The LDC programme is being implemented in right timing to improve the water distribution system to link up with high pressure pipelines by the rehabilitated Chandnighat Water Treatment Plant.

3.2.2 Study on Components of the Project

The objective of the Project is to rehabilitate the existing facilities and to expand the initial functions of Chandnighat Water Treatment Plant. But, the Plant being the only source for water supply in that area, its activities shall be maintained to continue water supply during even construction period.

A water works consists of two main components, namely water treatment plant and water distribution networks. The water treatment plant in the Chandnighat Plant consists of water intake pump facility, water treatment facility and water distribution pump facility.

At the original request proposed by the Government of Bangladesh for the Project, the rehabilitation plan was only to expand and rehabilitate the present treatment capacity of 17,000 m^3/d (3.7 MGD) upto 39,000 m^3/d (8.6 MGD) and it did not include rehabilitation plan for water distribution main pipe. However, additional request to be included the rehabilitation of the main distribution pipe in the Project area has been proposed by DWASA to Japanese side at Preliminary Study stage. JICA study team has understood the necessity of such rehabilitation and agreed to include it to the scope of work for the Basic Design Study.

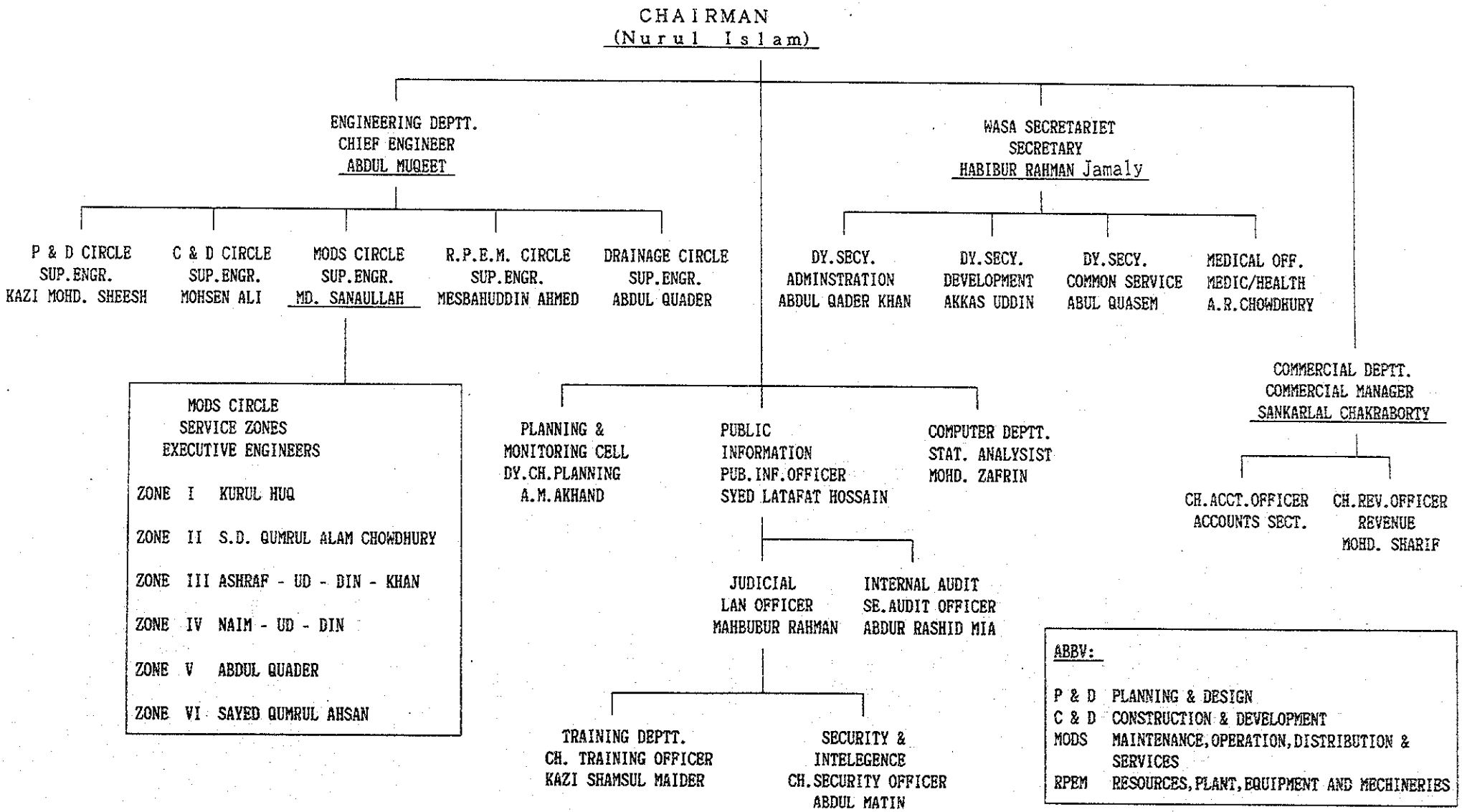
Accordingly, the component of the rehabilitation and expansion plan for the Project include the facilities of water intake pump, water treatment plant, water distribution pump and water distribution main pipe in the Project area.

3.2.3 Examination of the Project Operation Plan

(1) Organization of DWASA

The organization of DWASA is shown in Fig. 3-2. DWASA consists of three departments under direct control of the Chairman, namely the Secretari-

Fig. 3-2 Organization Chart for DWASA



at, the Engineering department and the Commercial Department. Besides, there are Planning and Monitoring Cell, Public Information, Computer Department, Training Department etc. directly under the control of the Chairman.

Recently, a member board system is introduced in DWASA as a decision making committee under the directive of the Chairman that comprises Member Engineer, Member Finance and Member Administration.

Total number of DWASA employee is 2,889 persons as of April, 1992, out of which 2,690 are permanent employees and the rest 199 are in casual employment.

Table 3-2 shows the number of personnel (DWASA) by Department.

Table 3-2 Number of DWASA Personnel by Department

Name of Department	No. of Personnel
Secretariat	330
Engineering Department	1,940
Commercial Department	485
Others	134
Total	2,889

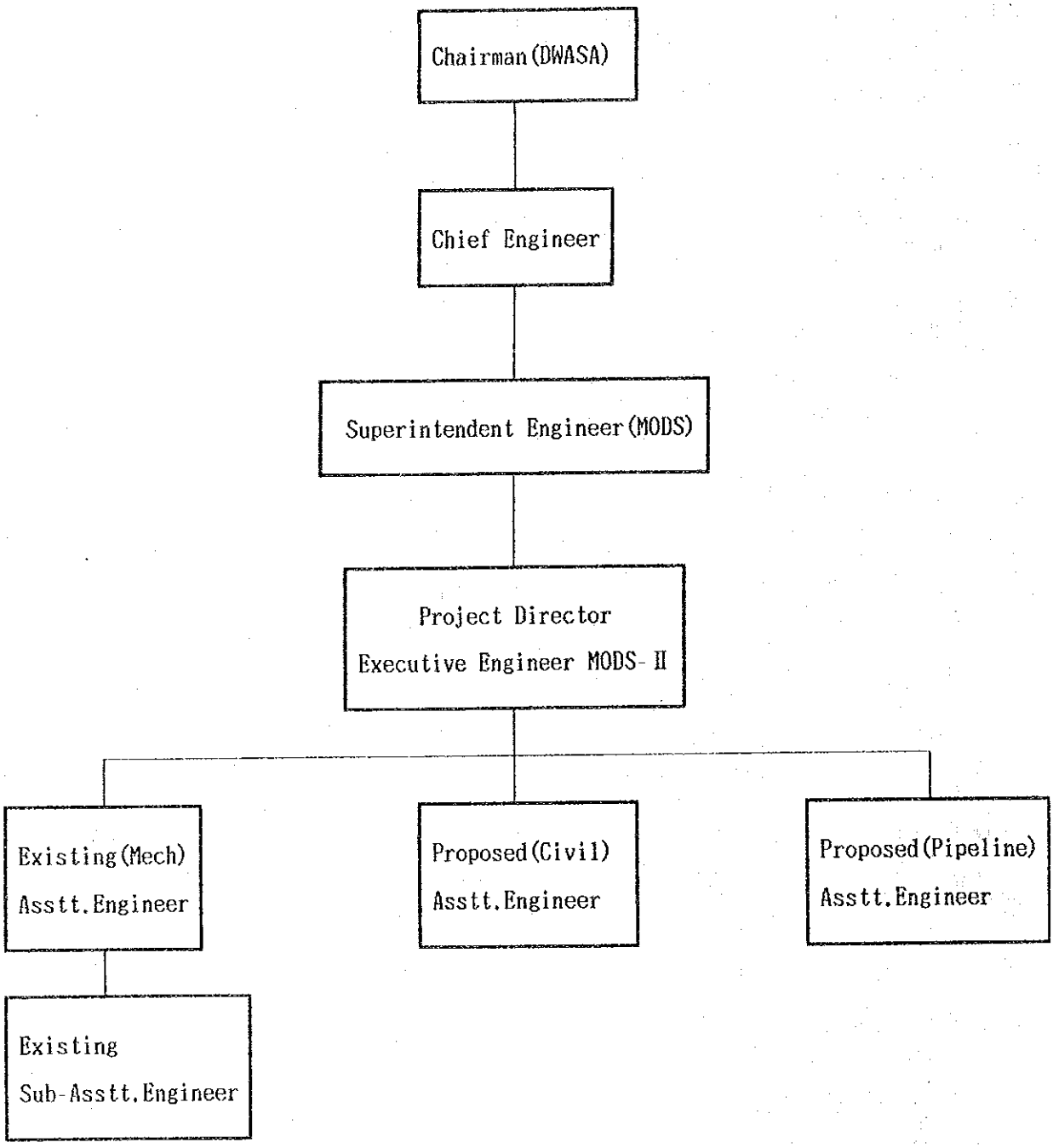
(2) Implementation Plan

The project area falls under MODS Zone II which operates under direct supervision of the MODS Circle belongs to Engineering Department in DWASA as shown in previous Fig. 3-2.

The organizations of the Project implementation, MODS Zone II is shown in Fig. 3-3.

Although the treatment capacity of the Plant will be increased more than twice of the existing capacity by the Project, a volume of the work for the filter operation will remain almost the same in practice because the

Fig.3-3 Organization of the Project Implementation



new filtration facility which will be installed non-valve type rapid sand filter.

On the other hand, it is observed that water quality management is not performed in the Plant at present. Also, careful dosing of chemicals are not maintained in the operation.

DWASA has a laboratory for water quality analysis where routine job for drinking water examination is being executed. At present, however, the laboratory has no function to analyze a waste water contamination affected by discharge drain from industries such as heavy metals. Since the laboratory has staff member enable to analyze them, equipment and agents for analysis shall be provided and stocked in the laboratory or contract analysis system for heavy metals and hurmful materials shall be established so as to improve management system for water quality control.

Table 3-3 shows DWASA's balance sheet for 3 years from 1987 to 1989, and Table 3-4 shows balance sheet for the last 10 months.

Following observation is made from the above mentioned.

1) DWASA's composition of finances for last 4 years till the year 1990 shows a favorable balance, but figures from a surplus to a deficit spending for the year 1991.

2) There is a deviation of approx. 15 % between revenue budget and actual expenditure for 1990. Which is assumed to be one of the major reason that the improvement of system loss for water supply mentioned above, especially for commercial control which did not propel on schedule.

3) As observed in the field survey, inadequate chemical dosing for water treatment and chlorination for ground water are maintained. The operational policy for water supply services is likely to accommodate its efforts preferably in water quantity than that of water quality. As regards inappropriate management system of DWASA, for instance, it is to point out the case of the urgent sewerage construction and rehabilita-

tion project for Dhaka city which was executed under the grant aid assistane from Japan. Although the project was completed in March 1992 and has been handed over to DWASA, assignment of personnel at required positions for proper operation of the sewerage treatment plant did not take place till August, 1992.

Presuming on such inadequate operation and inappropriate management system, the composition of fianances of DWASA is considered to maintain a favorable balance under such restrictive budget as mentioned above.

Although the operation and maintenance expenses for the Chandnighat Treatment Plant will be increased, when this Project is executed, the unit cost for produced water will be almost the same level as it is. Therefore, there is no component that should effect any change into the total balance sheet of DWASA at present because the increased operation and maintenance expense will be covered by water rates.

However, it will be necessary to shift required personnel and make provision for the budget for operation and maintenance of the Treatment Plant, which must be ensured in order to proper operation of the water supply system on schedule.

From the viewpoint of long scheme, DWASA is under way to prepare a master plan as startad earlier, in which large scals of treatment plant such as 200 MGD is designed, in order to improve the present status of water shortage in Dhaka city. When the plan is implemented, it is to be ensured that DWASA is prepared to bear the liabilities of heavy debt repayment at future course.

To cope with above mentioned circumstances, DWASA must take step to improve the financial standing in terms of price increase of water and sewerage rates, also improvement of financial losses and technical losses from water supply.

As regards to the required operation and maintenance expenses, the detail will be presented in succeeding Table 3-14 and in Chapter 5.2 in this report.

Table 3-3 DWASA's Balance Sheet for the Last 3 years

Unit : Million TK

Item	1987-88	1988-89	1989-90	1990-91 (Budget)
A. Income				
1. Water Supply	215.81	215.83	227.66	280.11
2. Sewerage	104.51	110.55	108.78	127.29
3. Others	41.68	50.77	63.86	63.59
Total	362.00	377.15	400.30	470.99
B. Expense				
1. Electrical Power	97.55	120.18	128.44	155.00
2. Chemical	5.72	6.63	7.92	14.00
3. Maintenance	15.33	24.42	35.99	25.80
4. Salary	63.33	69.79	86.88	98.71
5. Others	64.79	33.59	18.13	40.74
Sub-Total	(246.72)	(254.61)	(277.36)	(334.25)
6. Repayment	100.94	103.61	109.08	137.17
Total	347.66	358.22	386.44	471.42
Balance	14.34	18.93	13.86	- 0.43

Table 3-4 DWASA's Balance Sheet for the Last 10 months

unit:Million TK

Item	(1990-91)	(1991-92)
A. Income		
1. Water Supply & Sewerage	311.85	391.70
2. Fee	8.87	5.31
3. Meter	1.80	6.45
4. Rental Room	2.69	4.10
5. Royalty	6.95	5.42
6. others	1.08	3.79
Total	333.24	416.77
B. Expense		
1. Electrical Power	113.23	159.76
2. Chemical	5.43	9.26
3. Maintenance	19.83	25.51
4. Salary	64.01	73.69
5. Others	30.38	34.82
Sub-Total	(218.91)	(281.25)
6. Repayment	112.81	142.08
Total	331.72	423.33
Balance	1.52	6.56

3.2.4 Examination of Present Operational Condition of Water Treatment Plant

The following is a description of the present operational conditions of the water supply system in MODS Zone II.

(1) Present Status of the Treatment Plant

In 1874, the Plant was originally constructed and has been rehabilitated mainly pump facilities and electrical equipment during the years 1947 and 1970.

The general plot plan and flow chart diagram of the Plant are shown in Fig. 3-4 and Fig. 3-5.

1) Treatment Capacity

- Capacity of water intake pump

Pump station No.1	23,900 m^3/d (5.28 MGD)
Pump station No.2	21,900 m^3/d (4.80 MGD)
Total	45,800 n^3/d (10.08 MGD)

- Capacity of Filtration

Jewell filter	99.9 m^2
Paterson filter	92.0 m^2
Total	191.6 m^2

191.6 m^2 x 120 $m^3/m^2 \cdot d$ x 0.9 = 20,700 m^3/d (4.55 MGD)

Note : The capacity above mentioned is estimated providing the followings:

a) The filtration velocity is used a standard criteria of 120 $m^3/m^2 \cdot day$.

b) Water loss which is consumed in the Plant for back washing for filters is assumed 10% of water production because back washing of the

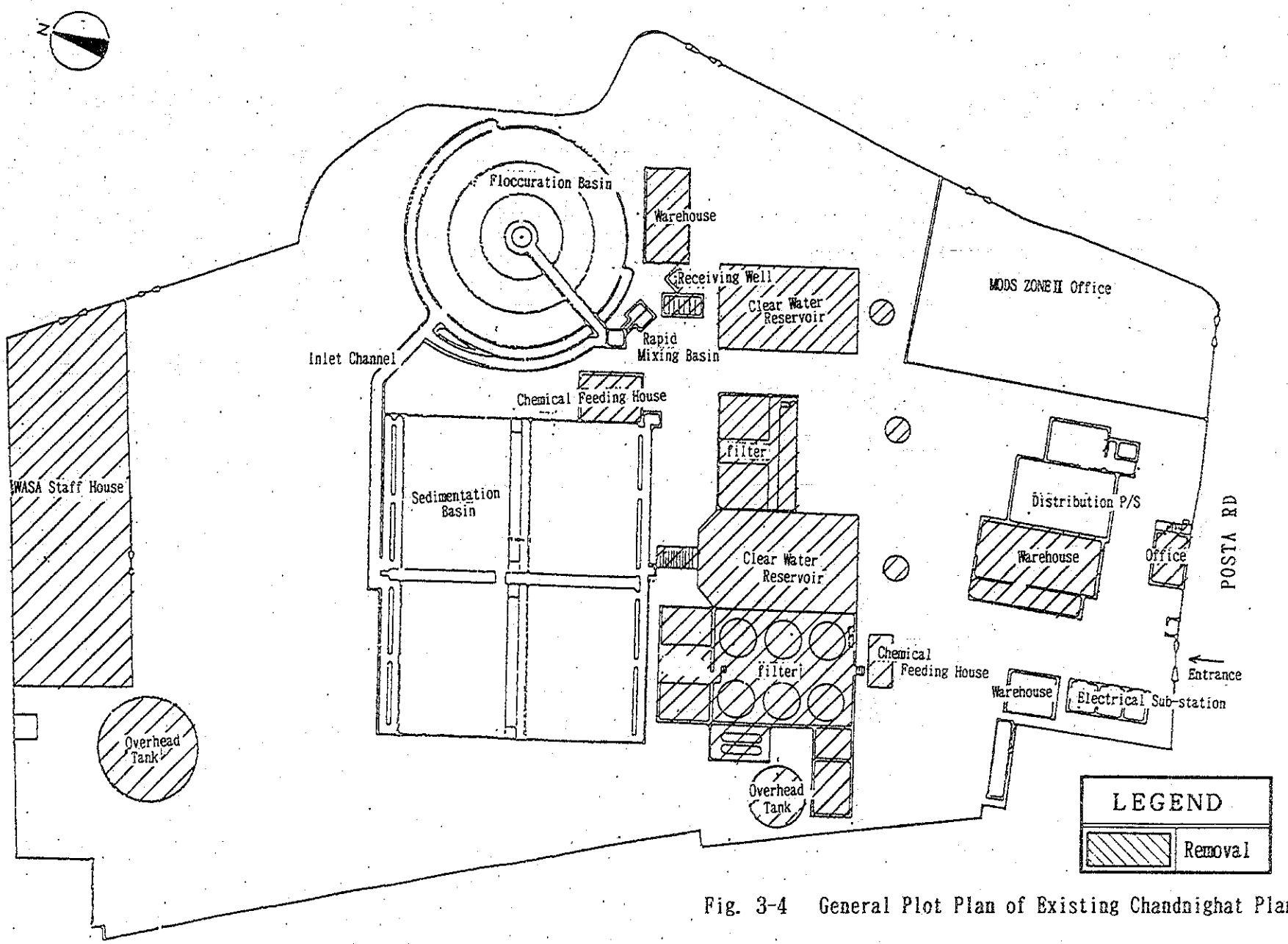


Fig. 3-4 General Plot Plan of Existing Chandnighat Plant.

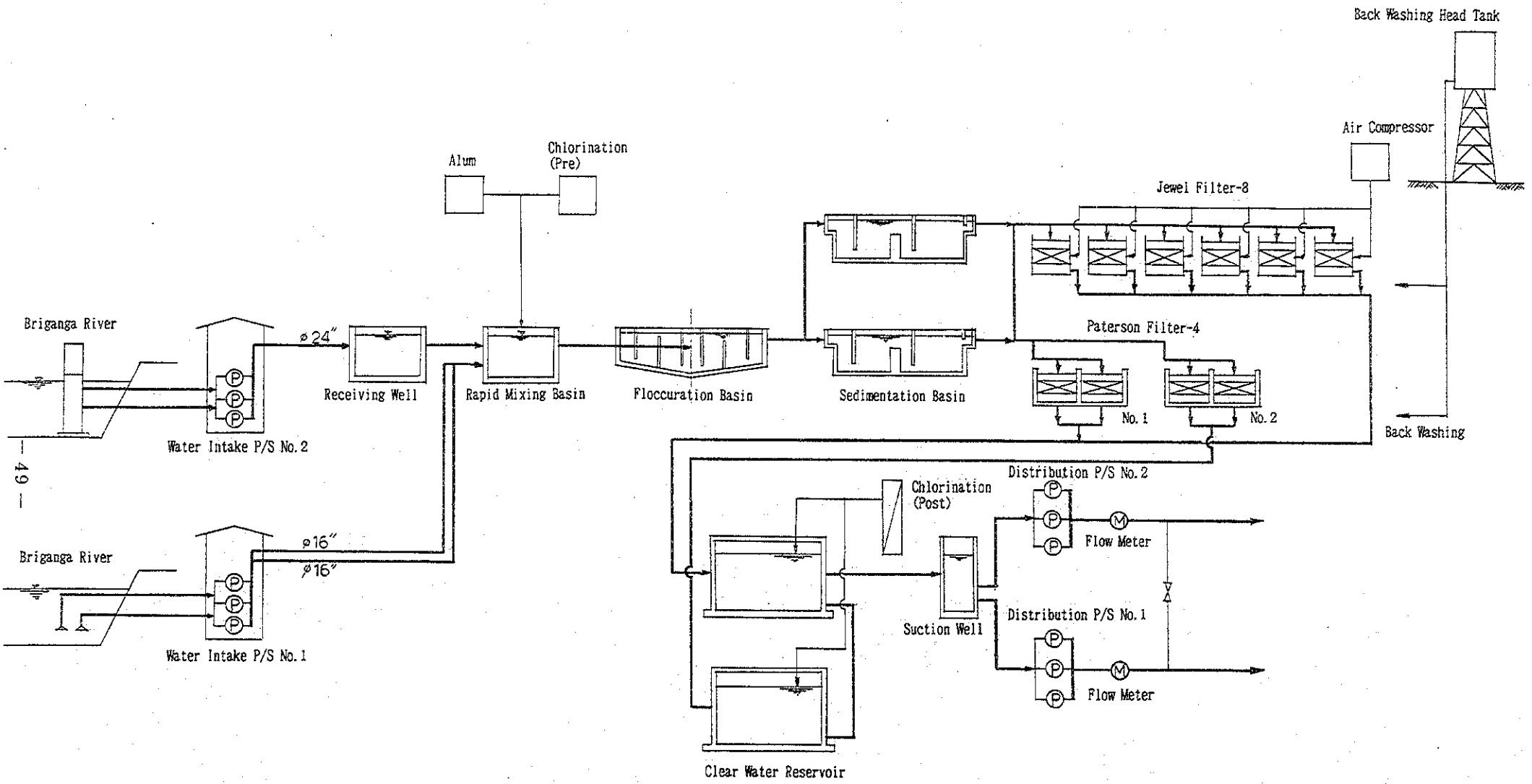


Fig. 3-5 Flow Chart Diagram

filters is maintaining 2 or 3 times a day at present.

- Capacity of distribution pump

Pump station No.1	23,000 m^3/d (5.04 MGD)
Pump station No.2	21,900 m^3/d (4.80 MGD)
Total	44,900 m^3/d (9.84 MGD)

Since there are two pump stations for water intake and distribution respectively, as it can be seen the above these pump facilities have twice of capacity of the filtration but one out of two pump stations is operating as stand by, respectively. Therefore, it can be said that the present production capacity of the Plant is limited by the capacity of the filtration(4.55MGD).

2) Quantity of Water Supply

According to DWASA's monthly management report, daily mean water production volume in the Plant for the last 10 months is 15,730 m^3/d (3.46 MGD) as show in previous Table 2.2.

3) Water Quality

Table 3-5 shows water quality of raw water and treated water. As it can be seen in Table 3-5, treated water quality is under WHO standard except iron content. Such Iron content is possible to reduce in terms of sufficient removal of suspended materials in general way of flocculation, sedimentation and filtration processes on premise of appropriate chemical dosing.

Turbidity of the treated water is 5 NTU for 1st sample and 4 NTU for 2nd one, which are under WHO standard. If the Plant was operated under the condition of appropriate chemical dosing against the raw water quality, treated water quality might be improved not only turbidity but also iron content. Along this line, management of water quality control including chemical feeding is emphasized for well operation of the Plant.

Detailed data for raw water quality is shown in Appendix B-7.

Table 3-5 Water Quality of Raw Water and Treated Water in Chandnighat Plant

Item	Sample	Local Analysis 1st	Local Analysis 2nd	in Japan	Standard	Ref. (Japan Standard)
pH	Raw Water	7.18	7.1	7.2	6.5 ~ 8.5	5.8 ~ 8.5
	Treated Water	7.25	7.1	7.4		
Tubidity	Raw Water	50	25	7	5(NTU)	2(NTU)
	Treated Water	<25 (5)	<25 (4)	< 1		
Color	Raw Water	-	-	32	15(TCU)	3(TCU)
	Treated Water	-	-	15		
Fe	Raw Water	0.932	0.612	0.40	0.3	0.3
	Treated Water	0.958 *	0.517 *	<0.05		
Mn	Raw Water	0.0	0.0	0.03	0.1	0.3
	Treated Water	0.0	0.0	<0.02		(0.05)
Cu	Raw Water	0.0	0.0	-	1.0	1.0
	Treated Water	0.0	0.0	-		
Cr	Raw Water	0.0	0.0	<0.02	0.05	0.05
	Treated Water	0.0	0.0036	<0.02		(Cr^{6+})
Hg	Raw Water	-	-	<0.0005	0.001	0.0005
	Treated Water	-	-	<0.0005		

Unit: mg/l (Except pH, Tubi, Color)

* : Over WHO Standard

Local Analysis is to be analized at Department of Environment (DOE), Dhaka.

( ) in Tubidity is to be analysized by the Study team

(2) Present Condition of the Plant Facilities

1) Water Intake Pump Facility

a) Water Intake Pump

There are two pump stations. Each pump station has two pumps with one stand by pump. The existing pumps of the pump station(P/S) No.1 were manufactured in the year 1947, while the pumps in the P/S No.2 were in the year 1970.

The applied design criteria of the pump of the P/S No. 1 and P/S No. 2 are 8.3 m^3/min (2.64 MGD) x 19.5 m x 41 kW and 7.6 m^3/min (2.4 MGD) x 19.5m x 41 kW, respectively. Two pumps out of six are operating for 15 to 18 hours a day and sometime 3 pumps for 1 to 2 hours. However, due to secular deterioration the pumps of the P/S No. 1 which is a vertical type of pump with 5 m vertical shaft are superannuated and observed to be hard for continuous operation after completion of the Project.

b) Transmission Pipe

This pipe is used for conveying the raw water from the water intake pump into the Water Treatment Plant. As for the P/S No. 1 the transmission pipe has been installed ϕ400 mm x 2 lines with material of SS, while ϕ 600 x 1 line for the P/S No. 2.

It was suggested by DWASA that the pipeline for the P/S No. 1 was installed 15 ft. under the existing surface of road and thereby its maintenance was very difficult for the local contractor.

2) Water Treatment Facilities

a) Receiving Well and Rapid Mixer

There is a small scale of receiving well with a rapid mixer in the Plant, but the rapid mixer is not functioning. Therefore, the chemical coagulation is not expected to be very much effective even if the liquid alum, as coagulant, is dosed with appropriate ratio.

b) Flocculation

The flocculation basin is located in the upstream of sedimentation basins. The flocculation basin is a type of vertically baffled channels with under drain collection pipes. Detention time of the basin is approx. 110 min. (Standard criteria is 20 to 40 min.) and then the velocity gradients is smaller than standard design criteria.

By observing actual operation, it can be seen that even after dosing an apprpriate coagulant one third of the coagulant pass through without certain mixed with the water depending on a streamline flow. Due to such reasons as no appreciable chemical dosing, rapid mixing and flocculation activity, the function of flocculation is observed to have uneven results affecting the time and flow rate.

c) Sedimentation

The structure of the sedimentation basin seems to be a gravity retaining wall with brick and soil. The basins are of the horizontal flow sedimentation type with a detention time of 4.0 hours. However, there is gravity retaining wall and baffle walls inside of the basins, which creates hindrance for normal operation. According to some observation, floc passes through the sedimentation basins to filters without sufficient settling, probably due to insufficient floc formation and the inside structure of the basis.

d) Filter

The filtration facilities are of the type as shown in the preceding chapter 2-2-2(5). There are six beds manufuctued by the material of SS and four beds manufactured by concrete.

Basic operating procedures such as the control of flow rate and back washing of filter media are almost similar between both type of the filters, operating of all control valves by manual procedure. Filter washing is done by a combination of air wash and backwash by water. No flow rate and losses of head of filters are being indicated.

The filtration is the most deteriorated facility in the Plant.

e) Clear-water Reservoir

There are two basins, one is of a capacity of 950 m^3 and the other is of 500 m^3 and a total combined capacity of the two is of 1,450 m^3 with a detention time of approx. 1.6 hours. But there is no service reservoir for storage of the clear-water produced during the night time in the treatment process.

3) Water Distribution Pump Facility

a) Water Distribution Pump

There are altogether 6 nos. of pumps between the two pump stations. Out of which, two pumps are in operation with one pump as stand-by for each

station.

Two pumps out of six are operating almost 18 to 20 hours per day to supply water to consumers. As mentioned earlier on the manufacture dates and design criteria of these pumps, this was also pointed out that the pumps were partially repaired during the year 1947 and 1970. By observing actual repair work in shop-house, it was established that the pumps of P/S No.2 are more deteriorated than the pumps of P/S No.1 which is more older than that of No.2.

4) Chemical Dosing and Chlorination

In the Chandnighat Plant, liquid alum is used as coagulant through out all season, while pre-chlorination is used only for dry season.

Solution of liquid alum and alumina contents are not clear due to none measuring of the solution. Alum dosing is done reluctantly by the operators on eye-measurement, as there is no facility for measuring equipment for alum injection.

Due to the relatively high raw water alkalinity (about 50 to 150 mg/l) and low water turbidity (about 20 to 50 mg/l) in dry season, there is low dosage of coagulant and pH value will be stable in good condition, therefore, the alkalinity still remains sufficient high and the pH value slightly declines.

As for dosing of liquid chlorinated lime as pre-chlorination, basic operating condition are almost similar to that of liquid alum.

The disinfection by chlorine is done by using of 50 kg gas cylinder. Among chlorination equipment, only one chlorinator is used for a clear water reservoir with capacity of 950 m^3, there is no adjustment against the volume of treated water. The other chlorination for a clear-water reservoir of 500 m^3 is injected from 50 kg gas cylinder directly, which is hazardous because by this process it is hard to control the volume of chlorine fed in either it is too much or too little.

5) Mechanical/Electrical Facilities and Instrumentation

As described at the beginning of this section, some modifications were implemented during 1947 and 1970. The existing main mechanical/electrical facilities and instrumentation in the Plant are of the following:

1) Water intake pump
2) Sump pump for water intake rooms

3) Rapid mixer
4) Back wash pump for filtration
5) Compressor for filtration
6) Pressure pump for chlorination
7) Water distribution pump
8) Sub-station, transformer and distribution panel for the treatment plant and for water intake
9) Generator
10) Inferential water meter

These facilities have varying operational conditions and deterioration of each component depends on its period for operation and locations in the treatment processes.

Presently the staff working on the Plant has been trying to maintain the existing facilities and to keep up good operating condition. But, these endeavors are limited due to the existing budgetary constraints.

For example, most of the equipment installed has a stand-by unit, but at present, those already being damaged. Two pumps out of six for the water intake pump are always under repairing. As to water distribution pumps, those are in the similar condition with the water intake pump.

Although it is possible to operate the Plant without a stand-by unit, the Plant will be deficient when the main operating equipment breaks down. It is to keep in mind that after completion of this Project, such main pumps either both No. 1 and No. 2 pump stations shall be operated continuously due to increase of treatment capacity.

Generally, equipment in the Plant should be repaired or replaced regularly with the corresponding maintenance plans. However, since 1970, no major repairs/replacements have been carried out in the Plant. Due to which, most of the mechanical/electrical facilities along with instrumentation has deteriorated severely and will require immediate major rehabilitation.

a) Substation

The Chandighat Treatment Plant receives its electrical power supply from the 11kV distribution line of the Lalbagh substation of Dhaka Electric Service Authority (DESA) belong to Bangladesh Power Development Board (BPDB) through a metering device installed by BPDB in the Plant.

Also, the water intake pump facility receives its electrical supply from the 11 kV distribution line of the said substation of DESA.

The two substations for the Chandnight Plant facilities have the following capacities:

- Transformer for the Plant
  ------- 3 phase, 50 HZ, 11kV/415 to 240 V
  800 kVA x 1 unit

- Transformer for the intake pump
  ------- 3 phase, 50 HZ 11kV/415 to 240 v
  750 kVA x 1 unit

Also, to meet emergency purpose for water intake, one electrical supply line has been installed from the sub-station inside the Plant to water intake pump station No.1.

b) Emergency Generator

A diesel engine generator is installed as follows:

Capacity : 400 kVA x 1 unit
Manufacturing year : 1974
The generator is in function, but actual number of operation for emergency purpose has never been recorded since its installation in the Plant. However, it seems that test run for maintenance has been performed once a year.

c) Low Voltage Distribution Lines

Low voltage electricity is distributed from two substations to treatment facilities and to water intake facility, respectively by underground cable. These lines, at present, seems likely not being maintained since its installation.

d) Control Facilities

The treatment facilities are supplied with electricity from their main switch box through distribution panel at low voltage of 415 - 240V. Most of the distribution panel are installed near their loads and with enough maintenance spaces. However, they have been deteriorated due to corrosion brought about by high humidity and temperature and suffer from shortage of spare parts. Observation confirmed that some of control panels are not in appropriate condition from the view point of safety.
All facilities are controlled by manual operation at the distribution panel.

The results of the ocular inspection showed that there are no major defects in actual operation except the need for some minor repairs as mentioned below:

The distribution panels for water intake pump of P/S No. 1 are deteriorated due to corrosion brought about by high humidity and temperature and thus required immediately repairs for maintenance.

Existing single electrical line of Chandnighat Water Treatment Plant is presented in Appendix B-9.

3.2.5 Examination of the Contents of the Request

(1) Expansion Capacity of the Plant

This rehabilitation and expansion plan requested presently by DWASA through the Government of Bangladesh is for strengthen the existing treatment capacity of 3.7 MGD up to 8.6 MGD. On the other hand, in the Minutes of Discussions which was exchanged between DWASA and JICA mission during the stages of the Preliminary Study and Basic Design Study, the capacity is mentioned to be increased up to 50,000 m^3/d (11MGD) as was requested by DWASA. The Minutes of Discussion is shown in Appendix A-2 for reference. As per our assessment the following is the reason and background that has been considered towards change of the request.

Background of the Original Request for 8.6 MGD

(i) The existing treatment facilities have different operational capacity in progress as shown below:

- Water intake facility (5.3 + 4.8) = 10.1 MGD
- Sedimentation facility = 4.6 MGD
- Filtration facility = 4.6 MGD
- Distribution facility (5.0 = 4.8) = 9.8 MGD

(ii) Aiming for effective use of the existing facilities as much as possible, the expansion plan should focus mainly into the sedimentation facility to increase its capacity at least up to the capacity of the water intake and distribution facilities.

As for the filtration facility, new filters are to be constructed to meet the designed flow rate in this Project because the facility is mostly superannuated.

(iii) Expansion of the treatment capacity of the sedimentation basin dealt with employment of high-rate setter module in it.

(iv) Depending on above basic conception and on the basis of the calculation given below.

(Capacity of the water intake facility) x (Diminution of the pump efficiency) x (water loss in the Plant processes)

= 10.1 MGD x 0.9 x 0.95 = 8.6 MGD

Background of Change of the Requested Increase of Capacity to 11 MGD

(i) The Chandnighat water treatment plant is requested to strengthen its production capacity as much as possible to deal with the problem of water shortage in the area.

(ii) Employment of high-rate settler module in the existing sedimentation basin, the capacity of the basin is expected to expand the treatment capacity up to maximum 11 MGD.

(iii) Three pumps at least out of six units of the water intake pump will be necessary to replace in this Project because of superannuation. The capacity of the pumps which will be replaced in this Project shall be designed to meet the required capacity of the rehabilitated treatment plant.

The above is the background of the change of the requested increase of capacity to 11 MGD in the Preliminary Study stage and the both parties have agreed providing that the appropriate capacity for expansion under this Project will be decided only after completion of the detailed survey and examination in the Basic Design Study.

With the understanding of the said background and the purpose of the Project, a study has been made on the view point of all technical aspect to assess the appropriate capacity of the treatment plant to be expanded under this Project.

As a result of the study the expansion of the capacity of the Plant is recommended to be 8.6 MGD, which is the capacity of the original request of DWASA.

The reason for such recommendation are as follows:

(i) Employment of high-rate settler module in the existing sedimentation basin cannot be recommended because of the technical, operational and maintenance standpoints as mentioned below.

- An open space between the end of the settler module and existing base of the basin will have a gap of 0.8 m only after installation of the high-rate settler module, which is very insufficient space to work for removal of sludge and cleaning of the basin by manually.

- Since the existing sedimentation basin was constructed about 120 years ago and its sidewall has been designed as gravity retaining wall with brick and soil. Additional load of new construction is not allowable taking consideration of strength of the structure. Moreover, there is no sufficient evidence whether it will be possible to construct supplemental fulcrums on the existing concrete base so as to install the settler module because the base of the sedimentation basin is not likely to be of reinforced concrete.

(ii) Therefore, expansion of treatment capacity in the sedimentation process be enhanced by mean of construction of new sedimentation basin.

(iii) As for the location plan for rehabilitation it was found out that the existing plant is situated within limited area for construction of sedimentation basins and filter having a capacity of 11 MGD. It is impossible to install the same within the proposed site even if high-rate settler module is employed for sedimentation basin to enhance its capacity. It is limited to 8.6 MGD for construction of expansion facilities in the projected site.

In the course of the above study the following location plans have been prepared for discussion.

1) Location Plan for 11 MGD

Planning condition:

1. Sedimentation basin --- to plan 4 basins with high-rate settler module in order to effectively use the proposed site.

2. Filter ---------- to plan non-valve type filter unit by rapid sand filter standard filtration velocity of 130 $m^3/m^2 \cdot d$.

3. Clear water reservoir - to plan a reservoir having a detention time of 1.5 hours for proposed treatment capacity.

4. Service reservoir ---- There is no service reservoir included in this plan.

Location plan :

The location plans are shown in Fig. 3-6 and 3-7. As a result of the study, there is limitation of space for construction of the planned facilities within the existing site, especially for sedimentation basin and filters.

2) Location Plan for Rehabilitation Plan Case 1 for 8.6 MGD

Planning condition :

1. Sedimentation basin -- to plan on the same condition to 1) above.

2. Filter ---------- to plan on the same condition to 1) above.

3. Service reservoir ---- to plan a reservoir having detention time of 3.8 hours.

Location plan :

After demolishing and removal of the existing over head tank, filters and two clear water reservoirs, new sedimentation basin, filter, service reservoir A(1,050 m^3) and service reservoir B(5,200 m^3) will be constructed in this project. The location plan is shown in Fig. 3-8.

3) Location Plan for Rehabilitation Plan Case 2 for 8.6 MGD

Planning condition :

1. Sedimentation basin -- to plan for 4 nos. basins of conventional type.

2. Filter ---------- to plan on the same condition to 1) above.

3. Clear water reservoir - to plan a reservoir having detention time of 1.7 hours.

4. Service reservoir ---- There will be no service reservoir.

Location plan :

After demolishing and removal of the existing over head tank, filters and clear water reservoirs (950 m^3), new sedimentation basin, filter, clear water reservoir (2,300 m^3) will be constructed in this Project. The existing clear water reservoir (500 m^3) only will be used as it is.

The location plan is shown in Fig. 3-9.

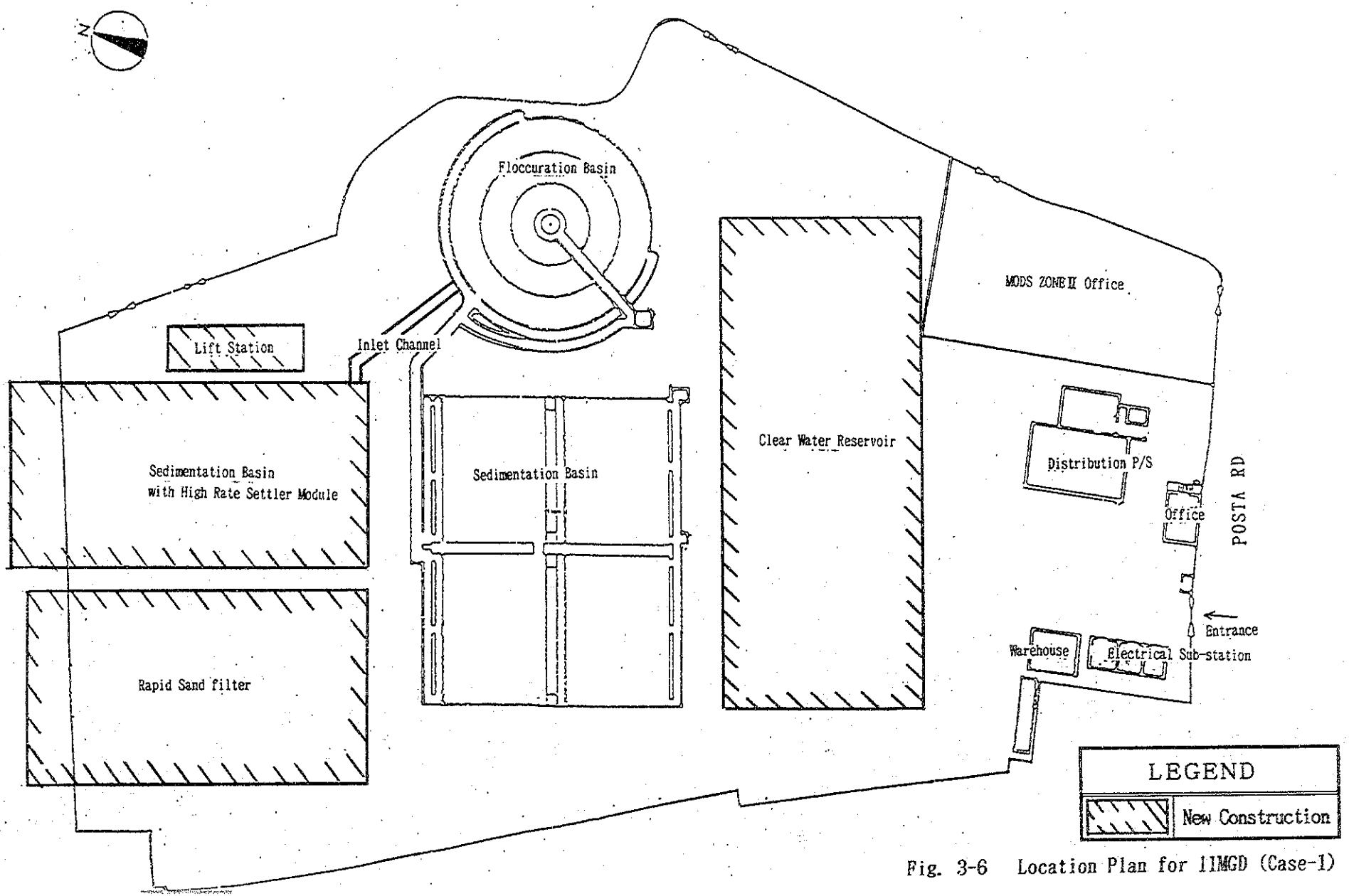


Fig. 3-6 Location Plan for 11MGD (Case-1)

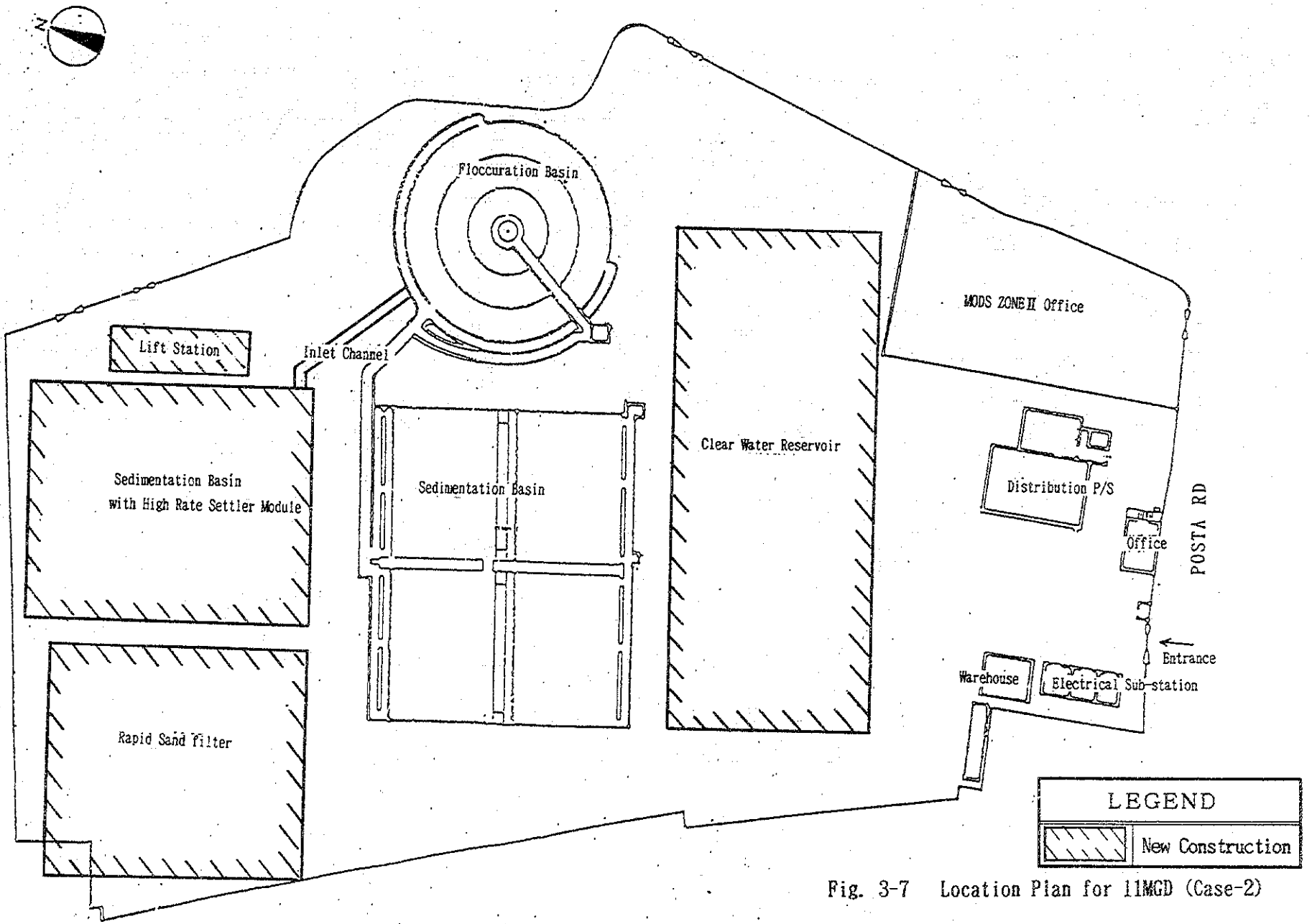


Fig. 3-7 Location Plan for 11MGD (Case-2)

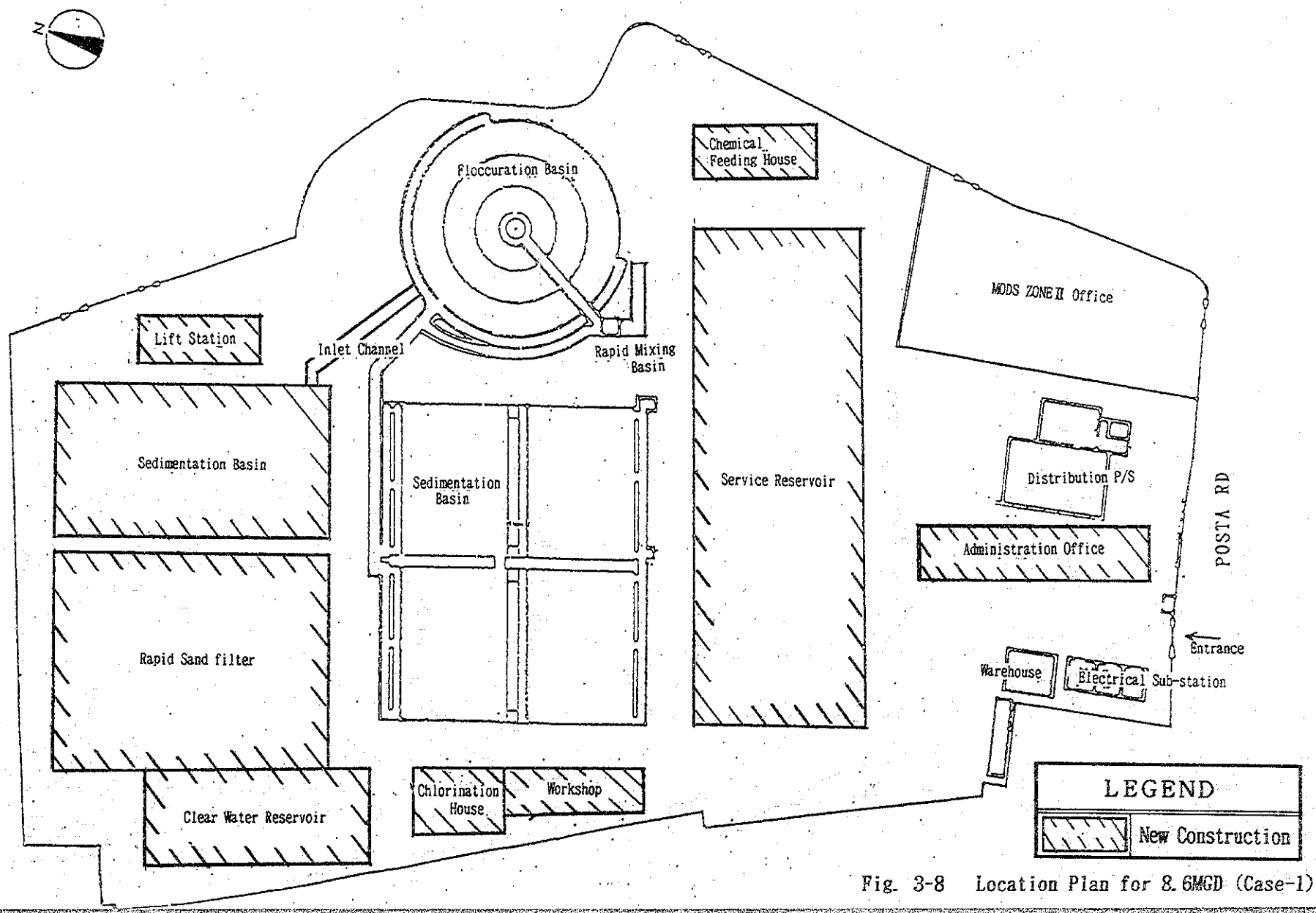


Fig. 3-8 Location Plan for 8.6MGD (Case-1)

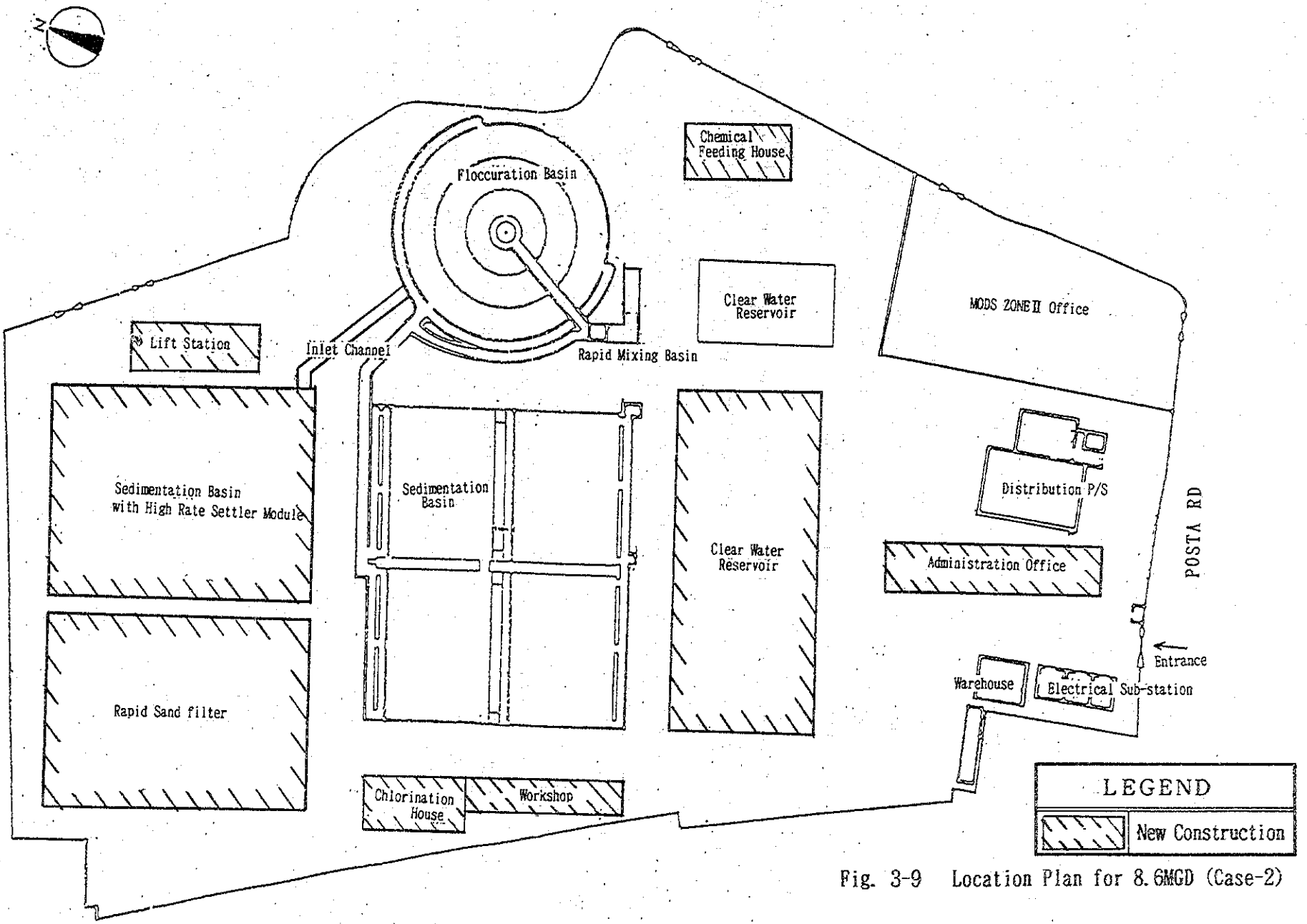


Fig. 3-9 Location Plan for 8.6MGD (Case-2)

(2) Examination of the Alternative Rehabilitation Plans

The following are to be considered for further discussion in relation to the alternative plans which will be focused to get attention on the necessity of service reservoir.

1) Purpose of Clear Water Reservoir and Service Reservoir

Purpose of clear water reservoir is to control or maintain a gap between changeable production volume of water in treatment plant mainly due to back washing in filtration process and the water supply volume, besides for reaction of chlorination activity.

Standard design criteria for the said purpose is usually employed considering detention time of more than 1 hour against designed flow.

In case a service reservoir is planned, the reservoir should be used for this purpose instead of a clear water reservoir like others.

Purpose of service reservoir is to control or reserve a water to meet hourly huge consumption and only for emergencies. For this purpose detention time usefully employed should be from 8 up to 12 hours. In this Project, however, storage and reserve of the water produced in night-time should be primarily considered, therefore detention time of 3 up to 5 hours is recommended taking into consideration of stoppage of water supplying service in the night time.

2) Outline of Alternatives

Besides having the existing, another clear water reservoir of 1,000 m^3 is planned in the rehabilitation plan requested by DWASA. Considering the present state of the Chandnighat water supply system, there are scope for further discussion on the subject taking into account of the followings:

(i) There are two clear water reservoirs of 950 m^3 and 500m^3 in the Chandnighat Plant at present. If proposed new reservoir of 1,000 m^3 is constructed in the Project, the sum of total capacity of the

reservoir will stand 2,450 m^3 that is equivalent to detention time of 1.5 hours which is the same as the present condition.

Previously there were five over head tanks situated at Armanitola Ashek Lane, Victoria Park, Tipu Sultan Road and Nawabgonj under the water supply area from the Chandnighat. Water used to be charged in the over head tanks through the rising supply pipes. But, these rising supply pipes are now transformed into a delivery main so as to give direct supply of water, resulting such tanks became an incapable facility and have been removed at present. Accordingly the existing water supply system of the Chandnighat water works has no function in respect of the reserve of water in either inside or outside of the Treatment Plant.

(ii) To construct a reservoir of 1,000 m^3 in line with the request, it is impossible to design one reservoir having a capacity of 1,000 m^3 at the site after removal of the filters, without removal of a clear water reservoir of 950 m^3 together due to limitation of space.

Therefore, two reservoir having a capacity of 500 m^3 - 600 m^3 be planned separately instead of one basin, but it is not an effective plan from economical stand point of view.

A relation between the two subjects mentioned above is likely to be different such as on the function of water supply system and its economical aspects. But, this two points should be examined carefully and settled on the way of discussion including the location plan in this particular project owing to limited space in the proposed site. Therefore, the following are prepared as the possible alternatives and to be considered for further discussion.

Case-1

- Aiming to reserve the water produced in night-time, two service reservoirs having capacity of 800 m^3 and 4,900 m^3 shall be constructed. In order to do the same, existing over head tank, Jewel filters, Paterson filters and two other clear water reservoirs

will be removed.

- In order to effectively utilize the site area, a high-rate settler module will be employed for sedimentation basin to be constructed in this Project.

Refer previous Fig. 3-9 for the location plan.

Case-2

- Aiming at saving the implementation cost, the sedimentation basin shall be designed to be of a conventional type.

- In order to effectively construct clear water reservoir, a reservoir having a capacity of 2,300 m^3 shall be constructed at the site after removal of existing Jewel filters, Paterson filters and the clear water reservoir of 950 m^3. Another clear water reservoir of 500 m^3 will remain as it is.

3) Comparison of Alternatives

Table 3-6 shows the comparison of the alternatives by the factor.

Each alternative has its positive and negative aspects in the feature of the plan. As regards to operation and management, both the plan are suitable for the operators because basically the treatment processes are similar as it is. However, considering the treatment stability case-2 is advantageous, because case-1 employs a high-rate settler module.

As for the system control, in case-2 there may remain some problems to control/management of the distribution pump as because there is no service reservoir in the Chandnighat water supply system. From actual production capacity point of view, case-1 is more advantageous because this alternative plan keeps provision for water produced by the plant during night-time as mentioned earier. In other words, it may be said that the existing treatment system is not being able to produce water sufficiently, that is one of system loss.

As regards to required construction area, both case-1 and case-2 are

available for construction of the planned facilities in the projected site. For the construction cost case-1 is costlier for having the advantage of produced water volume.

Table 3-6 Comparison of Alternatives on Basic conception for Rehabilitation of W.T.P.

	Case 1	Case 2
1. Capacity of clear water reservoir / service reservoir	6,250 m^3	2,800 m^3
2. Detention time	3.8 hours	1.7 hours
3. Actual water production capacity	39,000 m^3/d x 20/24 + 6,250 m^3 x 0.8 = 37,500 m^3	39,000 m^3/d x 20/24 + 2,800 m^3 x 0.8 = 34,700 m^3
4. Operation & maintenance	a) Greater ability in system control of the water works because there is a service reservoir. b) Required additional attention for removal of sludge and cleaning of the basin due to installation of settler module. c) Required maintenance times of 1.5 compared with Case 2 for cleaning of the sedimentation basin.	a) Marginal ability for system control of the water works because there is no strage tank. b) Required the same maintenance as it is impractice. c) Less than Case 1 comparing the time for cleaning of the sedimentation basin.
5. Effective utilization of existing facilities	a) No effective utilization of existing facilities because two clear water reservoirs will be removed in this Project. b) However, effectively utilize the space of the site due to enable to design the service reservoir of greater depth (effective depth = 4.3 m) without any change to the water level of existing reservoirs.	a) Slightly effective because one clear water reservoir will be removed and the other reservoir (500 m^3) will be remained as it is. b) However, no effective utilization of the space of the site because the depth of the reservoir is affected by the water level of existing one in order to connect both reservoirs.
6. Implementation cost	100 %	93.5 %

4) Selection of Alternative Plan

On the basis of the study and comparison of components discussed above, Case 1 is recommended as the viable system of the treatment plant for the following reasons.

i) From the point of view of demand for water, a rehabilitation plan with allowable expansion of the production capacity should take precedence.

ii) In case of no service reservoir in a water supply system, the treatment plant always runs the risk for uncertain trouble in operation and management on the treated water quality and quantity because of limited allowance in operation.

(iii) Even though the construction cost of Case 1 higher than that of Case 2, the production unit cost for water which is the expense for chemical and power consumption shall be the same.

(3) Outline of Recommended Rehabilitation Plan for the Water Treatment Plant

As the results of examination of the contents of the request it is found that if DWASA's rehabilitation plan be changed only or few items, the rehabilitated plant may became a well balanced facilities and functions as the whole system.

Table 3-7 shows the comparison between outline of the requested rehabilitation plan and the recommended one.

Table 3-7 Comparison between outline of the Requested Rehabilitation Plan and Recommended Plan

Name of Facility	Requested Rehabilitation Plan by GOB	Recommended Plan ○ : Additional or Gread up to the Request ● : Curtail or Spec-down from the Request : Same / Similar to the Request
1. Water Intake Facility		
1) Water Intake Pump	- Not any	○ 3 pump units of P/S No.1 will be replaced.
		○ Operation switch panel for the pumps will be replaced.
2) Transmission Pipe	- Not any	○ Transmission pipe for P/S No. 1 and No. 2 will be installed. Existing one will remain as stand-by
2. Treatment Facility		
1) Flash Mixing	- To install a mixer	Corn type mixer will be installed.
2) Flocculator Basin	- To install flocculators	● Some modification will be done.
3) Sedimentation Basin	- To modified some part of inside structure of the existing basin	ditto
	- To install inclined plate in the existing sedimentation basin in order to strongthen the treatment capacity	○ New sedimentation basin with high rate settler module will be constructed.
4) Filter	- To construct newly to meet requirement of upgrading capacity for design flow	ditto
5) Clear Water Reservoir	- To construct additional capacity of 1,000 m^3	○ Service reservori will be constructed with a capacity equivalent to the detention time 3 to 4 hours.
6) Chemical Feeder	- To replace	ditto
3. Distribution Facility	- Not any	○ 3 pump units of P/S No.2 will be replaced.
		○ Operational switch panel for the pump will be replaced.
4. Substation for Treatment Plant	- To replace 800 kVA transformer into 1,000 kVA	● One electrical supply line has been installed from the sub-station inside the Plant to water intake P/S No. 1 for emergency purpose. As the frequency for emergency usage is few,it is no considered to use it in this Project.

		In case of shortage of capacity of the tranformer meeting reguirement of the rehabilitated Plant, 187 KVA will be provided from DWASA.
5. Drainage Pipe for Back Washing	- Not any	○ As the existing pipe is insufficient in size, it is neccesary to install larger pipe.
6. Flow Meter	- To install a electrical flow meter	● Weir type flow meter will be installed.
7. Sampling System	- To employ a sampling system using sampling pump	● Sampling by manually will be employed instead of sampling pump system.
8. Distribution Main Pump	- To install distribution main pipe for smooth connection into existing water supply network	ditto

With reference to the above, a Minutes of Discussion which was signed between DWASA and member of Basic Design Study team is shown in Appendix A-4.

In addition to the above, it was requested by DWASA that raw water intake point be removed toward more center of the river so that raw water may not be affected from environmental pollution.

Taking consideration of pollution of the river water by the waste discharged from industries and inhabitants living along side the river, the request of the above carried great importance, but the same can not be considered under this Project for the reasons described hereinafter.

- As shown in previous Table 3-5 and Appendix B-7, there is no problem, as of this time on the basis of collected materials including data analyzed in this study. Because harmful materials such as chrome, cyanogen and mercury are more or less for specification of water quality standard of WHO.

- Since the Buriganga river is one of the main channel for internal water transports, it is necessary to receive an approval or permission from the authorities concerned in order to change the location

of water intake facility. But, till now no discussion or meeting is held with the authorities concerned on the subject.

However, it is recommended that a monitoring and observation system to sum up the pollution of the river water be established by DWASA, so that a fruitful discussion with authorities concerned can be held under a leadership of DWASA in future.

(4) Improvement of Water Supply Condition in the Water Works Service Area

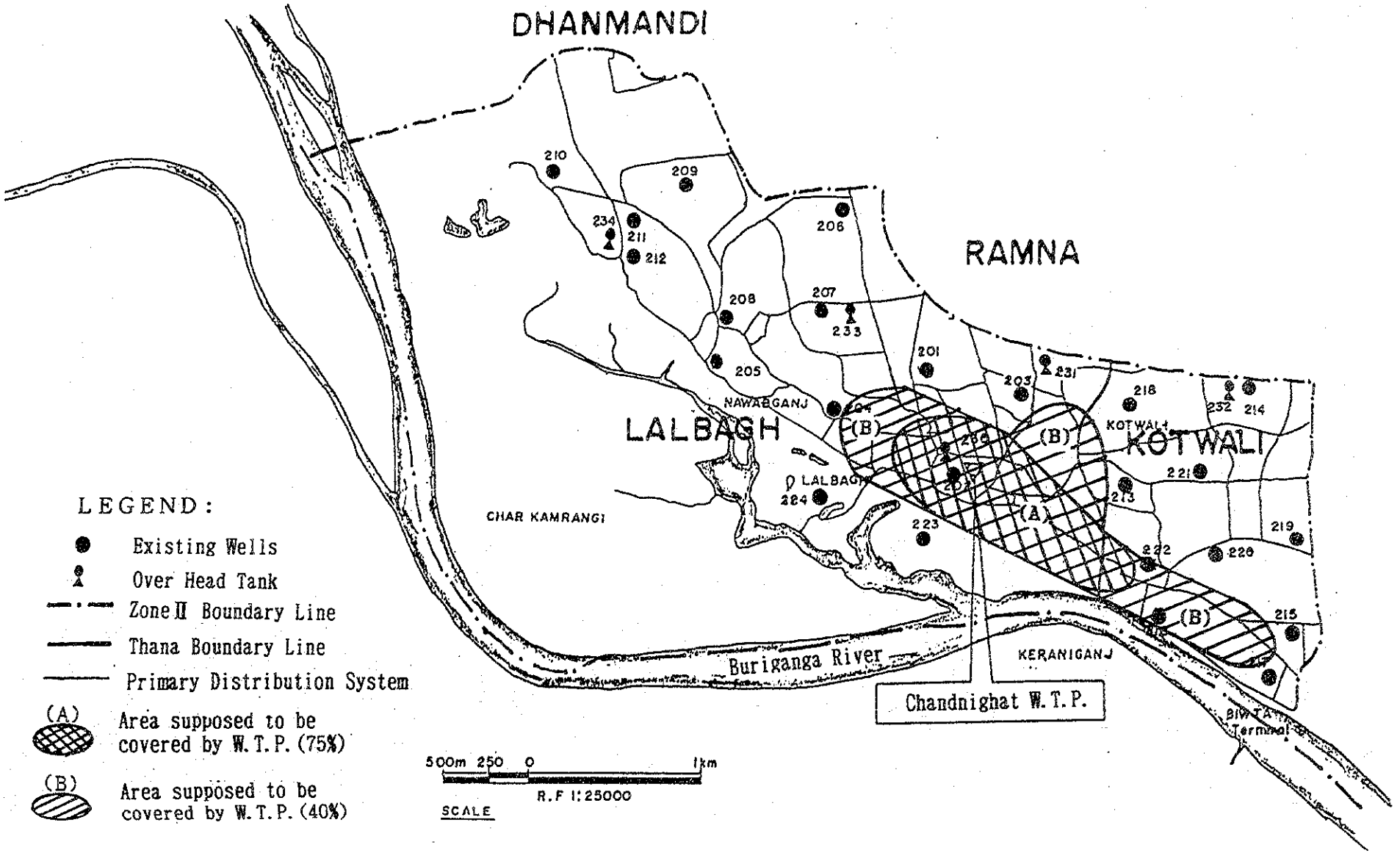
1) Study of the Present Service Area under the Water Works

As mentioned eariler, it is very hard to identify the boundary of area which are being covered by the Chandnighat water works for water supply service. Because the distribution network is a complexe mechanism of pipes in most of the areas which has been connected in most unplanned manner.

Under the circumstances, the study team assumed the responsibility to examine the area covered under the water works on the basis of the up-dated drawings of distribution system and information from DWASA's engineers, as well as from the result of questionnair survey that was carried out during the field survey in the study. The results of the examination are shown in Fig. 3-10.

(A)-area in the Fig. 3-10 is an area where 75 % of total consumption of water is supposed to be supplied from the Chandnighat water works, and remainder 25 % is from the deep tubewells. While (B)-area is an area where 40 % of total consumption of water is supposed to be supplied from the water works, and remainder 60 % is from the deep tubewells.

Fig. 3-10 Water Supply Service Area
under Chandnighat Water Works(Present)



2) Present Population in the Service Area under the Water Works

The present population in the service area under the water works is assumed approx. 222,000 of which break down is shown in Table 3-8.

The said population status is assumed on the basis of the total population including census population and non-permanent population in Zone-II area estimated in the previous 2.3.3, and referred the Thana population in census for its break down. However, the population of Thana 51, Sultanganj U/C and a part of Thana 14 are excluded from calculation of above because of the following reasons.

- Thana 51 is located at delta which is in the junction point of the Buriganga river, and out-side the scope of DWASA water supply area at present.

- In the Thana 14, there is Bangladesh University of Engineer and Technology (BUET) on which approx. 10,000 persons are living in its dormitory and in the staff quaters of the institution concerned. Water consumed by the people within BUET area is supplied from a deep tubwell owned by University Authority, which is located in Zone VI where is outside of Zone II area.

Thana boundary is presented in Fig. 3-11.

3) Water Supply Quantity in the Service Area under the Water Works

As mentioned earlier, there are 24 No. of deep tubewells in Zone II. Among these some wells are supplying water to the government institution, colleges and hospital. Table 3-9 shows the breakdown of water supply in Zone II.

In the above table, there is indicated both production capacity of 109,000 m^3/d, which is original data collected in this study and supply quantity revised the same based on the official record of 95,360 m^3/d which is the average supply quantity for the last 10 months reported in the monthly management report of DWASA.

Table 3-8 Population Served by Chandnighat Water Works and Other Deep Tube Wells (Present)

Thana	Ward	Present Population (as of 1991) Total Population	(A) area covered by Chandnighat 75 %	(B) area covered by Chandnighat 40%	(A+B) area covered by Chandnighat	area covered by Deep Tubu wells only
KOTWARI	19	51,310	(20%) 10,260	(35%) 17,960	(55%) 28,220	(45%) 23,090
	20	77,320	(5%) 3,870	(40%) 23,200	(45%) 27,070	(55%) 50,250
	21	49,800	—	—	—	(100%) 49,800
	22	26,300	—	—	—	(100%) 26,370
	23	35,910	—	(40%) 14,360	(40%) 14,360	(60%) 21,550
	24	32,990	—	(80%) 26,390	(80%) 26,390	(20%) 6,600
Sub - Total		273,700	(5%) 14,130	(30%) 81,910	(35%) 96,040	(65%) 177,660
LALBAGH	10	64,900	—	—	—	(100%) 64,900
	11	9,800	—	—	—	(100%) 9,800
	12	80,230	—	(20%) 16,050	(20%) 16,050	(80%) 64,180
	13	67,260	—	(10%) 6,730	(10%) 6,730	(90%) 60,530
	14	4,990	—	(40%) 2,000	(40%) 2,000	(60%) 2,990
	15	31,770	(10%) 3,180	(20%) 6,350	(30%) 9,530	(70%) 22,240
	16	62,090	(60%) 37,250	(20%) 12,420	(80%) 49,670	(20%) 12,420
	17	27,440	(85%) 23,320	—	(85%) 23,320	(15%) 4,120
	18	20,820	(60%) 12,490	(30%) 6,250	(90%) 18,740	(10%) 2,080
	(51)	(75,630)	—	—	—	(75,630)
	(14)	(10,000)	—	—	—	(10,000)
Sub - Total (Sub - Total)		369,300 (454,930)	(31%) 76,240 —	(13%) 49,800 —	(34%) 126,040 —	(66%) 243,260 —
Grand - Total (Grand - Total)		643,000 (728,630)	(14%) 90,370 —	(21%) 131,710 —	(35%) 222,080 —	(65%) 420,920 —

THANA & WARD IN DWASA ZONE-II AREA

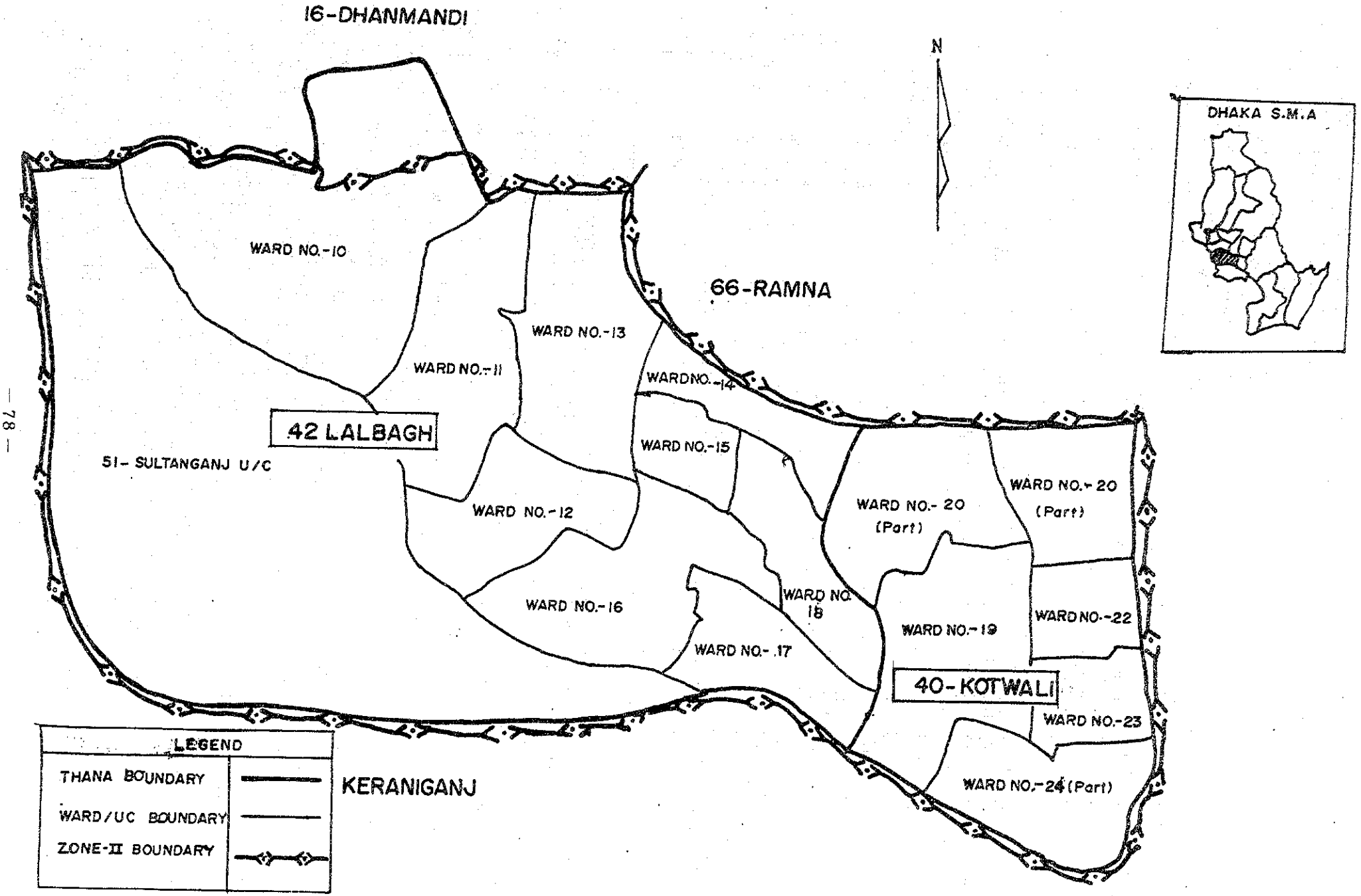


Table 3-9 Water Supply Quantity of Wells in Zone II by Porposes

Well No.	LOCATION	Production Quantity (m³/day)	Supply Quantity (m³/day)			Remarks
			Total	Special Supply	Town Supply	
201	DHAKESWARI	2,900	2,520	—	2,520	
202	DHAKA WATER WORKS	6,050	5,260	1,580	3,680	30% supply to filter back washing
203	BAKSHEBAZAR	2,880	2,510	—	2,510	
204	RAHAMATULLAH	2,510	2,180	—	2,180	
205	NAWABGANJ	3,600	3,130	—	3,130	
206	AZIMPUR (No. 6)	3,360	2,920	—	2,920	
207	AZIMPUR (No. 7)	5,280	4,590	—	4,590	
208	PEELKHANA (No. 2)	7,450	6,480	6,480	—	100 % supply to B.D.R
209	PEELKHANA (No. 3)	7,530	6,550	3,270	3,280	50% supply to B.D.R
210	HAZARIBAG (No. 3)	5,040	4,380	—	4,380	
211	HAZARIBAG (No. 6)	5,130	4,460	—	4,460	
212	HAZARIBAG (No. 5)	5,020	4,370	—	4,370	
213	ABUL HASNAT RD	2,880	2,510	—	2,510	
214	FULBARIA	5,520	4,800	—	4,800	
215	JAGANNATH COLLEGE	4,080	3,550	1,070	2,480	30% supply to J.N.C
216	MITFORD HOSPITAL	4,200	3,650	2,560	1,090	70% supply to Mitford, Hospital
217	SIMSON ROAD	4,680	4,070	—	4,070	
218	AGAMAHSHI LANE	5,280	4,590	—	4,590	
219	DHOLAI KHAL (NOWABPUR)	5,020	4,370	—	4,370	
220	S. D. PARK	4,680	4,070	—	4,070	
221	BANGLADESH MATH	3,360	2,920	—	2,920	
222	ARMANITOLA	4,490	3,910	—	3,910	
223	ISLAMBAGH	3,760	3,270	—	3,270	
224	RAJNARAYAN DAS RD	4,900	4,300	—	4,300	
Total		<109,600 >	95,360	14,960	80,400	

Note:— B. D. R. Represents Bangladesh defence services.
— J. N. C. Jagannath College
— D. M. C. (Dhaka Medical College) hostel is supplied by Zone-VI.
— BUET (Bangladesh University of Engr. & Tech.) has its own deep tubewell.
— Central Jail, Dhaka has not been included in this table.

The water supply quantity from each water source inside the water works service area is assumed to be 33,400 m^3/d taking account of location of the wells, the distribution network and Thana boundary. The break down of the supply quantity is shown in the table below.

Table 3-10 Estimation of Supply Quantity into the Water Works Service Area

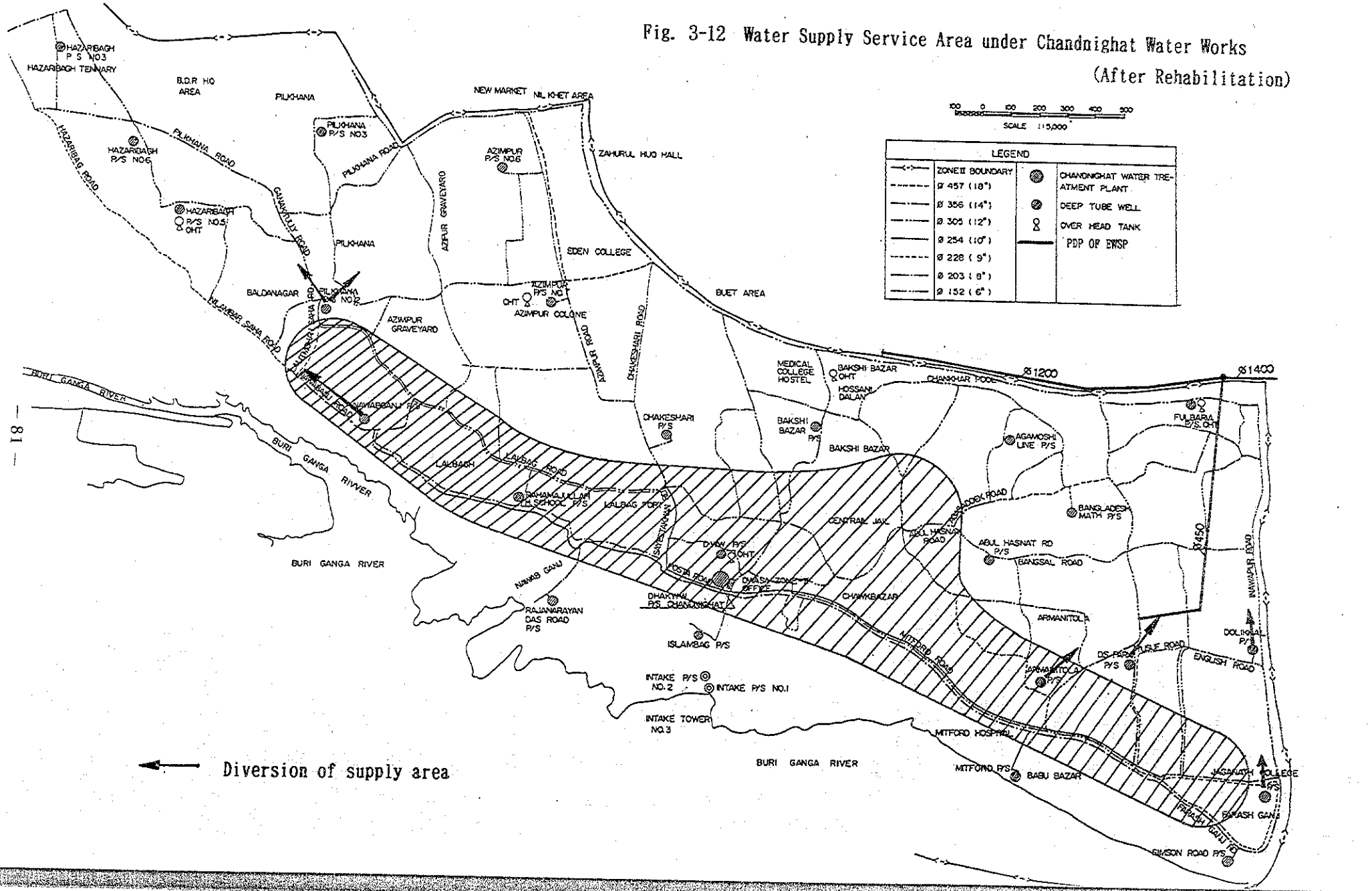
Name of Water Source	Supply Quantity	Supply Ratio into Water Works Service Area	Supply Quantity into Water Works Service Area
Chandnighat Plant	15,730 m^3/d	100 %	15,730 m^3/d
No. 201	2,520	20	500
202	3,680	100	3,680
203	2,510	30	750
204	2,180	30	650
213	2,510	30	750
215	2,480	60	1,500
216	1,090	80	900
217	4,070	70	2,940
218	4,590	20	900
220	4,070	30	1,200
222	3,910	40	1,600
223	3,270	70	2,300
Total			33,400

4) Study of the Projected Service Area under the Water Works

After completion of this Project, the supply capacity of the Chandnighat water works will increase from 15,730 m^3/d to 37,000 m^3/d which is assumed operational allowance of 5 % against the production capacity of 39,000 m^3/d. With this expansion of the capacity, the water shortage in the areas of (2), (3) and (4) showing in the previous Fig. 2-6 will be relieved, and moreover the service area shall well appropriate for expansion.

The projected service area of the water works is illustrated in Fig. 3-12.

Fig. 3-12 Water Supply Service Area under Chandnighat Water Works
(After Rehabilitation)



Upon installation of the control valves for deep tubewells of No. 205, Nawabganj, No. 208, Peelkhana No. 2, No.215, Jagannath College, No. 220, S.D. Park, No. 222, Armanitola toward arrow mark showing in Fig. 3-12 above, another water shortage areas of (1), (5) and (6), namely Hazaribag, Peelkhana and Siddig Bazar will also be relived from the problem of shortage of water.

The population in the projected service area of the water works is estimated to increase from approx. 222,000 to approx. 268,000 as shown in Table 3-11.

5) Water Supply Quantity in the Projected Service Area under the Water Works

Depending upon the calculation for estimation of supply quantity in the present service area under the water works, the supply quantity for the projected service area under the water works is assumed to be 51,500 m^3/d as shown in the Table 3-12.

Table 3-11 Population Served by Chandnighat Water Works and Other Deep Tube Wells(After Rehabilitation)

Thana	Ward	Population After Rehabilitation				Population before rehabilitation covered by Chandnighat
		Total Population	Expanded area to be covered Chandnighat	Water supply area covered by Chandnighat	Area covered by Deep Tubewells only	
KOTWARI	19	51,310		(55%) 28,220	(45%) 23,090	(55%) 28,220
	20	77,320		(45%) 27,070	(55%) 50,250	(45%) 27,070
	21	49,800		——	(100%) 49,800	——
	22	26,370		——	(100%) 26,370	——
	23	35,910		(40%) 14,360	(60%) 21,550	(40%) 14,360
	24	32,990		(80%) 26,390	(20%) 6,600	(80%) 26,390
Sub - Total		273,700		(35%) 96,040	(65%) 177,660	(35%) 96,040
LALBAGH	10	64,900		——	(100%) 64,900	——
	11	9,800	(40%) 3,920	(40%) 3,920	(60%) 5,880	——
	12	80,230	(40%) 32,090	(60%) 48,140	(40%) 32,090	(20%) 16,050
	13	67,260	(15%) 10,090	(25%) 16,820	(75%) 50,440	(10%) 6,730
	14	4.990		(40%) 2,000	(60%) 2,990	(40%) 2,000
	15	31,770		(30%) 9,530	(70%) 22,240	(30%) 9,530
	16	62,090		(80%) 49,670	(20%) 12,420	(80%) 49,670
	17	27,440		(85%) 23,320	(15%) 4,120	(85%) 23,320
	18	20,820		(90%) 18,740	(10%) 2,080	(90%) 18,740
	(51)	(75,630)		——	(75,630)	——
	(14)	(10,000)		——	(10,000)	——
Sub - Total (Sub - Total)		369,300 (454,930)	(12%) 46,100	(46%) 172,140	(54%) 197,160	(34%) 126,040
Grand - Total (Grand - Total)		643,000 (728,600)		(42%) 268,180	(58%) 374,820	(35%) 222,080

Table 3-12 Estimation of Supply Quantity
in the Projected Service Area under the Water Works

Name of Water Source	Supply Quantity	Supply Ratio into Water Works Service Area	Supply Quantity into Water Works Service Area
Chandnighat Plant	37,000 m^3/d	100 %	37,000 m^3/d
No. 202	3,680	100	3,680
204	2,180	100	2,180
205	3,130	50	1,570
215	2,480	40	1,000
216	1,090	50	550
217	4,070	60	2,580
222	3,910	40	1,200
223	3,270	50	1,830
Total			51,500

6) Effectiveness of Improved of the Water Supply Status

The following is a description on the effectiveness of improved water supply status in Zone-II when this Project is executed, depending upon the result of above study on the population and supply quantity for the projected service area under the water works.

The result of the study is summarized as shown in Table 3-13 hereinafter, which contains the table on population, supply quantity and water demand in the both service areas, that is the water works and other deep tubewells installations, before and after the rehabilitation works under this Project.

As regards demand for water in the above table, daily demand for water per capita is to be estimated based on an average calcultion by weight of permanent population times its daily water consumption and non-permanent population times its daily water consumption, for instant 194 l/c•d for Kotwali and 226 l/c•d for Lalbagh, which includes leakage water loss of 35 %. Regarding this figures refer to the previous 2.3.3 (Demand for water).

Table 3-13 Improvement of water Supply Status through Execution of this Project

	Item	Present Water Supply Status	Water Supply Status After Project
Service Area under Water Works	1. Population in Zone II	222,080 pers.	268,180 pers.
	a) Katwali area	96,040	96,040
	b) Lalbagh area	126,040	172,140
	2. Water Supply Quantity in Zone II	33,400 m^3/d	51,500 m^3/d
	3. Demand for water in Zone II	47,120 m^3/d	57,530 m^3/d
	a) Katwali area (19711/c.d)	18,630	18,630
	b) Lalbagh area (22611/c.d)	28,490	38,900
	4. Insufficient Ratio	29 %	10 %
Service Area under Deep Tubewells	1. Population in Zone II	420,920 pers.	374,800 pers.
	a) Katwali area	177,660	177,660
	b) Lalbagh area	243,260	197,160
	2. Water Supply Quantity in Zone II	62,730 m^3/d	65,900 m^3/d
	3. Demand for water in Zone II	89,440 m^3/d	79,030 m^3/d
	a) Katwali area (19711/c.d)	34,470	34,470
	b) Lalbagh area (22611/c.d)	54,970	44,560
	4. Insufficient Ratio	30 %	17%
Zone II Area	1. Population in Zone II	643,000 pers.	643,000 pers.
	2. Water Supply Quantity in Zone II	96,130 m^3/d (21.1 MGD)	117,400 m^3/d (25.8 MGD)
	3. Demand for water in Zone II	136,560 m^3/d (30.0 MGD)	136,560 m^3/d (30.0 MGD)
	4. Insufficient Ratio	30%	14%

As it can be seen in the table above, the insufficient rate for water supply in the service area under the water works is assumed to be 29% at present and expected to improve up to 10 % after execution of the Project.

Also in the other service area under the deep tubewells, it is expected for improvement of the insufficient water rate from 30 % at present up to 17 % after completion this Project.

The above study on improvement of the water supply status is based on the estimation provided that the present water leakage ratio of 35 % will remain unchanged even after the Project. Apparently, it is to be assumed that higher the water supply pressure after the Project is larger the leakage ratio. Hence it is necessary to propel a certain measure towards leakage detection control simultaneously with this Project. In this regard, the importance of improvement of the leakage control activities will be discussed in Chapter 5 in this report.

(5) Outline of Recommended Rehabilitation for Distribution

As the results of the examination mentioned above, it is confirmed that the projected service area under the water works and the improvement of water supply status in the area are to be appropriated.

With these circumstances, the basic policy of the rehabilitation plan for the distribution main is to be as follows:

1) Supply Area

(i) This rehabilitation plan aims to expand the water supply service area covered under the Chandnighat water works, thereby the areas of (2), (3) and (4) shown in the previous Fig. 2-6 will overcome the trouble of water shortage. The water supply area will be covered under the rehabilitated water works is assumed as shown in Fig. 3-13.

(ii) The area of (1), (5) and (6) in Fig. 2-6 mentioned earlier will be relived the said trouble, provided that the main water supply area of Nawabganj (well No. 205), Peelkhana No. 2 (well No. 208), Jagannath College (well No. 215), S. D. Park (well No. 220) and Armanitola (well No. 222) be changed toward the arrow mark shown in the figure above.

2) Piping

The pipe which is designed for the rehabilitation plan will be selected on the basis of the suitability of the material, strength of the pipe

and proper to execution in the site.

3) Diameter

The distribution pipe which will be installed under the Project is categorized as distribution main. The diameter of the pipe will be designed by an apprehensive size as to maintain appropriate velocity of water and hydraulic grade, taking consideration of future modification of distribution plan with relation to EWSP. Therefore, the pipe is designed to be of the same size from the upstream to downstream of the water supply.

4) Connection to Existing Pipeline

The distribution main will be connected with a valve at the key point of the existing pipe network so that the water supply service may be expanded towards more wide areas equally.

The existing main pipe such as rising supply pipe and town supply pipe will be used as second main in terms of demotion to a lower rank, considering their utility.

A result of an excavation test which was carried out during the field survey for confirmation of materials and conditions of the existing distribution pipes as well as confirmation of buried materials under the road along the planned main pipeline route is summarized as follows:

- Material of Pipe :Ductile cast iron pipe (more than ϕ 300 mm in diameter) Cast iron pipe, GP pipe, Asbestos - cement pipe, PVC

- Location of pipe :Distribution pipe is installed at the center of road as a regulation but additional pipe line is installed irregularly depending on the space due to being existing sewer and gas pipe, etc.

- Depth : 0.8 m to 1.2 m in covering

The result of the excavation test is presented in Appendix B-7.

(6) Cooperation of the Community

Since the Project area is in the downtown of the old Dhaka, the roads are narrow in width and winding. However, street vendors are occupying at the both side of the road as a place to earn their living.

The execution of the rehabilitation works for the piping shall be implemented along these road for approx. 4 km. Therefore, the Project can not be expected to perform smoothly on schedule without proper understanding and cooperation from the people who are living in the project area. Question for creating such understanding has been discussed and confirmed by the both Bangladesh and Japanese side at JICA Preliminary Study stage. Accordingly Bangladesh side agreed that the Basic Design Study would be excuted through providing full cooperation from the people living in the concerned area.

In response to this, DWASA had a series of discussion with the local residents and held meeting with the representatives of the people and concerned municipal authorities in March, 1992. After confirmation and assurance of their cooperation DWASA informed on the subject to the Government of Japan. The Minutes of Meeting on this matter are enclosed in Appendix A-3 for reference.

The execution of the excavation test which was carried out by the Basic Design Study team, in order to confirm the status of existing distribution pipes, was implemented smoothly on schedule without any trouble.

3.2.6 Necessity of Technical Cooperation

The Project is going to be implemented in order to expand and improve the existing facilities of the Chandnighat Water Treatment Plant. The Project is not aimed at making dramatic changes in the function of the water works.

As the Plant has been operated since 1874, it is observed that DWASA has enough experience for operation and maintenance of the Water Treatment Plant. Therefore, there is no request on the technical cooperation.

But, in this connection, we would like to point out the following, which is recommended for further discussion.

In order to operate a water treatment plant as per design conditions, an appropriate chemical dosing is essential to formulate a stable flocs. It is to be noted that there are no management system in the Plant for water quality control including chemical dosing and water quality analysis. After completion of the rehabilitation, it will be necessary and imperative for establishment of a good management system to undertake the water quality control in the Plant in view of proper operation of the rehabilitated facilities.

This Project shall be implemented keeping the water works in operation as it is in practice to supply water to the consumer. Therefore, the execution schedule has been placed carefully and in three stages which is summarized as follows:

Stage 1 : Construction of sedimentation basin, filter and chlorination & clear water basin and chemical dosing facility.
After completion of the above works, water supply will be started using the newly constructed facilities.

Stage 2 : Removal of existing filter and clear water reservoir etc.

Stage 3 : Construction of service reservoir at the site after removal of the existing facilities mentioned above, thereby overall test run will be carried out towards completion of the

Project.

The period between completion of the stage 1 and completion of the stage 3 is scheduled for about one year. During this period training for technology transfer will be carried out, as on the job training. Therefore, it is considered that no technical cooperation for operation of the Plant is required in this Project.

Measurement of leakage control is very much important for this Project because water leakage is assumed to increase than the existing level due to increase of water supply pressure inside of the distribution pipes after rehabilitation of the water supply system under execution of this Project.

As for the measurement of leakage control, however, DWASA has commenced to carry out LDC Programme under an assistance of World Bank. Therefore, it is also not necessary for technical assistance in this Project.

3.2.7 Basic Conception for Execution of the Project

As a result of examination of the contents of the request, the basic conception for execution is summarized as below:

- Objective of the Project

  The Project aims to rehabilitate and expand the existing water treatment plant so that the water shortage in the area of MODS Zone II may be relieved off.

- Expected result from the Project

  Through execution of the Project the treatment capacity of the Plant will be strengthened from the 17,000 m^3/d (3.7 MGD) up to 39,000 m^3/d (8.6 MGD).

  Also, depending on the execution of the Project the existing water supply insufficient rate of 29 % is expected to come down to 10 % in the area which is covered by the Chandnighat water works and

from 30 % to 14 % in the whole area of Zone II.

- Capability of execution of the Project

The Project is to attend rehabilitation of the existing facilities and not aimed at any change of the existing system. Therefore, it may occur that there will be slight change to the financial and personnel plan for the operation and maintenance of the Chandnighat water works. The production unit cost will remain almost the same. Therefore, increase of operation and maintenance cost may be covered by the water supply rate. However, attention should be given to increasing of chemical expense in order to operate the Plant as per design condition for which an appropriate chemical dosing would be required so that treated water quality may be improved.

As mentioned above, it has been judged appropriate to implement the Project in the form of grant aid assistance from the Government of Japan though there is something for DWASA to improve its management. Accordingly, the Basic Design is followed hereinafter on the premise that the Project will be implemented under the Grant Aid Assistance from Japan.

However, it is considered reasonable to modify part of the contents of the request as stated earlier and accommodate the components as much as possible within the budgeted allocation.

3.3 Project Description

3.3.1 Executing Agency

DWASA operates under the directive of Ministry of Local Government, Rural Development and Cooperatives (LGRD) and is responsible for the execution of the Project.

DWASA has also managed the Narayanganj Narshindi water works which was constructed under the Grant Aid Assistance from the Government of Japan in 1988.

3.3.2 Location and Condition of Project Site

(1) Location

Fig. 3-13 shows the location of the Project site.

The location map includes the Chandnighat Water Treatment Plant, its water intake pump station and part of the deep tubewells as well as proposed storage site for contruction equipment and materials.

(2) Infrastructure of the Surrounding Area

1) Electricity

The electric power source in the Project area is provided from Lalbagh Substation (Islam Bagh Substation) under Lalbagh Thana which is controlled by Dhaka Electric Supply Authority (DESA) and operate under the directive of Bangladesh Power Development Board (BPDB).

Lalbagh Substation has a power source of 3ϕ - 50 Hz - 10/14 MVA - 33/11 kV x 3 units which has been used to work under the load ratio tap-changing transformer, but operate under the fix tap transformer at present.

An 11 kV under ground power line runs along the road from which a service line has been connected into the existing substations inside the Plant and water intake pump station. An 415 - 240 V overhead power line runs along the road.

Low voltage power failure takes place occasionally during a month, but 11 kV power failure is few.

2) City Gas

Natural gas is in use for household cooking and other by the inhabitants in the Project area, supply of which is made through underground pipeline and its popularization is more than 90 %.

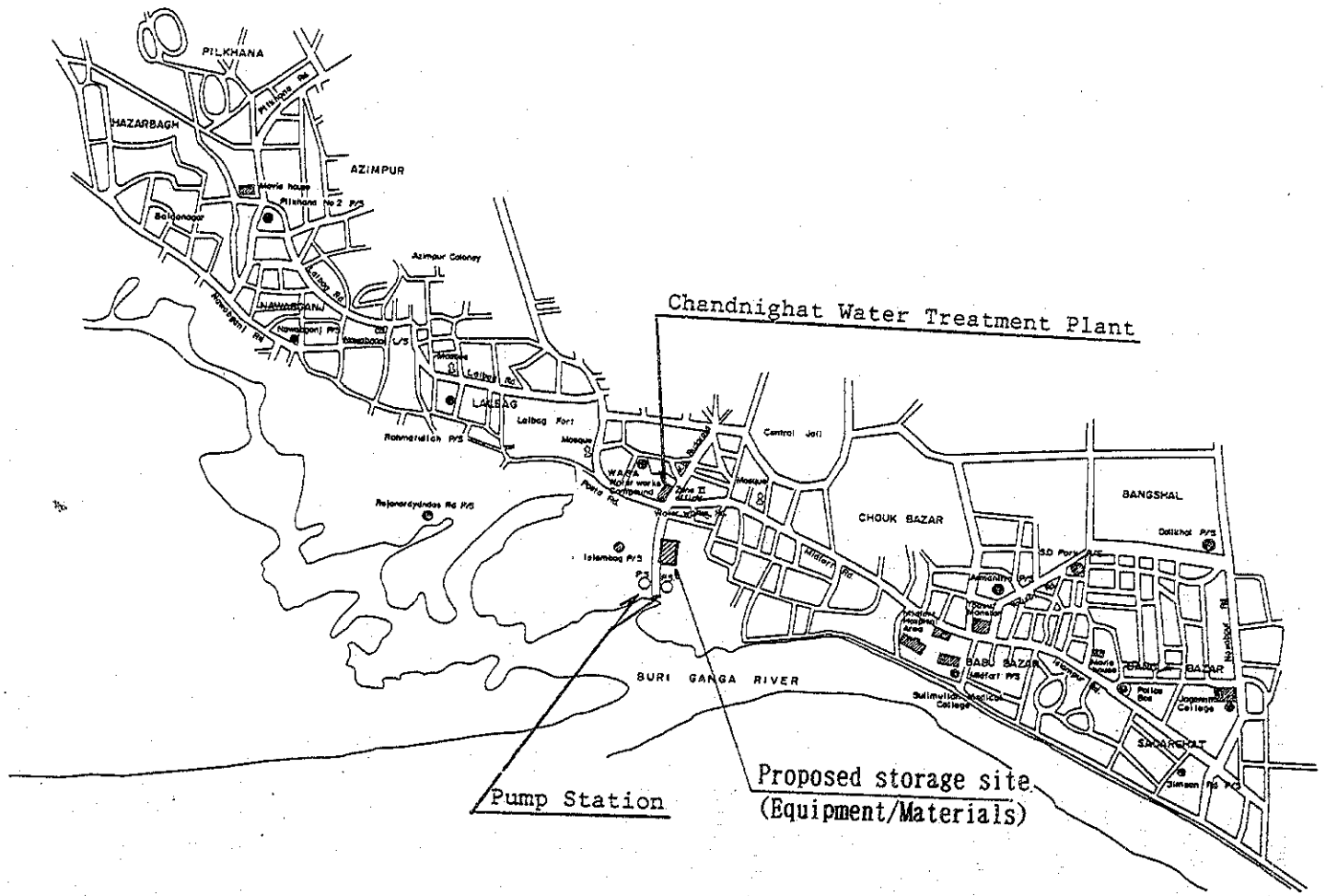


Fig. 3-13 Location of Project Site

3) Telephone Communication

Present status of telephone communication in most places of old Dhaka city including Project area is complicated due to overload and ageold system, however, MODS Zone II office has connected one telephone line in April 1992.

3.3.3 Operation and Maintenance Plan

(1) Management System

From the organization of DWASA, MODS CIRCLE Zone II will be the in charge of execution of the Project. Management set up of the same is shown in previous Fig. 3-3. (Refer to page 43)

(2) Personnel Plan

The personnel to be engaged for operation of the Chandnighat Water Treatment Plant is proposed as shown in Fig. 3-14. (See page 95).

It is to recommend that one assistant engineer together with some operators be assigned for water quality management. The engineer should be trained on the technical work for water treatment plant at Narayanganj Water Treatment Plant before shifting to his job at Chandnighat Water Treatment Plant.

(3) Budget Plan

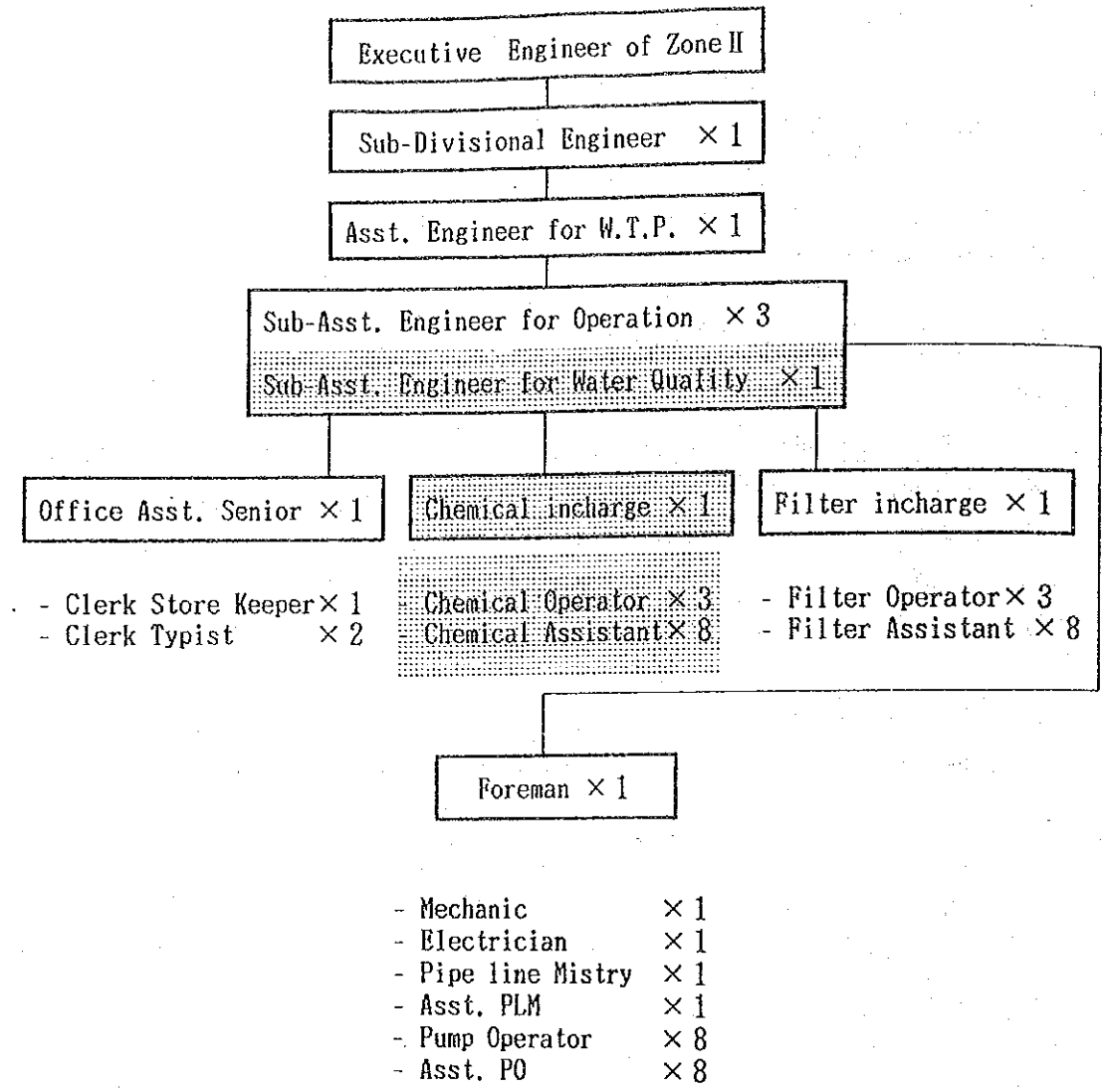
The budget to be engaged for implementation of the Project and operation and maintenance of the rehabilitated Chandnighat Water Treatment Plant is summed up as follows:

1) For Before and During Execution of the Project

a) Removal of a quater for DWASA personnel which is situated inside Chandnighat Plant.

b) Water supply service to consumer by tank lorry for 30 days. (2

Fig. 3-14 Organization Plan for Chandnighat W.T.P.



Note : Newly organized

days x 15 times)

c) Repair of leakage of water from distribution pipe. (to propel leakage Detection Control Programme)

d) Flushing work for cleaning of distribution pipe after exchange of connection of supply pipe.

e) Reinforcement of water quality analysis system at DWASA laboratory.

f) Customs duties on imported equipment and materials.

The above be estimated by DWASA to make budget plan, according to neccesity refering succeeding Table 4-11, inicial expense for implementation of the Project.

2) For After Completion of the Project

a) Personnel salary

Personnel, at least 13 persons, be engaged for operation of the Water Treatment Plant. If reinforcement of man power for operation and maintenance of the distribution pipeline as well as water quality analysis in the laboratory, additional personnel be considered for employment.

b) Operation cost

Expendable supplies for operation of the Water Treatment Plant is presented in Table 3-14 compared with the present status.

c) Maintenance cost

As for maintenance cost, the following be considered taking well operation and maintenance into account:

- Periodical repair and maintenance of mechanical and electrical facilities and equipment; to appropriate 1 %/year out of ini-

Table 3-14 Operation Cost

Name of Facility	Existing Assumption	After Expansion
1. Power Consumption	Capacity (kW) x Unit x Hour/D (H/D) = Consumption (kW H/D)	Capacity (kW) x Unit x Hour/D (H/D) = Consumption (kW H/D)
(1) Water Intake		
a) No. 1 Pump	41 x 2 x 18 = 1,476	45 x 2 x 24 = 2,160
b) Discharge pump		0.75x 1 x 1 = 1
c) No. 2 pump	41 x 1 x 3 = 126	41 x 2 x 24 = 1,968
d) discharge pump		0.75x 1 x 1 = 1
(2) Treatment Plant		
a) Sedimentation		
- Sludge pump		5.5 x 4 x 1 = 22
- Discharge pump		0.75x 1 x 1 = 1
b) Lift pump		45 x 2 x 24 = 2,160
c) Filtration		
- Back washing	55 x 1 x 10 = 550	
- Surface washing		45 x 1 x 1.5 = 68
d) Distribution pump		
- No. 1 pump	81 x 2 x 18.5 = 2,997	81 x 2 x 20 = 3,240
- No. 2 pump		90 x 2 x 20 = 3,600
e) Alum feeding		
- mixer		2.2 x 1 x 24 = 53
- Feeder		0.4 x 1 x 24 = 10
f) Chlorination	2.2 x 1 x 19 = 42	2.2 x 1 x 20 = 44
g) Deep well pump	55 x 1 x 6 = 330	
		Total 13,816
(3) Others	29	72
	Total 5,550	Total 13,400
	5,550 kWH/d x 0.8 x 365 D/Y	13,400 kWH/D x 0.8 x 365 D/Y
	x @2.45 TK/kWH = TK 4.0 Mill/Year	x @2.45 TK/kWH = TK 9.6 Mill/Year
2. Chemical Consumption	Dosage (kg/D) x Period (day/year) = Consumption (kg/year)	Dosage (kg/D) x Period (day/year) = Consumption (kg/year)
(1) Alum		
1) Dry season	170 x 240 = 40,800	650 x 240 = 156,000
2) Rainy season	510 x 120 = 61,200	2,050 x 120 = 246,000
	Total 102,000	Total 402,000
	120,000 kg/Y x @11 TK/kg = TK 1.3 Mill/Year	402,000 kg/Y x @11 TK/kg = Tk 4.4 Mill/Year
(2) Chlorination		
1) Dry season	85 x 150 = 12,700	300 x 150 = 45,000
2) Rainy season	50 x 210 = 6,300	250 x 210 = 16,800
	Total 19,000	Total 61,800
	19,000 kg/Y x @25 TK/kg = TK 0.5 Mill/Year	61,800 kg/Y x @25 TK/kg = TK 1.5 Mill/Year

tial equipment cost for first 5 years and 2 %/year for after that.

- Sludge removal from sedimentation basins; 3 times/year for existing basins and 5 times/year for new constructed basins.
- Cleaning of each concrete basins; 1 time/year for flocculation and service reservoir.
- Other routine maintenance work

The operation and maintenance cost estimated in terms of the above, which be prepared by DWASA when the Project is executed, is presented in Table 4-12 in 4.4.6 (2) (Page 167).

CHAPTER 4 BASIC DESIGN

CHAPTER 4. BASIC DESIGN

4.1 Design Policies

In order to establish a rehabilitation plan for the existing Water Treatment Plant, natural and social conditions, construction and supply status, also characteristics of this plan must be taken into account.

(1) Natural Condition

Climate of Dhaka is typical subtropical monsoon and it has definit distinction of wet season (May to October) and dry season (November to April). Temperature rapidly rises from March, which is the end of dry season and it reaches the maximum during April and May and the rising temperature sometimes reaches far beyond 35 °c. During wet season, temperature begins to fall but variation in temperature prevails, at times hot humid days continues till late September. Temperature falls in the beginning of dry season and the minimum temperature appears on January.

Table 4-1 Climate of Dhaka (1989)

Month	Precipitation	Maximum Temperature	Minimum Temperature	Humidity
Jan.	—— (mm)	27.8 (°C)	6.8 (°C)	69 (%)
Feb.	32	32.6	11.6	64
Mar.	——	37.2	14.6	59
Apr.	85	38.4	20.6	68
May	228	39.4	21.8	78
Jun.	319	36.5	22.1	82
Jul.	347	34.1	24.4	84
Aug.	259	35.5	25.3	79
Sep.	305	35.3	24.4	85
Oct.	240	35.4	19.8	82
Nov.	0	33.4	15.6	74
Dec.	12	31.0	11.0	73
Total	1,827	—	—	—

Source: "1991 Statistical Yearbook of Bangladesh", Bangladesh Bureau of Statistics

Precipitations of wet season are estimated as 100 - 400 mm/month and during designing phase, intensity of rainfall should be considered.

(2) Socio - Economical Condition

Features of the economy of Bangladesh are:

- Limited natural resource
- Dependency on agriculture (nearly half of GDP, about three - fourth of labor and export).
- Structural red international payments
- Low domestic savings.
- Reliance on foreign assistance about 45% of the total budget expenditure for Central Government.

Considering the income level, implementation of the Project by using expensive facilities and equipment not seem to be realistic due to the costly construction fee and supply status of facilities part needed for operation and maintenance of the Plant. Therefore, on facility planning, simple structure with durability, low cost and easy operation should be given high priority. As concrete, automatic recorder which will require periodical check-up and repair by experts, should be avoided and equipment that needs consumable articles should be minimized.

(3) Construction Condition

Ability and efficiency of engineers and labors, which influenced by local circumstances, customs and climate should be fully examined. In procurement of construction materials, domestic materials should be given priority and to utilized as much as possible, as per Bangladesh Government directive.

Domestic laborer can be obtained easily. So, during the construction work man-power must be utilized fully and efficiently rather than construction machinery.

(4) Grade of Facility and Scope of Work

1) Grade of Facility

The purpose of this plan is for rehabilitation/expansion of existing facility. Since the plan aims at renewal of existing deteriorated

facilities and increase of the treatment capacity, grade of newly built facilities should be basically the same as existing ones.

However, existing chemical dozing procedures are also offen ignored, newly built facilities must be designed to enable simple/proper chemical dozing system.

2) Well-Balanced Plant Capacity

Well-balanced plant capacity is one of the main purpose of this plan. As mentioned in the previous chapter, intake and distribution pump has capacity of the about 10 MGD. On the other hand the capacity of sedimentation basin and filter are only 4 MGD. At this plan the capacity of sedimentation basin and filter will be increased and total capacity of the plant will also be developed.

Previously there existed 5 units of over-head tank within the distribution area of Chandnighat W.T.P., which have been maintained for clear water storage purpose but now some of them are either demolished or have been abandoned as mentioned earlier.

Consequently, changing some of the request, clear water reservoir with the capacity which big enough to produce/store the clear water during night time should be constructed and thereby ensure total stable operation of the Plant in question of water supply.

3) Scope of Work

Scope of work for this Project includes rehabilitation/expansion intake facility and Water Treatment Plant, which was requested by the Government of Bangladesh. Apart from these consolidation of distribution mains was additionally requested from DWASA made during the Preliminary Study period.

Regarding the plan requested by DWASA for extending the intake pipe toward to the middle of the river at the discussion meeting during Basic Design Study period should be eliminated from the scope of work considering its low necessity and complicated procedure to procure

permission/approval from the related authorities.

4.2 Examination on Basic Design Condition

4.2.1 Basic Design Condition

1) Design Water Supply Area

Design water supply area is within DWASA's MODS Zone II Area.

2) Design Flow Rate

This plan aims for rehabilitation and expansion of existing water supply facility. However, due to the limitation of space on the site, expansion of facility capable to cover the water demand of designed supply area is impossible. Therefore, the scale of expansion should be to that amount which is allowable within the existing site for construction of facilities to be expanded.

Design flow rates are:

a. Daily average flow rate Q= 39,000 m3/D

b. Design flow rate for the plant Q=41,000 m3/D (including the loss of sludge disposal at sedimentation tank and back washing at sand filter)

3) Water Source

Water source for this Plant is Buriganga river water, as used to be.

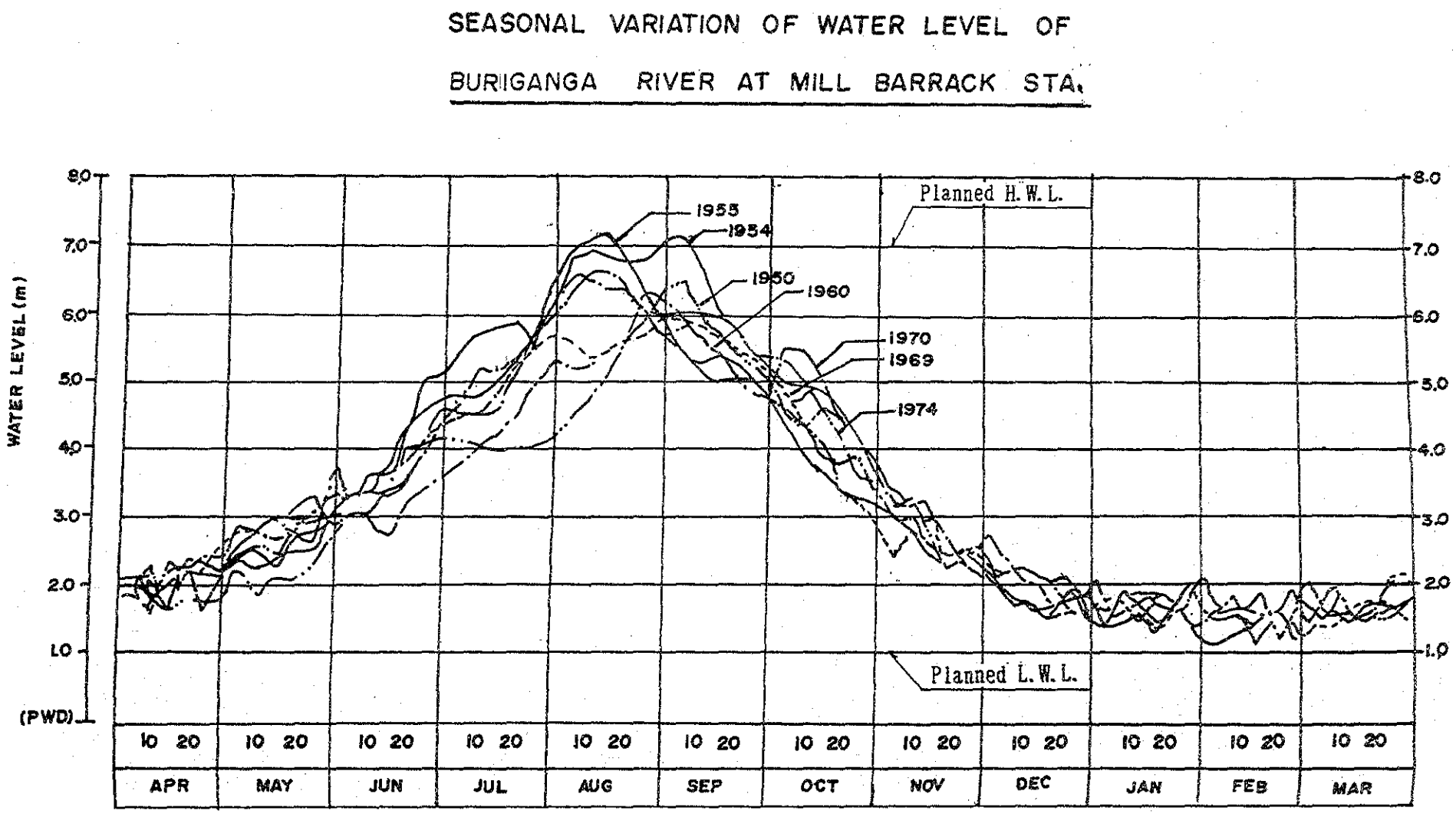
4) Hydraulic Profile

Intake pumping station is located outside of the embankment of Buriganga river and it is 600 m far from W.T.P. Existing ground elevation is + 9 m at lower part, + 11 m at higher part along sedimentation basin in the Plant site.

While there is a intense seasonal fluctuation in the river water level, it is + 1.0 m during dry season but in wet season it may rise up to + 7.0 m at maximum. However, during the flood occurred in 1988, which deemed to be the biggest one in recent years, the intake pumping station was not submerged, although surrounding areas were under the water at that time.

Fig. 4-1 shows seasonal variation of water level of Buriganga river.

Fig. 4-1 Variation of Water Level of Buriganga River



5) Raw Water Quality

Table below shows the result of water analysis performed during this Basic Design Study and data obtained .

Table 4-2 Raw Water Quality of Chandnighat W.T.P.

Date	4.23	4.29	5.19	6. 6	6.19	7. 3	8. 1	9.29	10.4	10.4
Turbidity	50.0	25.0	7.0	31.0	35.0	15.0	37.0	100.0	100.0	60.0
Color unit	—	—	32	—	—	—	—	15	15	15
pH	7.18	7.10	7.20	9.10	8.90	7.30	8.00	7.01	7.41	7.07
Alkalinity	168	144	—	50	35	50	50	—	—	—
NH4 - N	—	—	—	1.61	0.90	0.97	1.55	0.64	0.60	—
Cl	48.0	26.5	—	—	—	—	—	4.3	1.3	—
CN	—	—	—	—	—	—	—	<0.01	<0.01	<0.01
Hg	—	—	<0.0005	—	—	—	—	<0.0005	<0.0005	<0.0005
Cd	—	—	—	—	—	—	—	<0.005	<0.005	<0.005
As	—	—	—	—	—	—	—	<0.005	<0.005	<0.005
Pb	—	—	—	—	—	—	—	<0.02	<0.02	<0.02
Fe	0.93	0.61	0.40	—	—	—	—	3.3	—	3.4
Mn	0.0	0.0	0.03	—	—	—	—	0.05	—	0.06
Cr	0.0	0.0	<0.02	—	—	—	—	<0.02	0.0	<0.02
Cu	0.0	0.0	—	—	—	—	—	—	—	—
Coliform	4,000	1,600	—	194	120	80	100	—	—	—
Remarks	By Basic Design Study Team			From French Report (1989)				From data of the Request (1991)		

Note : Unit is mg/l excluding pH

Regarding turbidity, which is one of the most important water quality indexes for operation and management of water treatment plant, it was recorded below 30 and relatively low figure during dry season namely April and March but it gradually rises from June and by the beginning of wet season and during flood season it reaches to 100.

Among other water quality indexes, coliform and NH4-N indicate high figure during dry season and there is influence from urban waste discharge. Heavy metals excluding iron and harmful materials are within the WHO's standard.

With these data, design raw water quality is determined as follows:

pH..... 7.0 - 9.0

Turbidity..... 10 - 500 degree

Color..... 10 - 15 degree; excludes color affected by organic material and dye works.

Alkalinity..... 35 - 150 mg/l

6) Treated Water Quality Objective

Table 4-3 shows the result of water quality analysis of which samples were taken from the tap water within the Plant and existing data which were attached in the request. Excluding iron, other indexes are within WHO's standard guideline, however iron, which causes "red water", can be treated by pre-chlorination and sufficient turbidity removal. Thus, WHO standard, which is used as the guideline for national water quality standard in Bangladesh, is adopted as treated water quality objective for this plan.

Table 4-3 Treated Water Quality of Chandnighat W.T.P.

Date	92.4.23	92.4.29	92.5.19	91.10.2	91.10.4	WHO
Turbidity	<25	<25	<1	5	3	5
Color unit	—	—	15	—	—	15
pH	7.25	7.1	7.4	7.0	6.89	6.5-8.5
Alkalinity	152	160	—	—	—	—
NH4 - N	—	—	—	<0.4	0.75	—
Cl	40	56.5	—	—	1.6	250
CN	—	—	—	—	<0.01	0.1
Hg	—	—	—	—	<0.0005	0.001
Cd	—	—	—	—	<0.005	0.005
As	—	—	—	—	<0.05	0.05
Pb	—	—	—	—	<0.02	0.05
Fe	0.958	0.517	<0.05	—	0.16	0.3
Mn	0.0	0.0	<0.02	—	—	0.1
Cr	0.0	<0.02	<0.02	—	—	0.05
Cu	0.0	0.0	—	—	—	1.0
Coliform	0.0	0.0	—	—	—	0/100ml
Residual chlorine	—	—	—	0.2	—	—
Remarks	By Basic Design Study Team			From data of the Request		

Note : Unit is mg/l excluding pH, Turbidity and Color.

4.2.2 Design Criteria

(1) Water Treatment Plant

Rehabilitation plan for the existing Water Treatment Plant is established based on Japanese design criteria.

However, clear water service reservoir must be designed based on the water supply status of design area. From the view point of existing status of the Plant and purpose of this rehabilitation plan, detention period of the reservoir should be more than 4 hours preferably. But due to limitation of the site and construction cost, construction of deeper reservoir will be more costly also keeping relation to other components, depth of recervior should be planned less the 5.5 m.

Table 4-4 Design Criteria for Water Treatment Plant

Standard Value	Receiving Well	Rapid Mixer	Floccuration Basin	Chemical Sediment. Basin	Sediment. Basin with Plate Setrler	Rapid Sand Filter	Service Reservior
Retention period	>1.5min.	1-5min.	20-40min.	3-5hrs.	>60min. in plate 20-40min.	-	>8hrs.
Average flow velocity	-	1.5m/sec.	15-30cm	<48m/min.	<0.6m/min.	Max 150m/D Min 120m/D	-
Sand layer	-	-	-	-	-	60-70cm	-
Gravel layer	-	-	-	-	-	20-30cm	-
Backwashing flow rate	-	-	-	-	-	0.6-0.9m3/min.	-
Backwashing time	-	-	-	-	-	4-6min.	-
Surface washing flow rate	-	-	-	-	-	0.05-0.1m3/min.	-
Surface washing time	-	-	-	-	-	4-6min.	-

Source : Japanese design criteria for water treatment plant

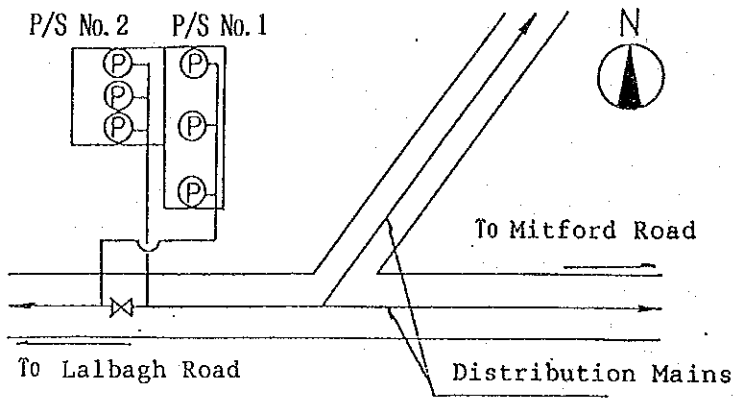
(2) Distribution Mains

1) Supply Area

Upon decision of supply area caused by the renewal and existing of distribution pump, the supply area should be separated depend on the renewal and exiting of the pump as follows (see the figure below):

(i) Water pumped from existing pump station No.1 will be supplied mainly to Lalbagh Road Area.

(ii) Water pumped from rehabilitated pump station No.2 will be supplied mainly to Mitford Road Area including North - East Area.



2) Pipe Type Selection

Considering the existing road status, ductile cast iron pipe K-type should be used because:

(a) Distribution main will be required long duration time.
(b) Heavy traffic
(c) Roads are narrow and many of them are also complecated with existing distribution lines.

3) Flow Velocity

General standard adopted of flow velocity is of a range of Max. 6.0 m/sec, Min. 0.3m/sec., however, taking pump head and pipe friction loss into account, economical flow velocity namely, 0.8 - 1.2 m/sec. is adopted.

4) Covering

Adopting DWASA standard, covering for distribution pipe is 1.2 m.
This figure is common among many countries.

5) General Condition upon Construction Work

a) Back filling must be done with sand.
b) Surplus soil should be free-disposed.
c) Road pavement reiteration should be implemented based on the concerned municipal office standard.

4.2.3 Construction Method and Period

(1) Construction Method

Normally local construction method be adopted, but regarding lift pumping well, sedimentation basin, filter and clear water service reservoir which will be constructed adjacently to existing sedimentation basin, sheathing work should be done with steel sheet pile which will be installed using non-vibration pile driver.

Since existing sedimentation basin was constructed in 1874 and walls are made by bricks applying its eroded structural strength and stability, external surcharge and impact must be avoided.

(2) Construction Period

The expansion work included in this Project is supposed to be implemented, maintaining the constant water supply by existing facilities in practice, and long term treatment suspension should not be allowed.

Therefore, the following 3 phases for work procedure are recommended.

i) Establishment of new water supply system utilizing new facilities that is lift pump facility sedimentation basin, filter together with chemical dozing facility and completion of change of piping inside of the Plant for water supply.

ii) Demolition and removal of existing filters and clear water reservoir.

iii) Construction of new service reservoir at the above mentioned removal site. After the piping work for distribution line total test operation will be carried out.

Under above conditions, construction work can't be finished within 1 year as described in Fig. 4-2. Consequently, implementation plan should be considered to be performed as contract authorization (acts incurring liabilities on the Treasury) accordance with condition of implementation period for Japanese Grant Aid Assistance.

4.3 Basic Plan

4.3.1 Plot Plan

Plot plan for the rehabilitation work of the Water Treatment Plant be examined for the maximum utilization of the site condition and taking the relationship between new and existing facilities into account, which should be systematic as the whole.

Since the work site is very narrow and limited, roads for construction and maintenance work after completion of the rehabilitation works also should be carefully designed to prevent the burden of additional site.

Installation route for distribution mains and junction points to existing lines should be designed with careful assuring of public roads.

4.3.2 Water Treatment Facilities Plan

In this clause, outline of proposed plan and design condition for each facilities, which is forementioned in previous clause, will be described.

(1) Outline of Proposed Plan

Name of the plant: Chandnighat Water Treatment Plant
Location: Dhaka city, DWASA MODS Zone II Area
Site area: 3.43 ha
Ground level: Existing ground level +9.4m to +11.4m
Design ground level +9.4m to +11.4m
Raw water: Burighanga river water
Water level L.W.L +1.3m
H.W.L. +7.3m

Water treatment method: Chemical coagulation, sedimentation and filtration method

Slude disposal method: River disposal
Distribution method: Pumping method

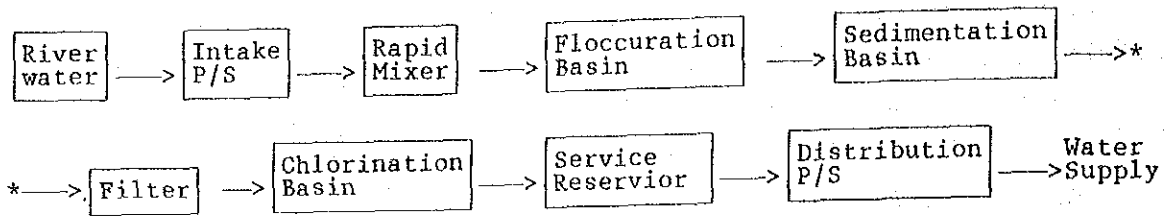
Design flow rate: Daily average treatment flow rate 39,000 m^3/d
Hourly maximum supply flow rate 44,000 m^3/d

Design water quality: as follows

Items	Raw water	Treated water (object)
pH	7.0 - 9.0	6.5 - 8.5
Turbidity	10 - 500	5
Color Unit	10 - 15*	15
Alkalinity	35 - 150	——
		(WHO standard)

Note : *Not include a color affected by organic material

(2) Treatment flow chart



(3) Outline of Rehabilitated Facilities

Comparing with utilization of existing facilities, planned facilities to be rehabilitated in this Project are summerized as shown in Table 4-5.

(4) Capacity and Design Condition of Major Facility

1) Intake pump

Intake pump No.1 should be renewed due to deterioration. Capacity of pumps should equal to the existing ones. Existing pumps are vortex vertical type (main shaft length is 5 m) and since there is no intermediate bearing, bearing strength is small. Upon renewal of pump, below mentioned 2 types of pump can be considered.

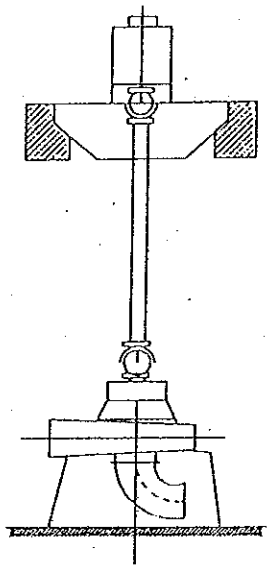
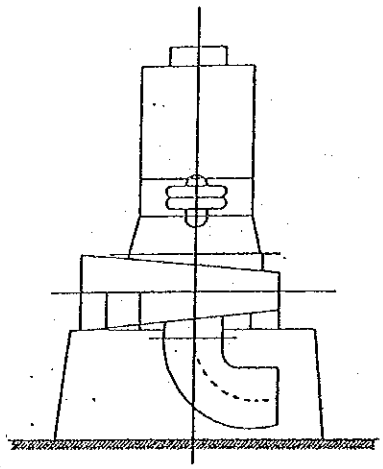
Table 4-5 Outline of Rehabilitated Facilities

Name of facility	Dimension × Units (spare)	Capacity	Renewal	Existing
Intake facility				
1. Intake pipe (No.1)	Φ400 mm x 2			○
(No.2)	Φ400 mm x 2			○
2. Intake pump (No.1)	Φ250 mm x 7.6 m³/min. x 20 m x 45 kW x 3 units (1 unit)		○	
- Discharge pump	Φ50 mm x 0.2 m³/min. x 8 m x 0.75 kW x 2 units (1 unit)		○	
- Control panel	Interior self-standing type x 1 unit	For Intake/discharge pump	○	
3. Intake pump (No.2)	Φ250 mm x 7.6 m³/min. x 19.5 m x 41 kW x 3 units (1 unit)			○
- Discharge Pump	Φ50 mm x 0.2 m³/min. x 8 m x 0.75 kW x 1 unit	w/ wall type control panel	○	
- Control Panel				○
4. Transmission Pipe	Φ700 mm x 445 m		○	
Water treatment facility				
1. Receiving well	12.3 m x 12.3 m x 12.3 mH x 1 unit		○	
- Flow meter	Weir type flow meter		○	
2. Rapid Mixer	Corn type	Q = 41,000 m³/d	○	
3. Floccuration Basin	Φ28 m x 3.4 mH x 1 unit	V = 1,400 m³		○
4. Existing Sedimentation Basin	18.8 m x (32 - 2.7) m x 3.4 mH x 2 units	Q = 20,500 m³/d		○
- Interior reform			○	
5. Sedimentation Basin	4.0 m x 32.1 m x (4.1 ~ 4.8) m x 4 units w/ plate	Q = 20,500 m³/d	○	
- Sludge discharge pump	Φ150 mm x 100 m x 2 m³/min. x 10m x 5.5 kW x 4 units		○	
- Control panel	Interior self - standing type x 1 unit		○	
6. Rising pump	Φ300 mm x 14.3 m³/min. x 10m x 4.5 kW x 3 units (1 unit)	Q = 41,000 m³/d	○	
- Control panel	Exterior self - standing type x 1 unit		○	
7. Filter	4.5 m x 8.6 m x 5.9 mH x 8 units Back washing water retaining type	Q = 39,000 m³/d	○	
- Surface washing pump	Φ250 mm x 6.0 m³/min. x 20m x 37 kW x 2 units (1 unit)		○	
- Control panel	Exterior self - standing type x 1 unit		○	
- Waste water pipe	Φ800 mm x 500 m		○	

Name of facility	Dimension × Units (spare)	Capacity	Renewal	Existing
8. Chlorination Basin	12 m x 33 m x 5.0 mH x 1 unit Divided in 2 systems		○	
9. Clear water Reservoir	20.7 m x 65 m x 5.3 mH x 1 unit Divided in 2 systems		○	
10. Distribution pump (No.1)	Φ150 mm x 100 mmx 8 m³/min. x 42 m x 81 kW x 3 units (1 unit)			○
- Control panel	Interior self- standing type			○
11. Distribution pump (No.2)	Φ150 mm x 100 mmx 7.8 m³/min. x 43 m x 90 kW x 3 units (1 unit)		○	
12. Distribution flow meter	Interior self- standing type Turbine type x 2 units	for No. 1 pump	○	○
13. Distribution flow meter	Turbine type x 2 units	for No. 2 pump Q = 150 ～ 1,000 m³/hr	○	
14. Coagulant ingection equipment	15 lt/min x 2 kg/m² x 0.4 kW x 2 units (1 unit)		○	
- solutior Tank	10 m³ x 2 units		○	
- Mixer	Vertical type 2.2 kW x 2 units		○	
- Control panel	Interior self - standing type x 1 unit		○	
15. Chlorination equipment	10 kg/hr x 3 units (1 unit)	For pre and past chlorination	○	
- pressure pump	Φ40 mm x 15 lt/min. x 40 m x 2.2 kW x 3 units (1 unit)		○	
- Control panel	Interior self - standing type x 1 unit		○	
16. Control management panel	Interior self - standing type x 1 unit		○	
Facilities for Distribution main				
1. Distribution pipe for Shankhari Bazar Area	Φ500 mm x 1,380 m	Q = 15,600 m³/d	○	
- Air valve, flow-off valve	3 units each		○	
2. Distribution pipe for Peelkhana, B.D.R. Area	Φ500 mm x 1,410 m	Q = 15,600 m³/d	○	
- Air valve, flow-off valve	3 units each		○	

Name of facility	Dimension × Units (spare)	Capacity	Renewal	Existing
3. Distribution pipe for K.B. Rudoro Road Area	Φ300 mm x 380 m		○	
- Air valve, blow-off value	1 unit each		○	

Table 4-6 Comparison of 2 Types for Intake Pump

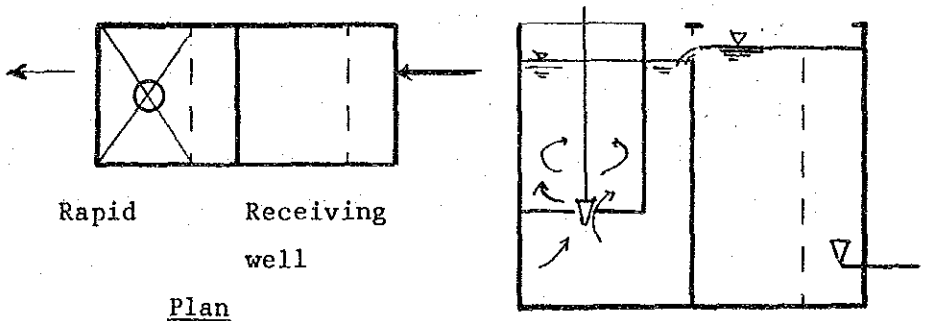
	Vertical Pump(Two-stories)	Vartical Pump (Single-story)
Conditions	Same type as existing pump of P/S No. 1	Same type as existing pump of P/S No. 2
Schematic Diagram		
Advantage Merit	Since moter is installed of the 1st floor of pump room, there's no possibility of flooding.	Pump is connected with motor directly and structure is also simple.
Demerit	Reinforcement for intermediate shaft is indispensable due to thrust surcharge.	Maintenance work is troublesome because pump is settled below the room floor.
Evaluation	Since the pump are going to be installed in existing pump room, surcharge should be considered carefully. In case of single story pump, surcharge will be applied only to installed base, and no intermediate shaft is advantageous for pump structure from view point of operation and maintenance.	

By above mentioned comparison study, vertical single story pump is adopted.

2) Receiving Well/Rapid Mixer

- Intake flow rate is determined by pump capacity and operating units, while measurement of that rate is fundamental element for setting chemical feeding rate and successive treatment processes. However, high grade device would not be necessary, weir type flow rate with visual measurement should be adopted.

- Rapid mixer aims at admixture and diffusion of injected chemical. Admixture can be achieved by external machinal energy and also by causing turbulence or vortex flow utilizing flow energy. In this case, raw water is pumped from intake P/S, flow energy method can be applied. Schematic diagram of corn type mixer which will be adopted is shown below:



Plan

Section

3) Sedimentation Basin

- Sedimentation basin is installed to remove large part of suspended solid or flocks formed by chemical coagulation applying gravity sedimentation and to lessen loads for successive filter. Sedimentation basin should have 3 faculties of sedimentation, buffer and sludge disposal, in which principal item of sedimenation faculty will be discussed as follows.

Sedimentation faculty is an activity that remove inflow turbidity materials efficiently and most important index relating to the removal rate is surface load factor. Where inflow rate is Q and sedimentation area of basin is A, surface load factor Vo is as follows:

$$Vo = Q/A$$

Vo has velocity dimension of mm/min.

If settling velocity of removal flock is V, design of the basin should be enabel Vo = V. Thus, to improve removal rate, below mentioned 3 methods can be proposed:

1) Enlarge sedimentation area A.

2) Increase settling velocity of flock V

3) Decrease flow rate Q.

High-rate settler module is designed to enlarge sedimentation area and improve efficiency. In this plan, settler module is applied to utilize projected site efficiently. High-rate settler module has 2 types as below:

Table 4-7 Comparison of High-Rate Settler Module

	Plate type		Pipe - type	
Flow Direction	Horizontal		Vertical(upper)	
Installation Plan	Area Story Height	Ratio(100%) Double 1,614 mm	Area Story Height	Ratio(250%) Single About 1,000 mm
Maintenance Work	Visual inspection		Since clogging due to sludge sedimentation and algae occures occasionally, dry washing is required several times in a year.	
Domestic Results	About 800 plants in Japan		About 80 plants in Japan	
Evaluation	Although horizontal type needs more height compared with vertical type, it will be installed in newly built basin which can be designed to be suitable. Thus, horizontal type,which has more results and easy in maintenance, is adopted.			

By above mentioned comparison work, horizontal plate will be utilized.

- To ensure sedimentation function sludge disposal equipment, which is suitable for structure of basin, should be installed. Although there are sludge disposal valves in each 4 systems of existing sedimentation basin, they are only drain valves for drainage of sedimented sludge and washing during suspension period of its operation. The existing drainage facility will be used as it is.

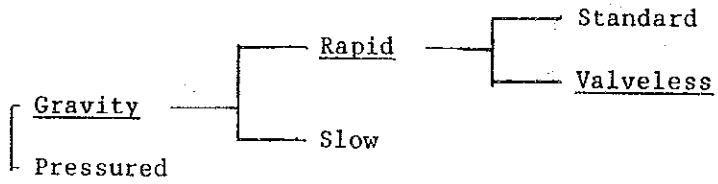
- As to newly constructed basin, sludge drainage facility that is composed of sludge pits and sludge discharge pump will be installed,which enable sludge discharge during operation. However, sludge discharge by pump is only available at inlet portion, where a lot of sediment settles. In the case of removal of sedimented sludge completely, operation must be stopped as well. For the easy operation and maintenance, the basin should be separated in 4 units and each unit must be operated respectively.

- According to standard design criteria for the design of water supply facility by Japan water works association, in a case of employment of plate settler, it is indicated that surface load factor is 4 - 9 mm/min, average velocity is less than 0.6mm/min, clearance between bottom of equipment and basin should be more than 1.5 m.

In this plan, design should be performed according to these standards.

4) Filter

- Filters can be categorized as below:



Existing filters, jewel filter and Paterson filter, can be categorized Gravity - Rapid - Standard type. Since both of those are deteriorated, all of existing filters should be demolished and new filter meeting to design treatment flow should be constructed.

Back washing water retaining type rapid filter, categorized into Gravity-Rapid-Valveless, which is easy in operation and maintenance, will be adopted as new filter and pressured jet washing will be applied for surface washing.

- According to before mentioned standard, filter velocity is 120 - 150 m/D, thickness of sand filter is 60 -70 m, effective diameter of sand is 0.6 -0.7mm, uniformity coefficient is less than 1.7 and under-drain system should have the structure that permits equal and efficient filtration and back washing.

In this plan, design should be carried out within these standard.

4.3.3 Facility and Equipment Plan

The following Table 4-8 shows the facilities and equipment for rehabilitation under this Project.

Table 4-8 List of Facilities and Equipments for Rehabilitation

(1) Water Treatment Plant

1) Mechanical Plan

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
1	Intake facility				
1.1	Rehabilitation for old intake facility				
1.1.1	Intake pump	Intake pump	Vertical vortex pump 7.6 x m³ x 20 m x 45 kW x 400 V x 50 Hz	3 units	
		Pressure gage	0 ~5 kg/m³	3 units	
		Check valve	Φ300 mm	3 units	
		Delivery valve	Φ300 mm Mannual butterfly valve	3 units	water type
		Piping materials	SGP. STPY	1 set	
		Sleeve pipe	DCIP Φ450 mm	1 unit	
		Flange plate	Φ450 mm	1 set	for water cut-off
1.1.2	Grating age	Grating	Steel plate	40 m²	
1.1.3	Drainage pump	Drainage pump	Self-suction vortex pump 0.2 m³/min. x 8 m x 0.75 Kw x 400 V x 50 Hz	1 unit	
		Pressure gage	0 ~ 1.5 kg/m²	1 unit	
		Sluice valve	450 mm	1 unit	
		Piping materials	SGP	1 set	
1.1.4	Lifting equipment	Chain block	Mannual chain block with geared trolley 3,000 kg	1 unit	
1.2	Rehabilitation for new intake facility				
1.2.1	Drainage pump	Drainage pump	Self-suction vortex pump 0.2 m³/min. x 8 m x 0.75 Kw x 400 V x 50 Hz	1 unit	
		Pressure gage	0 ~ 1.5 kg/m²	1 unit	
		Sluice valve	φ50 mm	1 unit	
		Piping materials	SGP	1 set	

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
2.	Water treatment facility				
2.1	Receiving well. Equipment for rapid mixer				
	1) Raw water pipe	Raw water pipe	DCIP Φ700 mm	1 set	
	2) Over-flow pipe	Over-flow pipe	DCIP Φ500 mm	1 set	
	3) Drain pipe	Drain valve	Manual butterfly value Φ200 mm	2 units	water type
		Drain pipe	SGP. DCIP Φ200 mm	1 set	
	4) Raw water flow rate measuring equipment	Measuring equipment	weir type	1 set	
	5) Mixer	Mixer	Corn type	1 unit	
2.2	Rehabilitation for existing sedimentation basin				
2.2.1	Drain valve headstock	Headstock		4 units	
2.2.2	Drain pipe	Drain valve	Manual butterfly value Φ200 mm	1 unit	water type
		Drain pipe	SGP. DCIP Φ200 mm	1 set	
2.2.3	Sleeve pipe	Outlet pipe fop treated water	DCIP Φ700	1 unit	
2.3	Equipment for new Sedimentation basin				
	1) Inlet gate	Inlet gate		4 units	
	2) Settling plate	Settling plate	Vertical flow type	4 sets	
	3) Collecting trough	Collecting trough	FRP	12 units	
	4) Sludge disposal pump	Sludge disposal pump	Horizontal vortex pump 2 m^3/min. x 10 m x 5.5 kW x 400 V x 50 Hz	4 units	
		Pressure gage	0 ~ 1.5 kg/m^2	4 units	
		Check valve	Φ150 mm	4 units	
		Eluice valve	Φ150 mm	8 units	
		Piping materials	SGP	1 set	

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
	5) Sleeve pipe	Treated water pipe	DCIP ϕ700 mm	1 unit	
		Sludge disposal pipe	DCIP ϕ150 mm	8 units	
		Pressured water jetting pipe	DCIP ϕ100 mm	4 units	
		Outlet pipe for Sludge disposal pump	DCIP ϕ150 mm SGP ϕ50 mm	1 unit 1 unit	
	6) Drainage pump	Drainage pump	Submersible pump 0.15 m³/min. x 8 m 0.75 kW x 400 V x 50 Hz	2 units	
		Pressure gage	0 ~ 1.5 kg/cm²	2 units	
		Check valve	ϕ50 mm	2 units	
		Sluice valve	ϕ50 mm	2 units	
		Piping materials	SGP	1 set	
2.4	Equipment for rising pump pit				
	1) Rising pump	Rising pump	Submersible pump 14.3 m³/min. x 10 m x 45 kW x 400 V x 50 Hz	3 units	
		Pressure gage	0 ~ 2 kg/cm²	3 units	
		Check valve	ϕ450 mm	3 units	wafer type
		Delivery valve	Manual butterfly volve ϕ450 mm	3 units	
		Piping materials	STPY	1 set	
	2) Pump lifting equipment	Chain block	Manual chain block with geared trolley 5,000 kg	1 unit	
		Frame		1 set	
	3) Sleeve pipe	Inlet pipe	DCIP ϕ800 mm	2 units	
2.5	Equipment for Rapid sand filter				
	1) Valves	Raw water valve	Manual butterfly valve ϕ300 mm	8 units	Wafer type
		Piping materials	SGP	1 set	
		Connecting valve	Manual butterfly valve ϕ600 mm	6 units	Wafer type

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
		Drain valve	Manual butterfly valve ϕ700 mm	8 units	wafer type
		Surface washing valve	Manual butterfly valve ϕ350 mm	8 units	wafer type
		Drain valve for inlet channel	Manual ϕ150 mm	4 units	
		Drain valve for collecting channel	Manual butterfly valve ϕ150 mm	8 units	wafer type
		Drain valve for drainage channel	Manual butterfly valve ϕ150 mm	8 units	wafer type
		Drain valve for treated Water Channel	Manual butterfly valve ϕ150 mm	2 units	wafer type
	2) Outlet weir	Outlet weir	weir width : 1,000 mm	6 units	
	3) Drainage trough	Drainage trough	FRP	48 units	
	4) Surface washing equipment	Surface washing equipment	SGP	8 sets	
	5) Filter medium	Filter medium	Effective diameter : 0.5~0.6 mm Thickness : 600 mm	8 sets	195 m^3
	6) Gravel	Gravel	Thickness : 300 mm	8 sets	98 m^3
	7) Underdrainage	Under drainage	Strainer type	8 sets	
	8) Surface washing pump	Surface washing pump	Submersible pump 6m^3/min. x 20 m x 37 kW x 400 V x 50 Hz	2 units	
		Pressure gage	0 ~ 5 kg/cm^2	2 units	
		Check valve	ϕ300 mm	2 units	
		Delivery valve	Manual butterfly valve ϕ300 mm	2 units	wafer type
		Piping materials	SGP	1 set	
	9) Connection piping	Piping materials	SGP	1 set	
	10) Pump lifting equipment	Chain block	Manual chain block with geared trolley 3,000 kg	1 unit	
		Frame		1 set	
	11) Sleeve pipe	Inlet pipe	DCIP ϕ800 mm	1 unit	
		Raw water pipe	SGP ϕ300 mm	8 units	

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
		Discharge pipe	STPY ϕ700 mm	8 units	
		Discharge pipe	DCIP ϕ700 mm	2 units	
		Drain pipe	SGP ϕ150 mm	18 units	
		Surfawce washing pipe	SGP ϕ350 mm	8 units	
		Outlet pipe	DCIP ϕ800 mm	1 unit	
		Connecting pipe	STPY ϕ600 mm	16 units	
2.6	Equipments for chlorination basin				
		Inlet pipe	DCIP ϕ800 mm	1 unit	
		Inlet valve	Manual butterfly valve ϕ800 mm	2 units	wafer type
		Piping materials	STPY	1 set	
		Delivery valve	Manual butterfly valve ϕ800 mm	2 units	wafer type
		Piping materials	STPY, DCIP	1 set	
2.7	Equipments for clear Water reservoir				
2.7.1	Valves, Sleeve pipe	Inlet pipe	DCIP, STPY	1 set	
		Inlet valve	Manual butterfly valve ϕ800 mm	2 units	wafer type
		Outlet pipe	STPY, DCIP	1 set	
		Outlet valve	Manual butterfly valve ϕ800 mm	2 units	wafer type
		Drain pipe	SGP, DCIP	1 set	
		Drain valve	Manual butterfly valve ϕ800 mm	2 units	wafer type
		Outflow pipe	DCIP ϕ500 mm	1 set	
2.7.2	Distribution pump	Distribution pump	Horizontal vortex pump 7.8 m^3/min. x 42 m x 90 kWx 400 V x 50 Hz	3 units	
		Pressure gage	0 $\sim$ 6 kg/cm^2	3 units	
		Check valve	ϕ300 mm	3 units	
		Inlet valve	Manual butterfly valve ϕ300 mm	3 units	wafer type

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
		Delivery valve	Mannual butterfly valve ϕ300 mm	3 units	wafer type
2.7.3	Distribution flow meter	Flow meter	Turbine type 150 ~ 1,000 m³/hr	2 units	
		Valve	Manual butterfly valve ϕ300 mm	4 units	wafer type
2.7.4	Connecting pipe	Piping materials	SGP, STPY	1 set	
2.8	Chemical feeding equipment				
	1) Alum tank	Alum tank	poly ethylene tank 10 m³	2 units	
		Bucket		2 sets	
	2) Mixer	Mixer	Vertical type 2.2 kW	2 units	
		Frame		2 sets	
	3) Control frame	Frame		1 set	
	4) Alum pump	Alum pump	Metering pump 15 lt/min. x 2 kg/m² x 0.4 kw x 400 V x 50Hz	2 units	
		Pressure gage	0 ~ 3 kg/cm²	2 units	
		Valves	Viayl chloride	1 set	
	5) Piping materials	Water supply pipe	VP	1 set	
		Chemical feeding pipe	VP	1 set	
		Drain pipe	VP	1 set	
	6) Lifting equipment	I beam			
		Chain block	Manual chain block with geared trolley 500 kg	1 unit	
		Bucket		1 unit	
2.9	Chlorination Equipment				
	1) Chlorine injector	Chlorine injector	10 kg/hr	3 units	Ejector included
	2) Pressured water tank	Pressure water tank	Horizontal vortex pump 100 lt/min. x 40 m x 2.2 kW x 400 V x 50 Hz	3 units	
		Pressure gage	0 ~ 5 kg/cm²	3 units	
		Check valve	ϕ50 mm	3 units	
		Sluice valve	ϕ50 mm	8 units	

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
		Piping materials	SGP	1 set	
	3) Piping work	Pressure gage	0 ~ 5 kg/cm²	2 units	
		Piping materials	VP	1 set	
	4) Lifting equipment	I beam		1 set	
		Chain block	Manual Chain block with geared trolley 500 kg	1 unit	
		Bucket		1 unit	50 kg bomb x 4
	5) Ventilator	Ventilator		2 units	
	6) Emergency tool set	Gas mask		2 sets	
		Tool set		1 set	
3.	Archetectual Incidental equipment				
3.1	Administration office				
	1) Water analysis fixtures	Jar tester		1 unit	
		Turbidity meter	Portable type	1 unit	
		pH meter	Portable type	1 unit	
		Residual chlorine meter	Portable type	1 unit	
		Sink		1 unit	
	2) Maintenance tool	Maintenance tool		1 set	

(2) Electrical Plan

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
1.	Intake facility				
1.1	Control panel	Old intake pump control panel	Interior steel made self-standing type	1 unit	
		New drainage pump control panel	Interior steel made wall type	1 unit	
		Wiring materials		1 set	
2.	Water treatment facility				
2.1	Control panel	Power distribution panel	Exterior steel made self-standing type	1 unit	
		Well pump control panel	ditto	1 unit	
		Drainage pump control panel	Interior steel made self-standing type	1 unit	
		Alum injection control panel	ditto	1 unit	
		Chlorine injection control pane	ditto	1 unit	
		Rising pump control panel	Exterior steel made self-standing type	1 unit	
		Surface washing pump control panel (1)	ditto	1 unit	
		Distribution pump control panel	Interior steel made self-standing type	2 units	
		Back washing pump control panel	Exterior steel made self-standing type	1 unit	
		Control monitor panel	Interior steel made self-standing type	1 unit	
		Power distribution panel for temporary work	ditto	1 unit	
		Surface washing pump control panel (2)	ditto	1 unit	
		Level switch	Electrode type	3 units	
		Wining materials		1 set	

No.	Name of work	Specifications			
		Name of equipment	Specifications	Quantity	Remarks
2.2	Exterior lighting	Power distribution panel	Interior wall type	3 units	
		Ground lamp	230 V, 100 W	18 units	
		Fluorescent lamp	230 V, 100 W	15 units	
		Wiring materials		1 set	

(2) Distribution Main

Piping materials for each distribution route are as follows:

No.	System	Piping waterials		Quantitiy	Peuarles
1.	Shankhari Bazar system	Plain Pipe	Φ 500 mm	1,840 m	
		Butttertly value	Φ 500 mm	4 units	
		Sluice value	Φ 350 mm	2 units	
		Ditto	Φ 300 mm	1 unit	
		Ditto	Φ 250 mm	1 unit	
		Pipetittings, coupling		1 set	
2.	Peelkhana, B.D.R. system	Plain pipe	Φ 500 mm	1,410 m	
		Buttertly value	Φ 500 mm	2 units	
		Sluice value	Φ 300 mm	2 units	
		Ditto	Φ 250 mm	1 unit	
		Ditto	Φ 150 mm	1 unit	
		Pipetittings, coupling		1 set	
3.	K.B. Rudora Road system	Plain Pipe		380 m	
		Buttertly value		1 unit	
		Sluice velue		1 unit	
		Ditto		1 unit	
		Pipetittings, coupling		1 set	