAS) 8 m3/m2·day (ExA)
disinfection (emergency)	○	○	○	HRT 30 min
sludge gravity thickening	○	○	○	surface loading rate 60 kg-ds/m2·day
sludge digestion	○		○	retention period 30 days
gas tanks	○		○	storage for 12 hrs
dewatering equipment (belt press)	○	○	○	sludge loading rate 100 kg-ds/m·hr
sludge drying bed(stand-by)	○	○	○	
control building	○	○	○	
sludge dewatering building	○	○	○	
other buildings	○	○	○	

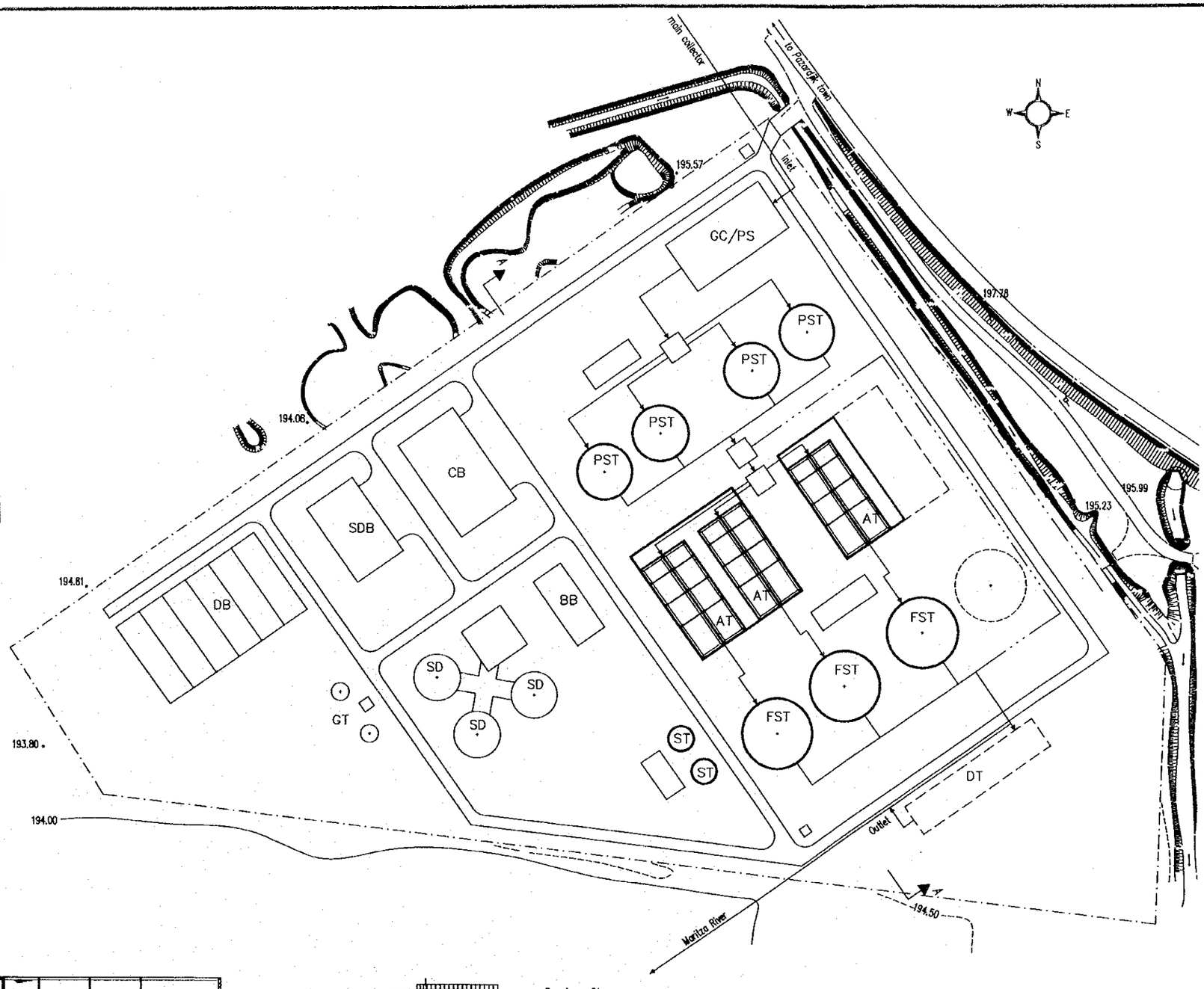
TABLE 4.3.3 EVALUATION OF WASTEWATER TREATMENT PROCESS IN DIMITROVGRAD

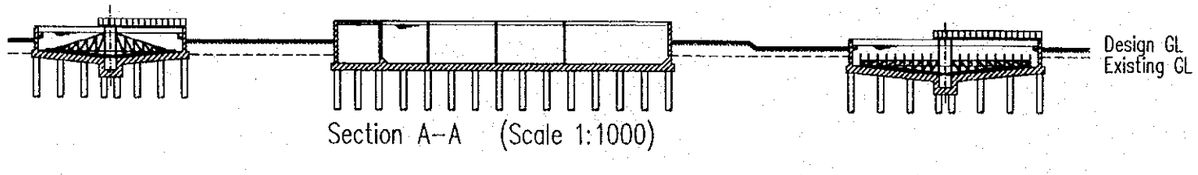
Item	Applied to WWTP in Dimitrovgrad	Conventional Activated Sludge (CAS) Method		Extended Aeration (ExA) Method	
Possibility to be selected by flowrate	31,000m3/d	Yes	◎	Yes, but generally not applied	○
Treated Water Quality	To meet EC Standard	possible to achieve target water quality stabilized	◎	the same as CAS method	◎
Sludge Treatment	until dewatering process in WWTP	any type of sludge treatment process is applicable	◎	the same as CAS method	◎
Advanced Treatment in the Future	To be considered	Nitrogen removal: applicable by additional airation tank or re-arrangement of inflow pattrern Phosphorous removal: applicable by additional facility	○	Nitorgen removal: applicable by re-consideration of operation Phosphorous removal: the same as CAS	◎
WWTP Site	Purchased and Fixed	The necessary area is less than ExA method.	◎	The necessary area is wider than CAS method. But the site in Dimitrovgrad has enough space for ExA method.	○
Effectness to Surrounding Environment	Unnecessary to considered because of not residential area	Odor and noise are produced, but insignificant.	○	the same as CAS method	○
Applicability to increase in load,quantity and bquality	Discharge to river over design flowrate after primary treatment	Inferior to ExA method.	○	Superior to CAS method	◎
Cost	Civil works	Moderate(Lower than ExA method)	○	Higher than CAS method	△
	Mechanical and Electrical Facility	Moderate(Higher than ExA method)	○	Lower than CAS method	◎
Operation and Maintenance		Normal	○	Simpler than CAS because of less mechanical facility	◎
Evaluation		No problem for any item.	○	No problem for any item. Select this method because of cheaper and easyer maintenace than CAS method	◎

LEGEND

GC: Grit Chamber (Screens oilremoval)
PS: Pumping Station
PST: Primary SedimentationTank
AT: Aeration Tank
FST: Final Sedimentation Tank
DT: Desinfection Tank
ST: Sludge Thickener
SD: Sludge Digester
DB: Sludge Drying Bed
GT: Gas Tank
CB: Control Building
SDB: Sludge Dewatering Building
BB: Blower Building

Boundary Line
Future Expansion
Water Flow
Bypass





Section A--A (Scale 1:1000)

SCALE 1:2000

0 10 20 30 40 50 100m

FIG. 4.3.1 GENERAL LAYOUT OF PAZARDJIK WWTP

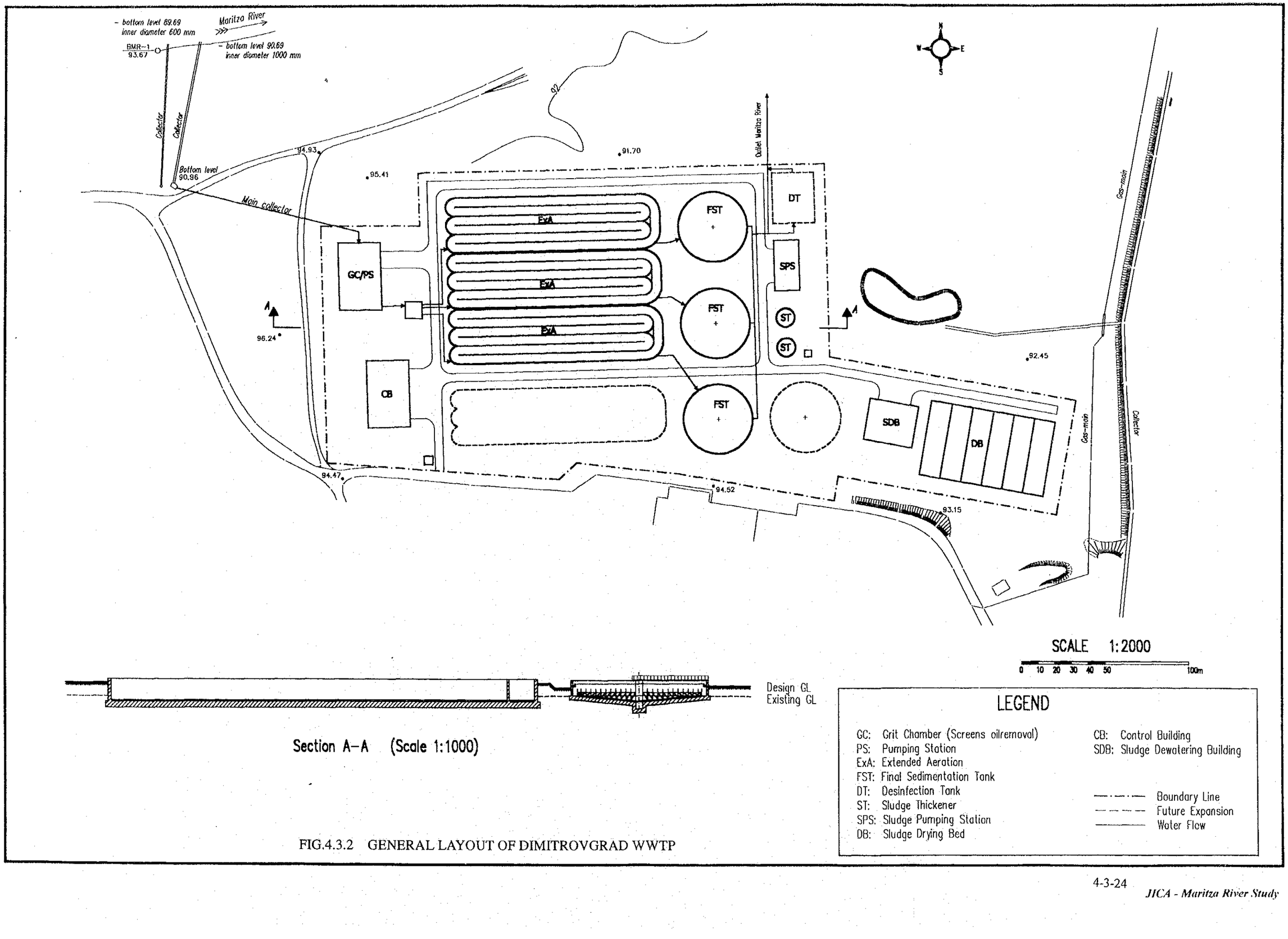


FIG.4.3.2 GENERAL LAYOUT OF DIMITROVGRAD WWTP

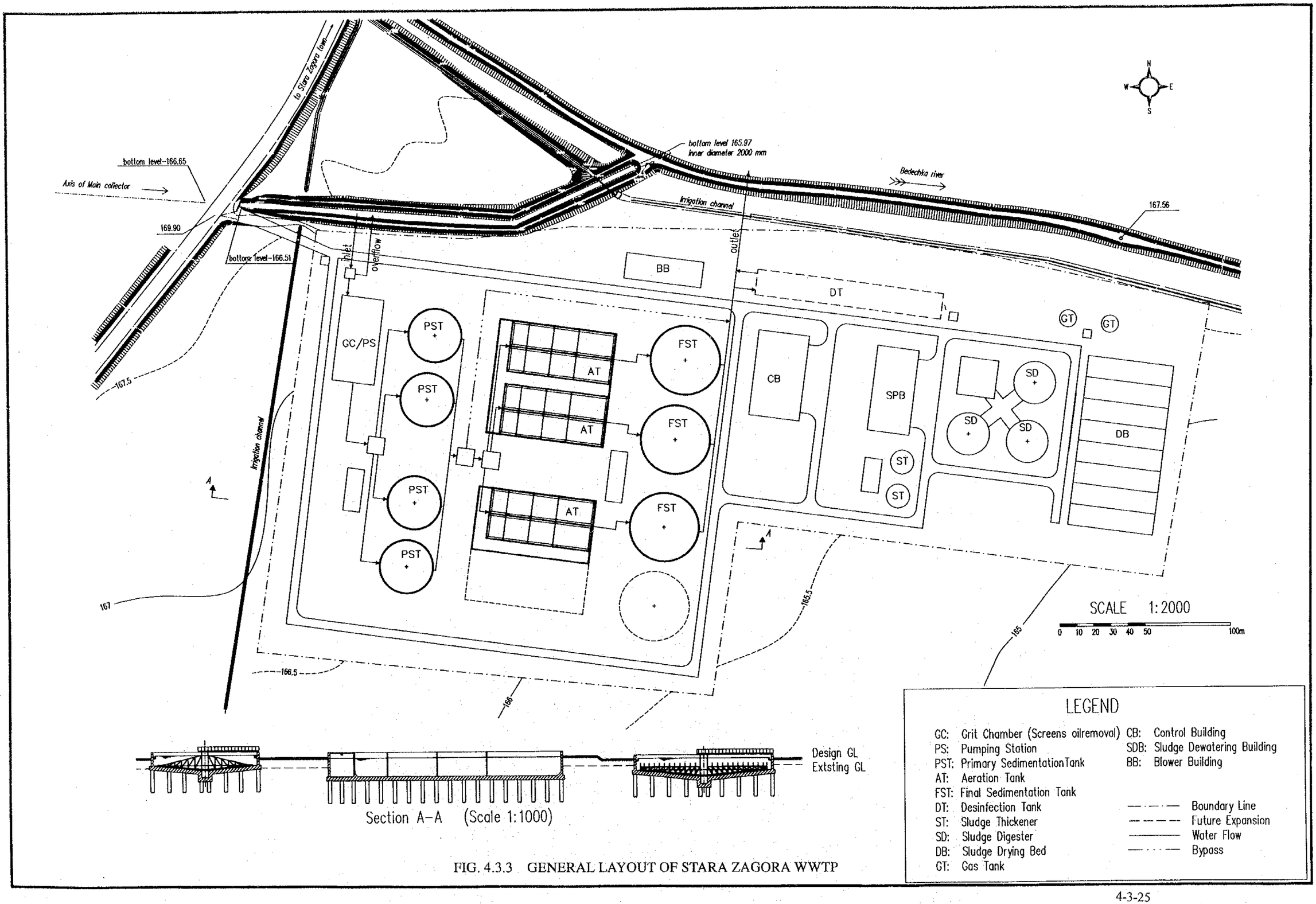
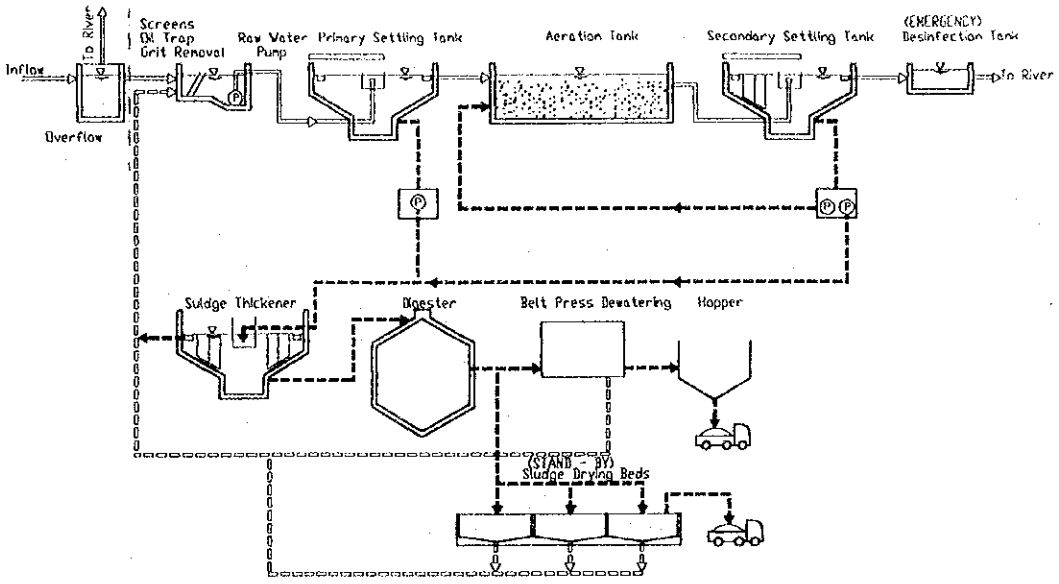
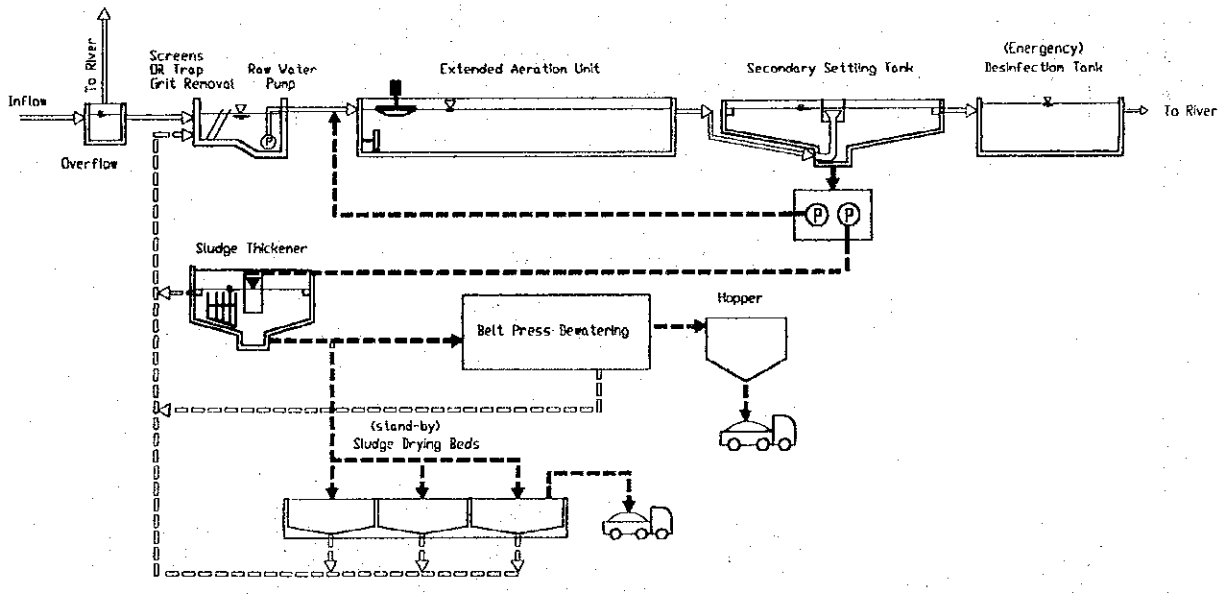


FIG. 4.3.3 GENERAL LAYOUT OF STARA ZAGORA WWTP



Conventional Activated Sludge Process



Extended Aeration Process

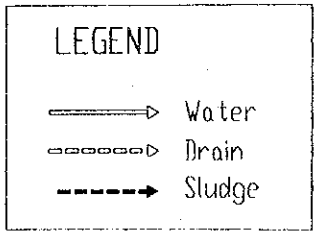
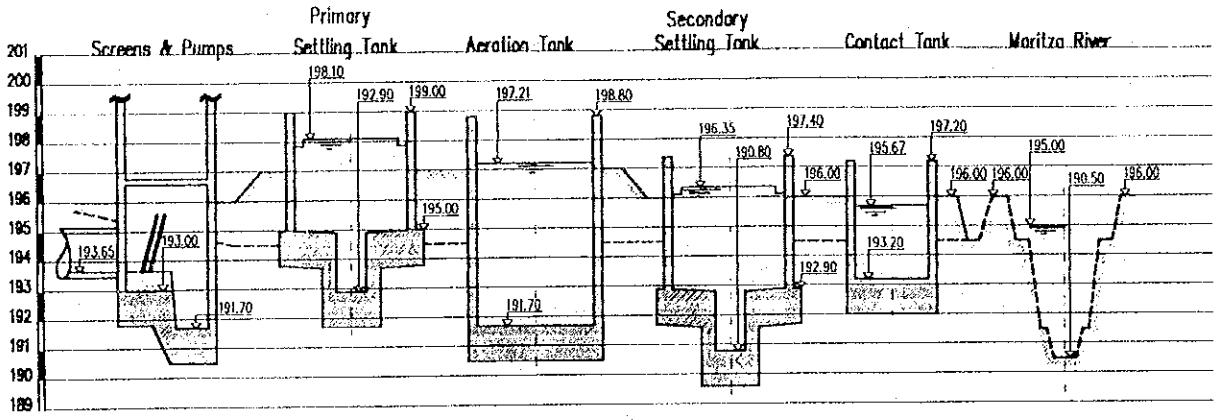
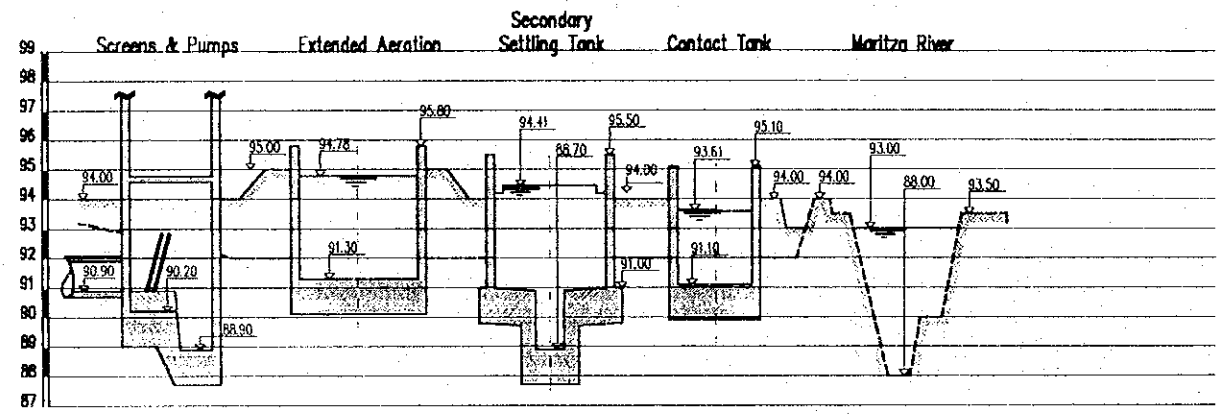


FIG. 4.3.4 PROCESS FLOW DIAGRAM

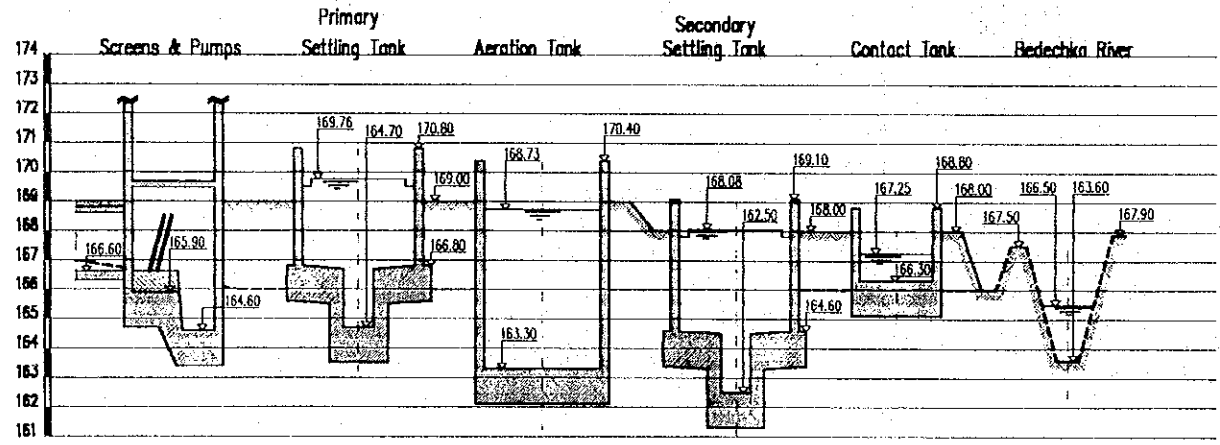
Pazardjik WWTP



Dimitrovgrad WWTP



Stara Zagora WWTP

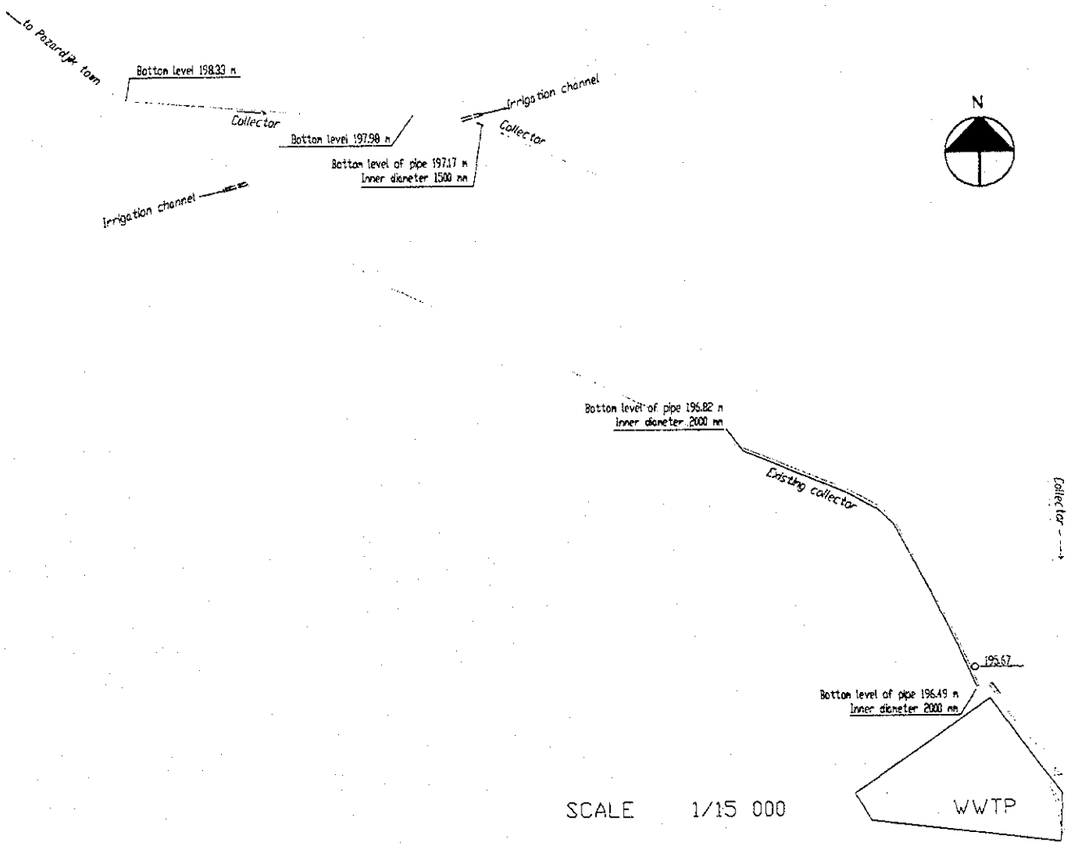


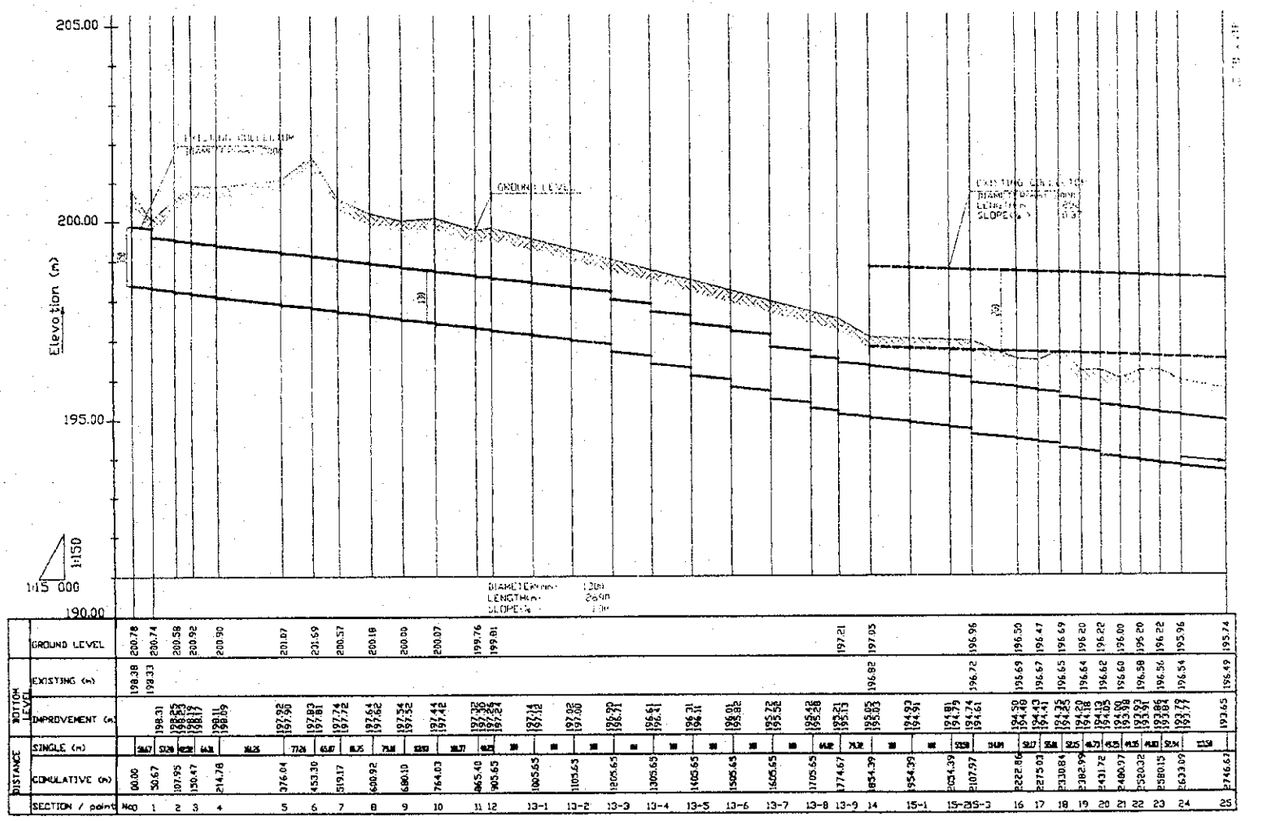
LEGEND

-----	Existing Ground Level
——	Design Ground Level

Scale V 1: 250
H none

FIG. 4.3.5 HYDRAULIC PROFILE

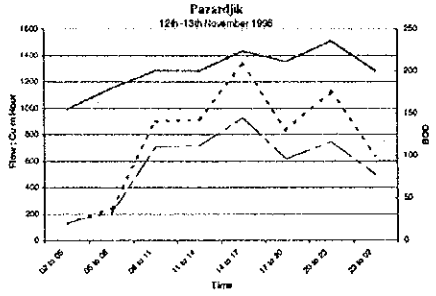


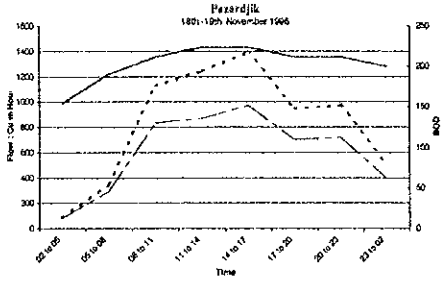


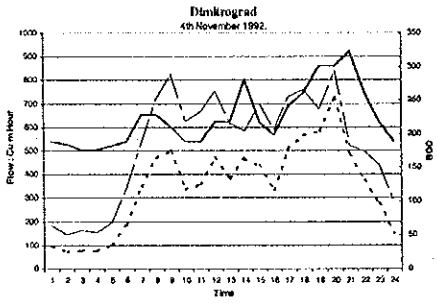
LEGEND

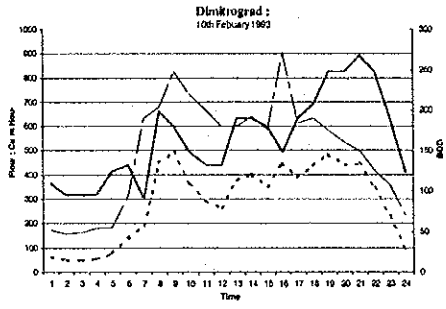
———	IMPROVEMENT MAIN COLLECTOR
- - - - -	EXISTING MAIN COLLECTOR

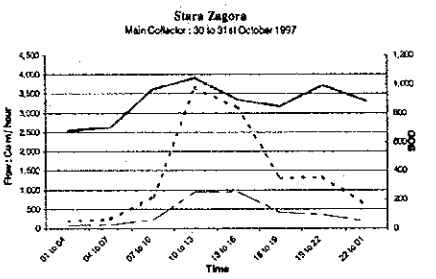
FIG. 4.3.6 MAIN COLLECTOR PROFILE IN PAZARDJIK

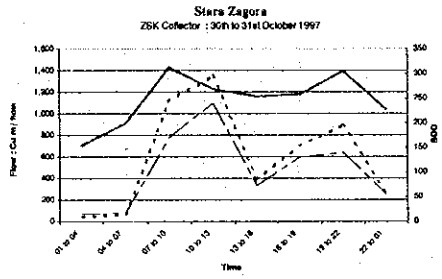


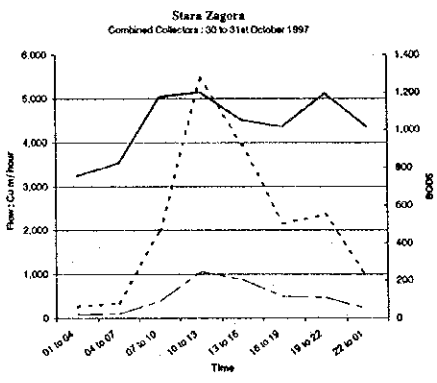












DATA SHOWS:

Town	Dimitrovgrad	Pazardjic	Stara Zagora
BOD5	52 mg/c/d	35 mg/c/d	74 mg/c/d
Average Flow Rate	14,285 cu m/d	31,067 cu m/d	105,936 cu m/day
Estimated unaccounted for wastewater	9,000 cu m/d	24,000 cu m/d	72,000 cu m/d
Indicated BOD Loss	N/A	2 Tons per day	2.5 Tons per day

Showing

: Total BOD5 in Kg/hour in the Collector

: Collector Flow in Cubic Meters /hour

: High Rates of flow coincident with low BOD ; symptomatic of heavy unaccounted for water (possible Infiltration)

: Symptomatic of loss of BOD in the larger systems; possible exfiltration

: Suspected High transfer rates between the Groundwater and the sewers especially at Pazardjic

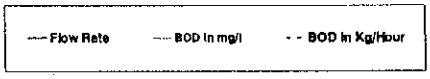


FIG. 4.3.7 DIURNAL FLOW PATTERNS IN THE MUNICIPAL COLLECTORS

4.4

COST ESTIMATION AND CONSTRUCTION PLAN

4.4 Cost Estimation and Construction Plan

4.4.1 Cost Data & Basis

The Cost data referred to when compiling our estimates was:

1. The previously reported master plan cost charts and statistics developed for the project (Based on experience elsewhere in Central & Eastern Europe).
2. Checked against local statistics as a comparative reference in respect of the civil works costs: However local experience of this class of contracting, is in reality, very limited and this cost data has been used with caution (appears subjective).

As referred to in Section 4.3 the costs are estimated only in respect of the Project of collecting and treating and discharging the Existing Wastewater.

The estimates exclude all land costs, service costs, support services, land costs, power supply costs, and Bulgarian taxes and import customs duties, stamp duties and like charges.

4.4.2 Local Contracting Resources

Apart from modifications and minor extensions to some Municipal water & Wastewater Works, there is almost no / very little experience of Contracting the Construction of a Modern Municipal Wastewater Treatment Works to the requirements normally demanded by IFIs and set out for international tender:
'I.e. With typically:

- FIDIC type contracting terms
- Pre or post qualification requirements that the tendering Contractors have a satisfactory track record and have the technical and financial resources to complete the contract on time (or guarantee financial compensation).
- With Performance Guarantees & liquidated damages built-in
- Project management expertise a prerequisite

- Proven Experience with the class of work required

It is however clear that in recent years some Bulgarian firms are building up the capacity to handle works of this type, and have also now accumulated some experience of with working with 'Western' expertise and Contractors (E.g. Greek & Turkish firms).

Accordingly we recommend that the Wastewater Contracts Implementation be tendered internationally and Tendering Contractors invited to form Joint ventures with local contractors to undertake civil works and Plant installation support: In this way the civil works can benefit from Experienced Project managerial support and yet can retain the benefits of local organizations and the many skills locally available.

4.4.3 Available Materials & Services

Whereas it is now normal for an IFI to require 'open' least-cost performance based international tendering, the following 'Foreign-Local' table is presented to appraise explain local wastewater plant construction and manufacturing potential:

APPRAISAL OF LOCAL/FOREIGN CAPABILITY TO IMPLEMENT ITEMS TO INTERNATIONAL SPECIFICATIONS

Activity	Local	Foreign
Civil Works know-how & skills	Satisfactory but foreign support with financial resources, specialized equipment and project management may be advantageous	
Buildings	Satisfactory Large building material industry	
Mechanical Plant	Locally manufactured WW treatment equipment includes: • Screens • Tank bridges & scrapers • Gate stops	Most Proprietary Process Contractors purchase plant outside Bulgaria.
Pipes	Plastic, Concrete & Steel	Not necessary to import pipes if manufacture is supervised
Electric plant	Local assemble of small control panels	Prefer Complete control systems are imported
Cables	Local manufactured	Not Necessary

Power transformers	Local manufactured	Not Necessary
Process Control	Limited manufacturing Potential	Prefer complete Control Systems

4.4.4 Cost Estimations

Construction cost of the proposed wastewater treatment plants in Pazardjik, Dimitrovgrad, and Stara Zagora was estimated as shown in Table 4.4.1.
The cost estimate include following items:

1) Direct construction cost
   - Preparation, which includes demolishing works if necessary
   - Main works composed of construction of wastewater treatment plans including civil, mechanical, and electrical works.
2) Engineering cost : 5 % of the direct cost
3) Administration cost : 10 % of the direct cost
4) Physical contingency : 15 % of the direct cost

The cost estimated cost was divided into foreign currency and local currency provision as shown in the table.

The operating cost is estimated with flow rate and treatment process based on one from the World Bank issued for Central and Eastern Europe.
Operational & maintenance costs are estimated as:

ANNUAL O&M COSTS

Item	Pazardjik WWTP	Dimitrovgrad WWTP	Stara Zagora WWTP
Percentage to the direct construction cost	15 %	7 %	15 %
O&M cost (US$ 1000/year)	2,961	828	3,434

TABLE 4.4.1 CONSTRUCTION COST OF THE WWTPs

Pazardjik WWTP (unit : US$1000)

		FC	LC	Total	Remark
1	Direct Cost	13,527	6,213	19,740	
1-1	Preparation	1,764	810	2,574	15% *((1-2)+(1-3)) : include demolishing
1-2	Construction (WWTP)	10,950	4,590	15,540	
1-3	Construction (main collector)	813	813	1,626	
2	Engineering	1,579	395	1,974	10% *1 : FC=80% LC=20%
3	Administration		987	987	5% *1 for LC
4	Physical Confingency	2,029	932	2,961	15% *1
5	Grand total	17,135	8,527	25,662	

Dimitrovgrad WWTP (unit : us$1000)

		FC	LC	Total	Remark
1	Direct Cost	8,103	3,720	11,823	
1-1	Preparation	1,057	485	1,542	15% *(1-2) : include demolishing
1-2	Construction (WWTP)	7,046	3,235	10,281	
2	Engineering	946	236	1,182	10% *1 : FC=80% LC=20%
3	Administration		591	591	5% *1 for LC
4	Physical Confingency	1,215	558	1,773	15% *1
5	Grand total	10,264	5,106	15,370	

Stara Zagora WWTP (unit : us$1000)

		FC	LC	Total	Remark
1	Direct Cost	16,189	6,703	22,892	
1-1	Preparation	1,472	609	2,081	10% *(1-2)
1-2	Construction (WWTP)	14,717	6,094	20,811	
2	Engineering	1,831	458	2,289	10% *1 : FC=80% LC=20%
3	Administration		1,145	1,145	5% *1 for LC
4	Physical Confingency	2,428	1,005	3,433	15% *1
5	Grand total	20,449	9,311	29,760	

4.5

OPERATION & MAINTENANCE ORGANIZATION

4.5 Operation & Maintenance Organization

4.5.1 Introduction and Background

The previous Master Plan reviewed in detail the existing institutional arrangements concerning the management of the Maritza River Basin, and went on to propose measures for the institutional development necessary to promote its integrated environmental management. The Operation and Maintenance Organization aspect of this Feasibility Study is strictly limited towards recommending measures for the sustainable operation of the proposed wastewater treatment plants *within* the three priority towns of Pazardjik, Dimitrovgrad and Stara Zagora. A review of the organizational arrangements of the entire Regional Water and Wastewater Companies (VIK) of the priority towns, or VIKs in Bulgaria in general, and any proposals for their re-structuring as a whole is excluded.

Within the entire Maritza River Basin, there are only five Municipal WWTPs. However, none of these five are to be found in the Maritza River Basin of the Municipalities/VIK's to which the priority towns belong. In order to gain an appreciation and understanding of the present organizational approach to WWTP operation in Bulgaria, it was necessary to look further afield and at a range of plants of different sizes. In the course of this review, the team visited and interviewed staff at the WWTPs at Sofia, Plovdiv, Ihtiman and Pavel Bania, while visits without interview included Radnevo and Haskovo. Extensive interviews were also conducted with the senior management at the VIKs of the priority towns.

It is clear that within the current organizational approach to WWTP operation in Bulgaria, there is plenty of scope for rationalization. Although such rationalization would be on a small scale now because there are only a small number of plants, there would be genuine benefits. The scale of these benefits will increase as more WWTPs come on line and there are greater opportunities for efficiency gains. Although we are limiting our comments here to the context of WWTP operation, there are clearly huge improvements to

be gained through a thorough review of the structures of all the VIKs as a whole.

The general organizational approach does not appear to vary from one VIK to another, either in terms of overall structure or, more specifically, in terms of the operation of WWTPs, regardless of their size. This is, perhaps, a reflection on the previous centralized system of governmental control where standardization was practiced. As will be demonstrated in the following sub-sections, minor modifications individually tailored to the organizational structures of the three VIKs' to which the priority towns belong will yield positive benefits without the need for the introduction of any radical measures.

4.5.2 Proposed Organizational Improvements to the VIKs

The VIKs' are over-staffed and inefficient, particularly below the managerial level. As noted above, this is undoubtedly a throwback to the previous centralized system of governmental control practiced in Bulgaria where standardization and jobs for all were the primary aims, and efficiency and productivity were not considerations. This is demonstrated by the current levels of staffing in the existing WWTPs and the proposed levels for the new ones. It is also clearly demonstrated in the ratio of VIK employees per thousand head of population served where the current ratios are approximately 1.5 for Pazardjik, 1.8 for Dimitrovgrad and 1.8 for Stara Zagora. If Vodokanal's WWTP staffing estimates are factored in, the ratios become 2.1, 2.3 and 2.9 for Pazardjik, Dimitrovgrad and Stara Zagora respectively.

These staff ratios are, from a commercial point of view, unacceptably high, particularly when compared to the average ratio of approximately 0.63 employees per 1000 head of population served in the UK for a privatized utility providing *both* water supply and sewerage (collection, treatment and disposal) services, or the conservative estimate of less than 1 employee per thousand people served observed in a well run public or private utility company around the world. Although it is recognized that many operations are still done manually in Bulgaria, with a ratio of employees per thousand people served between 3 and

4 times higher than in the UK (or 2 to 3 times globally), it is clear from the organization charts that there is a lot of room for staff optimization. Fig.4.5.1 to 4.5.3 shows. Proposed organization for the new WWTPs at Pazardjik, Dimitrovgrad and Stara Zagora.

(1) Pazardjik

Operation and maintenance of the proposed new WWTP will require the formation of a new department within the Water Company and will need to be fully staffed with new people. In order for this to be successful, the reorganization of Water Supply and Sewerage Ltd, Pazardjik must be combined with the acceptance of a realistic level of staffing for the WWTP which corresponds with the preliminary design presented in this feasibility study.

In the context of organizational improvements to enable the sustainable operation of the proposed new WWTP, a new wastewater division should be created which should be subdivided into WWTP and Sewerage System. The WWTP side would be responsible for the sewage treatment and disposal (including effluent, sludge, screenings/grit) and the Sewerage System would be responsible for collection. Common elements, such as pumping station operation and maintenance, should be assigned to one of the sub-divisions but would work in both as required. The WWTP Division should share a common base to ensure maximum interaction and effective use of common resources; this location should be the new WWTP. The organization chart showing the proposed revisions is presented at the end of this Chapter, although it is once again pointed out that the revisions shown are the minimum necessary to establish and operate the WWTP and do not include a restructuring of the entire Company.

With respect to staffing the new WWTP, the company is grossly over-staffed and given the correct re-training (including post-commissioning on-the-job training) should seek to fill most of the positions from within their current staff resources, with the exception of the WWTP Manager, who may need to be recruited from outside the region as an experienced individual is required for this position. Assuming that the appropriate basic skills are

available within the Company at present and that realistic staffing levels are applied, this recruiting and re-training from within will be a valuable first step in restructuring the Company. The exact level of staffing required for the new works can not be precisely determined at this time as the level of automation has not been agreed. However, we have indicated on the revised organization chart a total of 27 staff to operate and maintain the new WWTP; we still consider this figure to be on the high side, but for now it represents a balance between automation and levels of staffing.

(2) Dimitrovgrad

Operation and maintenance of the proposed new WWTP will require the formation of a new wastewater division within Dimitrovgrad VIK and will need to be fully staffed with new people. With respect to the implementation of organizational improvements to enable the sustainable operation of the proposed new WWTP, this new wastewater division should be divided into WWTP and Sewerage System sub-divisions. The WWTP side would be responsible for the sewage treatment and disposal (including effluent, sludge, screenings/grit) and the Sewerage System would be responsible for collection. Common elements, such as pumping station operation and maintenance, should be assigned to one of the sub-divisions but would work in both as required. The WWTP Division should share a common base to ensure maximum interaction and effective use of common resources; this location should be the new WWTP. The organization chart showing the proposed revisions is presented at the end of this Chapter.

Dimitrovgrad VIK is presently over-staffed. They should seek to fill most of the positions for the new WWTP from within their current staff resources, with the exception of the WWTP Manager, who may need to be recruited from outside the region as an experienced individual is required for this position. Assuming that the appropriate basic skills are available within the Company at present and that realistic staffing levels are applied, it should be possible to re-train the existing staff (who are reported to be highly motivated) and fill most of the positions. This recruiting and re-training from within will

be a valuable first step in restructuring the least efficient VIK of the three priority towns. The exact level of staffing required for the new works can not be precisely determined at this time as the level of automation has not been agreed. However, we have indicated on the revised organization chart a total of 19 staff to operate and maintain the new WWTP; we still consider this figure to be on the high side, but for now it represents a balance between automation and levels of staffing.

(3) Stara Zagora

As previously stated, Stara Zagora is the biggest of the three priority towns and currently has two WWTPs in operation, with a third due to come on line in 1999. In the context of organizational improvements to enable the sustainable operation of the proposed new WWTP, a new regional Wastewater Treatment Division should be created. The Wastewater Treatment Division would be responsible for the sewage treatment and disposal (including effluent, sludge, screenings/grit) at all four WWTPs. The structure of the VIK with regard to the sewerage systems in each of the Technical Regions would remain as they are at the moment: although we do not believe the current arrangement to be the most efficient and that there would be great efficiency gains by creating a regional Sewerage Network Division, this is beyond the remit of this study. The Wastewater Treatment Division should be centrally located at the new WWTP to ensure maximum co-operation, interaction and effective use of common resources. As many services as possible which are common to all the plants should also be centralized here, such as workshop, laboratory, vehicles etc, and consideration should be given to centralizing some of the staff functions, such as mechanical and electrical maintenance teams. The organization chart showing the proposed revision is presented at the end of this Chapter.

Even though Stara Zagora VIK is the most progressive of the priority towns, it is still grossly over-staffed. They should seek to fill most of the positions for the new WWTP from within their current staff resources (although re-training will be required) with the exception of the WWTP Manager, who may need to be recruited from outside the region as

an experienced individual is required for this position. Assuming that the appropriate basic skills are available within the Company at present and that realistic staffing levels are applied, especially for the Kazanlak plant and the proposed new WWTP, this recruiting and re-training from within will be a valuable step in restructuring the Company. As in the case of Pazardjik, the exact level of staffing required for the new works can not be precisely determined at this time as the level of automation has not been agreed. However, we have indicated on the revised organization chart a total of 38 staff to operate and maintain the new WWTP; we still consider this figure to be on the high side, but for now it represents a balance between automation and levels of staffing.

4.5.3 Future Requirements for Operation and Maintenance

This section of the Chapter will concentrate on the organizational and staffing aspects of the operation and maintenance (O&M) of the proposed WWTPs for the three priority towns, and not the "physical" aspects. It will make broad recommendations as to the future requirements of the three towns in the context of operating and maintaining the proposed new WWTPs.

It is clear that the future sustainable operation and maintenance of the WWTPs is dependent upon improving the operational efficiency of the proposed works from the outset, and the VIK itself. The proposed operational improvements discussed in sub-section 4.5.2 are essential. However, to some degree, it is possible to look at specific measures that can be applied directly to the WWTPs' in isolation (i.e. are not dependant on reorganization of the whole VIK) to assist in the successful future operation of the WWTP. These measures, not all of which are applicable to all three priority towns, could include the following:

- centralization of WWTP functions and associated services, including some of the staffing;
- applying realistic manning levels, i.e. more or less to western European levels;

- introducing remote (e.g. telemetry) alarms at the smaller works so 24 hour operator presence is not required;
- using the opportunity of new WWTPs to update safety equipment and operational necessities currently lacking, as well as create an essential spares store;
- reviewing the shift system;
- promoting interaction between staff at the different (particularly the smaller) plants and the network operatives;
- providing incentives and other measures to promote staff motivation;
- providing regular and structured training;
- providing better health and safety measures;
- encouraging selected staff to learn more about the other works in the region so there is built-in flexibility in the VIK with regard to regional staffing and potential efficiency benefits – potentially more interesting for the operatives too.

A detailed 'Strategic Plan' covering every aspect of the development of the WWTP and the VIK's involvement at each stage and in each aspect of this development, from inception to commissioning and operation (and maintenance), must be developed. The VIK's do not at present have the experience or in-house capability to undertake such an exercise and should seek outside assistance from an experienced water/wastewater operator from western Europe to draw up the Strategic Plan. This plan will assist the VIK's in preparing themselves and their staff for the operation of the works and be a key element in the sustainable operation and maintenance.

The VIK's should introduce ways of measuring operational performance of the WWTPs' using appropriate key performance indicators, such as the chemical content of effluent being discharged, chemical content of influent to the works (especially applicable in situations /circumstances where testing and monitoring of industry discharges is important), frequency of breakdowns, etc. Key performance indicators also act as incentives and, for added effect, can be tied to key objectives of national strategy.

It is important that the VIKs' are fully aware of what they can expect from the construction of the new works and take advantage of the opportunities that will be available at this time. With the right advice and proper pre-planning (i.e. the Strategic Plan), they will have the opportunity to operate and maintain the new WWTPs to the right level. The new works will provide the right equipment (in terms of the operating plant and machinery, and the equipment to maintain it), spares, staff training and maintenance requirements. Proper planned preventative maintenance of plant and equipment must be actively practiced. A proper schedule and manual must be produced by the contractor during construction and must be adhered to by the plant management. This should include every conceivable element of total plant operation and maintenance.

The majority of the initial cost of the operation and maintenance of the new WWTP will be included in the construction contract. However, the cost of subsequently operating and maintaining the works to the correct level and of retaining the appropriate spare parts and maintenance materials etc in stock will have to be met by the VIK. It is, therefore, essential that the VIK sharpens up its commercial approach to providing water and sewerage services as the money saved in greater staff efficiency, proper allowances in the tariff (see sub-section 4.5.5) and practicing planned preventative maintenance will more than off-set the costs of operating and maintaining the new WWTP.

General maintenance must be improved on the WWTPs', such as grass cutting, cleaning and disinfecting, visual inspections of the assets, etc. Proper logs and accurate records must be kept on plant running times, down time, etc. These are all areas that can be linked to performance indicators and so used to motivate staff to perform.

Two final points to be made in this section are important elements to both the employees and the VIK in the successful and sustainable operation and maintenance of the WWTPs, and must be given the importance they deserve and be implemented; they are:

- regular and appropriate training of all staff from managers to operatives/laborers (this

is dealt with in more detail in the following section),

- the establishment and maintenance of proper health and safety procedures.

4.5.4 Future Training Requirements for O & M

The level of training should be more uniform between the VIK's. With respect to the particular area of safety training, or more specifically Health and Safety, the legal requirement should be far more prescriptive. Guidelines should be issued by the Ministry of Public Works and Housing, or other appropriate Ministry to ensure that the workers at the WWTPs, the general public at large and anyone else who may come into contact with a WWTP is adequately protected from the associated dangers.

For the new WWTPs', successful and sustainable operation can only be achieved if planned preventative maintenance is practiced. This can only be achieved in practice through the proper structured training of all employees, from the director down to anyone and everyone who will work in or come into contact with the sewers and the WWTPs.

Staff selection for appointment and promotion in Bulgaria is generally based on seniority and a perceived level of technical competence, rather than the matching of candidates skills and competence with pre-defined requirements for the position. This is a poor management practice that must be addressed and corrected so that the best available candidate for a post is awarded that post.

In addition, almost none of the senior management staff we have come into contact with or are aware of has any experience of western European-style management techniques and practices. Bearing in mind the cultural and organizational changes that will occur in the next few years, this is a shortfall that must be rectified through the provision of training in such areas as general management, commercial business management, planning, maintenance and budgeting to those employees of the VIKs' who are seen as the key members of the management team. Even if reorganization of the VIKs' occurs after the

commissioning of the proposed new WWTPs', which is not the ideal scenario from the point of view of sustainable operation, having the right senior managers in place with the right training who understand what is required and will act accordingly will be essential.

At the WWTP level, appropriate and adequate training of all the staff from the Works Manager to the laborers is of paramount importance for the smooth and efficient running of the works. As mentioned on a number of previous occasions, the VIKs' are over-staffed, the existing WWTPs' are overstaffed, and the Vodokanal figures for the proposed staffing for the new WWTPs' are excessive – in the order of 4 to 5 compared to a labor-intensive plant in western Europe. One of the main reasons for this level of over-staffing was explained in sub-section 4.5.2 as being a throwback to the previous centralized system of governmental control where standardization and jobs for all was the primary aim. This had the effect of creating staff functions and roles that are, on the whole, very narrowly defined. As a consequence, staff did not operate flexibly across more than one role, other than in very exceptional circumstances. Unfortunately, this attitude/ approach is still prevalent today and is "accepted" as the norm by nearly all employees from senior management/director level to trainee. It is an attitude that is deeply ingrained in the workforce and one that must be replaced by a more flexible work ethic. The provision of good quality, appropriate and structured training will go some way to changing the current attitude, but time and proof through application will be needed to convince employees.

It is proposed that training should be carried out on two levels, manager/management and operator. Manager here refers to the WWTP manager (or area manager for the WWTPs, if appropriate) and management refers to senior staff in the VIK, i.e. the Works Manager's 'line managers'. Operator is used as a generic term and is deemed to include the works operators, M&E staff, maintenance personnel, laboratory technicians. However, to ensure the fullest understanding at the manager/ management level, managers will undertake the same training as the operators as well as their own specialized training. It is suggested that additional modules are included to enable selected senior managers/management to receive some training as trainers.

Training for the operation of the WWTP should be sub-divided into two primary areas:

- Introductory and Preparatory Training.
- Specific Training for Operation of the WWTP.

Introductory and preparatory training should take two forms, classroom and workshop. It is intended to give all the staff a grounding in the basics required to operate a works and ensure that they have achieved a uniform minimum standard before the all-important specific training starts. The operators will participate in all the workshops and selected classroom courses. The managers will attend all workshops and classroom courses, this will not only ensure a thorough across-the-board training, but also be appropriate preparation for their future training as trainers.

In brief, the workshops will cover:

- an introduction to the main components to be found in the WWTP, such as pipes and fittings, penstocks, valves, flow measurement devices etc, their function, and how they work;
- routine maintenance on the aforementioned components, repair and rectification of common faults and problems, replacement, when to call in external/specialist assistance;
- practical demonstrations on safety at the works, safety equipment and safe operating methods/procedures, handling of hazardous materials and waste;
- clearance of blockages to pipes, screens, pumps and chambers etc.

Similarly, for all the staff, the classroom training will cover:

- Background to the wastewater treatment plant project, the importance of treating wastewater, the effect of industrial wastewater, environmental benefits of treatment,

etc.

- Introduction to the basic principles of the treatment process involved, the effect of industrial wastewater and the need to monitor and control discharges, and relevant legislation (EU and Bulgarian) governing discharges of (treated) wastewater.
- Introduction of personnel to the basic elements of plant management, as well as the provision of instruction and guidance concerning practical work organization on operating plant.
- Introduction of personnel to practical plant operation, as well as utilization of supporting material, information systems, reporting and control measures/procedures.
- Introduction to general/routine plant maintenance and planned, preventative maintenance.
- Potential operational problems and basic/general emergency procedures (i.e. outline 'action plans' and 'emergency action plans').
- Health and safety at the works.

In addition to the above, the following classroom courses will be held for the managers, although it is recognized that some of the top VIK staff may, by this time, have undertaken specialized management training referred to earlier in this section:

- Management, organization and reporting.
- The economics of plant maintenance and upkeep.
- A preview of the total system operation.
- Further information on the principles of the treatment process involved at the WWTP and throughout the system as a whole.

The classroom-based training and courses should be specifically tailored towards the WWTP and the staff in order to provide, as far as possible, a relevant yet flexible approach. Appropriate course notes should be provided for all the above courses and workshops. It is intended that the above 'Introductory and Preparatory Training' is conducted by an

external (international) consultant or operator experienced in this type of training. It is also intended that training will be provided by the WWTP contractor, and that there may be some degree of overlap between the external consultant's course and the contractor provided training.

The second primary area of training, 'Specific Training for Operation of the WWTP' would be intended to provide detailed and in-depth training and should be provided by the Contractor. It should concentrate on the actual plant and equipment provided, the specific operating procedures, instrumentation and control, actual emergency scenarios/procedures, the actual maintenance requirements, etc. It should be based on and work through the contractor's Maintenance Manual for the WWTP and combine hands-on experience at the plant, additional (contractor-provided) workshop training, and classroom training.

It is strongly recommended that the external (international) consultant who conducted the 'Introductory and Preparatory Training' reviews the contractor's detailed training proposals before the training commences, and then closely monitors the training as it progresses to try and ensure a consistent and appropriate standard of training, and provide a coordinated holistic approach.

In the WWTP Tender Document, contractors *must* be instructed to provide detailed proposals for the training they propose, which as a minimum, should fall within the following guidelines:

- Timing of the training, which must be conducted in the erection and commissioning period.
- The design standards and procedures adopted.
- The relevant quality assurance procedures to be adopted for design and monitoring, and the effluent quality control procedures to be proposed.
- Keeping of plant records, metering of wastewater influent and effluent flows.
- The operational methodology and preventative maintenance procedures.

- Hands-on operation of the various items of mechanical and electrical plant and equipment.
- Emergency scenarios and procedures, i.e. action plans for emergency incidents.

It is recommended that the WWTP contractor is required to provide a period for monitoring and assisting of the WWTP operatives after commissioning and hand-over of the plant to the VIK.

The 'Specific Training for Operation of the WWTP' must also include the so-called 'Operational Tasking'. Operational Tasking includes the setting up at the WWTP of purpose-designed operational records systems, operational procedures (either to complement those previously laid down by the contractor in the O & M manual or to provide additional ones), and planned maintenance procedures. Record systems can either be set-up as computer-based or manual. Initially, a manual system would be more workable, but a final decision can be taken at a later stage. The Operational Tasking can be set-up by either the external consultant or the contractor; if it is set up by the contractor, the external consultant should monitor it. Operational Tasking must be in place prior to commissioning and, ideally, should be programmed to overlap with the contractor provided training, and then continue into the contractor's monitoring period after hand-over. This will allow sufficient time to confirm that the systems are appropriate and give the operators' time to implement and familiarize themselves with the systems, and give them the confidence to operate the WWTP.

4.5.5 Water Supply Revenue System and Cost Recovery

(1) Current Practices in Water Supply Revenue System and Cost Recovery

Tariff Setting Mechanism, Components & Approval

The legal basis for the setting of tariffs by the VIKs' is the "Methodology for Setting of

Water Tariffs" issued by the Council of Ministers with Decree No 98 of 29 April 1998, and published in State Gazette 40/1996. The Methodology is (legally) based on the Law on Prices and Rules for Implementation of the Law on Prices, Accountancy Law, Water Law, National Account Plan, National Accountancy Standard, and Regulation No 9 for "Use of Water Supply and Sewerage Systems", promulgated in State Gazette No 77/1994. Relevant key points of the Methodology are set out below.

- The Methodology deals with the price of potable and non-potable water supply, and the collection and treatment of wastewater. There is no mention of disposal of either effluent, sludge or grit and screenings.
- The tariff setting method is based on the "cost plus" principle. In other words, in the case of water supply, the price of $1m^3$ is determined on the basis of full costs for extraction, treatment and supply, plus a profit margin (Article 3 (1) of the Methodology).
- The allowable level of the profit margin is up to 12% of the costs if there is no investment program, and could be as much as calculated to cover the costs for an investment program related to rehabilitation of water supply and sewerage networks, and rehabilitation and upgrading of facilities (Appendix B to Article 11 of "Rules for Implementing the Law on Prices"). New facilities are not specifically mentioned but are, apparently, deemed to be included.
- Investment programs are approved by the Minister of Regional Development and Public Works for companies with more than 50% state ownership and by the respective Municipal Council for municipal companies.
- Full costs for one calendar year are determined on the basis of the reported full costs for billed water for the previous year and the projected costs for the next year.
- The volume of water expected to be sold is determined on the basis of water billed for the last three years and the projected volume for next year.
- Prices can be uniform for all the regions under one water company, but are allowed to differ if the supply is different, i.e. gravity or pumped water. (Article 14 of the Methodology).

- There are two categories of clients: the first category is the so-called 'population' (i.e. the public at large) and 'budget institutions' (i.e. ministries, schools, hospitals, etc.) for whom the pricing is the same, and the second is industry with a higher price. The lower price for the first category is for two reasons; (1) population and budget institutions are VAT exempt, and (2) water supply charges are calculated with a lower electricity price under this category.
- Billing is done on a monthly basis for both categories of consumers.
- Meters are read monthly for legal entities (companies) and periodically (periods not to exceed 3 months) for population (Article 26 of Regulation No 9).
- Non-metered water is determined and charged on a fixed monthly basis as follows: (a) 10 m^3 for centrally heated and 7 m^3 for non-centrally heated properties per registered inhabitant; (b) 15 m^3 for each 100 m^2 or for part of 100 m^2 of arable land; (c) 0.1 m^3 per m^2 for seasonally used properties (cottage, bungalow etc.) and properties without registered inhabitants; (d) 5 m^3 per m^2 for buildings under construction (Clause 5, Article 30 of Regulation No 9).
- According to Order No 20/1997 of MRDPW each consumer is required to install a water meter by the end of 1998.

The water tariffs consist of three components; water supply, wastewater collection, and (if applicable) wastewater treatment (including sludge disposal). Each component is determined on the basis of separate calculations of expenditures for the activity, expected volume of water to be supplied and wastewater to be collected and treated.

Particularly relevant to this section of this Feasibility Study is the operation and maintenance aspect of the costs/tariff for the WWTP which, as indicated above, are budgeted and calculated as a specific component of the water tariffs by the VIK's. There are no government subsidies or cross-subsidies. Some key points relating to the O & M costs for wastewater are given below.

- Wastewater is not metered, but is estimated empirically as a percentage of the water

billed and varies in the different regions; for VIK Sofia this figure is 95% of drinking water billed.

- Treated wastewater is also estimated as a percentage of wastewater billed; i.e. for VIK Sofia this is about 95 %.
- The price for treating 1m³ of wastewater is determined on the basis of full costs for treatment plus a profit margin;
- 'Population' and 'budget institutions' pay a price which is linked only to the volume of potable water billed. In some VIKs 'population' does not pay for wastewater treatment, though the plants exist - the costs for treatment are usually born by the industry.
- The charge for 'industry' varies according to the volume of potable water billed and the pollution loading of the effluent, as follows: (1) BOD_5<200 mg/l; (2) BOD_5 200 to 600 mg/l; (3) BOD_5 > 600 mg/l;
- The cost of treating wastewater and the apportionment of those costs between the different categories of customer depends on the type of region (industrial, rural, residential) and availability of WWTP;
- "Capital maintenance" for WWTP equipment (i.e. the cost of major items required for maintenance) is not recognized as an expenditure that can be included in the overall water supply tariff and that can be passed on to the customers. At present, capital maintenance items are funded by separate loans from one of the ministry's budgets for which the VIK must submit an application.

The main conclusion that can be drawn from the above points concerning O & M costs for wastewater collection and treatment is that whereas the costs for operation are, in theory at least, fully covered through tariffs, the maintenance costs are not. Not only are the "capital maintenance" costs not recovered, but there is no understanding of the true cost of maintenance at a WWTP, or even what items should be included and costed for as maintenance programs don't exist.

Like the investment programs, tariffs are subject to approval by the Ministry of Regional

Development and Public Works for companies with more than 50% state ownership and by the respective Municipal Council for municipal companies.

Cost Recovery

The following are (legally) recognized as expenditures and can be recovered through tariffs:

- materials (chemicals and spare parts for repair of tangible assets);
- energy costs and fuels;
- external services (for maintenance and repair of buildings, facilities, equipment, vehicles etc. usually done by external firms);
- depreciation (on tangible assets, the allowance against which is calculated in accordance with Accountancy Act);
- salaries;
- social security charges;
- others (vocational qualification and unemployment, business trips, participation in exhibitions and fairs etc.);
- supporting activities (transport, laboratories etc.);
- organization and management;
- "realization" (billing and collection, maintenance of office equipment, insurance, rent for premises etc.);
- financial (100% of the interest charged on loans and securities).

There are a number of deficiencies in the current cost recovery mechanism, the most prominent of which are summarized below:

- Inadequate allowances for depreciation (from the Accountancy Act) and amortization;
- Capital investment – repayment of the capital element of a loan used for acquiring

fixed assets is not recognized as a tax deductible expenditure;

- Capital maintenance for wastewater treatment equipment is not recognized as an expenditure that can be included in the tariff.

(2) Considerations for Future Changes in Water Supply Revenue System and Cost Recovery

It is clear that full cost recovery is essential if the WWTPs, which are the subject of this feasibility study, are to be successfully and sustainably operated and maintained.

Clause 33, Article 2 of the Proposal for EU Framework Directive in the Field of Water Policy (COM(97) 49 final - 97/0067 (SYN)) defines "full cost recovery" as meaning that the following cost elements of any services provided in relation to water use are paid by the user through prices or charges:

- Operation and maintenance costs;
- Capital maintenance costs;
- Capital costs (capital element (principal) and interest payments);
- Reserves for future improvements and extensions.

Although it is noted that exemptions may be granted for the following reasons:

- in order to allow the basic level of water use for domestic purposes at an affordable price;
- in order to allow the capital cost subsidies for infrastructure projects which are designed to assist in the achievement of specific environmental objectives;
- in order to take account of a specific geographical or climatic situation of a region.

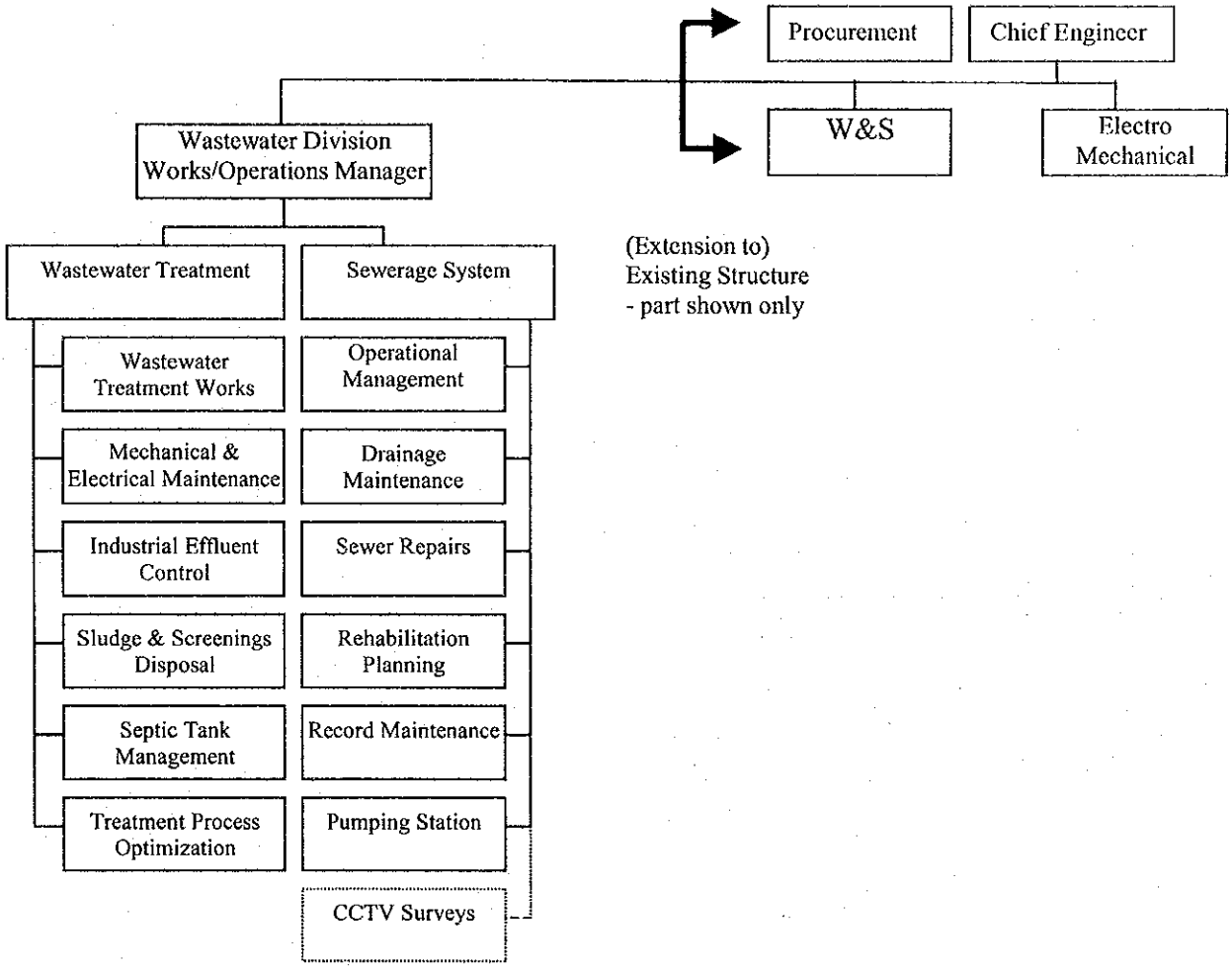
There are a range of measures to be considered in respect of future changes in the water supply revenue system and cost recovery. Some of these considerations are fundamental and require changes to the laws and/or regulations currently in force in Bulgaria, others

require action from the VIKs, while there are some issues that can be addressed at 'WWTP' level. While the context of this part of the feasibility study is the sustainable operation of the WWTPs' in the three priority towns, it is inevitable that we will touch on the larger issues, particularly when looking at cost recovery and revenue systems. The following list is not intended to be a comprehensive or detailed list of recommendations, but suggestions made in line with the preceding text.

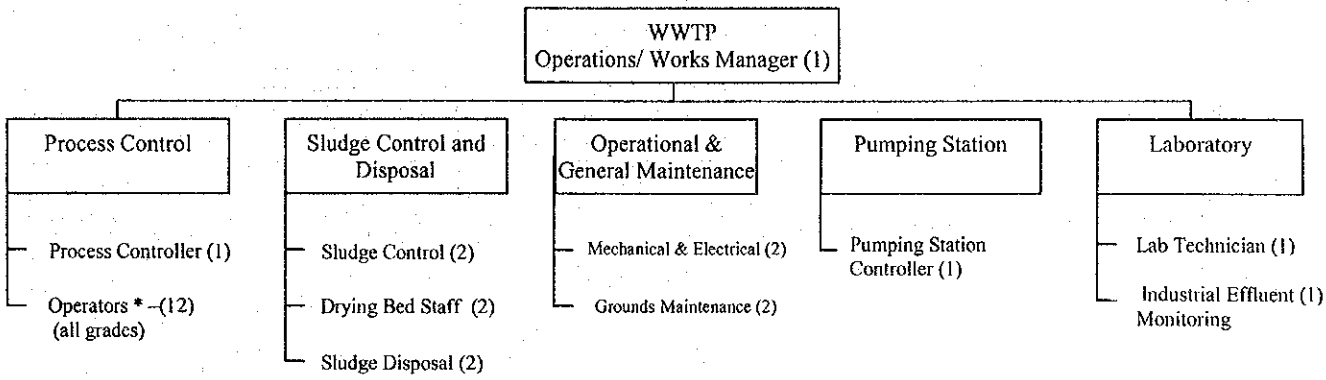
- Full cost recovery, as defined above, must be achieved, and the Government and VIKs must start implementing the necessary direct and supporting measures immediately.
- Improvement in non revenue water losses through specifically addressing the major points.
- Increase the allowances for depreciation and amortization of the VIK assets.
- Repayment of the capital element of a loan used for acquiring fixed assets or any other major capital expense necessitating a loan should be recognized as a tax deductible expenditure.
- Capital maintenance for WWTP equipment should be recognized as an expenditure that can be included in the tariff.
- Increase the presently allowable 12% "profit margins" added to the cost of supplying and, where applicable, collecting and treating wastewater to a more realistic figure that allows for realistic future levels of sustainable investments by the VIKs to be achieved, although clear principles and rules must be established.
- The true cost of operating and maintaining a WWTP to ensure the correct and sustainable operation and maintenance of the facility must be determined and provided. This should include, as a separate and specific item, the treatment and disposal of sludge, screenings and grit with due consideration for both the short-term and medium/long (i.e. EU) requirements.

FIG.4.5.1 Proposed Organizational Improvements to Facilitate Operation of the New WWTP at Pazardjik (Part Diagram – Refer to Existing)

(1) Operation Division Structure



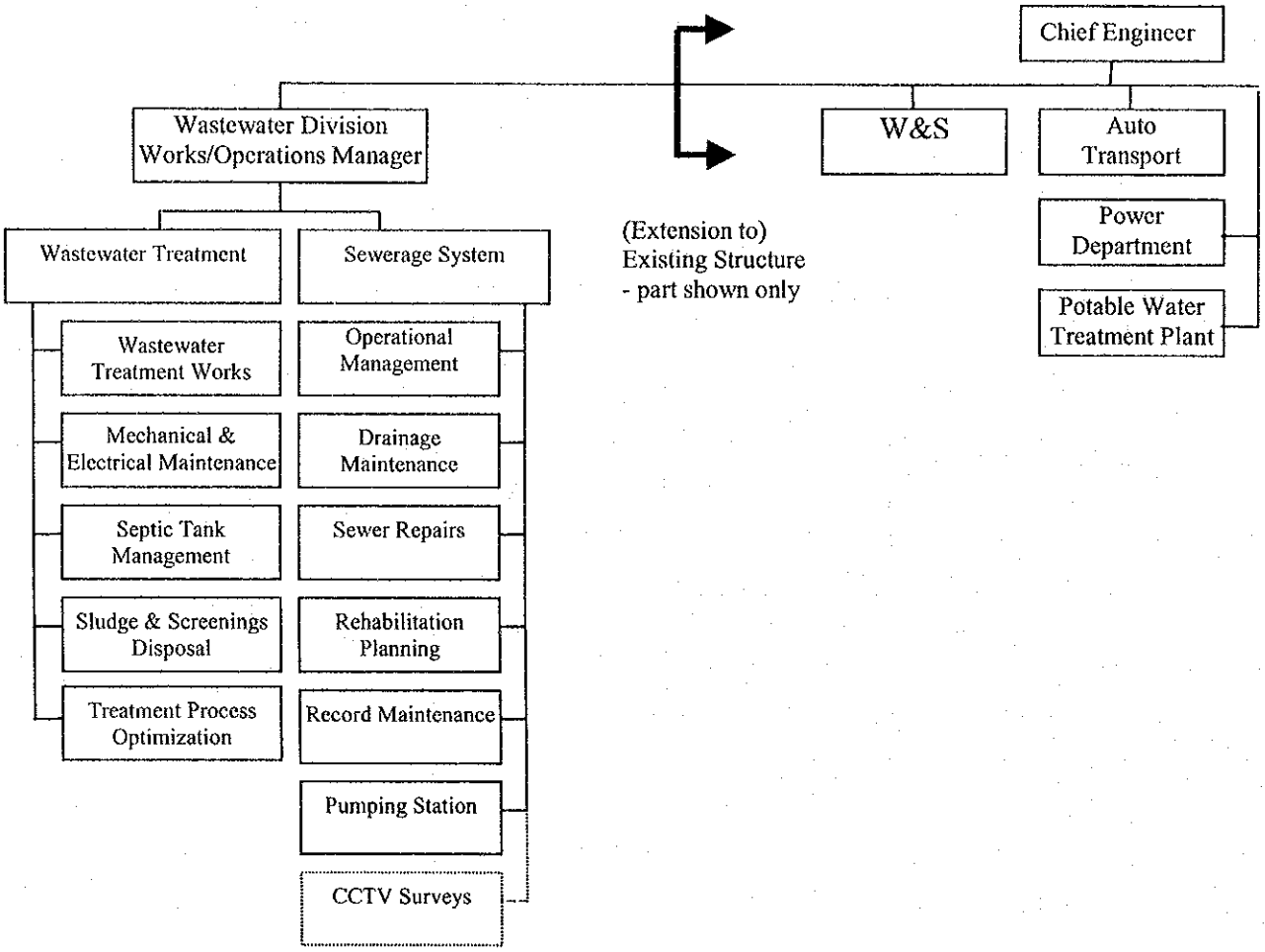
(2) Indicative WWTP Operation



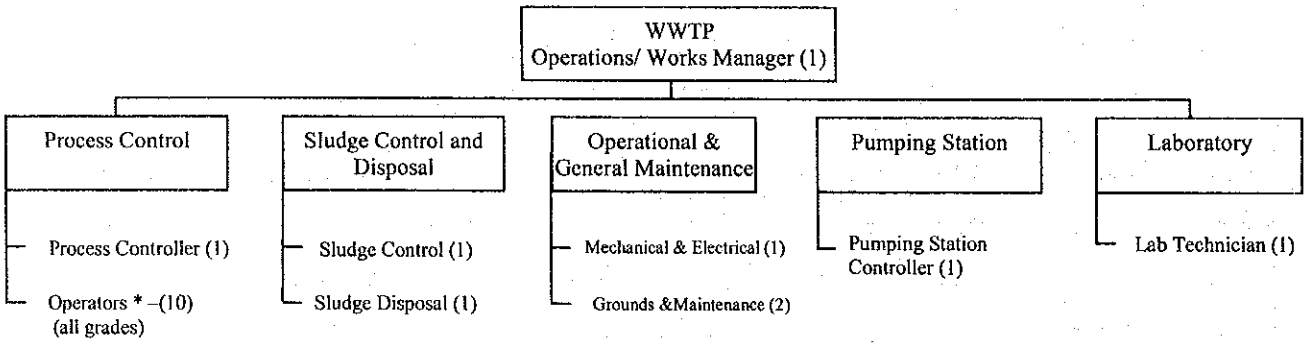
Note: * It is noted that in Bulgaria, operators are often normally M&E trained personnel. The term "operator" above, is therefore a generic term and includes different levels of operator.

FIG.4.5.2 Proposed Organizational Improvements to Facilitate Operation of the New WWTP at Dimitrovgrad (Part Diagram – Refer to Existing)

(1) Operation Division Structure



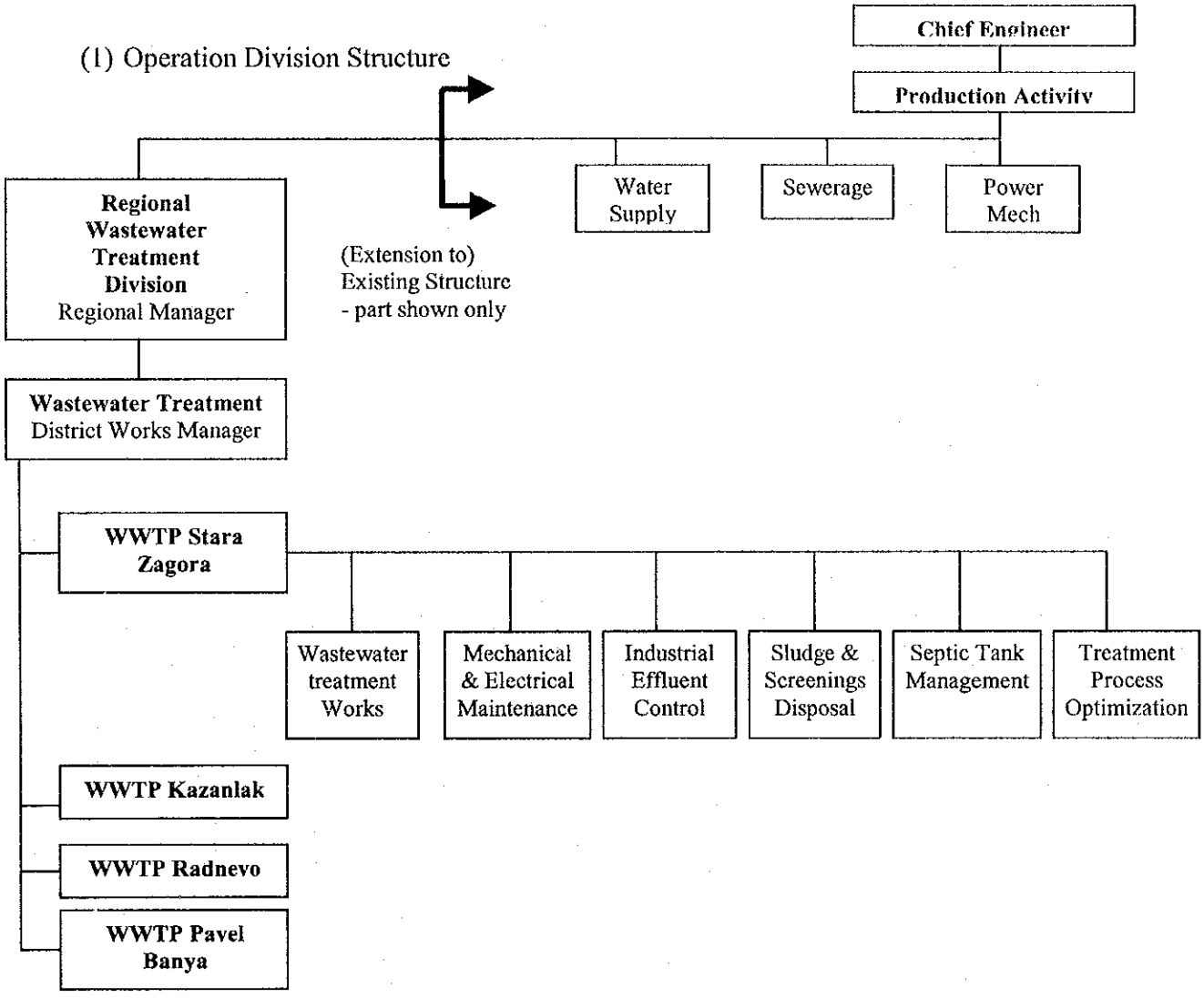
(2) Indicative WWTP Operation



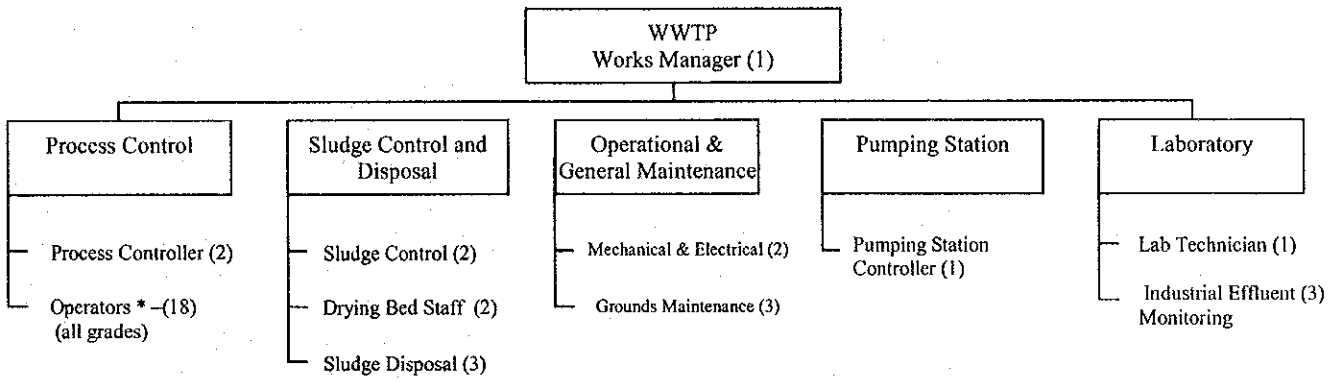
Note: * It is noted that in Bulgaria, operators are often normally M&E trained personnel. The term "operator" above, is therefore a generic term and includes different levels of operator.

FIG.4.5.3 Proposed Organizational Improvements to Facilitate Operation of the New WWTP at Stara Zagora
(Part Diagram – Refer to Existing)

(1) Operation Division Structure



(2) Indicative WWTP Operation



Note: * It is noted that in Bulgaria, operators are often normally M&E trained personnel. The term "operator" above, is therefore a generic term and includes different levels of operator.