CHAPTER 6 PRIORITY PROJECT

6.1 Necessary Conditions for Priority Project

A feasibility study will be conducted on the priority project. The priority project should consist of the priority components out of all the facility improvement components of the master plan. In selecting the priority components, the following criteria are taken into consideration.

1) Urgent Necessity

The components having urgent necessity of implementation.

2) Number of Beneficiaries

The components that will benefit a large the number of people.

3) Operational Cost Efficiency

The components that will contributes to the cost efficiency of the operation, thereby contributing to the stable management of the water supply utilities.

4) Improvement of Health

The components that will contribute to the improvement of the people's health.

6.2 Selection of Priority Project

All the facility improvement components of the master plan have been evaluated according to the criteria given above. Those components having high evaluation marks are shown in Table 6.2.1.

Table 6.2.1 Project Components of High Importance

Components	Urgency	Number of Beneficiaries	Operational Cost Efficiency	Improvement of Health
(1) Renewal of intake and transmission pumps with repair of some sections (urgent portion) of the Soroca - Balti pipeline	XXX	XXX	XXX	X
(2) Rehabilitation and improvements of the water treatment plant in the Soroca-Balti water supply system	XXX	XXX	X	XXX
(3) Completion of suspended construction of distribution reservoirs in Balti (urgent portion)	XXX	XXX	XXX	X
(4) Extension of the Soroca - Balti pipeline to Falesti with provision of a distribution reservoir	XX	X	XX	XXX
(5) Extension of the Soroca - Balti pipeline to Riscani with provision of a distribution reservoir	XX	X	XX	XX

Evaluation mark: XXX: highest importance, XX: high importance, X: importance

At the time of preparing Progress Report (1) in Moldova, the following packages of the components were proposed tentatively as possible cases for the priority project.

Case A: (1) + (2) + (3)

Case B: (1) + (2) + (3) + (4)

Case C: (1) + (2) + (3) + (4) + (5)

Out of above cases, Case C has been determined to be the priority project as the subject of the feasibility study. The project locations are shown in Figure 7.1.1.

PART 3
FEASIBILITY STUDY

CHAPTER 7 INTRODUCTION

7.1 Priority Project

All the facility development components included in the master plan were evaluated according to four criteria (urgent necessity, number of beneficiaries, operational cost efficiency, and improvement of public health), and it was concluded that the priority should be given to the following components that aim to improve the water supply systems of the priority areas, i.e., Cities of Balti and Soroca and Towns of Falesti and Riscani:

(1) Renewal of the existing transmission pumps for raw and clear waters and urgent repair works of the transmission mains of the Soroca-Balti water supply system,

(2) Rehabilitation and improvement of the existing water treatment plant of the Soroca-Balti water supply system,

(3) Completion of the unfinished distribution reservoir in Balti,

(4) Extension of the clear water transmission main to Falesti with provision of a distribution reservoir, and

(5) Extension of the clear water transmission main to Riscani with provision of a distribution reservoir.

Locations and dimensions of the project components are shown in Figure 7.1.1.

7.2 Project Areas

The areas where the direct benefits of water supply improvement are expected through the implementation of the priority project are:

City of Balti
City of Soroca
Town of Falesti
Town of Riscani

7.3 Water Demand

The population served and the water demand in the target year 2015 were projected in the master plan as shown in Table 7.3.1.

Table 7.3.1 Projected Water Demand

City/Town/Village	Population served		Water demand (m^3/d)	
	2000	2015	2000	2015
Soroca	44,988	46,442	7,961	12,178
Balti	158,230	168,086	33,907	44,950
Riscani	4,366	16,182	1,100	4,347
Falesti	9,500	18,749	2,718	5,197
Sub-total	217,084	249,459	45,688	66,673
Other towns & villages	50,340	109,512	7,812	24,051
Total	267,424	358,972	53,500	90,724

The water demand from all the areas in 2015 projected in the master plan is about 91,000 m^3/d, but the water demand in 2015 considered in the priority project will be about 67,000 m^3/d which corresponds to the demands from the 4 cities/towns (sub-total) as shown above.

The capacities of transmission pumps will be planned to meet the demand 67,000 m^3/d, while the attention will be given for the future expansions for meeting the demands from the remaining areas. However, for planning the capacities of the water treatment plant and the water transmission pipelines, the water demands from the other towns and villages will be also taken into account because the capacities of these facilities cannot be expanded easily in the future.

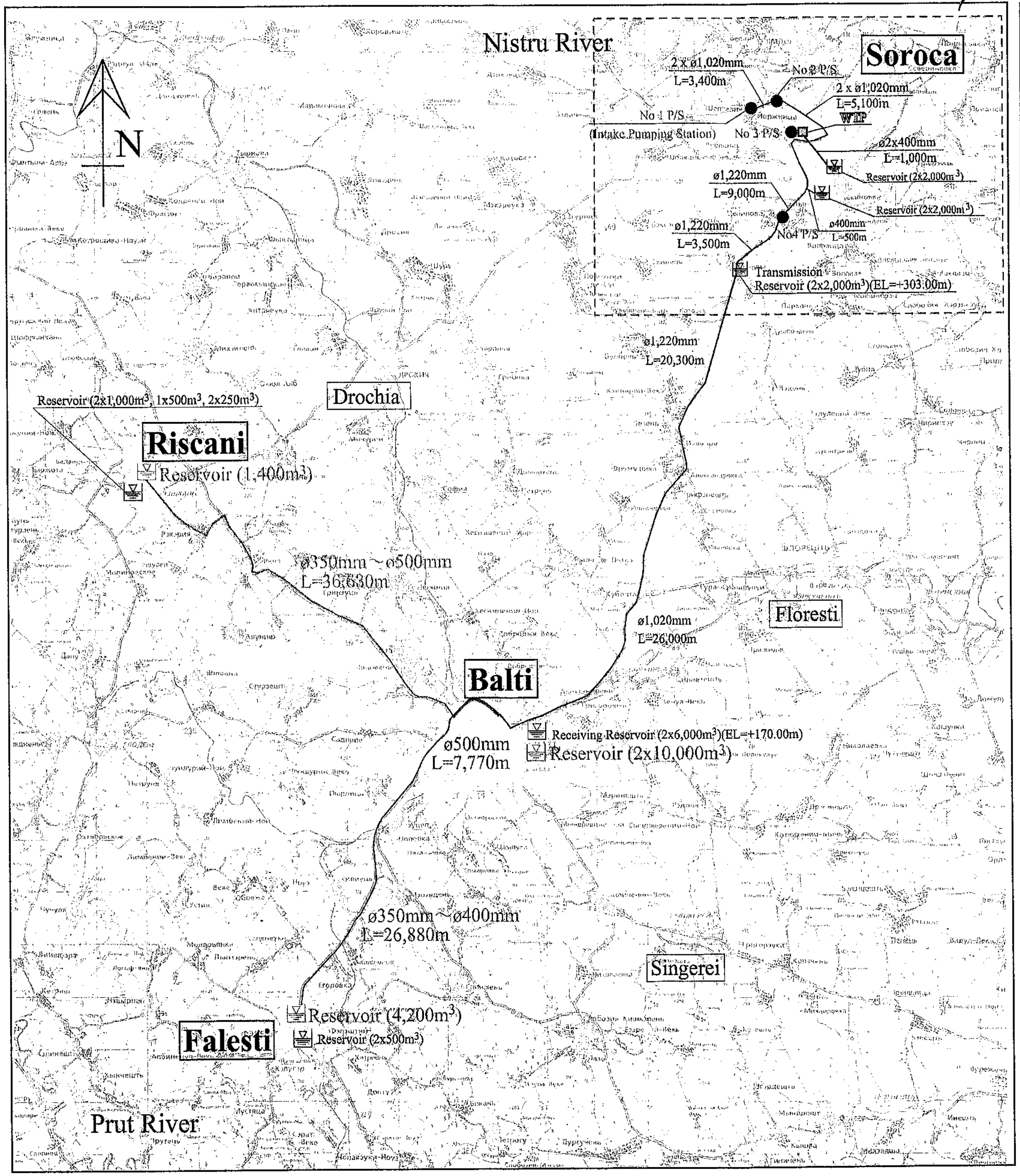
The self-consumption of the treated water in the treatment plant at 3 % will be added to the above water demand when planning the capacities of the raw water transmission pipeline and the water treatment plant.

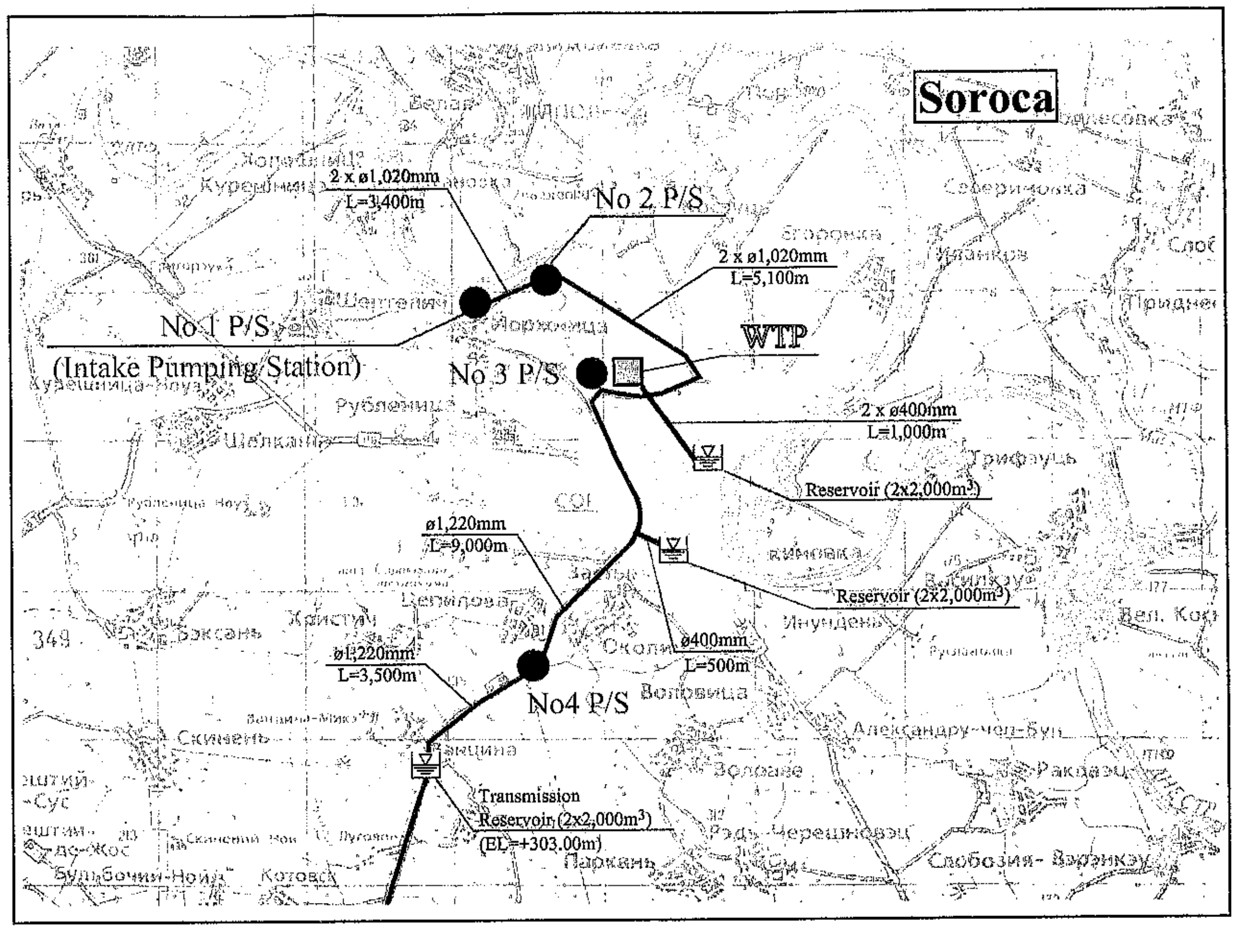
7.4 Water Source

Nistru River is the water source of the present Soroca-Balti water supply system. In the master plan stage it was confirmed that Nistru River is the reliable source of raw water for the water supply systems in the study area.

The flow of Nistru River is regulated through the dam reservoir of Novo-Dniestrovsk hydrosystem located upstream from Soroca in the territory of Ukraine near the Moldovan frontier, and two countries evenly share the available river water in accordance with the agreement in 1994. The Moldovan share of usable amount of water is sufficient to meet the water demands from potable water supply in this region as well as in Chisinau.

As regards the water quality, the Nistru river water has no problem as the raw water for the water supply when treated by conventional technologies of disinfection, coagulation, sedimentation, and filtration.





LEGEND
(Project Components)

C-1	■	Renewal of intake and transmission pumps / Urgent repair work of Soroca-Balti pipeline
C-2	▒	Improvement of the water treatment plant (WTP)
C-3	■	Completion of suspended construction of distribution reservoirs in Balti (20,000 m3)
C-4	■	Extension of transmission pipeline to Falesti / Construction of distribution reservoir
C-5	■	Extension of transmission pipeline to Riscani / Construction of distribution reservoir

Figure 7.1.1 Locations of Priority Project

CHAPTER 8 PRELIMINARY DESIGN

8.1 Planning Basis

The water demands in 2015 from the 4 cities and towns, which are Soroca, Balti, Riscani and Falesti, are as follows:

City of Soroca:	12,200 m^3/d
City of Balti:	45,000 m^3/d
Town of Riscani:	4,300 m^3/d
Town of Falesti:	5,200 m^3/d

Therefore, the total water demand of feasibility study is 66,700 m^3/d. However, the capacity of the water treatment plant and transmission mains should be designed to meet the water demand in 2015 including the other towns and villages considered in the master plan. The capacity of the pumps will be designed to meet the said water demand 66,700 m^3/d.

The basis of water flow rates for the respective facilities is shown in Table 8.1.1. Specific design flow rates for the major facilities are shown schematically in Figure 8.1.1

Table 8.1.1 Basis of Design Flow Rates for the Facilities

Facility	Basis of Design Water Flow Rate	Demand Area
Pumps in raw water intake (PS-1) and PS-2	Maximum Daily + Operation loss in treatment plant (3%)	4 cities/towns
Raw water transmission mains	Maximum Daily + Operation loss in treatment plant (3%)	All the areas considered in the master plan
Water Treatment Plant	Maximum Daily + Operation loss in treatment plant (3%)	All the areas considered in the master plan
Pumps in PS-3 and PS-4	Maximum Daily	4 cities/towns
Clear water transmission mains	Maximum Daily	All the areas considered in the master plan
Clear water transmission reservoir	Maximum Daily	All the areas considered in the master plan
Water distribution reservoir	Maximum Daily	Each of 4 cities/towns

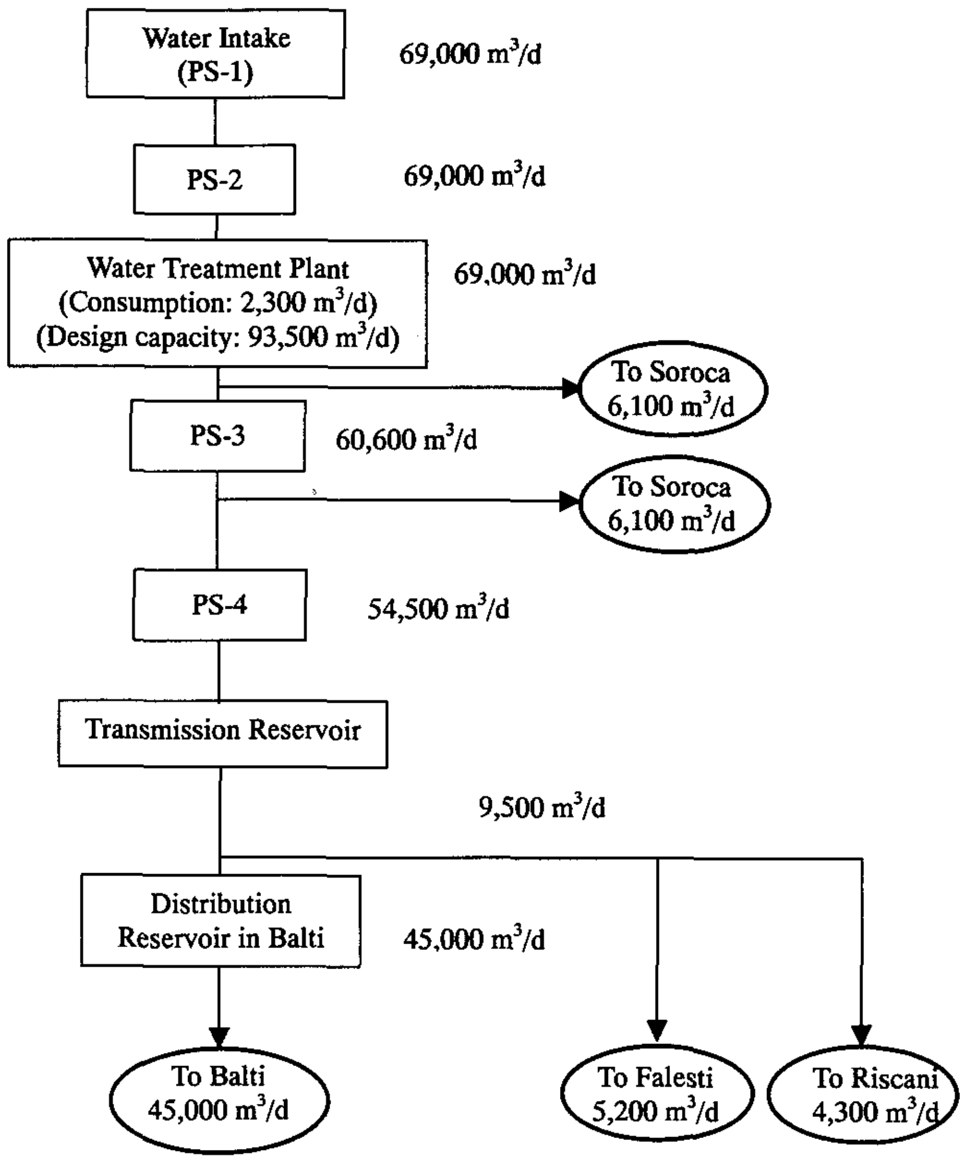


Figure 8.1.1 Design Water Flow Rate for the Priority Project

8.2 Design Criteria

Design criteria for the relevant water supply facilities are shown below. These are basically extracted from "Construction Norms and Rules (CN & R) 2.04.02-84 - Water Supply External Networks and Facilities," which has been derived from GOST and adopted in Moldova. When necessary, other criteria such as that given in "Guidelines for Design of Water Supply Facilities in Japan," which is generally used in Japan, are also referred.

8.2.1 Transmission Main

Design criteria for the transmission main are as follows:

- Covering depth: 1.0m
- Material of pipes: Ductile cast iron pipe with corrosion prevention
- Flow velocity: Less than 3.0 m/s for the gravity system and economical velocity for the conveyance system by the pumps
- Friction loss: Hazen-Williams formula shown below is adopted:

  $H = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85} \times L$

  Where, H: Friction loss of Pipe (m)

  C: Coefficient of flow (100 for existing pipes and 110 for new ones)

  D: Diameter of Pipe (m)

  Q: Flow Rate (m3/s)

  L: Pipe Length (m)

8.2.2 Pumping Stations

Design criteria for the pumping stations are as follows:

- Number of pumps: 3 sets/station including stand-by pump
- Stand-by pump: 1 set/station
- Type of pumps: Centrifugal, horizontal type

8.2.3 Distribution Reservoirs

Design criteria for the distribution reservoirs are as follows:

- Retention time: 24 hours (in total of all the distribution reservoirs in a municipality)
- Material: Pre-cast concrete panel for the unfinished reservoir in Balti

  Reinforced concrete for new reservoirs in Riscani and Falesti
- Height of the reservoir: 3m-5m
- Minimum earth cover: 50cm embankment from the top of the reservoir
- Number of basin: Two separated basins per each reservoir
- Seismic force: Horizontal coefficient of seismic force shall be considered based on CN & R.

8.2.4 Water Treatment Plant

(1) Contact Chamber (Pre-chlorination Chamber)

The existing contact chamber (pre-chlorination chamber) is also functioning as a receiving well. The retention time of a receiving well should not be less than 1.5 minutes against the design water flow (Japanese guideline for receiving wells). The actual capacity of the pre-chlorination chamber is much larger than this.

(2) Required Amounts of Chemicals

1) Raw Water Quality

Turbidity of the raw water has been estimated as shown below based on the results of water quality analyses in the treatment plant laboratory for the last 6 years (the actual data are provided in the Supporting Report).

Turbidity (Kaolin scale): Minimum: 0.5 mg/l, Average: 5 mg/l, Maximum: 200 mg/l

2) Kinds and Amounts of Chemicals to be Used

The present practices of applying chemicals in this treatment plant and the Chisinau water treatment plant, of which the water source is also Nistru River, were investigated. Based on these practices, kinds and amounts of chemicals to be used were determined as follows:

Coagulant: Aluminum sulfate (solution containing Al_2O_3 at 10 %)

Dosing rate: Min. 5 mg-solution/l
Ave. 10 mg-solution/l
Max. 100 mg-solution/l

Filter aid: Poly-acryl-amide (5 % solution)

Dosing rate: Ave. 10 mg-solution/l (dosing before filtration)

Disinfectant: Chlorine gas (liquid)

Dosing rate: pre-chlorination 3 mg/l, post-chlorination 2 mg/l

(3) Chemical Mixing Chambers

Capacity: 1 - 5 minutes retention against the design water flow (in accordance with the Japanese Guideline)

(4) Lateral Flow Sedimentation Basin

Flow velocity:	40 cm/min or less (Japanese Guideline)
Surface loading rate:	15 - 30 mm/min (Japanese Guideline)
Settling velocity:	21 - 36 mm/min (CN & R)
Effective basin depth:	3 - 3.5 m (CN & R)
	3 - 4 m (Japanese Guideline)
Basin width:	6 m or less (CN & R)
Length/width ratio:	3 - 8 (Japanese Guideline)
Number of basins:	2 or more (Japanese Guideline)
Weir overflow rate:	Construction norm of outlet weir is provided (CN & R)
	500 m^3/m/d (Japanese Guideline)

(5) Rapid Sand Filter

Filtration rate (single layer):	120 - 288 m/d depending on the kind of sand, grain size distribution, and the layer thickness (CN & R)
	120 - 150 m/d (Japanese Guideline)
Filtration rate (multi layer):	168 - 240 m/d depending on the kind of sand, grain size distribution, and the layer thickness (CN & R)
	240 m/d or less (Japanese Guideline)
Layer thickness (single layer):	70 - 200 cm (CN & R)
	60 - 70 cm (Japanese Guideline)
Layer thickness (multi layer):	40 - 80 cm CN & R)
	60 - 80 cm (Japanese Guideline)
Backwashing:	
Backwash water pressure:	1.6 - 3.0 m (Japanese Guideline)
Backwash water volume:	0.72 - 1.08 $m^3/min/m^2$ depending on the kind of sand, grain size distribution, and the layer thickness (CN & R)
	0.6 - 0.9 $m^3/min/m^2$ (Japanese Guideline)
Backwash time:	5 - 7 minutes depending on the kind of sand, grain size distribution, and the layer thickness (CN & R)
	4 - 6 minutes (Japanese Guideline)

(6) Backwash Sludge Separation Basin:

Capacity:	Greater than or equal to the volume of backwash wastewater at one time (Japanese Guideline)
Number of basin:	2 or more (Japanese Guideline)

(7) Sludge Basin (Sludge Deposit Pond):

Capacity:	Greater than or equal to the volume of sludge discharged in one day or at one time (Japanese Guideline)
Number of basin:	2 or more (Japanese Guideline)

(8) Clear Water Reservoir:

Capacity:	At least one-hour volume (Japanese Guideline)
Number of basin:	2 or more (Japanese Guideline)

(9) Quality of Treated Water

To comply with the drinking water quality standard (GOST 2874-82) as given in the Supporting Report.

8.3 Facility Development Plan

The following descriptions refer Drawing numbers. These drawings are contained in the volume of "Drawings". But some of them are also included in this Main Report with the same drawing numbers.

8.3.1 Rehabilitation of the Existing Pumping Stations

(1) Outline

There are four existing pumping stations in the Apa-Canal Soroca-Balti water supply system.

The raw water is conveyed to the Soroca-Balti water treatment plant by the No.1 and No.2 pumping stations (PS-1 and PS-2) in sequence. After treatment, water is led to the clear water reservoirs (storage volume;3@3,000m^3 = 9,000m^3). The treated water is transmitted from the No.3 pumping station (PS-3), which is located in the water treatment plant premises, to the No.1 transmission reservoirs (TR-1: storage volume; 2@2,000m^3 = 4,000m^3). Part of treated water is distributed to Soroca city by gravity. On the way to TR-1, part of water is also distributed to Soroca city under pressure. No.4 pumping station (PS-4) conveys the water further to No.2 transmission reservoirs (TR-2: storage volume;2@2,000m^3 = 4,000m^3). From the reservoirs to the receiving reservoir in Balti city, the water flows through one pipeline with diameters of 1,220 mm and 1,020mm and the lengths of 20.3km and 26.0 km, respectively, by gravity.

The water demand in the priority project for the design year of 2015 is around 67,000m^3/day. The design capacities of these pumping stations are 69,000m^3/day as intake volume, so only about one third of the original design capacity. The flow diagram for the pumping stations and reservoirs is shown in Drawing 1. Each of the pumping stations is shown in Drawings 2 through 5.

(2) Selection of the Type of Pumps

The intake pumps, the booster pumps and the transmission pumps should be replaced by smaller and more efficient pumps, with new discharge ratings at the respective pumping stations.

These pumps convey water from one pumping station to the next or the reservoirs. Due to so high delivery pressure, ranging from 55 m to 93 m, the pumps of a horizontal centrifugal type with double suction are selected. To save the energy cost, the pumps must have high efficiency, of 80～85%.

In addition to the above main pumps, there are two bilge pumps in PS-1. The new bilge pumps are of a horizontal centrifugal type with self-single suction. There are two pumps to feed backwash water to the elevated tanks in PS-3. They are of a horizontal centrifugal type with double suction.

(3) Number of Pumps

There will be three pumps in each pumping station. At normal times, either two of the three pumps commissioned while either one of them in each station stands-by.

There will be two bilge pumps at PS-1 and two of backwash water feed pumps at PS-3. Either one of them is commissioned while the other one stands by.

(4) Specification of Pumps

The total delivery heads required for respective pumps were calculated using the Hazen-Williams formula for pipe loss computation as shown in Table 8.3.1. Hydraulic profile of the existing transmission main is shown in Figure 8.3.1.

Table 8.3.1 Delivery Head Required for the Pumps

Applicable PS for the pipe section	C	D (m)	Q (m^3/s)	L (m)	V (m/s)	H1 (m)	H2 Actual head (m)	H3 (m)	H4 Total head (m)	Remark
PS-1	100	1	0.40	3,400	0.51	1.33	48	3	52.33	2 lines
PS-2	100	1	0.40	5,100	0.51	1.99	85	3	89.99	2 lines
PS-3	100	1.2	0.71	9,000	0.63	4.18	68	3	75.18	
PS-4	100	1.2	0.63	3,500	0.63	1.30	76	3	80.30	

Specifications of the pumps suitable for above requirements were determined as shown in Table 8.3.2. Replacement of valves related to the pumping stations is shown in Table 8.3.3.

Table 8.3.2 Pump Specifications

Pumping Station	Function of Pump	Pump Specification	Number of Pump*
PS-1	Intake	24.0 m^3/min×52.3m×300kW	3
	Bilge	1.0 m^3/min×20.0m×7.5kW	2
PS-2	Booster	24.0 m^3/min×90.0m×500kW	3
PS-3	Transmission	21.3 m^3/min×75.0m×360kW	3
	Backwash	15.0 m^3/min×21.0m×75kW	2
PS-4	Transmission	17.7 m^3/min×80.0m×350kW	3

* Including one standby each

Table 8.3.3 List of Valve Replacement

Place	Name	Movement		Type	Dia. (mm)	Piece	Remark
		motor	manual				
PS-1	suction			butterfly	500	3	pump connect
	check			swing	400	3	pump connect
	delivery			gate	400	3	pump connect
	check			swing	100	2	bilge
	delivery			gate	100	2	bilge
PS-2	suction			butterfly	500	3	pump connect
	check			swing	400	3	pump connect
	delivery			gate	400	3	pump connect
	intake collector			gate	800	2	open air
	outlet collector			gate	800	2	open air
PS-3	suction			butterfly	500	3	pump connect
	check			swing	400	3	pump connect
	delivery			gate	400	3	pump connect
	suction			butterfly	400	3	pump connect
	check			swing	300	2	pump connect
	delivery			gate	300	2	pump connect
	pipeline			butterfly	1,000	1	
PS-4	suction			butterfly	450	3	pump connect
	check			swing	350	3	pump connect
	delivery			gate	350	3	pump connect

(5) Water Hammer Prevention

Water hammer is a phenomenon that water pressure inside the pipe greatly surges upward or downward because of a sudden change in flow velocity. It will happen in a water main connected to a pump when the electric power supply suddenly interrupted, a high-lift pump is turned on, or valves are closed or opened suddenly.

If water hammer occurs, the pumps and/or valves may be destroyed, or the pipes may be crushed or burst.

The water hammer is protected by either one of the following methods or their combination:

i) A flywheel is installed on the pump axis for the purpose of increasing rotating inertia of pump

ii) A surge tank is placed on the pipeline for the purpose of reducing the pressure.

iii) Air vessel is placed on the delivery main for the purpose of rapid pressure drop.

iv) Air valves are mounted at a negative pressure point(s) on the pipeline for the purpose of introducing air when water hammer occurs.

Apa-Canal Soloca Balti has been protecting pumps and valves from water hammer using air valves and powered valves for rapid water release. When pumps stop because of power failure or an accident, the powered valves start opening immediately and the upward pressure surge is prevented owing to water release. But these pressure release valves are defective so have never been operated these several years.

Water hummer prevention measures are needed at all the sections of transmission lines: (1) 3.4km from PS-1 to PS-2 with a lift of 46m, (2) 5.1km from PS-2 to the water treatment plant with a lift of 81.5m, (3) 9.0km from PS-3 to PS-4 with a lift of 60.5m, and (4) 3.5km from PS-4 to TR-2 with a lift of 67m. The safe and sure means of water hammer prevention are to be used in the combination of the air vessels, the air valves and flywheel.

As a result of a water hammer computation, the following measures are adopted for the water hammer prevention at respective pumping station (see Drawing 1).

Pumping Station	Water hammer prevention measure	Remark
PS-1	Flywheel (GD2 = 150 kg-m^2)	
PS-2	-	No measure is necessary
PS-3	Air vessel (V = 50 m^3)	Requires frost protection
PS-4	Air vessel (V = 30 m^3)	Requires frost protection

(6) Ancillaries of Pumps

Since the old pumps are removed and new pumps of a smaller size are installed, the ancillaries of the pumps such as connecting piping, powered inlet gate valves, powered outlet gate valves and check valves must be replaced.

The current water flows and cumulative quantity from one pumping station to the next or reservoirs must always be indicated by a flow indicator- recorder. The pump delivery pressure needs to be indicated by a pressure gage.

(7) The Operating System of Intake Pumps at PS-1 and Booster Pumps at PS-2 Combined

At present, water is pumped from the PS-1 to the PS-2, and the pumps at the PS-2 directly boosted the water to the water treatment plant. There is no reservoir at the PS-2 premise. The timing of the operation of the pumps at the PS-2 is a delicate and difficult job for the operator.

The new operating system of the intake pumps at the PS-1 and the booster pumps at the PS-2 combined must be designed automatically. There is the water level indicator at the intake well and each reservoir. There is the powered valve at the suction side and delivery side of each pump and the pressure indicators will be installed at the necessary points. The new operating system of the PS-1 and the PS-2 combined will become automatically as interlocked between these equipment, the water indicator, the powered valve and the pressure indicator.

The new operating system of the Intake pumps at the PS-1 and the booster pumps at the PS-2 combined must be designed as follows:

1) The Conditions for Start of the Intake Pump at PS-1

   i) Water level in the pump suction well is 1m higher than the elevation of the suction pipe axis.

   ii) Suction valve of the pump is open and the delivery valve of the pump is close.

   iii) When the conditions of the above i) and ii) are fulfilled, the operator can start the pump manually.

   iv) When the pressure of the delivery valve reaches the prescribed value, the outlet valve can be opened automatically.

2) The Conditions for Stop of the Intake Pump at PS-1 Automatically

   i) Water level in the suction well has become less than 1m above the elevation of the suction pipe axis

   ii) The delivery pressure has dropped beyond the prescribed value, or has risen beyond the prescribed value as a result of discontinued flow.

3) The Conditions for Start of the Booster Pump at PS-2

   i) The clear water reservoirs of Soroca-Balti water treatment plant does not become high water level (HWL).

   ii) Suction valve of the pump is open and the delivery valve of the pump is close.

   iii) When conditions of the above i) and ii) are fulfilled and the suction water pressure reaches the prescribed value, the pump can be started automatically.

   iv) When the pressure of the delivery valve reaches the prescribed value, the outlet valve can be opened automatically.

4) The Conditions for Stop of the Booster Pump at PS-2 Automatically

   i) The suction pressure has become lower than the prescribed value.

   ii) The delivery pressure has dropped beyond the prescribed value or has risen beyond the prescribed value as a result of discontinued flow.

(8) Design Concept of Transmission System

The transmission system is composed of the four pumping stations, transmission reservoirs and transmission mains. The control system must be designed to start and stop automatically/manually in the local control panel at the each pumping station. There should always be operators, who monitor the local control panel and take necessary tasks for mechanical and electrical operation and maintenance, as required, at each pumping station.

The following control features must be realized in the local control panels at each pumping station.

1) The conditions of the pump start and pump stop as mentioned in the section (7) Operating System of Intake Pumps at PS-1 and Booster Pumps at PS-2.

2) Under normal operation in PS-1, PS-2, PS-3,and PS-4, two pumps are always in commission. But sometimes only one pump is in commission.

3) Two pumps do not start at the same time.

(9) Electrical Facility

1) Electric Power Supply Network Provided for the Pumping Stations

i) Existing 110/35/10 KV open switchyard substation at Soroca

Electric power for the pumping stations is supplied from the existing 110/35/10 KV open switchyard substation of Moldelectrica Northern Power Supply Networks with two transformer banks at Soroca.

ii) Two 35/10 KV open switchyard substations at Cosauti and Tsepilovo

There are two existing open switchyard substations at Cosauti and at Tsepilovo with 35 KV overhead lines connected to the above existing 110/35/10 KV open switchyard substation at Soroca.

iii) PS-1

Electric power for PS-1 is supplied with two 10KV feeder cables, 1800m long each from the substation at Cosauti. During investigation one line is out of service and its reinforced concrete support has been constructed.

iv) PS-2

Electric power for PS-2 is supplied with 10KV two feeder cables, 250m long each from the substation at Cosauti.

v) PS-3

Electric power for PS-3 is supplied with two 10 KV feeder cables, 250m long each from the open switchyard substation at Soroca. In addition, electrical power for the water treatment plant is also supplied from the open switchyard substation at Soroca through PS-3.

vi) PS-4

Electric power for PS-4 is supplied with two 10 KV feeder cables, 50m long each from substation at Tsepilovo.

2) Evaluation of Electrical Facilities

Life assessments was applied to the 10KV metal-enclosed switchgear and 1,250KW synchronous motors for the main water supply pumps during the first study period in July 2001.

As the result of the above life assessment, it is considered necessary to take the following measures.

a. to perform major maintenance and testing
b. to establish newly replacement plan

For details, see the Supporting Report.

On the other hand the evaluation of the remaining electrical facilities such as 10KV-400/230V transformers, 380V distribution boards, local distribution boards, control switch stations, cables, cable racks, lighting system, grounding system, etc. is the same as the result of the above life assessment.

It means that it is considered necessary to take measures in order to avoid possible electrical failures, such as improper maintenance, mechanical and electrical interlock failures, gradual component deterioration or insulation breakdown, excessive moisture, and the presence of foreign objects or live animals inside the equipment.

3) Recommendations

The following are recommended in order to maintain safe and stable operation of the pumping stations.

i) High voltage motors for the water supply pumps (intake pumps, booster pumps, transmission pumps)

The intake pumps, the booster pumps, and the transmission pumps should be replaced with smaller and more efficient pumps with new discharge ratings at the respective pumping stations.

Accordingly high voltage motors for these pumps should be replaced with new motors with the following features.

a. squirrel cage induction motor (asynchronous)

b 6 KV, 50Hz, totally enclosed fan cooled

From a economical point of view the rated voltage of these motors having output capacity from 151 kW to 800KW should be 6KV instead of 10 KV.

ii) Low voltage motors

The old pumps should be replaced with smaller and efficient pumps. Accordingly low voltage motors for these pumps should be replaced with new motors having output capacity up to150KW and the following feature.

a. squirrel cage induction motor (asynchronous)

b. 380V, 50Hz, totally enclosed fan cooled

iii)Electrical Equipment and Materials

a. Replacement of electrical equipment and materials

The following existing electrical equipment and materials should be replaced with new ones.

- 10 KV metal-enclosed switchgear
- 10KV- 400/230V power transformers
- 380 V distribution boards
- Local distribution boards
- control switch stations
- cables
- cable racks
- lighting system,
- grounding system

b. Scope of electrical equipment to be replaced with new one

Overall electrical network is shown in the drawing / Overall Key Single Line Diagram (see Drawing 14). Scope of electrical equipment to be replaced with new one is also shown in this Drawing.

c. Modification of electrical equipment

c-1. It should be noted that the following equipment modified is required with the application of 6KV motors.

- 10KV - 6.3 KV power transformers (adder)
- 6KV - 400/230V power transformer instead of 10KV-400/230V power transformer
- 6KV metal-enclosed switchgear instead of 10 KV metal-enclosed switchgear
- 6KV power cables instead of 10KV cables

c-2. Type of switchgear

- 6KV metal-enclosed switchgear

* Incoming and bus tie switchgear to be provided with vacuum circuit breaker (VCB) or SF 6 gas circuit breaker (GCB)
* Motor feeders and transformer feeders to be provided with vacuum contactor and current limiting fuse links
* 6KV switchgear control

Incoming and bus tie switchgear and transformer feeders to be controlled by DC 110Vor DC 125V control power, which is provided from the DC 110V or DC 125V batteries and charger. However, motor feeders to be provided by DC 125V batteries and charger. However, motor feeders to be provided by AC 110V or AC 220V control power derived from own control transformer (6KV/110V or 6KV/220V).

- 380V distribution board

* Incoming and bus tie switchgear to be provided with air circuit breaker (ACB), which is controlled by DC 110V or 125V control power.
* Motor feeders, motor operated valve feeders, and other feeders to be of motor control centers with power fuses or molded-case circuit breakers (MCCB), magnetic contactors, thermal overload relays, which is controlled by AC 110V or AC 220V control power derived from own control transformers (380V-110V or 380V- 220V)

- DC 110V or DC 125V batteries and charger.(adder)

For 6KV switchgear control and 380V switchgear control DC 110V or DC 125V batteries and charger to be provided.

c-3. Type of 10 KV power feeders from the substation at Cosauti to PS-1

Taking safe operation and maintenance into consideration the 10KV power cables should be provided instead of the 10KV overhead lines.

iv) Attention to existing electrical equipment in the Cosauti substation and the Tsepilovo substation

We have to draw attention that major maintenance and testing should be performed by Moldelectrica Northern Power Supply since average of lifetime of electrical equipment installed in the Cosauti substation and the Tsepilovo substation is approaching. As for the power transformers (35-11KV) in both substations we will focus on the following recommendation:

a. Transformer should be replaced with new one. Acording to the nameplate data of the existing power transformers manufacturing year is 1978. It means that replacement of these transformers is imminent taking their lifetime into consideration.
b. Larger capacity transformers to be provided in order to avoid severe voltage drop during large motor starting

(10) Control System in the Pumping Stations

1) Outline of Control System at the Pumping Stations

We will focus on control system at the pumping stations PS-1, PS-2, PS-3, and PS-4.

At the present, the pumps for the water supply have been operated manually by the operators allocated to the respective pumping stations after their receipt of command from the dispatcher at the water treatment plant.

This means that control of the existing pumping stations relies on operator's skill. However, some issues to damage pumps and motors in the past were reported during the first study period in July 2001.

Under the circumstances, it is considered necessary to provide a local control panel in the respective pumping stations in order to establish ease and stable operation of the pumping stations in terms of monitoring and control.

2) Application of Local Control Panels in the Pumping Stations

i) Main features of application of the local control panels in the pumping stations should be as follows :

a. to establish ease and stable operation
b. to integrate to supervisory control and data acquisition system (SCADA) at the water treatment plant (as for SCADA system refer to paragraph (5) of Section 2.3.3)

ii) The local control panels should have the following functions:

a. Control mode selections such as remote/local, automatic/manual, selection of operation pump

b. Control switches such as on/off push buttons for pumps, open/stay/close push buttons for motor operated valves

c. Instrumentation such as pressure gauges at inlet line and outlet line of pumps, water flow meters, level meters at reservoirs, voltage, motor kW, motor current

d. Indications such as ready for operation, pump status (running & stopping), valve status (full open, full close, stopping)

e. Alarming such as pump heavy trouble, pump light trouble, motor heavy trouble motor light trouble, valve trouble, inlet line pressure high, inlet line pressure low, outlet line pressure high, outlet line pressure low, reservoir level high, reservoir level low, electric power failure

f Logic functions

iii) Remote terminal units

Next to the local control panel remote terminal unit (RTU) should be provided in respective pumping stations. The objectives of the RTU are:

a. The RTU works with the SCADA system by way of fiber optic cable links to provide the functionality of the complete system.

b. The RTU is able to operate as a stand-alone unit to provide local monitoring and control.

c. The RTU is to provide the basic data acquisition functions required and to enable remote control from Master Terminal Unit located at the water treatment plant

8.3.2 Rehabilitation of the Existing Transmission Mains

(1) Outline and Existing Conditions of the Transmission Mains

1) Outlines

Outlines of the existing transmission mains of ACSB are as follows:

Section	Pipe Diameter (mm)	Length (m)
Intake (PS-1) - PS-2 - WTP	1,020	8,500 x 2 lines
WTP (PS-3) - PS-4 - Transmission Reservoir	1,220	12,500
Transmission Reservoir - Branch for Falesti	1,220	20,300
Branch for Falesti - Distribution Reservoir in Balti	1,020	26,000

The most part of the existing pipeline was laid under the agricultural field. Some sections of the pipeline cross the road are protected by steel casing pipes of 5.9 mm thickness. Some portions are not protected due to the change of the direction of a brook and soil erosion. These portions of the pipeline should be protected by concrete.

The existing pipes under the ground are covered by the plastic sheets and not affected by corrosion. However, the exposed pipes at the brook crossings and the erosion will be easily affected by corrosion. These pipe sections should be painted to prevent the corrosion.

Air-relief valves, air inlet valves, blow-off valves for the drain and gate valves are installed at appropriate positions of the transmission mains. Branch connection valves are also installed to distribute the water to the villages along the pipeline. However, these valves are not functioning any more. Replacement of the existing valves is required to keep the transmission mains in a good condition. The number of the said valves is summarized in the following table.

Name of the valves	Specification (mm)	Number
Air-relief valves	ϕ100	37
Air inlet valves	ϕ150	8
Blow-off valves	ϕ600	2
	ϕ400	3
	ϕ300	25
	ϕ150	16
Gate valves	ϕ1000	5
	ϕ800	5
Branch connection valves	ϕ300	1
	ϕ150	1

Cathode protection system is adopted to prevent the pipe corrosion. Four transformers and 12 sacrificed steel bars with 1.8 m long were installed between the PS-1 and No.2 transmission reservoir. However, these have been stolen, and need to be installed again.

2) Results of Pipe Thickness Survey by Ultra-sonic Thickness Gauge

A survey of the thickness of the existing pipes was conducted by the use of an ultra-sonic pipe thickness gauge. The thickness measurements were made at the top and the both sides of the upper part of the pipe. The results of the survey are shown in Table 8.3.4.

Table 8.3.4 Results of the Pipe Thickness Survey

Section	Results of the Pipe Thickness (mm)			Minimum Thickness (mm)	Remarks (Diameter of the pipe; mm)
PS-1 - PS-2	8.2	8.1	8.3	8.1	1,020
	9.7	9.9	9.8	9.7	1,020
	8.5	8.7	8.7	8.5	1,020
PS-2 - -WTP	8.9	9.1	9.6	8.9	1,020
	9.8	9.9	9.9	9.8	1,020
	9.7	9.9	9.7	9.7	1,020
WTP - PS-4	9.2	9.6	9.1	9.1	1,220
	11.5	-	-	11.5	1,220
	11.2	11.3	10.5	10.6	1,220
	11.4	11.3	-	11.3	1,220
PS-4 - Transmission Reservoir	11.2	11.2	11.2	11.2	1,220
	11.3	11.4	11.2	11.2	1,220
	9.7	9.7	9.6	9.6	1,220
Transmission Reservoir - Distribution Reservoir	8.8	-	-	8.8	1,220
	9.6	8.7	9.2	8.7	1,220
	8.4	8.5	8.4	8.4	1,020
	9.0	9.4	9.2	9.0	1,020
	9.0	9.5	9.4	9.0	1,020
	8.3	8.4	-	8.3	1,020
	8.5	8.5	-	8.5	1,020
	8.6	-	-	8.6	1,020

Under the prevailing conditions, the stress occurring against the maximum internal pressure can be calculated by the following formula:

σ = P*D/2*t

where: σ = stress along the circumference of the pipe (kgf/cm^2)

P= Internal pressure (kgf/cm^2)

D = Inner diameter of the pipe (cm)

t = Thickness of the pipe (cm)

The maximum internal pressure between PS-1 and WTP is 9.0 kgf/cm^2 and the minimum thickness of the pipe is 8.1mm, where the pipe diameter is 1,020 mm. And the maximum internal pressure and the minimum thickness of the pipe between the transmission reservoir and distribution reservoir are 18.0 kgf/cm^2 and 8.3 mm, respectively, where the pipe diameter is 1,020 mm. Therefore, the stress of the pipe can be calculated according to the above formula as follows:

σ = P*D/2*t = 9*102/(2*0.81) = 567 kgf/cm^2 < 1,400 kgf/cm^2

σ = P*D/2*t = 18*102/(2*0.83) = 1,106 kgf/cm^2 < 1,400 kgf/cm^2

The stress values in both of above sections are below the allowable limit of at 1,400 kgf/cm^2. Therefore, it is judged that the existing pipes themselves are usable for a considerable length of time.

(2) Rehabilitation Plan

Although the existing pipes have sufficient strength to be used for a considerable number of years, the exposed sections need protection by concrete. The damaged valves should be replaced, and the stolen cathode system should be reinstalled. The following table shows the length of the protection, numbers of the replacement and reinstallation.

Description	Specification (mm)	Quantity
Protection of the pipes	ϕ 1,000 mm	L = 150 m
	ϕ 1,200 mm	L = 50 m
Replacement of the Air-relief valves	ϕ 100	37 pcs
Replacement of the Air inlet valves	ϕ 150	8 pcs
Replacement of the Blow-off valves	ϕ 600	2 pcs
	ϕ 400	3 pcs
	ϕ 300	25 pcs
	ϕ 150	16 pcs
Replacement of the Gate valves	ϕ 1,000	5 pcs
	ϕ 800	5 pcs
Replacement of the Branch connection valves	ϕ 300	1 pcs
	ϕ 150	1 pcs
Reinstallation of cathode system		4 sets

8.3.3 Improvement of the Existing Water Treatment Plant

(1) Existing Water Treatment System

Figure 8.3.1 shows the system of water treatment in the existing Soroca-Balti water treatment plant. The plot plan of the ACSB water treatment plant is shown in Drawings 6, 7 and 8.

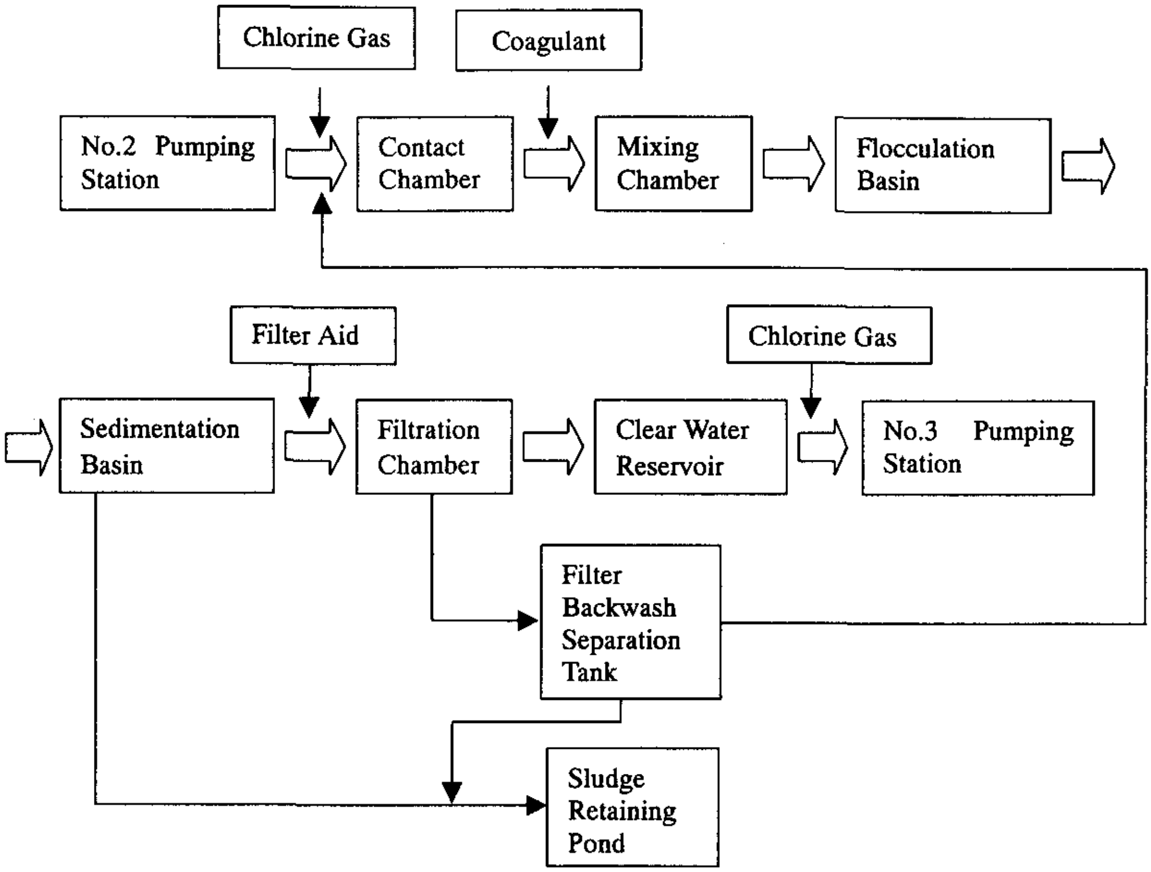


Figure 8.3.2 Treatment System in the Existing ACSB Water Treatment Plant

(2) Status of the Existing Facilities in the Water Treatment Plant

1) Design Capacity

It has been proposed in the master plan that the existing facilities in the water treatment plant of the Soroca-Balti water supply system be improved so that it can treat the amount of water demanded in 2015 by the objective 4 cities/towns and the other towns/villages considered in the master plan and the water to be consumed in the plant (3 % of the planned supply water). The planned amount of water to be treated is as follows:

93,500 m^3/d, 3,895 m^3/hr, 64.9 m^3/min, 1.08 m^3/sec

In the following, each existing facility in the plant will be reviewed in reference to the design treatment volume shown above.

2) Contact Chamber

This chamber allows the raw water to contact with chlorine that is injected into the chamber. Since the raw water transmission main from PS-2 (No.2 pumping station) is directly connected to this chamber, it is also functioning as a receiving well. It has the following feature:

Make and number:	Reinforced concrete, 1 chamber
Dimensions:	1.20 m (W) x 48 m (L) x 3 lines x 3.90m (D)
Volume:	674 m^3
Retention time:	10.4 minutes

As a receiving well, this capacity is more than sufficient since the required minimum retention time of receiving well is 1.5 minutes. In general, chlorine for pre-chlorination is often injected into receiving well or mixing chamber, and even when a contact chamber is not provided, chlorine is mixed well in downstream facilities. The retention time at 10 minutes is sufficient.

The contact chamber is shown in Drawing 8.

3) Chemical Injection Facilities

All the chemicals dissolving and dosing facilities were installed during 1980 to 1983. Some of them are already out of order, and others are still functioning, but their economic lives appear to have expired.

There are nine aluminum sulfate (say: alum) dissolving tanks and nine alum solution storage tanks beside the sedimentation basins (without the shelter). There are two alum dosing tanks, two caustic soda tanks, two fluosilicate sodium solution tanks and two polyacrylamide (say: polymer) tanks inside the building.

At present however, only alum dosing tanks and polymer solution tanks are in use. Caustic soda solution tanks and fluosilicate sodium tanks have never been used.

The chemicals currently used in the treatment plant are chlorine gas, alum, and polymer. Chlorine gas is injected at two stages: pre-chlorination and post-chlorination. The former is applied at the beginning of the water treatment aiming at disinfection of the plant facilities, and the latter is applied at the end of the treatment in order to disinfect treated water. Alum is applied to the raw water as a coagulant. Polymer is injected before the rapid sand filter as a filter aid to increase filtration efficiency.

All the chemicals transfer pumps for alum solution, and the dosing pumps for caustic soda and fluosilicate sodium solutions are broken.

The chlorine gas injection facilities are placed inside a house. These facilities are also deteriorated and out of order. There is no chlorine gas evaporation.

The amounts of the chemicals required for the operation with the design capacity are as follows:

i) Alum

Solid alum containing 25 % Al_2O_3 is used to make 10 % solution in the dissolution tank, and stored. The concentration of the solution is adjusted to 3 % - 10 % for injection by constant-rate pumps.

Injection rate of 10 % solution:

Minimum:	3,895 m^3/hr x 5 mg-solution/l = 19.5 kg- solution/hr = 1.95 kg-Al_2O_3/hr
Maximum:	3,895 m^3/hr x 100 mg-solution/l = 390 kg- solution/hr = 39 kg-Al_2O_3/hr
Average:	3,895 m^3/hr x 10 mg-solution/l = 39 kg- solution/hr = 3.9 kg-Al_2O_3/hr

ii) Polymer

Solution containing 4 - 5 % of polymer is injected at a rate of 10 mg solution per liter of the raw water.

Average injection rate: 3,895 m^3/hr x 10 mg-solution/l = 39 kg- solution/hr

iii) Chlorine

Liquid chlorine gas is purchased in cylinders. The injection rates base on the present practice are as follows:

Pre-chlorination (ave.): 3,895 m^3/hr x 3 mg/l = 11.7 kg/hr

Post-chlorination (ave.): 3,895 m^3/hr x 2 mg/l = 7.8 kg/hr

4) Chemical Mixing Chamber

The chemical mixing chamber .is provided, continuously from the contact chamber, for injection and mixing of the coagulant.

Make and number:	Reinforced concrete made, 1 chamber, 3 layers (3 floors)
Dimensions:	1.25 m (W) x 48 m (L) x 3 lines x 1.20 m (D) = 216 m^3
Retention time:	3.3 minutes (1 - 5 minutes according to Japanese Guideline)
Maximum flow velocity:	0.72 m/sec

The retention time is sufficient, but mixing efficiency is somewhat questionable because of the simple channel type. However, it is considered that the pipeline and the inlet channel leading to the flocculation basin and the air separation chamber within the basin will have effects for the sufficient mixing. Therefore, particular measures such as the provision of guide walls need not be considered. The chemical mixing chamber is shown in Drawing 9.

5) Flocculation Basin

The flocculation basin and the sedimentation basin are provided in an integrated structure. The structure is covered for abiding the cold climate. The feature of the flocculation basin is as follows:

Make and number:	Reinforced concrete, 8 basins
Dimensions:	6.0 m (W) x 12.6 m (L) x 4.75 m (D) x 8 basins
Effective cross sectional area:	5.80 m x 4.30 m - 2.00 m^2 = 22.94 m^2/basin (the sectional area of the concrete slope at 2.00 m^3 at the bottom of the basin is excluded)
Effective total volume:	12.4 m (L) x 22.94 m^2 - 18.30 m^3 = 266.20 m^3/basin (the volume 18.30 m^3 of the air separator at the inlet is excluded)
	266.20 x 8 = 2,130 m^3
Retention time:	30.5 minutes (20 - 40 minutes according to Japanese Guideline)

Mixing is caused by the jet flow from the pipes on the bottom. The water flows upward, passes the submerged weir, then enters the sedimentation basin. The retention time is at a standard level assuring the time necessary for coagulation/flocculation. No alteration work is necessary. Since the basin consists of 8 independent sub-basins, it is possible to clean, inspect, and carry out maintenance works one by one. Sludge is withdrawn by one line of 600 mm steel pipe laid under the basin bottom. Sludge-water mixture flows by gravity to the sludge deposit pond. The flocculation basins are shown in Drawing 9.

6) Sedimentation Basin

The sedimentation basin of the lateral flow type is connected to the flocculation basin having also 8 sub-basins, each of which functions independently. The feature of the sedimentation basin is as follows:

Make:	Reinforced concrete
Number of basins	8 basins (Japanese Guideline: 2 or more)
Dimensions:	6.0 m (W) x 44.4 m (L) x 4.75 m (D) x 8 basins
Effective depth:	3.30 m - 4.30 m (Japanese Guideline: 3 m - 4 m)
Effective cross sectional area:	
No bottom sludge	5.80 m x 4.30 m - 2.00 m^2 = 22.94 m^2/basin (the sectional area of the concrete slope at 2.00 m^3 at the bottom of the basin is excluded)
Effective total area:	22.94 m^2 x 8 =183.52 m^2

Bottom sludge at 1 m:	5.80 m x 3.30 m = 19.14 m^2/basin
Effective total area:	19.14 m^2 x 8 = 153.12 m^2
Flow velocity in the basin:	When there is no bottom sludge: 35.4 cm/min
	When the bottom sludge depth is 1.0 m: 42.4 cm/min
	(Japanese Guideline: 40 cm/min or less)
Surface area:	5.80 m (W) x 44.20 m (L) x 8 = 2,050 m^2
Surface loading rate:	31.6 mm/min (Japanese Guideline: 15 - 30 mm/min)
Length/width ratio:	44.2/5.8 = 7.6 (Japanese Guideline: 3 - 8)
Weir overflow load:	Total length: 30.0 m (L) x 2 lines x 8 basins = 480 m
	Overflow load: 93,500 m^3/d / 480 m = 195 m^3/m/d
	(Japanese Guideline: 500 m^3/m/d or less)
Sludge withdrawal pipe:	ϕ600 mm x 2 lines on the bottom of each basin, that lead to the sludge deposit pond by gravity flow.

The basin surface area seems to be somewhat insufficient according to the surface loading rate at 31.6 mm/min. However, the provision of 2 lines of outflow troughs that start at the one-third distance from the entrance and extend in a length of 30 m is expected to have a effect for extracting the clear water in the midway. Therefore, the capacity of the basin is judged to be sufficient, and structural modifications are not necessary.

The bottom sludge is, in principle, removed once a year by emptying the basin, and as necessary, sludge can also be withdrawn by the valve opening only. According to the raw water quality data in the last 6 years, it is considered that the sludge withdrawal is necessary 3 times a year: May and August, prior to and after the raining period of June - July, and January or February. It is considered appropriate to empty the basin for cleaning in May.

The bridges and gangways connecting facilities and their supporting metallic structures at the utility gallery are still serviceable but broken at places, so their economic lives appear to have expired. The inlet, outlet and desludging pipes are badly corroded. The sedimentation basins are shown in Drawing 9.

7) Filtration Chamber

The effluent from the sedimentation basin enters the gravity type rapid sand filter via influent pipes. The filter produces clear water that satisfies the drinking water quality standards. The feature of the filter is as follows:

Make:	Reinforced concrete
Number of filtration basins:	5 basins (Japanese Guideline: 2 or more)
Dimensions:	4.0 m (W) x 2 sections x 12.0 m (L) x 4.75 m (D) x 5 basins = 480 m^2

Filtration rate:	$(93{,}500\ m^3/d)/480\ m^2 = 195\ m/d$ Japanese Guideline: 120 - 150 m/d CN & R: 120 - 288 m/d Since the sand layer thickness is 1.8 m, there is no problem when the multi-layer filter is adopted. In this case: Japanese guideline: up to 240 m/d CN & R: 168 - 240 m/d

The filtration rate is relatively high at 195 m/d. According to the data on turbidity of the effluents in the last 6 years, the turbidity higher than the drinking water quality standard value of 1.5 mg/l occurred 12 times, and the highest value was 4.0 mg/l. It is possible to eliminate such a level of deviation from the quality standard by the perfection of operation and maintenance practices without altering the existing facility. The structure of the filtration basin allows to change the thickness of the filter sand up to 1.8 m. The sand layer is single at the present. In the case when the quality of the effluent becomes unsatisfactory, it is possible to take measures by employing the multi-layer sand filter. Therefore, modification of the structure is not necessary.

Washing of the sand filter is carried out as follows. Only backwashing is practiced with the water in two elevated tanks of 400 m^3 each, and surface washing is not applied.

Water pressure:	3 m
Backwash water volume:	$0.6\ m^3/min/m^2 \times 96\ m^2 \times 6\ min = 346\ m^3/time$
Elevated tanks:	Required capacity: 2 times x 346 m^3/time = 692 m^3 Existing tank (steel plate made): 400 m^3 x 2 = 800 m^3
Lift pump:	160 kW, 21 m lift, 2 pumps of which one is for stand-by

At the present, quality of the treated water is satisfactory, and the present backwash facility is able to perform its function required for producing the design volume of treated water. Therefore, improvement works such as installation of surface washing facility are not necessary.

The bridges and gangways connecting facilities and their supporting metallic structures at the utility gallery are still serviceable but broken at places, so their economic lives appear to have expired. All the inlet and outlet pipes and supporting brackets for valves-are badly corroded. Some of motorized valves are broken or malfunctioning, and their economic lives appear to have expired.

There are no filtered water flow measurement devices.

There are no water meters for the measurement of backwash water flows to the filters.

Although the precise evaluation of the elevated tank structure is somewhat difficult, reinforcement works for pillars and steel plates and surface painting work will suffice the present needs.

However, since the lift pumps to the elevated tank are over-sized and superannuated, they need to be replaced.

The filtration chambers are shown in Drawing 10.

8) Clear Water Reservoirs

Make and number:	Reinforced concrete, 3 reservoirs
Capacity:	24.0 m (W) x 30.0 m (L) x 4.0 m (effective depth) x 3 = 8,640 m^3
	(8,640 m^3)/3,895 m^3/hr = 2.2 hr (Japanese Guideline: 1 hr or more)

Each Apa Canal has distribution reservoirs to accept treated water at hourly maximum supply rate. The function of the clear water reservoir is to store the water for a certain period to abide minor troubles in the treatment facilities for the smooth operation of the clear water transmission pumps. Since this facility has a sufficient capacity for that function, structural improvements are not necessary.

9) Filter Backwash Separation Tank

The water used for backwashing the sand filters in the filtration chamber is transferred to this tank to separate sludge by settling. The supernatant is returned by pumping to the raw water inlet in the plant. Filter sand escaped from the filtration chamber is transferred by the sand lift pumps to a natural drying bed provided within the plant premise for recycled use.

Make and number:	Reinforced concrete, 2 tanks
Capacity:	12 m (W) x 24 m (L) x 4 m (D) x 2 tanks = 2,300 m^3
	Required capacity: 2 days volume.
	With a frequency of backwash at once per 2 days for every filter on average, the volume of the wastewater and the retention time are:
	346 m^3/1 filter/time x 5 filters/2 days = 865 m^3/d
	2,300 m^3/(865 m^3/d) = 2.6 days
Supernatant return rate:	When the turbidity of the filter influent is assumed to be 5 mg/l,
	Amount of sludge: 93,500 m^3/d x 5 mg/l = 0.47 ton/d.
	Assuming the concentration of the withdrawn sludge at 5 %,
	Volume of the sludge-water mixture: 0.47 x 100/0.5 = 94 m^3/d.
	Therefore, the return of the supernatant is:
	865 m^3/d - 94 m^3/d = 771 m^3/d
Supernatant return pumps:	2 pimps (one as standby), to the raw water inflow pipe.
Filter sand lifting pumps:	2 pumps, to the natural drying bed

The existing filter backwash separation tanks have a total storing capacity for 2 days. However, this facility is not used currently because sludge separation by settling is not adequate and the quality of the supernatant is not satisfactory for returning to the raw water inflow pipe. Therefore, improvement of this facility is necessary so that the supernatant can be reused.

By design the supernatant in the tank is conveyed back to the head of the plant by the pumps which were installed at the utility gallery. The sludge in the tank also flows to the sludge retaining pond by a sludge pump. The filter sand escaped from the filtration chambers is also conveyed to the natural drying bed by a sand pump. All of above pumps and pipes have never been used from the beginning. Part of the pumps, valves and pipes have been cannibalized and therefore lost. The rest are badly deteriorated and not usable.

10) Wastewater and Sludge Treatment

Settled sludge in the sedimentation basin flows by gravity to 2 sludge deposit ponds situated at 1 km away. These ponds also receive the sludge from the filter backwash separation tank and other facilities in the plant.

Pond capacity:	Upper pond:	76,200 m^3
	Lower pond:	52,500 m^3
	Total:	128,700 m^3

The volume of sludge-wastewater mixture that will be received by the ponds under the design water treatment volume at 93,500 m^3/d is estimated as follows:

Mixing chamber:	one time a year cleaning: 216 m^3 x 1 = 216 m^3/y
Flocculation basin:	4 times a year cleaning together with the sedimentation basin: 266 m^3 x 8 basins x 4 = 8,512 m^3/y
Sedimentation basin:	2 times a year withdrawals and another once for the emptied cleaning in which the sludge volume is assumed to be doubled: 1,100 m^3 x 8 basins x 4 times/y = 35,200 m^3/y
Filter backwash separation tank:	94 m^3/d x 365 days = 34,310 m^3/y
Total:	78,238 m^3/y (say 80,000 m^3/y including other discharges)

Two sludge retaining ponds have a total capacity of 128,700 m^3 against an estimated total sludge deposit of 80,000 m^3/y. Accordingly, each pond can be used alternately for a half year period, and naturally dried sludge can be removed for the final disposal. Therefore, provision of new sludge drying beds is not necessary.

11) Water Quality Analysis Equipment

The existing water quality analysis equipment is still functioning, but some of them are already out of order or old fashioned.

12) Architecture

The exterior and interior decorations of the filtration chamber buildings are partly broken as shown below, and they need to be repaired:

Broken Items	Quantity	Remarks
Ventilators	9 pieces	Filtration chamber building
Slate roof	870 m^2	Chemicals dosing building
Roof	3,100 m^2	Filtration chamber building
Wall	6,000 m^2	Filtration chamber building
Window frames and glasses	77 m^2	Filtration chamber building

(3) Improvement Plan

Based on the examination of the existing water treatment plant facilities as described above, the following improvements are proposed to rehabilitate the plant.

1) Contact Chamber and Sedimentation Basin

The facilities which are still serviceable will be in use, but the facilities which are deteriorated or broken at places need to be replaced or repaired. The following works are necessary for the rehabilitation of the contact chamber and the sedimentation basins.(see Drawing 9).

No	Item	Measures	Quantity
1	Wooden wall of sedimentation basin	Repair	200 m^2
2	Leakage from sedimentation basin and contact chamber	Elimination	
3	Ventilators on the roof of sedimentation basin and contact chamber	Replacement	30 pieces
4	Bridges, gangways and their supporting metallic structures	Repair and Replacement	5 t
5	Pipe	Painting	1900 m^2
6	Electric static censor type water level gage in the filtration chambers	Replacement	2 pieces
7	Flow indicator and recorder for quantity of water supplied to the contact chamber	Replacement	2 pieces
8	Sludge outlet valves: 300mm	Replacement	24 sets

2) Chemicals Injection Facilities

Based on the existing conditions of the chemicals dissolving and dosing facilities as described before, the existing concrete tanks need to be repaired and the equipment need to be replaced by new ones. The three alum solution tanks and three alum solution storage tanks without shelter need to be repaired. The two alum dosing tanks, two fluosilicate sodium solution tanks, and two polymer tanks in the buildings also need to be repaired.

Two alum solution pumps and two alum transmission pumps at the utility gallery beside the sedimentation basins also need to be replaced. At the chemical dosing room in the buildings, two alum dosing pumps, two fluosilicate sodium pumps, and two polymer pumps need to be replaced. The coagulant solution and dosing diagram is shown in Drawing 11.

The existing chlorine gas injection equipment must also be replaced by new one to disinfect the plant facilities and treated water. Two hot water type evaporators need to be installed on purpose of producing continuous chlorine gas. The counteraction equipment for chlorine gas and some maintenance devices e.g., gas masks or rubber coats need to be attached to for emergency. The chlorination system diagram is shown in Drawing 12.

The following table shows items to be replaced or newly installed for chemicals dissolving and dosing.

Name of facilities	Specification	Quantity*
Alum dissolving tank pump	0.3 m^3/min×10m×1.5kW	2 (1)
Alum transmission pump	0.4 m^3/h×10m×0.2kW	2 (1)
Alum dosing pump	0.02～0.4 m^3/h×3.0 kg/cm^2×0.2kW	2 (1)
Polymer pump	10～80 l/h×3.0 kg/cm^2×0.1kW	2 (1)
Fluosilicate sodium pump	0.2 m^3/h×3.0 kg/cm^2×0.2kW	2 (1)
Mixing blower	12 m^3/min×0.6 kg/cm^2×15kW	3 (1)
Mixer	15 m^3×7.5kW	2
Chlorine gas evaporator	5～20 kg/hr	2
Chlorine dosing machine	5～20 kg/hr×3.0 kg/cm^2	3 (1)
Counteraction equipment	Caustic soda dosing equipment	1 set

*(1) means that one standby is included

3) Filtration Chamber

The facilities which are still serviceable will be in use, but the facilities which are deteriorated or broken at places need to be replaced or repaired (see Drawing 10). The following works are necessary for the rehabilitation of the filtration chambers and the buildings:

No	Item	Measures	Quantity
1	Supporting layer(polymer concrete slabs)	Repair	Epoxy resin 50 kg
2	Sand (or zeolite) for No.6 filter	Replacement	190 m^3
3	Enameled tiles on filters	Repair	
4	Ventilators	Replacement	9 pieces
5	Sample taking hoses (15 mm PE hose)	Replacement	250 m
6	Hoses for the upper washing of filters (15 mm rubber hose)	Replacement	80 m
7	Bridges, gangways and their supporting metallic structures	Replacement	10 t
8	Slate roof	Repair	870 m^2
9	Roof of filtration chamber building	Repair	3,100 m^2
10	Pipe	Painting	3,200 m^2
11	Walls of the building	External lining	6,000 m^2
12	Window frames and glasses	Replacement	77 m^2
13	Devices for the measurement of pressure losses on filter	Replacement	5 pieces
14	Flow indicator and recorder for quantity of filtered water	Replacement	1 piece
15	Flow indicator and recorder for quantity of backwashing water for sand filters	Replacement	1 piece
16	Electric static censor type water level gage in the filtration chambers	Replacement	5 pieces
17	Powered inlet and outlet valves: 1000 mm	Replacement	11 sets
18	Powered inlet valves: 600 mm, from the sedimentation basins	Replacement	5 sets
19	Powered outlet valves: 600 mm, to the clear water reservoirs	Replacement	5 sets
20	Powered inlet valves: 1000 mm, of the clear water reservoirs	Replacement	1 set
21	Powered delivery valves: 1000 mm, to the filtration chambers	Replacement	1 set

4) Filter Backwash Separation Tank

Since the points of the backwash wastewater influent and the supernatant effluent are close to each other, short-cut currents occur and the sludge settling efficiency is low. In order to improve the performance, it is necessary to provide the guide walls thereby ensuring a sufficient settling time.

Because the supernatant is collected at the tank bottom, a portion of settled sludge is also trapped. In order to solve this problem, provision of separation walls is recommended so that they can prevent trapping of sludge and also function as overflow weirs thereby improving the quality of the supernatant. Items for the improvement are as follows:

1. Concrete block guide walls: 4.0 m (H) x 12 m (L) x 2 tanks = 96 m^2

2. Float-type overflow weir to be made on site

3. Supernatant return pump: 1.39 m^3/min, 10 m lift, 2 pumps (one is for standby)
   Although the backwashing will be done once per 2 days normally, the pump will have a capacity of returning the volume of water for once/day washing in 24 hours: 2,000 m^3/d.

4. Sand pump for sludge and escaped filter sand: 10 m lift x 2 pumps (one per tank)

Specifications of the pumps for replacement are as follows. The badly deteriorated and useless valves and pipes are also replaced (see Drawing 13).

Pump to be Replaced	Specification	Quantity*
Supernatant water return pump	1.39 m^3/min × 10m × 3.7kW	2
Sand pump	0.3 m^3/min × 10m × 2.2kW	2

* Including one standby each

5) Drain System of the Sludge Retaining Ponds

At the present, the discharges from the sludge deposit ponds are made through the upper and the lower steel-made discharge pipes.

It is proposed to provide a gate as specified below to the lower discharge pipe so that only the supernatant can be discharged steadily. It prevents escaping of the sludge to be dried naturally. The sludge treatment diagram is shown in Drawing 13.

Discharge gate: 800 mm dia. x 2 gates

6) Natural Drying Bed for Escaped Filter Sand

This drying bed was provided originally to retrieve the filter sand escaped from the filter together with the filtered sludge and separated in the backwash separation tanks. However, this drying bed is not used at the present. It is necessary to rehabilitate this facility in conjunction with the improvement of the sludge retaining ponds (see Drawing 13).

Natural drying bed: 25 m^2 x 2 beds

(4) Operating System of Water Treatment Plant

The operation of the water treatment plant starts in accordance with the start of operation of PS-2. The river water conveyed by PS-2 enters the treatment plant, flows by gravity through downstream facilities to be treated. The treated water is stored in the clear water reservoir. During these processes, no flow control is applied. However, in any case when the water level has exceeded the design level of a basin, the water overflows at the overflow weir provided at each basin. The overflow water discharges to outside the plant by gravity.

Operations of the major facilities in the plant are as follows.

1) Chemical Injection

The operation manager estimates injection rates of chemicals based on the data accumulated in the past such as the qualities of raw water and treated water and meteorological conditions, and also result of jar test. For daily operation, the operation manager determine an appropriate injection rate of each chemical in consideration of raw water quality and air and water temperatures, and operates the chemical injection facilities.

2) Sedimentation Basin

In principle usually, coagulation/flocculation and sedimentation operations are carried out using all units of basins regardless of variations in raw water quality and quantity. However, the stop of operation to carry out the following works shall be done one basin by one basin:

- Repair works within the basin
- Withdrawal of sedimentation sludge and basin cleaning

The following operations are made manually under the judgments of the operation manager:

- Selection of basin unit for above works
- Opening and closing of the raw water inflow gate
- Opening and closing of the treated water outflow gate
- Opening and closing of the sludge withdrawal valve
- Supply of backwash water

3) Filtration Chamber

For washing sand filters, the operation manager sets the conditions such as selecting the filters to be washed, setting the amount of washing water and the washing time. Opening and closing of valves and their interval and order are made through automatic control.

4) Backwash Sludge Separation Tank

The total capacity of the existing 2 backwash sludge separation tanks is equivalent to the water volume for 6 times backwashing. Two tanks are used alternately. One tank receives 3 times volume of backwash effluent, then after settling time, return the supernatant by the pump. After the supernatant return, settled sludge is withdrawn. Escaped filter sand is withdrawn according to the situation. The operation manager operates the pump and valves.

(5) Electrical Facilities

1) Evaluation of the Electrical Facilities in the Water Treatment Plant

Electrical power for the water treatment plant is also supplied from the open switchyard substation at Soroca through PS-3.

Life assessment was applied to the 10KV metal-enclosed switchgear and 1,250KW synchronous motors for the main water supply pumps during the first study period in July 2001. As the result, it is considered necessary to take the following measures:

- i) To perform major maintenance and testing
- ii) To establish newly replacement plan

For details, see the Supporting Report.

On the other hand the evaluation of the remaining electrical facilities in the water treatment plant such as 1 local distribution boards, control switch stations, cables, cable racks, lighting system, grounding system, etc. is the same as the result of the above life assessment.

It means that it is considered necessary to take measures in order to avoid possible electrical failures, such as improper maintenance, mechanical and electrical interlock failures, gradual component deterioration or insulation breakdown, excessive moisture, and the presence of foreign objects or live animals inside the equipment.

2) Recommendations for Electrical Equipment and Materials

The following are recommended in order to maintain safe and stable operation of the water treatment plant.

- i) The following existing electrical equipment and materials should be replaced with new ones.
    - a. Low voltage motors
    - b. Motor actuator for motor operated valves

c. 380 V distribution boards
d. Local distribution boards
e. Control switch stations
f. Cables
g. Cable racks
h. Lighting system,
i. Grounding system

ii) Scope of electrical equipment to be replaced with new electrical equipment

Scope of electrical equipment to be replaced with new electrical equipment is shown in the drawing / Overall Key Single Line Diagram (see Drawing 14).

iii) Modification of electrical equipment

Type of 380V distribution board should be changed into the following type in order to establish ease of operation and maintenance:
Motor feeders, motor operated valve feeders, and other feeders to be of motor control centers (MCC) with power fuses or molded-case circuit breakers (MCCB), magnetic contactors, thermal overload relays, which is controlled by AC 110V or AC 220V control power derived from own control transformers (380V-110V or 380V- 220V).

(6) Control System in the Water Treatment Plant

1) Outline of Control System in the Water Treatment Plant

We will focus on control system at the water treatment plant.

At the present the water treatment plant is operated manually by the operators after their receipt of command from the dispatcher at the water treatment plant.

This means that control of the existing water treatment plant relies operator's skill. Under the circumstances, it is considered necessary to introduce supervisory control and data acquisitions (SCADA) system in order to establish easy and stable operation of the overall water supply system including the water treatment plant and the pumping stations in terms of monitoring and control.

2) Application of SCADA System to the Overall Water Supply System

i) Main features of application of the SCADA system to the overall water supply system should be as follows:

a. The SCADA system offers control of remotely controllable objects in the water supply system.
b. The SCADA system can be as simple as gathering field data and transmitting such data to a control center in the dispatcher control room.
c. The SCADA system can be complex and include pipeline data, control of the water treatment facility, control pumps, and control transmission pipeline.

Overall supervisory control and data acquisition (SCADA) system configuration of the water supply system is shown in the drawing / SCADA Configuration (see Drawing 15).

ii) General description of functions of SCADA system:

a. Monitoring, alarming, tagging, and hard copying
b. Historical data processing (i.e. daily logs, disturbance data)
c. Topological the water supply system/pipeline coloring offering the possibility of connective tracing of the water supply system/pipeline
d. Topological pipeline color changing depending on the actual condition of the water supply system/pipeline
e. Easier tracing of the water supply system/pipeline on a graphical screen

iii) Major items of equipment of SCADA system

The SCADA system includes the following major items of equipment:

a. Microprocessors
b. Personnel computer
c. Remote terminal units (RTUs)
d. Software
e. I/O points
f. System communication by means of fiber optic cable links
g. Printers
h. Cabinet and console
i. AC and DC control power (UPS)

iv) Operator training

Operator training in the proper care and use of the SCADA system is important. Training is basically a process for changing behavior. These behavior changes are the product of new knowledge, replaced skills, or become observable, as improved work techniques of the operator.

3) Application of Local Control Panels in the Water Treatment Plant

i) Main features of application of the local control panels in the water treatment plant should be as follows:

a. To establish ease and stable operation for field operation
b. To integrate to supervisory control and data acquisition system (SCADA) at the water treatment plant

ii) The local control panels should have the following functions:

a. Control mode selections such as remote/local, automatic/manual, selection of operation pump
b. Control switches such as on/off push buttons for pumps, open/stay/close push buttons for motor operated valves
c. Instrumentation such as pressure gauges at inlet line and outlet line of pumps, water flow meters, level meters at reservoirs, voltage, motor kW, motor current
d. Indications such as ready for operation, pump status (running & stopping), valve status (full open, full close, stopping)
e. Alarming such as pump heavy trouble, pump light trouble, motor heavy trouble motor light trouble, valve trouble, inlet line pressure high, inlet line pressure low, outlet line pressure high, outlet line pressure low, tank level high, tank level low, electric power failure
f. Logic functions

8.3.4 Improvement of Intake Facility

Two steel pipes with diameter of 1,220 mm intake Nistru River water through respective intake box made by concrete, each having 8 windows of 1.0 m x 1.0 m width covered by metallic screen. However, the intake boxes have been damaged since a long ago, and ACSB has been compensating to fishermen until now. The intake boxes should be replaced to the new ones. Upon the replacement, the following items should be taken into consideration from the environmental point of view:

- Intake velocity should be less than 0.1 m/s for fish protection.
- Mesh size of the screen to be installed on the windows of the intake box should be less than 25 mm.
- Material of the screen should be steel with corrosion protection work.

8.3.5 Completion of the Unfinished Distribution Reservoir in Balti

(1) Capacity, Structure and Remaining Works

There are a unfinished distribution reservoir consisting of 2 basins in Balti just adjacent to the existing distribution reservoir operated by Apa Canal Balti. These 2 unfinished basins have a capacity of 10,000 m^3 each. The construction of the reservoir was stopped in1994.

The structure of the reservoir is flat-slab type. The walls, slabs and columns were made by pre-cast concrete and the bottom slabs were made by cast-in-place reinforced concrete. (See Drawings 16 and 17).

One of the unfinished basin is at 90 % of completion as the structure, and the other one at 70 %. However, cleaning the basement, reforming the opening between the walls, wall lining and plugging by the mortar or tar-epoxy for the water leakage prevention are required. And reconstruction of the remaining columns, slabs and walls, installation of air-ventilation facility, man-hole for the maintenance, over flow pipes, wall for the inlet pipe and covering the reservoir by the selected material should be carried out to complete the unfinished works.

Pipe connection with the diameter of 800 mm to the existing transmission main from the ACSB transmission reservoir, installation of the gate valve and a water level gauge in the reservoir for the valve control are also required for the pipe fittings and the smooth operation of the reservoir.

(2) Foundation

The maximum load (including the water) of the reservoirs is estimated at 7.0 t/m^2. Therefore, the bearing capacity of the soil should be more than 7.0 t/m^2. The bearing capacity of the soil is estimated by the use of the following formula:

$$Qa = 1/3*(\alpha*C*Nc+\beta*\gamma 1*B*Nr+\gamma 2*Df*Nq)$$

Where, Qa: Bearing capacity of the soil (t/m^2)

C: Cohesion (t/m^2)

$\gamma 1$, $\gamma 2$: Unit weight of the soil (t/m^3)

α, β: Coefficient of the foundation shape, α=1.3, β=0.4

Nc,Nr,Nq: Coefficient of bearing capacity

When the internal angle of the soil is 0 degree, Nc=5.3,Nr=0,Nq=3

Df: Depth of the foundation from the ground (m)

Cohesion of the soil is 1.8 t/m^2 based on the geological investigation. Depth of the foundation is around 2.0 m. The bearing capacity of the soil is estimated as follows:

$$Qa = 1/3*(1.3*1.8*5.3+0+1.6*2*3)=7.3\ t/m^2 > 7.0t/m^2$$

The spread type foundation will be adopted the reservoir, rather than the pile foundation.

8.3.6 Extension of the Transmission Pipelines to Riscani and Falesti

(1) General

Plan of the extension of the transmission pipelines to Riscani and Falesti is shown in Drawing 18.

1) Length of the Pipelines

Extension of the transmission pipelines to Riscani and Falesti is divided into three sections, which are common pipeline section, Riscani pipeline section and Falesti pipeline section. The common pipeline section to Riscani and Falesti starts at a new branch point of the existing ACSB transmission main before the main reaches the distribution reservoir. The common section ends at a point of branch to Riscani and Falesti, from where 2 pipelines extend to Riscani and Falesti, respectibely.

Lengths of above pipeline sections were obtained through the route and leveling surveys as shown below.

Section	Length (m)	Highest altitude through the section (m)
Common pipeline section	7,770	169.9
Pipeline to Riscani	36,630	239.6
Pipeline to Falesti	26,880	188.1
Total	71,280	

2) Distribution Plan to Riscani and Falesti

In the priority project, the water supply quantity has been planned to meet the water demands of the 4 cities/towns only. However, for determining the diameters of the new pipelines to Riscani and Falesti, the water demands from the villages existing along the routes of the pipelines should be also taken into consideration for enabling future supply of water to these villages. In the Master Plan, the water demands from these villages were also projected up to the year 2015.

Water demands from these villages in 2015 in accordance with the Master Plan are as follows.

Riscani Pipeline Section	
Village	Water demand (m^3/day)
Cirlateni	800
Singureni	300
Recha	400
Racaria	300
Riscani	4,300
Total	6,100

Falesti Pipeline Section	
Village	Water demand (m^3/day)
Rentel	600
Culuc	100
Catranic	200
Egorovca	200
Falesti	5,200
Total	6,300

The flow rate of the common section is 12,400 m^3/day according to the above tables. Diagram of distribution plan and lengths of pipelines sections until Riscani and Falesti are shown in Figure 8.3.3.

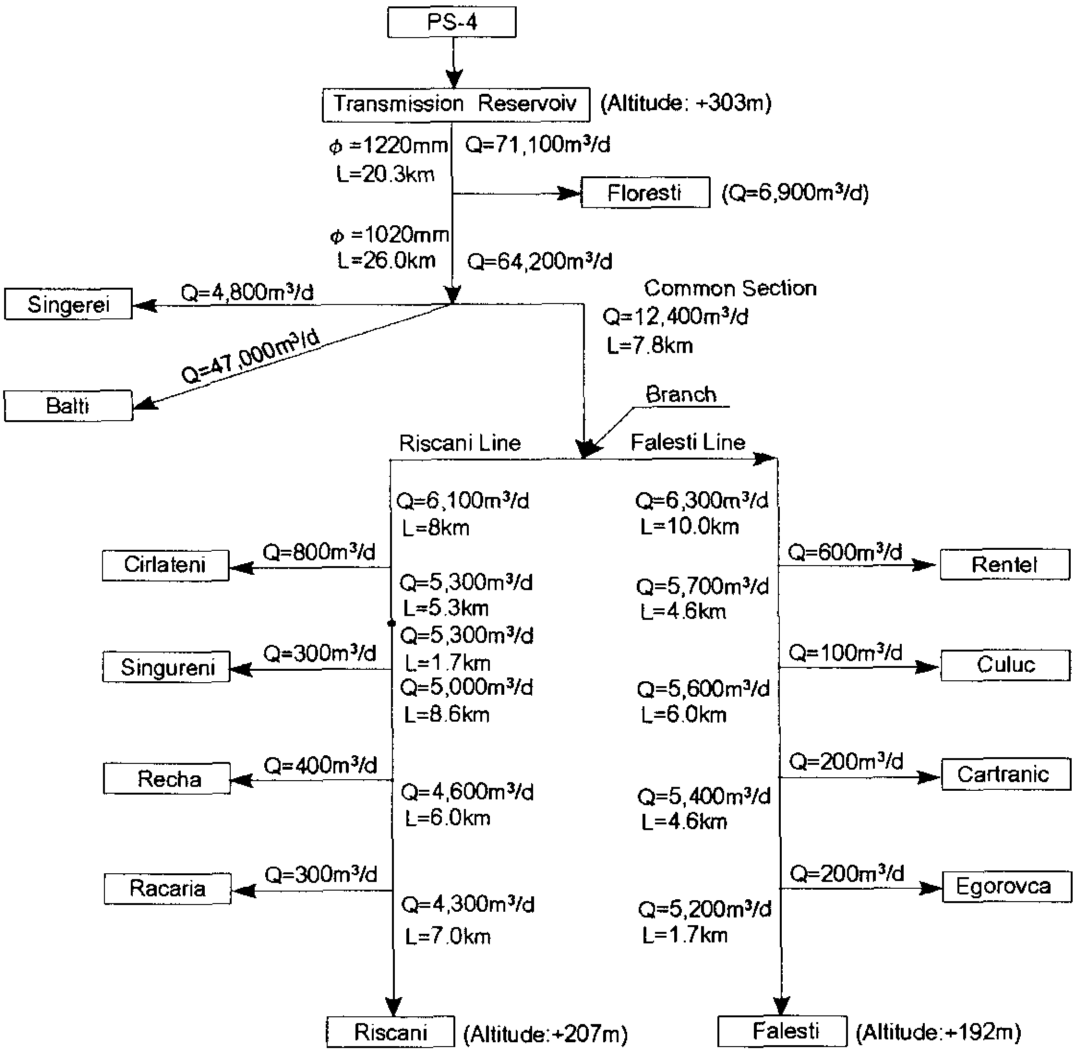


Figure 8.3.3 Diagram of Distribution Plan to Riscani and Falesti

3) Optimum Diameters of the Transmission Pipelines

The optimum diameters of the transmission pipeline to Riscani and Falesti are obtained through the pipe loss computation using the Hazen-Williams formula.

Water from the transmission reservoir, the altitude of which is 303 m, is allowed to flow by gravity to Floresti, Balti, Singerei, Riscani and Falesti if the pipeline diameter are appropriate. The diameters of the transmission pipelines to Riscani and Falesti are determined by taking into consideration of above conditions. The optimum diameter of each section has been determined as shown below.

Common Section

Section	Pipe Diameter (mm)	Length (m)
From the branch near the receiving reservoir in Balti to the new branch	ϕ500	7,800

Riscani Pipeline section

Section	Pipe Diameter (mm)	Length (m)
New Branch - Cirlateni	ϕ500	8,000
Cirlateni - Singureni	ϕ400	5,300
Cirlateni - Singureni	ϕ400	1,700
Singureni - Recha	ϕ400	8,600
Recha - Racaria	ϕ350	6,000
Racaria - Riscani	ϕ350	7,400
Total		36,600

Falesti Pipeline Section

Section	Pipe Diameter (mm)	Length (m)
New Branch - Rentel	ϕ400	10,000
Rentel - Culcu	ϕ350	4,600
Culcu - Cartranic	ϕ350	6,000
Cartranic - Egorovca	ϕ350	4,600
Egorovca - Falesti	ϕ350	1,700
Total		26,900

4) Hydraulic Profiles and Consideration

Hydraulic profiles of the proposed pipelines to Riscani and Falesti are shown in Figure 8.3.4 and Figure 8.3.5, respectively. In both Figures, H1 means the hydraulic profile corresponding to the water flow in the priority project, and H2 means the hydraulic profile corresponding to the water flow of the master plan.

According to these Figures, the gravity flow system is applicable for both pipelines. In the case of the priority project, the residual pressure at the proposed reservoirs in Riscani and Falesti is significantly high. Therefore, it is required to control the pressure by the gate valves provided on the pipelines.

There are some sections where the ground elevation is low and the residual pressure (pipe internal pressure) is quite high. When a gate valve on the pipelines is to be closed, a sufficient time should be taken for the operation so as to prevent water hammering.

The pipe should have a sufficient thickness to stand possible water hammer pressure and the maximum possible hydrostatic pressure. The maximum hydrostatic pressure will occur when all of the three distribution reservoirs in Balti, Riscani and Falesti are filled up and their inlet valves are closed. This pressure, as shown below, corresponds to the water level of the existing No. 2 Transmission Reservoir.

Section	Maximum hydrostatic pressure (kg/cm^2)
Common Section	22.5
Riscani Section	19.5
Falesti Section	19.5

5) Covering Depth and Location of the Pipeline

The minimum covering depth of the pipeline is 1.0 m to prevent the freezing of the pipe.

The routes of the pipelines are mostly in the agricultural fields along the roads except for the cases where there are obstacles or no space to install. Typical cross section of the pipelines is shown in Drawing 19.

(2) Common Section and Riscani Section

The common section of the transmission pipeline to Riscani and Falesti starts from the branch point on the ACSB transmission main before it reaches the existing distribution reservoirs in Balti. The pipeline crosses the land of forest nursery, the by-pass highway of Balti city, and the railroad. In this section, the pipeline also crosses many underground facilities such as electrical cables and a gas pipeline. For crossing the highway and railroad, the jacking method is recommended. After crossing the railroad, the pipeline reaches the point from where the pipeline splits to two lines leading to Riscani and Falesti.

After the split, the route of the Riscani line follows alongside the Balti-Riscani highway at its left and continues to the village Recea. Before the village Recea, the pipeline crosses the left tributary of Copaceanca River. A water pipe bridge will be required to cross this brook. After the village Recea, the pipeline runs at the left side of the road.

In the area of the highway junction near Riscani where the pipeline turns left toward Riscani, the pipeline crosses numerous underground facilities. Besides, it is necessary to cross around 10 secondary access roads. Such access roads have solid covering as a rule, therefore, reinstatement will be required after crossing by the open-cut method.

After turning toward Riscani, the pipeline runs on the left side of the road. It has to cross the water discharge channel from the bridge under the road. At the entrance to Riscani, the pipeline will cross the central street in the area of town market by the open-cut metho. This will require subsequent reinstatement of road covering. The pipeline will then follow via the central street of the town. After this, there is the brook Copaceanca to cross by the water pipe bridge. On this section there are numerous underground facilities of town communication network such as gas pipeline, sewers, electrical cables and telephone.

After crossing the brook, the pipeline continues to follow under the street and sidewalks that, after laying down the pipeline, will have to be reinstated. At the distance of around 1 km to the existing reservoirs, the pipeline will be laid at the right side of the road.

Profiles of the transmission pipeline to Riscani are shown Drawings 20 through 25.

Plan and section of air relief valve, blow-off valve, gate valve, inverted siphon, crossing the railroad, water pipe bridge, and protection of bend pipe are shown in Drawings 26 through 32.

Total pipe length, number of valves, railroad and highway crossings, etc. in the common section and Riscani section (to the planned reservoirs in Riscani) are summarized below.

Item	Common Section	Riscani Section			Total
	ϕ500 mm	ϕ500	ϕ400	ϕ350	
Pipeline length	7,770 m	8,000 m	15,600 m	13,430 m	44,400 m
		36,630 m			
No. of air relief valves	5	18			23
No. of blow-off valves	6	17			23
No. of gate valves	2 (every 3 - 4 km)	10 (every 3 - 4 km)			12
Railroad crossing by the jacking method	1	0			1
Highway crossing by the jacking method	2	1			3
No. of inverted siphons	1	2			3
No. of water pipe bridges	1	2			3

(3) Falesti Section

From the Riscani-Falesti split point in the City of Balti, the Falesti pipeline follows the right side of the Balti-Falesti highway, passes beside the filling station, crosses the highway to Glodeni by the method of horizontal drilling, crosses the brook and passes through outside the city, gardens, and alongside the Balti-Falesti road. Further the pipeline goes between a small pond and slope of road, crosses the gas supply pipeline with a diameter of 150mm.

After arriving to the railroad bridge, the pipeline crosses the Balti-Falesti-Chisinau highway, the two-lined railroad by jacking method and below the overflow water discharge channel made of concrete, arrives to the interchange of the Balti-Chisinau highway, and goes to the highway branch to Falesti. In this place the pipeline crosses one highway branch by open cut method. Following the right side of the road, the pipeline bypasses the cultural and entertainment center and will be laid in parallel to the road to Falesti and existing communication lines. On its way the pipeline crosses two highways in localities by open cut method.

On the way further, one more crossing of railroad by horizontal drilling method will have to be made. Afterwards the pipeline crosses several asphalt roads in localities by the open cut method, and reaches the new distribution reservoir.

On the entire length, the pipeline crosses numerous networks such as communication cables, electrical cables, gas supply pipelines, water supply pipelines and aerial high voltage transmission lines. Construction of the pipeline in this area assumes respective damage prevention measures.

Distance between the new reservoir and the existing reservoir is around 1.5 km. For connection of two reservoirs, the new pipeline should be constructed. The diameter of this pipeline is recommended to be 300 mm taking into consideration of pipe friction loss.

Total pipe length, number of valves, railroad and highway crossings, etc. from the Riscani-Falesti junction to the new reservoir are summarized in the following table.

<table>
<tr><th rowspan="2">Item</th><th colspan="2">Falesti Pipeline Section</th></tr>
<tr><th>Φ400 mm</th><th>Φ350 mm</th></tr>
<tr><td rowspan="2">Distance</td><td>10,000 m</td><td>16,880 m</td></tr>
<tr><td colspan="2">26,880m</td></tr>
<tr><td>No. of air relief valves</td><td colspan="2">18</td></tr>
<tr><td>No. of blow-off valves</td><td colspan="2">18</td></tr>
<tr><td>No. of gate valves</td><td colspan="2">8 (every 3 - 4 km)</td></tr>
<tr><td>Railroad crossing by the jacking method</td><td colspan="2">2</td></tr>
<tr><td>Highway crossing by the jacking method</td><td colspan="2">3</td></tr>
<tr><td>No. of inverted siphons</td><td colspan="2">21</td></tr>
<tr><td>Connection pipeline
(Φ300 mm)</td><td colspan="2">1,500 m</td></tr>
</table>

Profiles of the Falesti pipeline section are shown in Drawings 33 through 36.

Plan and section of air relief valve, blow-off valve, gate valve, inverted siphon, crossing the railroad, and protection of bend pipe are shown in Drawings 26 through 32.

8.3.7 Construction of Distribution Reservoirs in Riscani and Falesti

(1) Distribution Reservoir in Riscani

1) Location

A planned new reservoir in Riscani is located near the existing reservoir with capacity of 500 m^3. The space for a new reservoir is used for the field and is enough for the construction. The altitude of the new reservoir is approximately 210 m, almost the same as that of the existing one. This altitude allows the gravity flow in the water distribution system.

2) Capacity

The required total capacity of the new reservoir is estimated at 1,400 m^3 to make the total capacity of 4,300 m^3 including the existing ones taking into consideration the 24 hours retention of the planned water demand in 2015. Two reservoirs will be constructed in accordance with the Moldovan standard to prevent the stoppage of supply of water even when one reservoir is inoperable. Therefore the capacity of each reservoir is 700 m^3.

3) Structure

The grid type structure will be adopted for the reservoir which will be composed of the beams and columns made by the reinforced concrete. The height of the reservoir will be more than 3.5 m including the allowance between the upper slab and the high water level. Wall lining will be executed by the mortar or tar-epoxy to prevent the water leakage.

4) Foundation

The maximum load (including the water) of the reservoirs is estimated at 5.0 t/m^2. Therefore, the required bearing capacity of the soil as the foundation is more than 5.0 t/m^2. The bearing capacity of the soil is estimated by the same formula used for the unfinished reservoir in Balti.

Cohesion of the soil is 1.8 t/m^2 based on the geological investigation. Depth of the foundation is around 2.0 m. The bearing capacity of the soil is estimated as follows:

$Qa = /3^*(\alpha ^*C^*Nc+\beta ^* \gamma 1^*B^*Nr+\gamma 2^*Df^*Nq)$

$= 1/3^*(1.3^*1.8^*5.3+0+1.65^*2^*3) = 7.4\ t/m^2 > 5.0\ t/m^2$

The spread type foundation will be adopted for the reservoir. Plan and section of the planned distribution reservoir in Riscani is shown in Drawing 37.

5) Chlorination Facility

Distance between the WTP and the new reservoirs in Riscani is approximately 100 km. There is no chlorination facility between these two facilities, therefore, chlorination facility should be installed near the new reservoir to disinfect the transmitted water and keep the drinking water quality sufficiently.

(2) Distribution Reservoir in Falesti

1) Location

A planned new reservoir in Falesti is located on the highest hill near the town of Falesti. The site for the new reservoir is not used for the agricultural field and the available area is sufficient for the construction. Altitude of the new reservoir is approximately 190 m, allowing the gravity flow for the distribution system.

2) Capacity

The required capacity of the new reservoir was estimated at 4,200 m^3 to make total capacity of 5,200 m^3 including the existing ones in consideration of the 24 hours retention of the planed water demand in 2015. Two reservoirs will be constructed in accordance with the Moldovan standard. Therefore the capacity of each reservoir is 2,100 m^3.

3) Structure

The rigid type structure will be adopted for the reservoirs as is the case for Riscani. The height of the reservoir will be more than 4.5 m including the allowance between the upper slab and the high water level. Wall lining will be made by the mortar or tar-epoxy to prevent the water leakage.

4) Foundation

The maximum unit load (including the water) of the reservoirs is estimated at 6.0 t/m^2. Therefore, the required bearing capacity of the soil is more than 6.0 t/m^2. . The bearing capacity of the soil is estimated by the same formula used the reservoirs in Balti and Riscani.

Cohesion of the soil is 4.2 t/m^2 based on the geological investigation. Depth of the foundation is around 2.0 m. The required bearing capacity of the soil is as follows:

$$Qa = /3*(\alpha*C*Nc+\beta*\gamma 1*B*Nr+\gamma 2*Df*Nq)$$

$$=1/3*(1.3*4.2*5.3+0+1.61*2*3)=12.9\ t/m^2 > 6.0t/m^2$$

The spread type foundation is adopted as is the case in Riscani.

Plan and section of the planned reservoir in Falesti is shown in Drawing 38.

5) Chlorination Facility

Distance between the WTP and the new reservoirs in Falesti is approximately 90 km. There is no chlorination facility between these two facilities, therefore, chlorination facility should be installed near the new reservoir as is the case in Riscani.

8.4 Construction Schedule and Cost Estimates

8.4.1 Construction Plan

(1) General

This section deals with the construction plan and corresponding schedule for the water supply facility development plan described in the previous sections. The project consists of the rehabilitation works for the existing pumping stations, water treatment plant and transmission mains, completion of the unfinished reservoir, and expansion works for the transmission pipelines and the new distribution reservoirs.

Construction works of the project include earthworks, pipe works, concrete works, mechanical/electrical works, and miscellaneous works. Most of the construction works will be carried out by conventional methods and machineries; while more advanced methods will be employed, as necessary, to shorten construction periods and to achieve high quality.

(2) Geological Characteristics of the Sites for the Reservoirs

Geological investigations by core borings have been carried out at the proposed sites of reservoirs. The results are summarized as follows.

1) Balti

One boring with depth of 14 m were conducted at the site near the unfinished reservoir. The soil layers are composed of surface soil, which is called soil-plant layer, firm and semi-firm loam, and firm clay. The soil conditions are favorable for construction, and the bearing capacity is sufficient for the spread foundation. Groundwater level is around 12.5 m below the ground surface.

2) Riscani

Three borings with depth of 14 m were also conducted at the proposed site. The soil layers arel composed of surface soil, firm and semi-firm loam, firm clay, and sand. The conditions are favorable for construction, and the bearing capacity is sufficient for the spread foundation. Groundwater is not revealed to depth of 14 m.

3) Falesti

Two borings with depth of 14 m were also conducted at the proposed site. The soil layers are composed of surface soil, firm and semi-firm loam, and sand. The soil conditions are favorable for construction and the bearing capacity is sufficient for the spread foundation. Groundwater is not revealed to depth of 14 m.

(3) Major Construction Works

1) Rehabilitation of the ACSB Water Supply Facilities

Major construction works are composed of the rehabilitation works and reforming works. Rehabilitation works of the existing water supply facilities are mostly replacement of pumps and motors for the 4 pumping stations, and many valves and pumps for the dosing and chlorination system in the water treatment plant. Reforming works are mainly reform of the windows, walls, floors and roofs for the pumping stations and the water treatment plant.

Methods of rehabilitation works should be carefully considered not to take a long term to avoid a long term non-operation of ACSB water supply system.

Required major machineries for the replacement and reform are as follows:

- Crawler crane	Transport of facility, replacement and reform
- Truck crane	Transport of facility, replacement and reform
- Dump track	Transport of disposal

- Telpher Replacement
- Electric welding machine Replacement
- Compressor Replacement
- Submersible pump Replacement

2) Transmission Pipe-laying

Transmission pipelines will be laid to Riscani and to Falesti. The total length of the two pipelines is approximately 71,300 m. There are numerous obstacles to be crossed over or below especially in the areas of towns and villages. Horizontal drilling method will be recommendable to cross the railroad and highway. Water pipe bridge will be applied to cross over the river.

i) Preparatory works

Preparatory works for the installation of transmission pipes should be carried out in advance, to assess the site conditions for the selection of the best construction method, to plan temporary works required, and to plan safety management during the construction.

To assess the current conditions of the project sites, studies should be carried out for the following items:

- Geographical features
- Drainage conditions
- Road traffic conditions
- Roads, retaining walls, utility poles and overhead and under ground facilities
- Survey of drainage pipes
- Topography/Land survey
- Soil survey

ii) Construction materials

The following materials are used for the transmission pipelines.

- Ductile cast iron pipe (DCIP)
- Diameter (mm): ϕ 600, ϕ 400
- Air relief valve: ϕ 100
- Blow-off valve: ϕ 300, ϕ 200, ϕ 150
- Gate valve: ϕ 600, ϕ 400

iii) Construction methods

The most appropriate methods will be selected taking into account of the site conditions. The main study items for the selection of construction methods are as follows:

- Alternative alignments for pipe routes, depth, shape, type of structure
- Temporary work required
- Additional construction methods if required
- Environmental protection during the construction period
- Construction site organization
- Labor, material and construction equipment

● Open Cut Trench Method

This is the most rapid and technically appropriate method for shallow excavation. During excavation, side slope of the cut will vary according to the soil condition.

● Horizontal Drilling Method

Horizontal drilling method is one of the pipe-laying methods, in which pipes are pushed-in by the use of the horizontal drilling machine. In general, use of this method is limited for the straight section. It will be used to cross the highway and railroad. Drawing 32 shows the horizontal drilling method for crossing the railroad.

● Water Pipe Bridge Method

Water pipe bridge method is used to cross over rivers and deep brooks, where inverted siphon is not applicable. There are several types of water pipe bridge such as simple beam type, truss type, arching type, etc. In this case, the simple beam type supported by the pre-stressed concrete is recommended. Drawing 33 shows the water pipe bridge method.

iv) Required Equipment

Major construction machines used for the installation of the transmission pipeline are as follows:

- Backhoe	Excavation work
- Dump truck	Transport of surplus soil
- Pipe layer	Pipe laying
- Rammer	Sand bottoming roll
- Roller	Sand base rolling
- Crawler crane	Pipe laying for the water pipe bridge
- Concrete pump car	Concrete placement
- Horizontal drilling machine	Crossing the highway and the railroad
- Truck	Transport of materials

3) Construction of the Unfinished and New Reservoirs

Construction works of the unfinished reservoir in Balti and the new reservoirs in Riscani and Falesti include reforming works, concrete works, and pipe fitting works. Construction of the unfinished reservoir will require reforming the opening between the walls, wall lining for the water leakage prevention.

i) Preparatory Work

In order to ascertain the site condition, site surveys should be carried out before construction.

ii) Construction Method

No special construction method will be applied for the construction of reservoirs. The main civil work items for the construction of the reservoirs are shown below.

Items	Unfinished Reservoir in Balti	Reservoir in Riscani	Reservoir in Falesti
Access road	○	○	○
Land leveling	-	○	○
Reforming	○	-	-
Pipe fitting	○	○	○
Masonry retaining wall	-	-	○

iii) Required Equipment

Major construction machines used for the construction of the reservoirs are as follows:

- Backhoe — Excavation work
- Bulldozer — Removal of surplus soil
- Dump truck — Transport of surplus soil
- Tractor shovel — Earth leveling
- Concrete pump car — Concrete placement
- Transit mixer — Transport of concrete
- Vibrator — Concrete placement
- Air compressor — Cleaning of form
- Electric welding machine — Welding reinforcement bars

8.4.2 Construction Schedule

(1) Annual Workable Days

Annual workable days are estimated to be 235 days as shown below:

Average number of holidays per year	112 days
Average number of unworkable days per year:	18 days (snow, rain, ice-crusted ground and mud during November15 through April 15)
Total work suspension days per annum:	130 days
Working days:	235 days

(2) Working Time

All the construction works will be carried out during the daytime in principle. The working time is eight hours per day.

(3) Required Construction Period

The required construction period was estimated based on the construction volume, the working days and working time for each type of construction works/structures. However, this project is an urgent project. In order to reduce the construction period, it is recommended that the project be divided into the following 4 packages and executed simultaneously as shown in Table 8.4.1.

Package 1: Rehabilitation of all the pumping stations, the existing transmission pipeline, and the water treatment plant

Package 2: Completion of the unfinished reservoir in Balti

Package 3: Construction of the transmission pipeline of common pipeline section

Package 4: Construction of the transmission pipeline to Riscani and to Falesti

During the above rehabilitation and construction works, operation of ACSB facilities should be stopped at least for 6 months. Because it will be required not to supply the electricity during the replacement of the transformers, local control panels, motors and pumps.

It is recommended that the duration of the procurement of the mechanical and electrical facilities for replacement will be taken for 6 months.

Table 8.4.1 Construction Schedule of the Priority Project

Package	Work Item	Period 2003	2004	2005	2006	2007
Package 1	Design	—				
	Tendering		—			
	Equipment Procurement		—			
	Construction		···—	—		
Package 2	Design	—				
	Tendering		—			
	Construction		—			
Package 3	Design		—			
	Tendering			—		
	Construction			—	—	
Package 4	Design		—			
	Tendering			—		
	Construction			—	—	
ACSB system not operable			···	···		

8.4.3 Cost Estimates

(1) Basis of Cost Estimates

The project cost is estimated under the following conditions.

1) All the costs are estimated under the economic conditions prevailing in August 2002.

2) Exchange rate of currencies is: US$ 1.00 = 13.6 Lei

3) Engineering services cost and physical contingency are assumed to be 10 % of the total construction cost, respectively.

4) The following countries are considered for the origin of import materials and equipment:

   Ductile cast iron pipe: European countries

   Valves: Russia or Ukraine

   Mechanical and electrical equipment: European countries

5) Price inflation is not taken into account

(2) Components of Project Cost

The project cost consists of:

1) Construction cost,

2) Land acquisition cost including land compensation cost,

3) Engineering service cost, and

4) Physical contingencies

The costs for civil works and mechanical/electrical equipment are estimated based on the preliminary engineering design. The costs of civil works are estimated by multiplying the quantity of work by unit cost. The costs of mechanical/electrical equipment for the rehabilitation of water treatment plant and pumping stations are determined based on the quotations.

(3) Construction Cost

1) Rehabilitation of the ACSB Water Supply System

The construction costs for the rehabilitation of the ACSB water supply facilities are summarized below:

Unit: US$

Pumping Stations	PS-1	1,390,000
	PS-2	1,390,000
	PS-3	1,690,000
	PS-4	1,800,000
	Subtotal	6,270,000
Water Treatment Plant		2,160,000
Transmission Mains		561,000
Water Supply Instrumentation System		1,740,000
Total		10,731,000

2) Completion of the Unfinished Reservoir in Balti

The construction cost of the unfinished reservoir in Balti is as follows.

Completion of Unfinished Reservoir	US$ 336,000

3) Expansion of Transmission Pipelines to Riscani and Falesti

Total length of transmission pipeline to Riscani and Falesti is 71,280 m as shown below:

Section	Length (m)	Diameter (mm)
Common pipeline section	7,770	500
Pipeline to Riscani	36,630	350, 400, 500
Pipeline to Falesti	26,880	350, 400
Total	71,280	

The capacities of the new reservoir are 1,400 m^3 for Riscani and 4,200 m^3 for Falesti.

Construction cost of expansion of transmission pipeline to Riscani and Falesti is estimated as follows:

Common section of the transmission pipeline	US$ 1,410,000

Transmission pipeline to Riscani	UD$ 4,845,860
Transmission Pipeline to Falesti	US$ 3,750,000
Total	US$ 8,596,000

(4) Land Acquisition and Compensation Cost

The required land acquisition in the project consists of the areas of the reservoirs in Riscani and Falesti. Required areas for land acquisition include the access roads with a width of 10 m and lengths of 20 m for Riscani and 100 m for Falesti. The compensation for the land, which width is 10 m along the transmission pipelines to Riscani and Falesti during the construction is required. The required lengths of the compensation are estimated at 28.2 km for Riscani and 19 km for Falesti. The land compensation cost is assumed to be 10 % of land acquisition cost.

The land acquisition and compensation costs are estimated as shown in the following table.

Item	Place	Area (ha)	Unit Price (US$/ha)	Cost (US$)
Land Acquisition	Balti	0.1	1,400.00	140.00
	Riscani	0.4	1,400	560.00
	Falesti	0.7	1,400	980.00
	Subtotal	1.1	1,400	1,680.00
Land Compensation	Common pipeline	6.2	140	900.00
	Riscani	22.0	140	3,100.00
	Falesti	19.0	140	2,700.00
	Subtotal	47.2	140	6,700.00
Total				8,380.00

(5) Project Cost

The estimated total project cost is 25.3 million US$. Engineering service cost and physical contingencies were assumed respectively, to be 10 % of the construction cost based on the similar projects. Breakdown of the project cost is shown in Table 8.4.2.

Table 8.4.2 Project Cost

Item		Cost (US$)	Remarks
1. Construction	1) Rehabilitation of the ACSB water supply system	10,731,000	
	2) Completion of the unfinished reservoir in Balti	336,000	
	3) Expansion of the transmission pipeline of common section	1,410,000	
	4) Expansion of the transmission pipeline to Riscani and Falesti	8,596,000	
	Subtotal	21,073,000	
2. Land Acquisition		9,000	
3. Engineering Service		2,110,000	10 % of Construction Cost
4. Physical Contingency		2,110,000	10 % of Construction Cost
Total		25,300,000	

(6) O & M Cost

The major items of the operation and maintenance cost are electric power charges for the water treatment plant and the pumping stations, personnel cost and repairing cost. The electric power, cost of chemicals and personnel and repairing cost per year per water demand for the water treatment are estimated to be 26.4 kW/Y/(m^3/d), 1.08 US$/Y/($m^3$/d) and 3.48 US$/Y/(m^3/d) respectively, by referring to the Chisinau water treatment plant. The electric power charge of pumping station is estimated based on the outputs of the motors in the pumping stations. The repairing cost of pumps is estimated by assuming the 3 % of the equipment cost referring the O/M costs in similar projects.

Monthly motor outputs for 4 pumping stations are summarized as the following table.

Pumping Station	Monthly Motor Outputs	Remarks
PS-1	300 kW x 2 x 24hr x 30 days x 0.8 = 346,000 kW/M	Q=69,000m^3/d
PS-2	500 kW x 2 x 24hr x 30 days x 0.8 = 576,000 kW/M	Q=69,000m^3/d
PS-3	360 kW x 2 x 24hr x 30 days x 0.8 = 415,000 kW/M	Q=60,600m^3/d
PS-4	350 kW x 2 x 24hr x 30 days x 0.8 = 403,000 kW/M	Q=54,500m^3/d
Total	1,740,000 kW/M =20,880,000 kW/Y	Average Q=63,000m^3/d

Monthly/Yearly motor output per unit volume of lifted water by pump is as follows,

1,740,000 kW/M÷63,000 m^3 = 28 kW/M/(m^3/d) (336 kW/Y/(m^3/d))

Annual cost of electricity per unit treated/lifted water for WTP and pumping station is as follows, where unit price of electricity is assumed 0.6 Lei/kW.

26.4 kW/Ym^3 + 336 kW/Y.m^3= 362.4 kW/Y/(m^3/d)

362.4 x 0.6 = 217.4 Lei/Y/(m^3/d) (15.9 US$/Y/($m^3$/d))

Annual personnel and repairing cost for pumping station is as follows,

Construction cost for 4pumping stations; 4,400,000US$

Annual repairing cost; 4,400,000 x 0.03 = 132,000US$/Y

Planned supplied water from 2005 to 2015 for four cities/towns is shown the following table.

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Supplied Water (m^3/d)	45,100	48,800	54,500	56,100	57,800	59,600	61,400	63,100	64,900	66,700

The O & M cost has been estimated under above conditions as shown in Table 8.4.3.

The electric power for the pumping stations is the largest cost item in the O/M cost. The electric power consumption in the actual operation of the ACSB transmission pumps and the estimated power consumption of the renewed pumps are compared in terms of the power consumption to supply 1 m^3 of water. The comparison is shown below. The electricity consumption will decrease by approximately 30 %.

Pumps in 4 PSs	Water supply amount	Power consumption	Specific power consumption	%
Existing pumps (Actual operation in 1994)	75,890 m^3/day (Daily average)	87,400 kWh/day	1.15 kWh/m^3	100
Planned pumps (Estimated)	69,000 m^3/day	58,000 kWh/day	0.84 kWh/m^3	73

Table 8.4.3 Annual Operation and Maintenance Cost

Unit; US$

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Supplied Water (m3/d)	45,100	48,800	54,500	56,100	57,800	59,600	61,400	63,100	64,900	66,700
Supplied Water (m3/y)	16,461,500	17,812,000	19,892,500	20,476,500	21,097,000	21,754,000	22,411,000	23,031,500	23,688,500	24,345,500
Accounted-for water (m3/d)	36,080	39,040	43,600	44,880	46,240	47,680	49,120	50,480	51,920	53,360
Accounted-for water (m3/y)	13,169,200	14,249,600	15,914,000	16,381,200	16,877,600	17,403,200	17,928,800	18,425,200	18,950,800	19,476,400
Electricity	717,000	776,000	867,000	892,000	919,000	948,000	976,000	1,003,000	1,032,000	1,061,000
Chemical for WTP	50,000	54,000	61,000	62,000	64,000	66,000	68,000	70,000	72,000	74,000
Personnel and Repairing for WTP	157,000	170,000	190,000	195,000	201,000	207,000	214,000	220,000	226,000	232,000
O/M cost for Pumping Station	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000
Total	1,056,000	1,132,000	1,250,000	1,281,000	1,316,000	1,353,000	1,390,000	1,425,000	1,462,000	1,499,000

[Note] 1. Exchanges Rate 1US$ = Lei 13.6 = Yen 120.0
2. Life spans for facilities and equipment are as follows:
1) Civil and architectural facilities: 40 years
2) Mechanical and electrical equipment: 20 years

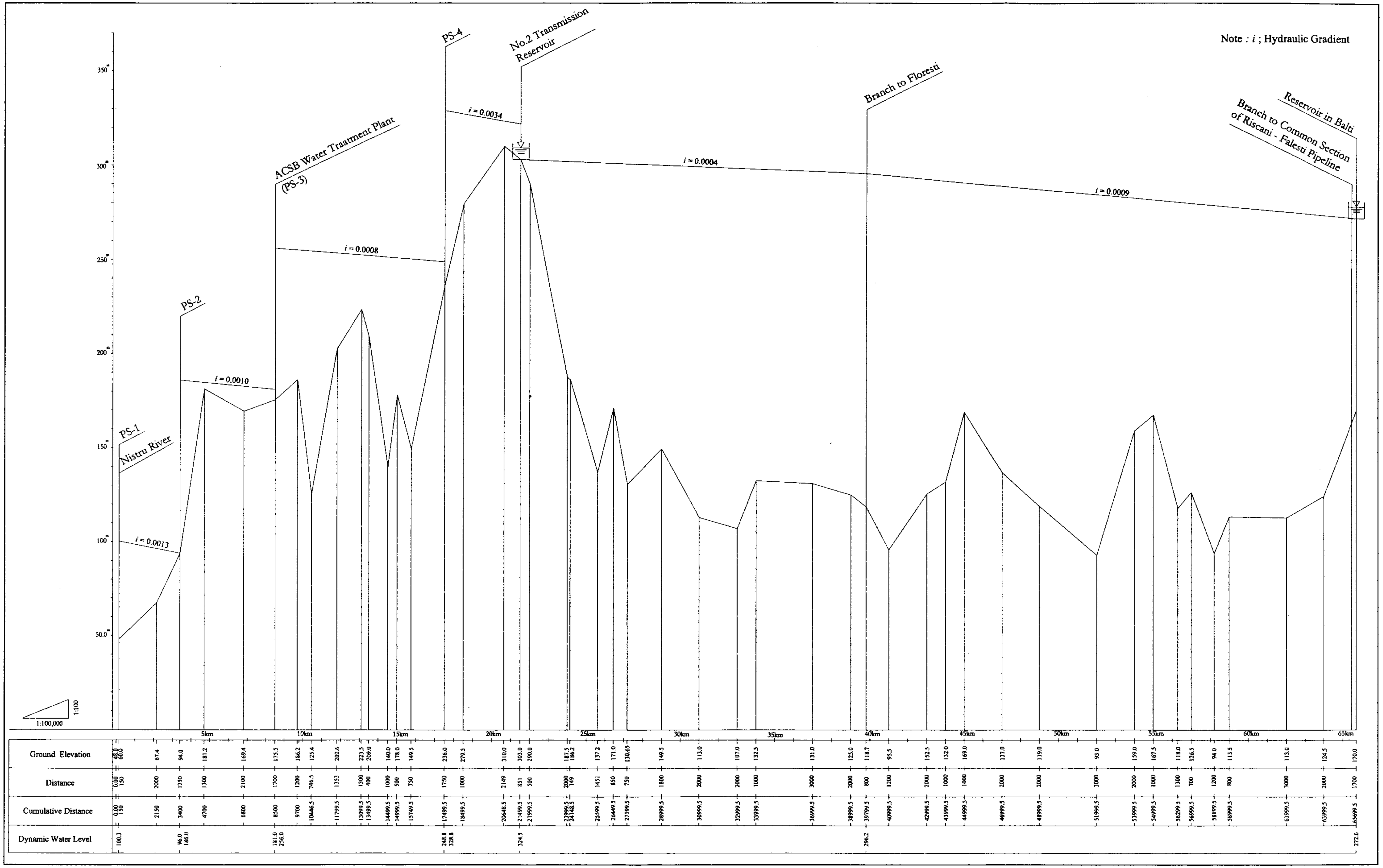
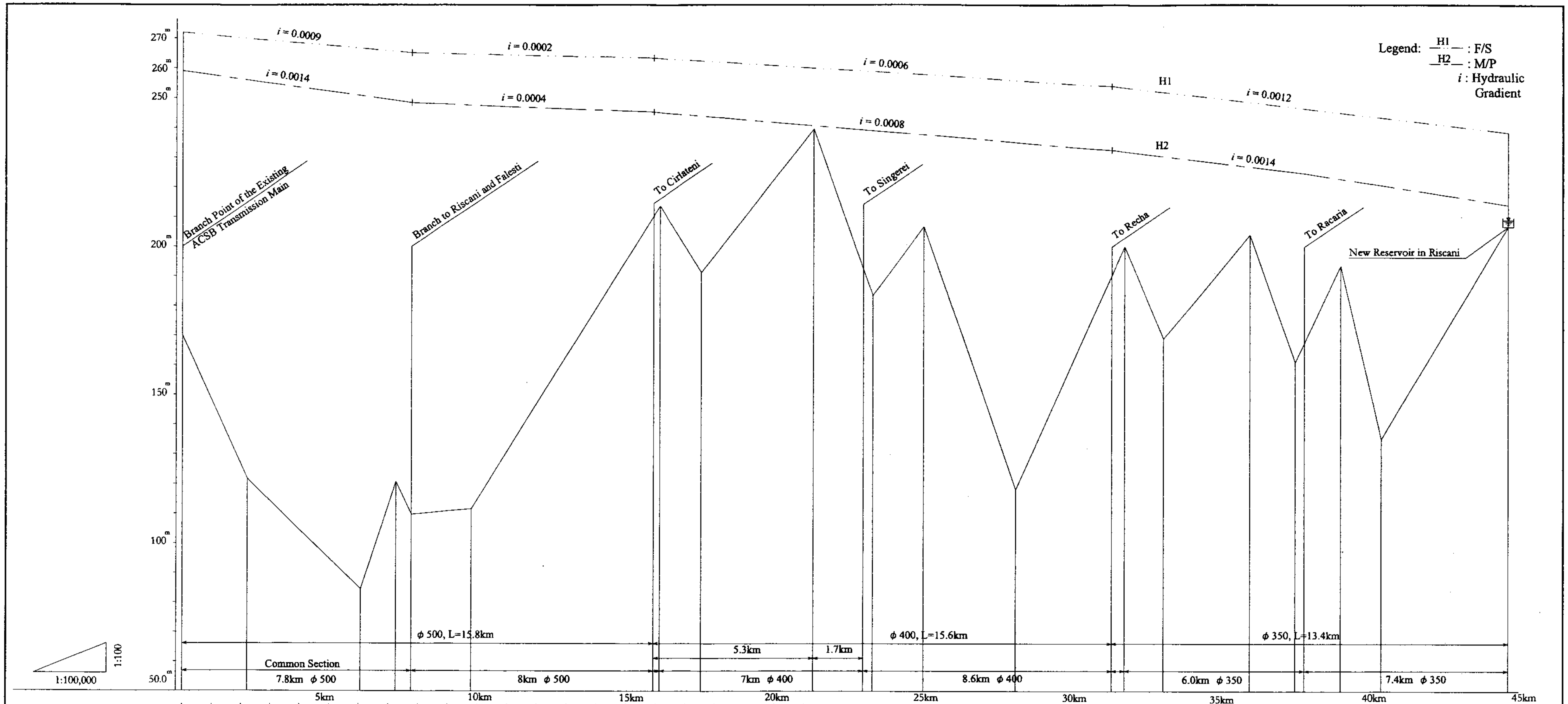
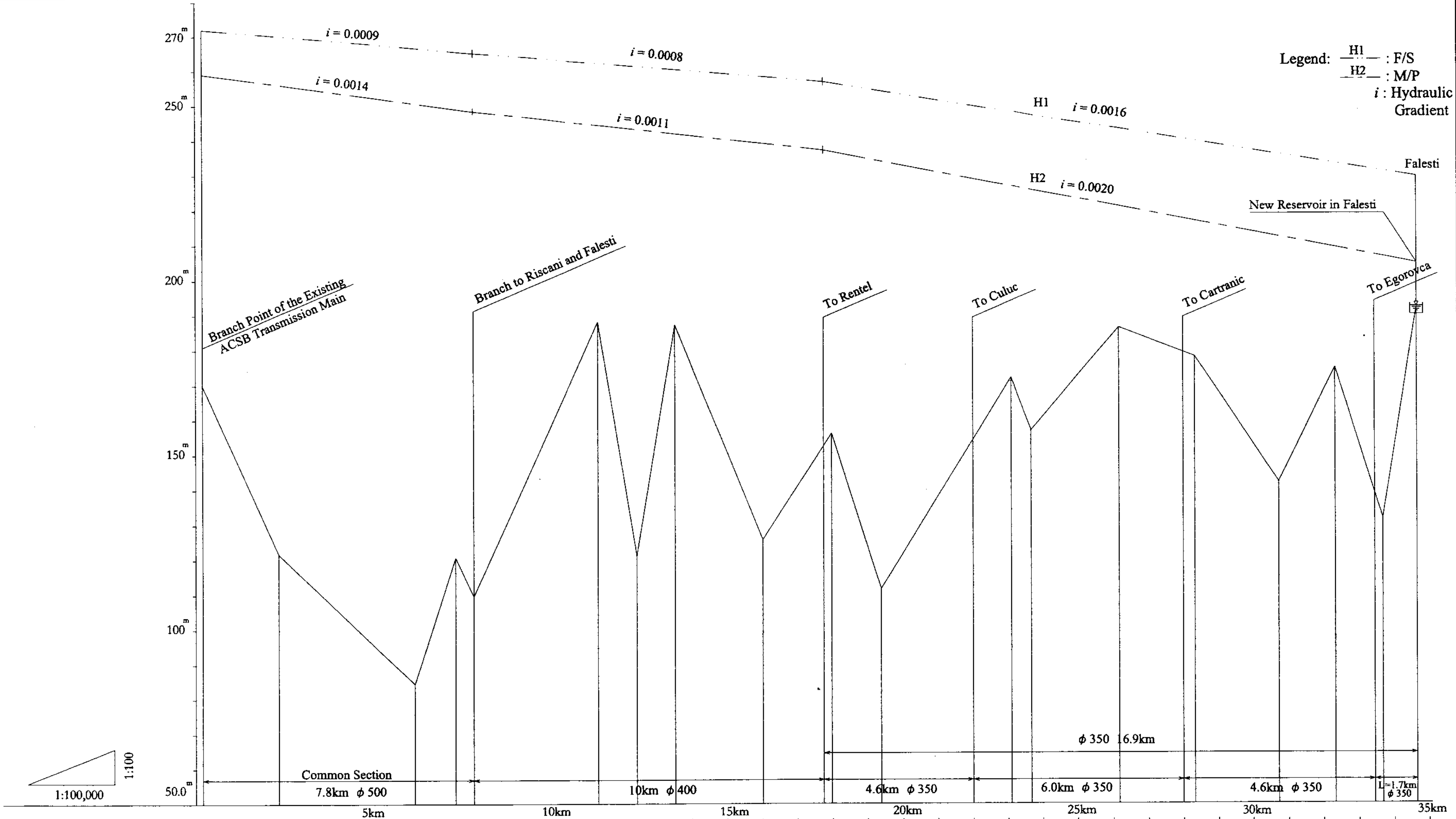


Figure 8.3.1 Hydraulic Profile of Existing ACSB Transmission Main



Ground Elevation	169.90	121.70	84.05	120.75	109.66	111.60	213.75	191.30	239.60	183.55	206.80	118.20	200.10	169.00	203.95	161.00	193.60	135.20	206.80
Distance	0.00	2204.00	3863.00	1184.00	519.00 / 0.00	1788.00	6334.00	1407.00	3769.00	2002.00	1698.00	3084.00	3666.00	1315.00	2905.00	1509.00	1521.00	1357.00	4273.00
Cumulative Distance	0.00	2204.00	6067.00	7251.00	7770.00 / 0.00	1788.00	8122.00	9531.00	13300.00	15302.00	17000.00	20084.00	23750.00	25065.00	29970.00	29479.00	31000.00	32357.00	36630.00
Dynamic Water Level	258.98 (272.6)				248.27 (265.8)		245.22 (264.1)		240.72	239.28			232.42 (254.7)			224.66			214.07 (239.1)

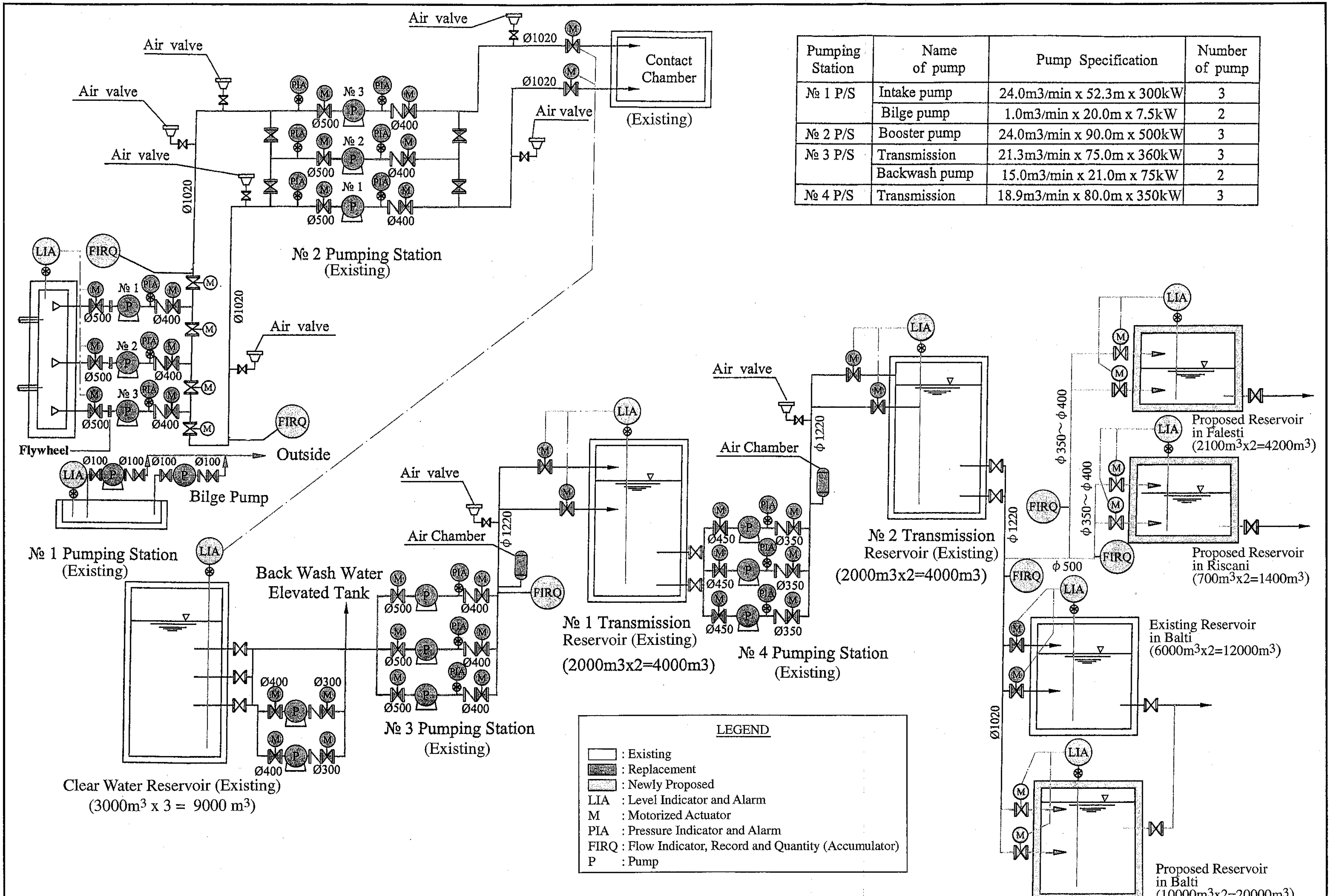
Figure 8.3.4 Hydraulic Profile of the Proposed Transmission Pipeline to Riscani



Ground Elevation	169.90	121.70	84.05	120.75	109.66	188.10	121.25	187.20	125.70		156.15	111.65		172.00	156.85	186.22		177.91	142.10	174.65		131.60	192.10
Distance	0.00	2204.00	3863.00	1184.00	519.00	3550.00	1100.00	1100.00	2498.00		1952.00	1407.00		3718.00	575.00	2493.00		2157.00	2400.00	1600.00		1350.00	980.00
Cumulative Distance	0.00	2204.00	6067.00	7251.00	7770.00	3550.00	4650.00	5750.00	8248.00		10200.00	11607.00		15325.00	15900.00	18393.00		20550.00	22950.00	24550.00		25900.00	26880.00
Dynamic Water Level	258.98 (272.6)				248.27 (265.8)					236.98 (257.3)			228.05				216.73				208.54		203.93 (230.0)

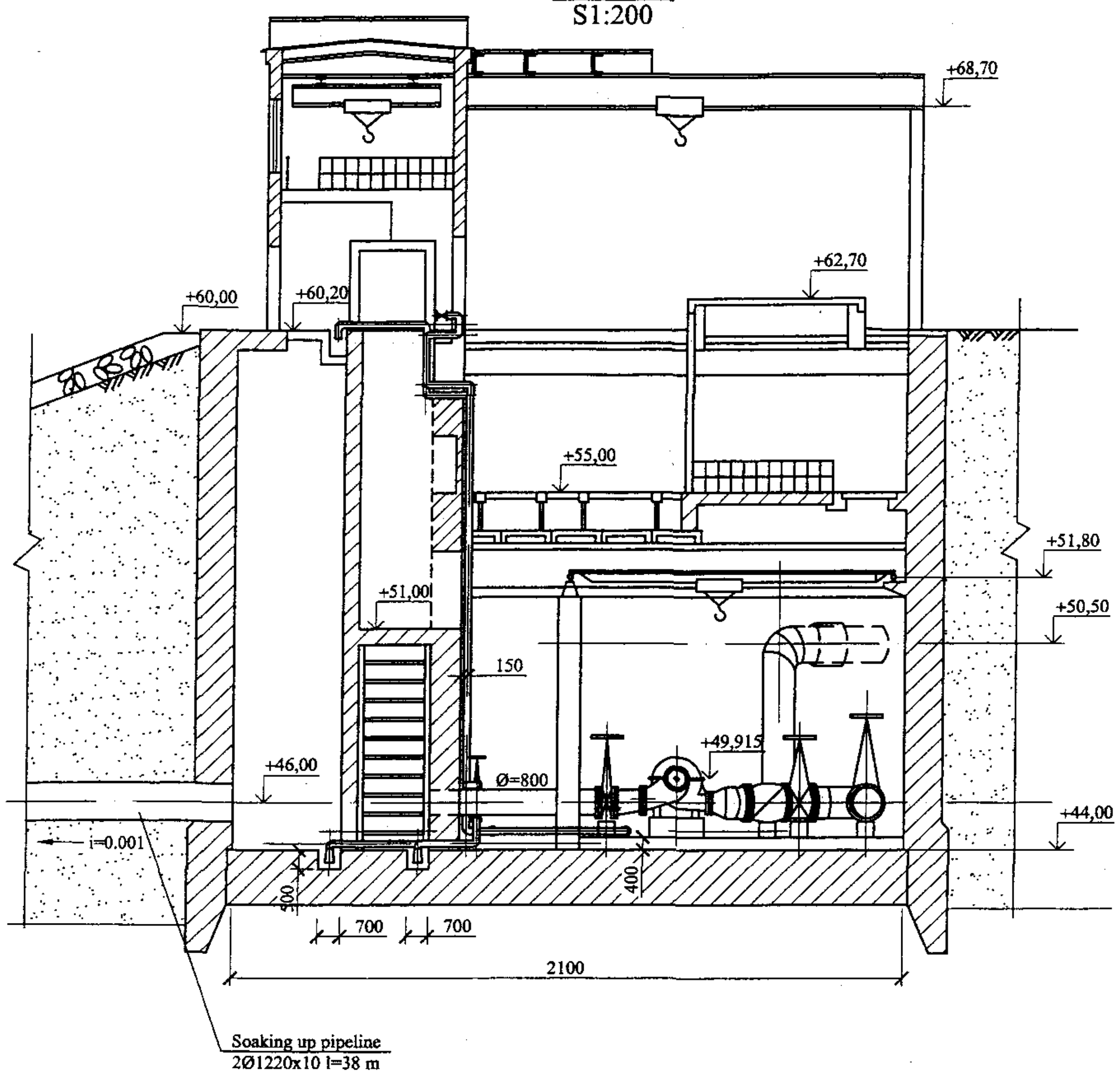
Figure 8.3.5 Hydraulic Profile of the Proposed Transmission Pipeline to Falesti

Pumping Station	Name of pump	Pump Specification	Number of pump
№ 1 P/S	Intake pump	24.0m3/min x 52.3m x 300kW	3
	Bilge pump	1.0m3/min x 20.0m x 7.5kW	2
№ 2 P/S	Booster pump	24.0m3/min x 90.0m x 500kW	3
№ 3 P/S	Transmission	21.3m3/min x 75.0m x 360kW	3
	Backwash pump	15.0m3/min x 21.0m x 75kW	2
№ 4 P/S	Transmission	18.9m3/min x 80.0m x 350kW	3

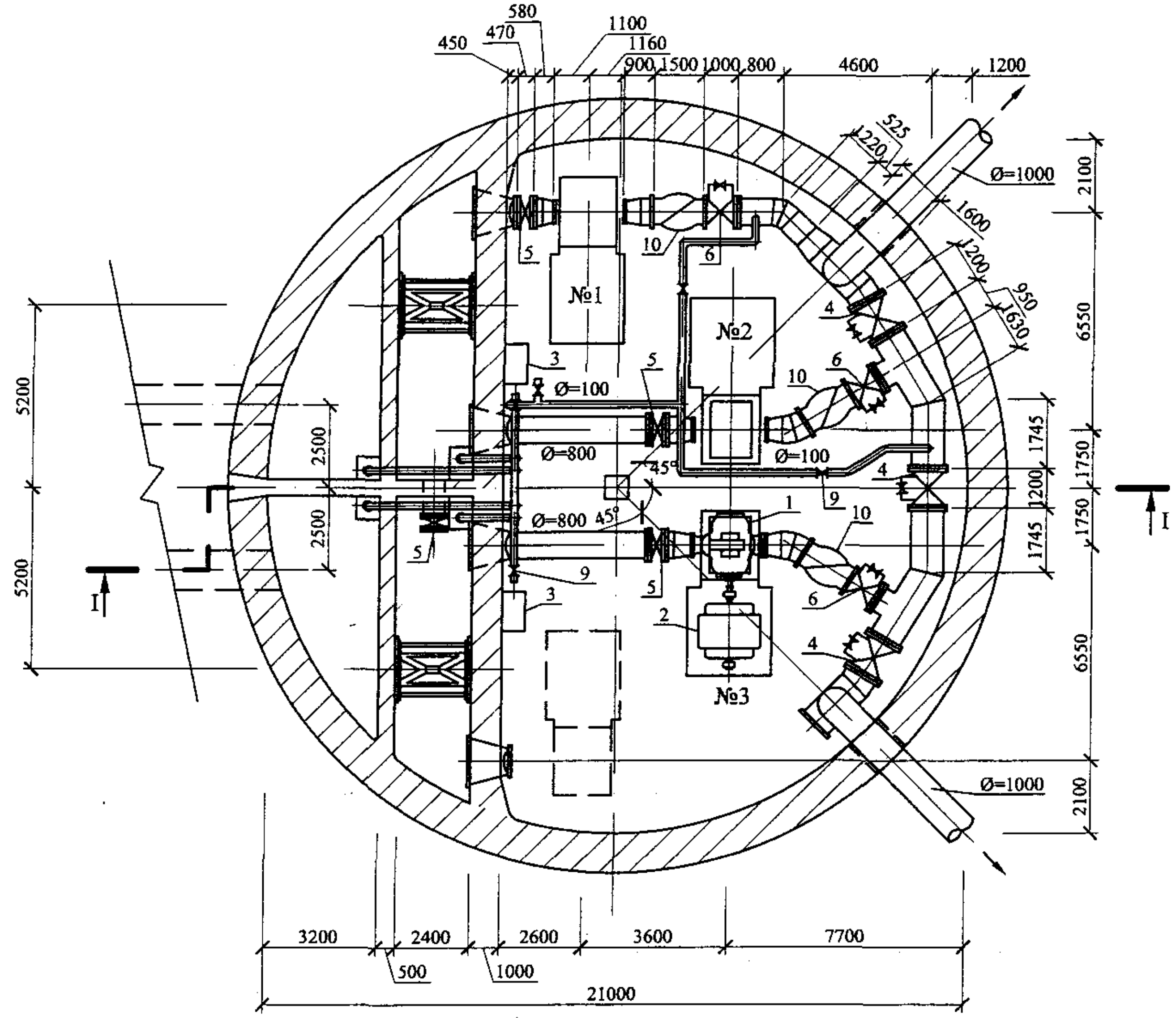


Drawing 1 Flow Diagram for Pumping Stations and Reservoirs

Section I-I
S1:200

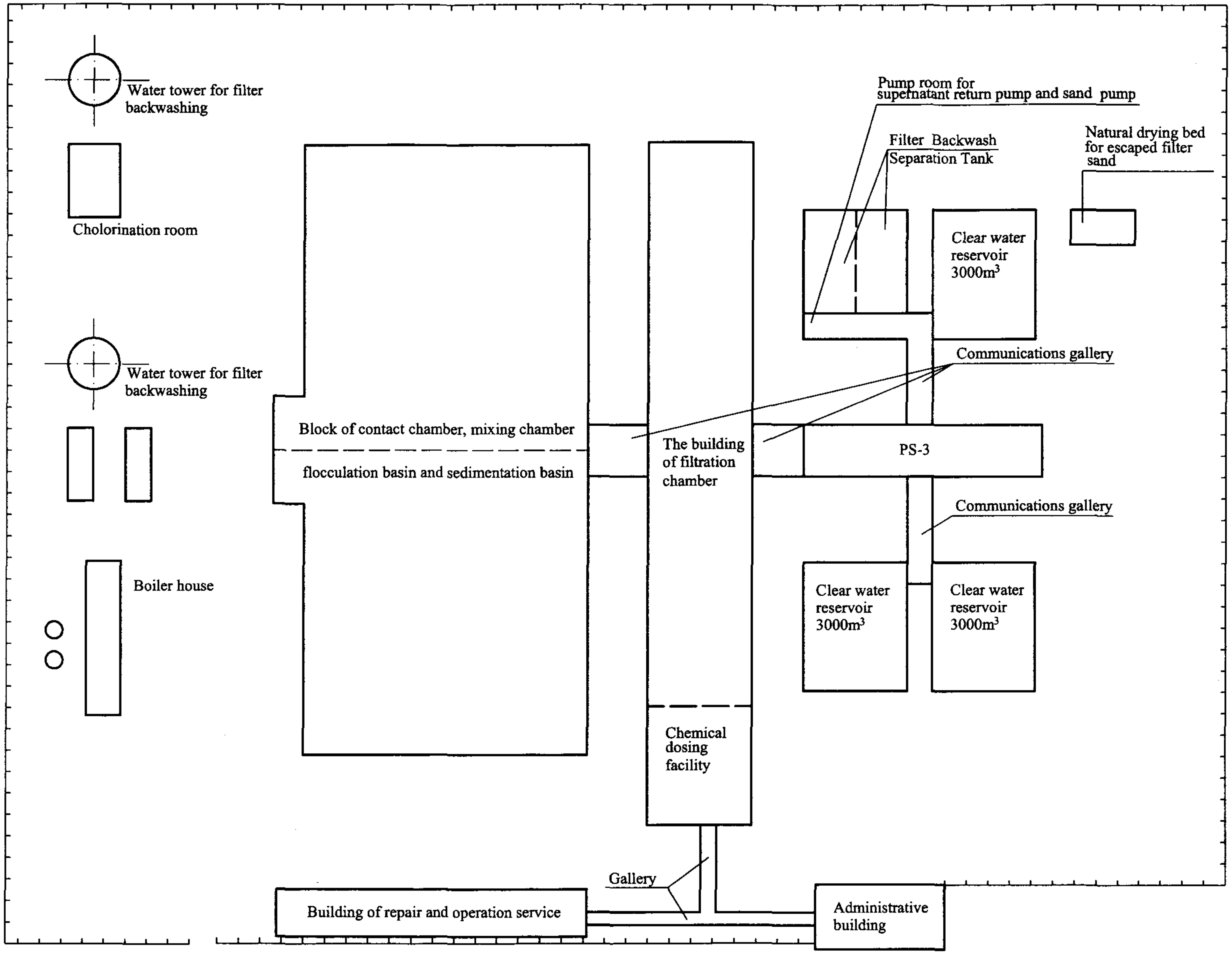


Plan on +51.40
S1:200

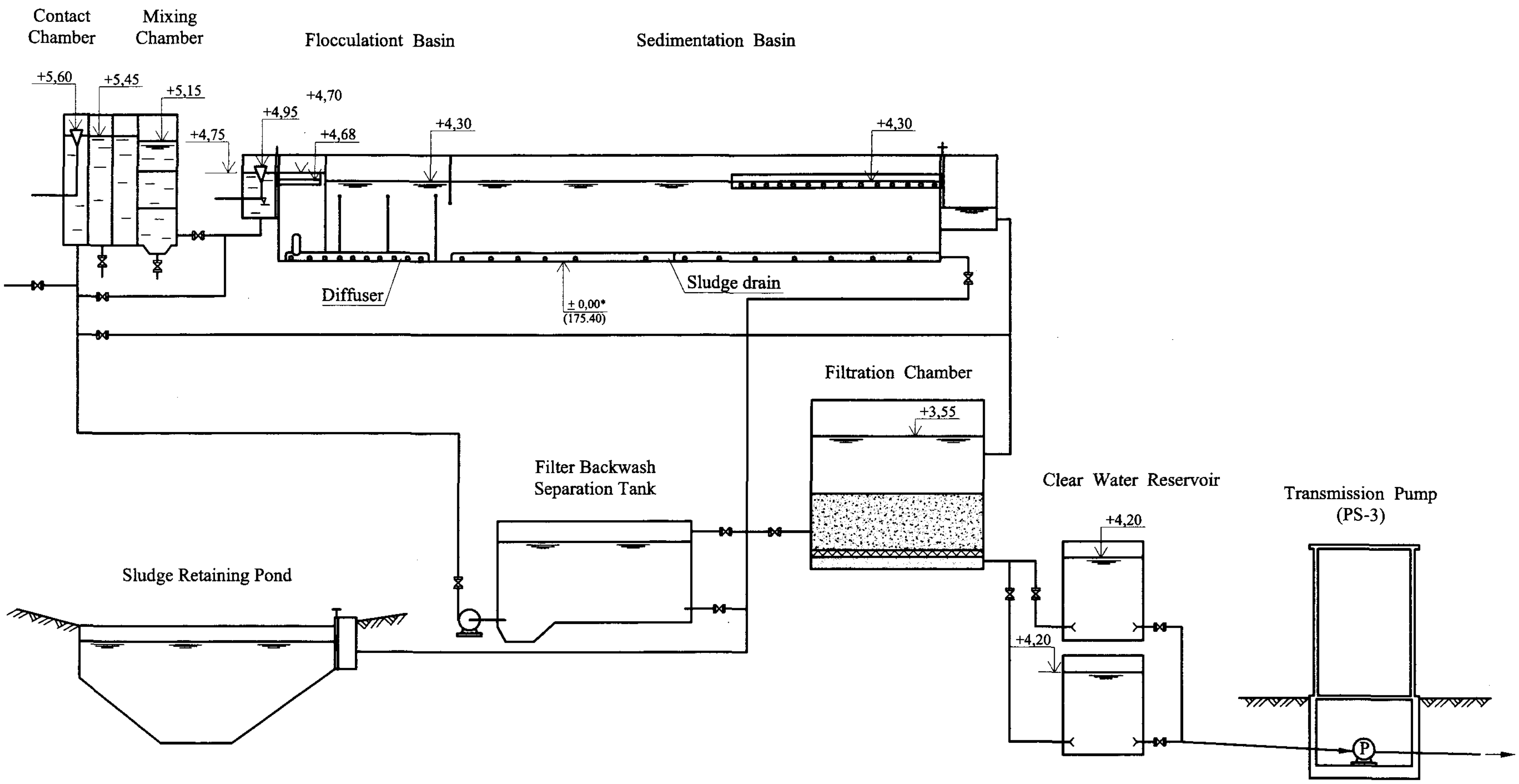


No. of the Position	Name	Quantity (amount)	Model or GOST
1	Pump Д4000-95(22НДс) Q=3996 m3/h, H=79 m	3	
2	Electric motor СДН-15-39-6 N=1250 kw	3	
3	Pump С-569 Q=54 m3/h, H=25 m Electric motor N=13 kw	2	
4	Gate valve electrically-actuated DN=1000 mm P=10Bar	3	30ч915бр
5	Gate valve electrically-actuated DN=800 mm P=25Bar	4	30ч925бр
6	Gate valve electrically-actuated DN=500 mm P=25Bar	3	30с927нж
7	Manual gate valve DN=100 mm P=10 Bar	1	30ч6бр
8	Manual gate valve DN=100 mm P=10 Bar	2	30ч906бр
9	Manual gate valve DN=150 mm P=10 Bar	13	30ч6бр
10	Check valve DN=600 mm P=25 Bar	3	19с15бр

Drawing 2 Plan and Section of №1 Pumping Station



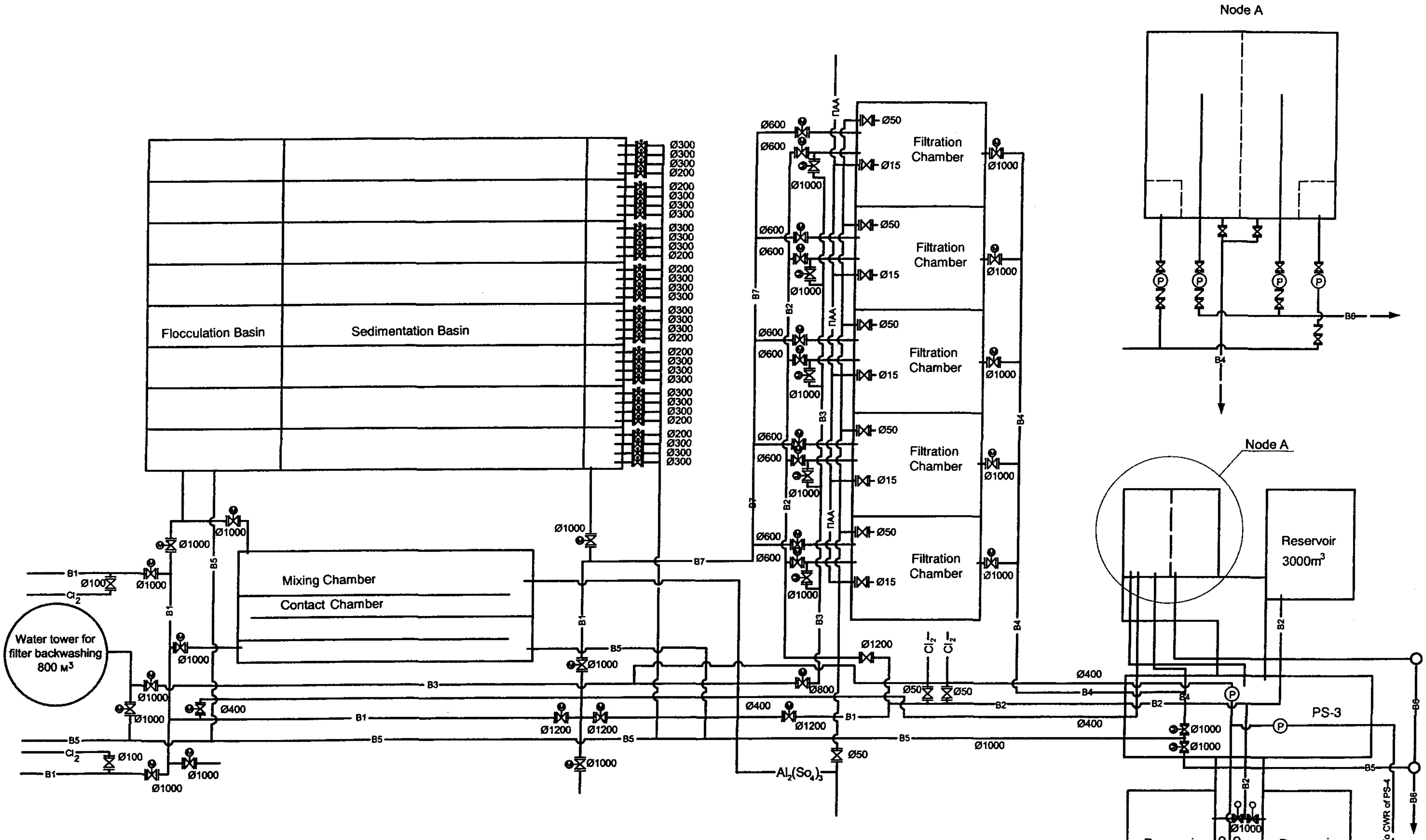
Drawing 6 Plan of Apa-Canal Soroca-Balti Water Treatment Plant



Note: * For the level ±0.00 is refered to elevation of 175.40

Drawing 7 Hidraulic Profile of the Treatment Plant

Drawing 8 Scheme of Existing Yard Pipelines of the Water Treatment Facility of Apa-Canal "Soroca-Balti"



B1-Трубопровод подачи сырой воды
B2-Трубопровод очищенной воды
B3-Трубопровод подачи промывной воды
B4-Трубопровод отвода промывной воды
B5-Трубопровод отвода сырых вод и шлама
B6-Трубопровод подачи осадка на иловые площадки
B7-Трубопровод отстоеной воды

Raw water pipeline
Pipeline for treated water
Pipeline for backwash water supply
Pipeline for backwash water discharge
Pipeline for discharging raw water and sediments
Pipeline for the discharge of sludge to the sludge deposit site
Cleard water pipeline