Table-4.2.3 Detection Levels Which CGWB Wishes

Group of Elements	Elements	Equipment	Detection Levels
Heavy Metals	Fe, Mn, Cu, Cr, Zn, Cd, Ni, Mo, Hg, Pb, Sb, etc.	ICP	max.10 ppb
	Fe, Mn, Cu, Cr, Zn, Cd, Ni, Mo, Hg, Pb, Sb, Al, As, Ba, Bi, Ca, Co, Li, Mg, Se, Sr, Ag, Sn	AA	max.50 ppb
Organic Compounds	Pesticides, Inorganic Compounds	GC	ppb Level or Better
Elements, Inorganic Compounds	Cl, F, NH_4, CN	Auto-Analyser	0.01-0.2 ppm
	Cl, F, NH_4, CN, Br, I, O_2, S, ORP, pH	IM	0.01-1.0 ppm

4.3 BASIC PLAN

4.3.1 Basic Plan for Major Items

The basic plan will be established in the following paragraphs to satisfy the request from CGWB based on the design policy and the design criteria discussed in previous paragraphs examining the plans prepared by CGWB.

The equipment shall be examined in accordance with the following groups of analysis for elements to be detected.

a) Heavy Metal Analysis
b) Organic Compound Analysis
c) Element and Inorganic Compound Analysis
d) Peripheral Equipment

(1) Heavy Metal Analysis

1) Type of Equipment to be Selected

There are ICP and AA for analysis of water quality of drinking water with sufficient detection level. The characteristics of the two types of equipment were compared in Table-3.3.3. The table describes that ICP has an advantage of analysing simultaneously a large number of elements without pre-treatment of samples except some special elements. Also ICP yields analysis data with a good repeatability and variety of applications. On the other hand, AA is characterised as a single element analysis due to the necessity of pre-treatment of samples to prevent the interference of other elements precisely. To analyse mercury, arsenic, selenium, and antimony, even ICP needs to extract such elements and ICP loses its advantage of multi-element analysis for the analysis of those items.

Therefore, it is concluded here that AA will show its advantage for the analysis of Hg, As, Se, and Sb, and ICP can be used for multi-analysis of other elements.

CGWB has been using AA since 1970's, and recent models have been designed and manufactured to give easier operation. Thus, CGWB will not have technical difficulty for using AA.

Regarding ICP, CGWB has not used this yet. But the operation of recent models of ICP has been improved very much to the degree easier than AA, and CGWB has long experience with AA. Therefore, CGWB is believed to be able to use ICP. ICP has such characteristics with little influence from the interfering elements because of the analysis principles, higher reproductivity (except for the special elements described above), easy operation and easy output for utilisation.

Thus, it can be concluded that the combined use of ICP and AA is very recommendable. The is recommended to be used mainly for general purpose for simultaneous multi-element analysis. On the other hand, AA is recommended to be used for the regular analysis of special elements such as Hg, As, Se, and Sb, and for special analysis of the water samples which are very probable of contamination by special elements requested by the Ministry of Environment and Forests.

Fig. 4.3.1 and 4.3.2 show the principle of the measurements of ICP and AA, respectively.

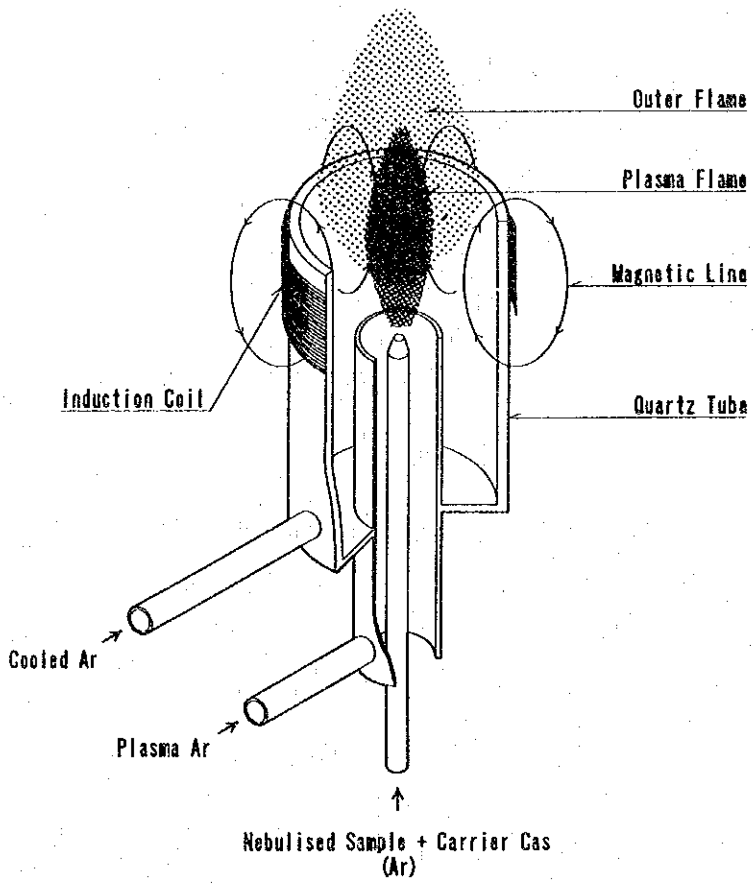


Fig. 4.3.1. ICP Plasma Torch

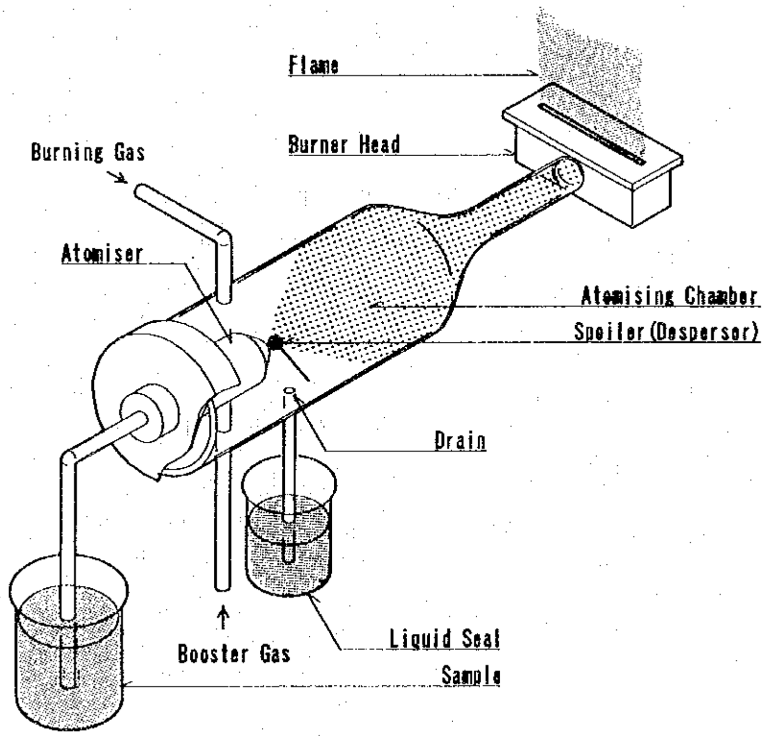


Fig. 4.3.2 Atomic Absorption Flame Burner

2) Units of Equipment Necessary

Regarding units of equipment necessary, it is concluded that the Project includes one unit of ICP and three units of AAs.

As for ICP, one unit for Hyderabad, where is planned to be installed at the present Chemical Laboratory, is included to avoid the re-installation as will be described in 4.4.2.

As for AA, as requested during the discussions, it is concluded to provide three units of AAs.

It is evaluated that ICP and AA will pose no problem for CGWB to utilise.

Next, the analysis capability of the equipment will be estimated.

ICP can analyse one water sample in about 4 to 5 minutes. If it is considered that preparation works are carried out, it may be very reasonable to estimate that about 50 samples can be analysed in a day. Then, 250 samples can be analysed in a week (50 samples/day x 5 day/week = 250 samples/week) and 12,500 samples can be analysed in a year (250 samples/week x 50 weeks/year = 12,500 samples/year).

AA can treat about 50 to 100 samples in a day for one element if pre-treatment is considered. If ten is the average number of elements to be determined for a water sample, even 100 elements can be treated in a day, 50 samples can be analysed in a week (100 elements/day x 5 days/week / 10 elements/sample = 50 samples/week). And 2,500 samples may be the average annual analysis capacity of AA assuming 50 weeks/year.

Table-4.3.1 summarises the equipment selected for heavy metal analysis.

Table-4.3.1 Equipment Selected for Heavy Metal Analysis

Group of Elements	Type of Elements	Equipment	No.of Units
Heavy Metals	Almost all Elements for Simultaneous Analysis	ICP	1
	Hg, As, Se, Sb and Special Elements	AA	3

(2) Organic Compound Analysis

1) Type of Equipment to be selected

A. Gas Chromatograph (GC)

Two GCs are used for the analysis of organic compounds and pesticides. Table-4.3.2 represents the comparison of five types of detectors. The detection limits are for chemical compounds which give response with a very high sensitivity, and those value will vary based on the chemical compounds, conditions and situations of the equipment. TCD is not selected this time due to poor response than other detectors.

Table-4.3.2 Comparison Table of Detectors for GC

Detectors	Detection Limits	Dynamic Range	Analysis Objectives
TCD	10^{-8}	10^{5}	Any Gas Other Than Carrier Gas
FID	10^{-11}	10^{7}	Almost All Organic Compounds
FPD	10^{-11}	10^{5}	Compounds Containing S and P
FTD	10^{-14}	10^{4}	Compounds Containing N and P
ECD	10^{-13}	10^{4}	Halogens & Nitro Group Compounds

Therefore, four types of detectors are used depending on elements to be analysed: ECD is used for elements which contain halogen (chlorine), such as PCB; FPD is used for elements containing phosphorous or sulphur; FID is used for organic solvents; and FTD is used for elements including nitrate or phosphorous.

B. Total Organic Carbon Meter (TOC)

TOC measures the total carbon and the total inorganic carbon in water samples and it calculates the total organic carbon.

It is recommended to analyse the collected sample with TOC soon to avoid air contamination to the sample because TOC is a very highly sensitive analyser. In case testing can not be made soon, it is recommended to try to test as quick as possible storing the sample in a dark place kept lower than 10 °C.

In accordance with the Japanese Standard for drinking water, the water quality standard and analysing methods are specified for organic compounds and pesticides as shown in Table-4.3.3. Although India also may need those equipment specified in the standard in the near future, it is recommended at this stage for CGWB to provide GC and TOC for the organic compounds and pesticides as shown in Table-4.3.4 because of the original request and the situation of CGWB who has little experience and equipment for this area. Therefore, it is recommended for CGWB first to get acquaintance with those equipment and compile experience and data and then, some years later when CGWB has enough personnel and experience to provide a line of more specialised and more sophisticated equipment like Liquid Chromatograph, Ion Chromatograph, GC-MS and so.

In short, it is desirable for CGWB to use GC and TOC for organic compounds analysis.

2) Units of Equipment necessary

It is recommended to procure 2 sets of GC and 1 set of TOC in this Project as an introductory stage. As for GC, 4 types of detectors, ECD, FPD, FID and FTD, shall be suitable for the objectives of analysis. Those detectors can be attached to either unit of GC interchangeably. And as for TOC, a unit of air purifier which aims to delete carbon content from air gas for testing shall be attached to TOC to maintain the detection accuracy.

Table-4.3.3 Water Quality for Drinking Water in Japan

	ELEMENTS	JAPAN	WHO	INSPECTION	
1	T.C.M.O	>100/ml	---	Ager-	a
2	Coliform	NP	NP	Fermentation	
3	Cyanogen	>0.01mg/l	>0.01mg/l	Absorptiometry	b
4	Mercury	>0.0005mg/l>0.05mg/l	>0.0005mg/l	Absorptiometry	
5	Lead	>0.05mg/l	>0.05mg/l	AA method	
6	Hexavalent Chromium	>0.01mg/l	>0.05mg/l	ICP method	
7	Cadmium	>0.01mg/l	>0.0005mg/l	ICP method	
8	Selenium	>0.01mg/l	>0.01mg/l	AA method	
9	Arsenic	>0.8mg/l	>0.05mg/l	AA method	
10	Fluorine	>10mg/l	>0.8mg/l	Absorptiometry	
11	Nitrogen Nitrate and Nitrogen Nitrite		>10mg/l	Absorptiometry	
12	Tri-chloroethylene	>0.03mg/l	---	GC-MS method	c
13	Tetra-chloroethylene	>0.01mg/l	---	GC-MS method	
14	Carbon Tetra-chloride	>0.002mg/l	---	GC-MS method	
15	1.1.2 Tri-chloroethylene	>0.006mg/l	---	GC-MS method	
16	1.2 Di-chloroethylene	>0.004mg/l	---	GC-MS method	
17	1.1 Di-chloroethylene	>0.02mg/l	---	GC-MS method	
18	Cis 1.2 Di-chloroethylene	>0.04mg/l	---	GC-MS method	
19	Di-chloroethylene	>0.02mg/l	---	GC-MS method	
20	Benzene	>0.01mg/l	---	GC-MS method	
21	Total Tri-Halomethan	>0.1mg/l	---	GC-MS method	d
22	Chroloform	>0.06mg/l	0.03mg/l	GC-MS method	
23	Bromo Di-Chrolomethane	>0.03mg/l	---	GC-MS method	
24	Di-Bromo Di-Chloromethane	>0.03mg/l	---	GC-MS method	
25	Bromoform	>0.09mg/l	---	GC-MS method	
26	Thiuram	>0.006mg/l	---	GC-MS method	e
27	Simazine	>0.003mg/l	---	GC-MS method	
28	Thiobencarb	>0.02mg/l	---	GC-MS method	
29	1.3 Di-Chloropropene	>0.002mg/l	---	GC-MS method	

a:Bacteria, b:Inorganic Compounds and Heavy Metals, c:General Organic Compounds
d:Organic Chloride, e:Pesticides

	ELEMENTS	JAPAN	WHO	INSPECTION	
1	Chlorine Ion	>200mg/l	>200mg/l	Titration Method	a
2	Potassium Permanganate Demand	>10mg/l	---		
3	Copper	>1.0mg/l	>1.0mg/l	ICP method	b
4	Total Iron	>0.3mg/l	>0.3mg/l	AA method	
5	Manganese	>0.05mg/l	>0.1mg/l	AA method	
6	Zinc	>1.0mg/l	>5.0mg/l	ICP method	
7	Sodium	>200mg/l	---	AA method	a
8	Hardness (Calcium, Magnesium)	>300mg/l	>500mg/l	Titration Method Weight Method	
9	Total Solid	>500mg/l	>500mg/l		
10	Phenol	>0.005mg/l	---	Absorptiometry	c
11	1.1.1 Tri-Chloroethane	>0.3mg/l	---	GC-MS Method	
12	Anion Surfactant	>0.2mg/l	---	Absorptiometry	d
13	PH	5.8 to 8.6	6.5 to 8.5	Glass Electrode	e
14	Odor	No Objection -able	No Objection -able	Sense Method	
15	Taste			Sense Method	
16	Color	5 degree	15 degree	Colorimeter	
17	Turbidity	2 degree	5 degree	Tyndallimetry	

a:Taste, b:Color, c:Odor, d:Surfactant, e:Basic Character

	ELEMENTS	JAPAN	WHO	INSPECTION	
1	Manganese	>0.5mg/l	0.1mg/l	AA Method	a
2	Aluminum	>0.2mg/l	---	ICP Method	
3	Residual Choline	>1.0mg/l	---	Electrical Current Method	b
4	2-Methyl isobornyl	(>0.00002mg/l) [>0.00001mg/l]	---	GC-MS Method	
5	Diosmin	(>0.00002mg/l) [>0.00001mg/l]	---	GC-MS Method	
6	Total Odor	>3	---	Sense Method	
7	Free Carbon Acid	>20mg/l	---	Titration	c
8	Potassium	>3mg/l	---	Titration	
9	Permangante Hardness(Calcium, Magnesium)	10 to 100mg/l	---	Titration	
10	Total Solid	30 to 200mg/l	---	Weight Method	
11	Turbidity	>1 degree (in the tap) >0.1 degree (in the distribution Facility)	---	Tyndallimetry	d
12	Langeria Index	<1 degree	---		e
13	PH	Around 7.5	---	Glass Electrode	

( ) Powdered Active Chacoal Treatment

[ ] Permanent Facility of Granular Active Carbon

a:Color, b:Odor, c:Taste, d:Turbidity, e:Corrosion

	ELEMENTS	JAPAN	WHO	INSPECTION	
1	Trans 1.2-Di-Chloroethylene	>0.01mg/l	---	GC-MS Method	a
2	Toluene	>0.6mg/l	---	GC-MS Method	
3	Xylene	>0.4mg/l	---	GC-MS Method	
4	P Di-Chlorobenzene	>0.3mg/l	---	GC-MS Method	
5	1.2 Di-Chloropropane	>0.06mg/l	---	GC-MS Method	
6	Di-Etylehexylphthalate	>0.06mg/l	---	GC-MS Method	
7	Nickel	>0.01mg/l	---	ICP Method	b
8	Antimony	>0.002mg/l	---	AA Method	
	Boron	>0.2mg/l	---	ICP Method	
91	Molybdenum	>0.07mg/l	---	AA Method	
0					
11	Formaldehyde	>0.08mg/l	---	GC Method	c
12	Di-Chloro Acid	>0.04mg/l	---	GC Method	
13	Tri-Chloro Acid	>0.3mg/l	---	GC-MS Method	
14	Di-Chloroace	>0.08mg/l	---	GC-MS Method	
15	Chloral Hydrate	>0.03mg/l	---	GC-MS Method	
16	Isoprothiolane	>0.008mg/l	---	GC-MS Method	d
17	Diazinon	>0.005mg/l	---	GC-MS Method	
18	Fenitorthion	>0.003mg/l	---	GC-MS Method	
19	Isoprothiolane	>0.04mg/l	---	GC-MS Method	
20	T.P.N	>0.04mg/l	---	GC-MS Method	
21	Propyzamode	>0.008mg/l	---	GC-MS Method	
22	Di-Chlorobos	>0.01mg/l	---	GC-MS Method	
23	Phenothiocarb	>0.008mg/l	---	GC-MS Method	
24	Chlornitrophen	>0.005mg/l	---	GC-MS Method	
25	Ibrobenphos	>0.008mg/l	---	GC-MS Method	
26	E.P.N	>0.006mg/l	---	GC-MS Method	

a:General Organic Compounds, b:Inorganic Compounds and Heavy Metals
c:Organic Chloride, d:Pesticides

Table-4.3.4 Equipment Selected for Organic Compound Analysis

Groups of Elements	Type of Elements	Equipment	No. of Units
Organic Compounds	Organic Compounds and Pesticides	GC (ECD, FPD, FID, FTD)	2
	Total Organic Carbon	TOC	1

(3) Element and Inorganic Compound Analysis

1) Type of Equipment to be Selected

In Japan, the Spectrometer and the Ion Chromatograph are being used for the analysis of those elements having better accuracy and detection level and better efficiency (higher performance). Table-4.3.3 describes the Japanese standard for water quality of drinking water. In this table, the absorption photometering and colourimetering stand for the ultraviolet and visible photometering.

CGWB will have better performance of analysis of the elements by having the simultaneous multi-element analysis with high resolution, if CGWB provides the combination of two types of equipment specified in the Japanese standard. The introduction of the Ion Chromatograph will, however, be considered after CGWB has become acquainted with GC which is one of the major parts of the Project. Here, the Semi-Automatic Analysis System (SAA) is recommended as a preparation stage, instead. The reasons of this recommendation is as follows:

One reason is the necessity of quick measurement for some elements. For example, it is requested to analyse NO_x and NH_4 within a short time (7 days) after the collection of the sample. To secure the analysis precision, it is recommended to establish an effective organisation to provide such analysing facilities close to the sampling spots taking considerations of the transportation of samples from the sampling spots to the analysing places. In this sense, it is a practical approach to build up SAA with a UV-VIS Photometer attached with an auto-sampler, an auto-injector, and a computer-operated data process unit which can output the analysis data automatically to improve the analysing performance. The system shall include auxiliary equipment for better operation and it is also recommended that each Chemical Laboratory placed in each Regional Office of CGWB is equipped with SAA so that the Laboratory can treat and analyse the collected samples very quickly and can make a practical sampling schedule. Another benefit will be that the analysis works can be done with the same chemical personnel because this system can make the automatic injection of samples to the detector, analysis, computation, and putting out the data although some additional works will be needed in manual works for the injection of reagents for colour development. And finally, doing this, each Chemical Laboratory will have the chance for up-grading the technological level and equipment. Eventually, this will lead CGWB to have higher status of technical level.

The Ion Meter (IM) is an easy and good device to determine the obstacle materials and their concentrations, and to estimate the qualitative value. Also this can be necessary for the determination of urgent and unexpected analysis in fields of pollution.

2) Units of Equipment Necessary

Each Chemical Laboratory is recommended to provide one set each of SAA and IM.

Table-4.3.5 summarises the equipment selected for element and inorganic component analysis.

Table-4.3.5 Equipment Selected for Element and Inorganic Compound Analysis

Group of Elements	Equipment	No. of Units
Elements and Inorganic Compounds	SAA	13
	IM	13

(4) Peripheral Equipment

The digital water level meters shall be omitted this time because this is not directly related to water quality monitoring although it is included in the request. Meantime, another requested item, computer software shall be included in each item.

The Mass Spectrometer is aimed to be used for the trace analysis of stable isotopes. The Mass Spectrometer should be used for the analysis of organic compounds together with GC. This should be considered after CGWB compiles enough experience with GC.

The Vadose Zone Samplers (VZS) shall be included for the analysis of pollution mechanism in the surface layer to unsaturated layer. The sampler is expected to extrude water from up to 3 m bgl. Two sets of the sampler shall be distributed to each Chemical Laboratory.

The Table-Type Waste Treatment Equipment (TWT) shall be equipped to the three Chemical Laboratories in Lucknow, Calcutta and Hyderabad. Table-4.3.6 exhibits the summary of the selection of Peripheral Equipment, and Table-4.3.7 summarises the selection of equipment discussed in 4.3.1.

Table-4.3.6 Equipment Selected for Peripheral Equipment

Group of Elements	Type of Elements	Equipment	No. of Units
Peripheral Equipment	Water Sample from Vadose Layer down to 3 m bgl.	Vadose Zone Sampler (VZS)	24
	Waste Water Treatment	Table-Type Waste Treatment Equipment (TWT)	3

Table-4.3.7 Summary of Equipment Selected

Group of Elements	Type of Elements	Equipment	No. of Units
Heavy Metals	Multiple Elements	ICP	1
	Hg, As, Se, Sb, etc.	AA	3
Organic Compounds	Organic Compounds, Pesticides	GC	2
	Total Organic Carbon	TOC	1
Elements and Inorganic Compounds		SAA	13
		IM	13
Peripheral Equipment	Water Samples from Vadose Layer	VZS	24
	Waste Water Treatment	TWT	3

4.3.2 Specifications of Major Equipment

Table-4.3.8 summarises the specifications of major equipment. The following is considered to make up the specifications.

(1) ICP

The most important function of this type of equipment is to make a multi-element simultaneous analysis particularly for heavy metals. Therefore, it is recommended to provide an auto-sampler and related accessories which enables a continuous auto analysis for a huge amount of samples in a concentrated short time. An ultrasonic nebuliser which can assure the high detection level of ICP and a hydrogen generator which can detect single element like Hg shall be included in the accessory list.

(2) AA

AA shall have functions of analysis of special elements (Hg, As, Se, Sb, etc.) which need pre-treatment for both AA and ICP. Therefore, AA shall be used for continuous mass analysis for those elements so that ICP can be used for a multi-element simultaneous mass analysis. An auto-sampler, a mercury reduction vapouriser for Hg analysis, and a hydrogen generator for As and other elements shall be included in the accessory list. The hollow cathode lamps shall be provided for such 23 elements as: Al, Sb, As, Ba, Bi, Ca, Cd, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Hg, Mo, Ni, Se, Sr, Ag, Sn, Zu.

Table-4.3.8 Specification of the Equipment

Equipment Specification	ICP	AA	GC(A)	GC(B)	TOC	SAA	IM	VS	TWT
Inspecter-Limit	max 12ppb	max 50 ppb	ppb level	ppb lebel	5 ppb	0.01-0.1ppm	0.02-0.2ppm	*	*
Power Source	1φ220V,50HZ or 3φ440V,50HZ	Do	Do	Do	Do	Do	Do	Do	DC.12V (Battery)
Specification	Spectrumn width: 160-800mm or wider, Doble grading, Spectrum PathBand: 0.027mm or smaller, CPU System Control	Wavelength Range:190-900mm or wider, CPU System Control Furnes Method can be operated	Detectors:ECD and FPD, CPU System Control	Detectors:FID ,FTD CPU System Control	Detector: CPU Controll-ed UV-VIS Spectro-meter, w/flow cell, W/Printer W/data Process-ing	Detector:NDIR, CPU System Control with Data Process-ing function	Degital Type with Printer Chemical Sedimentation Batch Type Max;1,000 ppm 25 l or more for one time.	Chemical Sedimentation Batch Type Max;1,000 ppm 25 l or more for one time.	Depth down to 3 m
Accessories	Hydride Generating Device, Auto-Sampler Data Processing, AVR, Ultrasonic Nebulizer, Exhaust Duct, Others	Hydride Generating Device, Mercury Vapourizer Unit, Auto-Sampler Data Processor, AVR, Exhaust Duct, Hollow Catched Lamps (23 pcs), Others	Auto Sampler, Auto Injector, Data Processor, AVR, Others	Auto Sampler, Auto Injectaor, Data Processor, AVR, Others	Auto Sampler, AVR, Others	Auto Sampler, AVR, Others	Stirrer, Electrode Stands, AVR, Ion Electodes (total 15 pcs including pH, Reference Electrode ORP,)		DC Pump, Hand Pump, Others

(3) GC

GC shall have the functions to analysis very low concentration compounds of pesticides, halogen compounds, and organic solvent. GC shall be equipped with 4 types of detectors of ECD, FTD, FID and FPD. One each detector for 4 types shall be attached to either unit of GC interchangeably. The analysing column shall be capillary column and an auto-sampler and an auto-injector shall be included to give higher performance.

(4) TOC

TOC shall have the functions of a continuous mass analysis for the contamination amount by organic matters. An auto-sampler shall be equipped.

(5) SAA

This system aims to be equipped in each Chemical Laboratory for mass analysis for elements and inorganic compounds. Therefore, this system should be operated very easily and can be operated with a small size generator. This system shall be consisted of a photometer type detector, an auto-sampler, an auto-injector (a flow cell), a data processor. The system shall be controlled by CPU automatically except colour development.

(6) IM

This will be located also in each Chemical Laboratory to analyse various kinds of ions and inorganic compound ions. This shall be digital and shall be equipped with stirrer, electrode stands and recorder. Those 15 electrodes shall be included as follows:

pH, ORP, Reference Electrode; Na, Cl, Br, I, Cd, Cu, Ag, S, F, K; NH_4, CN

(7) VZS

This also shall be distributed to each Chemical Laboratory. This can collect sample from the soil at any depth up to 3 m bgl. A hand pump and a DC pump shall be included.

(8) TWT

This equipment shall have the function of waste treatment for standard reagents and water samples which contain high concentration of toxic elements of Hg and CN. This shall be treated an a batch basis of 20 to 30 lit/time and max 1,000 ppm.

4.4 IMPLEMENTATION PLAN

4.4.1 Site Plan

Each Chemical Laboratory is located in the places shown in Fig. 2.2.1. The location of equipment may depend upon the allowable time of analysis after collection of samples. If the analysis elements are divided into three groups such as:
1) Heavy metals, 2) Organic compounds, and 3) Elements and inorganic compounds.

1) Heavy metals can be stored for a longer time after sampling, while 3) elements and inorganic compounds may need to be tested within shorter time (7 days) before the quality of water sample changes. Although 2) organic components, of course, are better to be analysed soon, samples may be stored for 1 to 2 months if objectives are pesticides and organic solvents which are relatively stable after pH adjustment. Therefore, 1) heavy metals can be tested in any place, while 3) elements and inorganic compounds need to be analysed in the places close to the sampling spots. And 2) organic compounds may be analysed in any place. Hence, 1) and 2) can be centrally-controlled by one or two centers, whilst 3) should be decentralisedly-controlled in locally situated Chemical Laboratories.

It is highly recommended to assign the Lucknow Laboratory where the Central Chemical Laboratory and Pollution Directorate situate as "the Chemical Analysis Centre" where it functions as the overall analysis, data base, reagent centre where it makes, controls, and distributes standard reagents to other Laboratories. In the chemical analysis centre, the experience and data of analysis for organic compounds shall be compiled for the further development of this area. For heavy metals, Lucknow shall be the northern centre and Hyderabad shall be the southern centre, and Calcutta (locating just in the central position between Lucknow and Hyderabad) shall be auxiliary centre to support both centres.

4.4.2 Allocation Plan of the Equipment

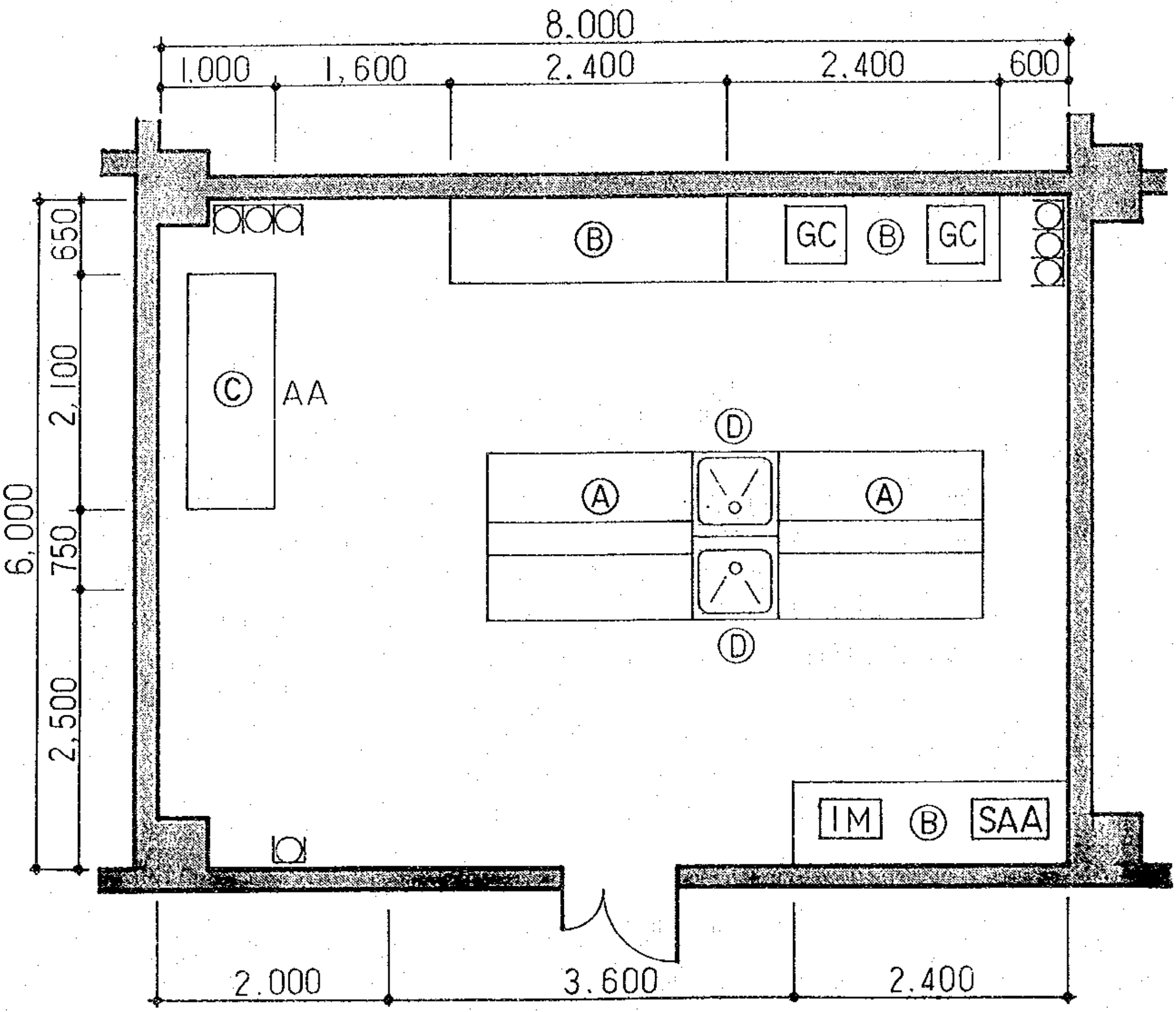
Based on the examination described in 4.4.1, the allocation plan of the equipment is decided as shown in Table-4.4.1. Fig. 4.4.1 through 4.4.3 exhibit example layouts of three Laboratories, and those layouts have typical floor areas of 50 m^2. The actual layout shall be drawn by CGWB based on the implementation plan.

Here the allocation of ICP is examined from the movement of the equipment after installation point of view. Although CGWB requested 2 units of ICP for Lucknow and Hyderabad, one unit for Hyderabad will be included in the Project since it is planned to be installed at the present Chemical Laboratory. However, another unit for Lucknow is excluded because CGWB has a construction plan of Regional Offices in Lucknow and Calcutta and it may need re-installation of the equipment in case the completion of Chemical Laboratory in Lucknow is delayed with some unpredictable reasons.

Table-4.4.1 Allocation Plan of the Equipment

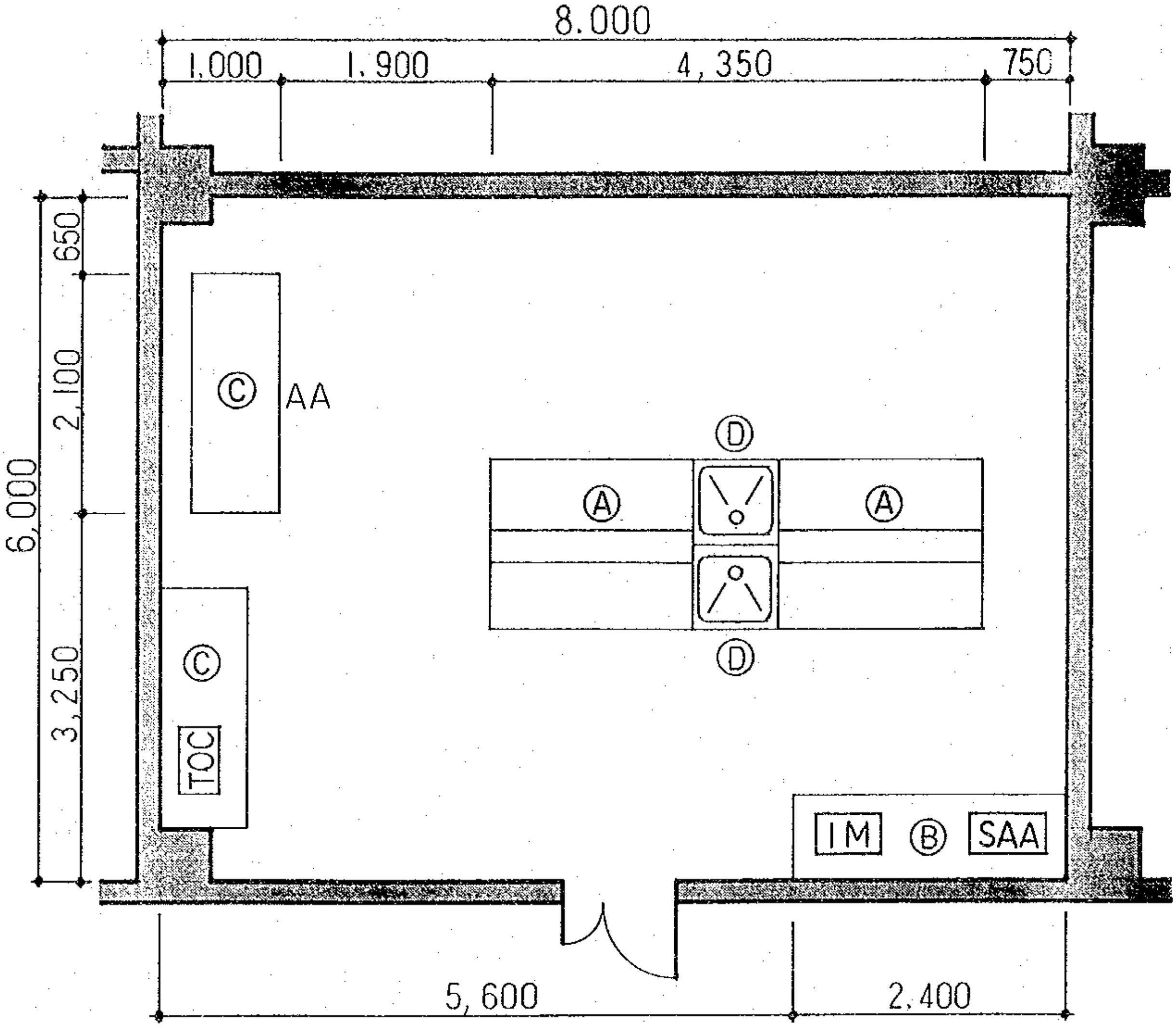
Group of Elements	Name of Equipment	No. of Units Allocated				
		Lucknow	Calcutta	Hyderabad	Others	Total
Heavy Metals	ICP	0	0	1	0	1
	AA	1	1	1	0	3
Organic Compounds	GC	2	0	0	0	2
	TOC	1	0	0	0	1
Elements, Inorganic Compounds	SA	1	1	1	10	13
	IM	1	1	1	10	13
Periphe-ral Equipment	VZS	2	2	2	18	24
	TWT	1	1	1	0	3

To draw a layout of the allocation of the Equipment, ICP and AA shall be placed in north to north west area in the Laboratory to avoid the direct sunshine because those equipment are essentially highly precision photo-analytical equipment and also those equipment shall belocated apart from the vibration sources like transport of vehicles, railways, compressors, etc. Also the precautions for the prevention of



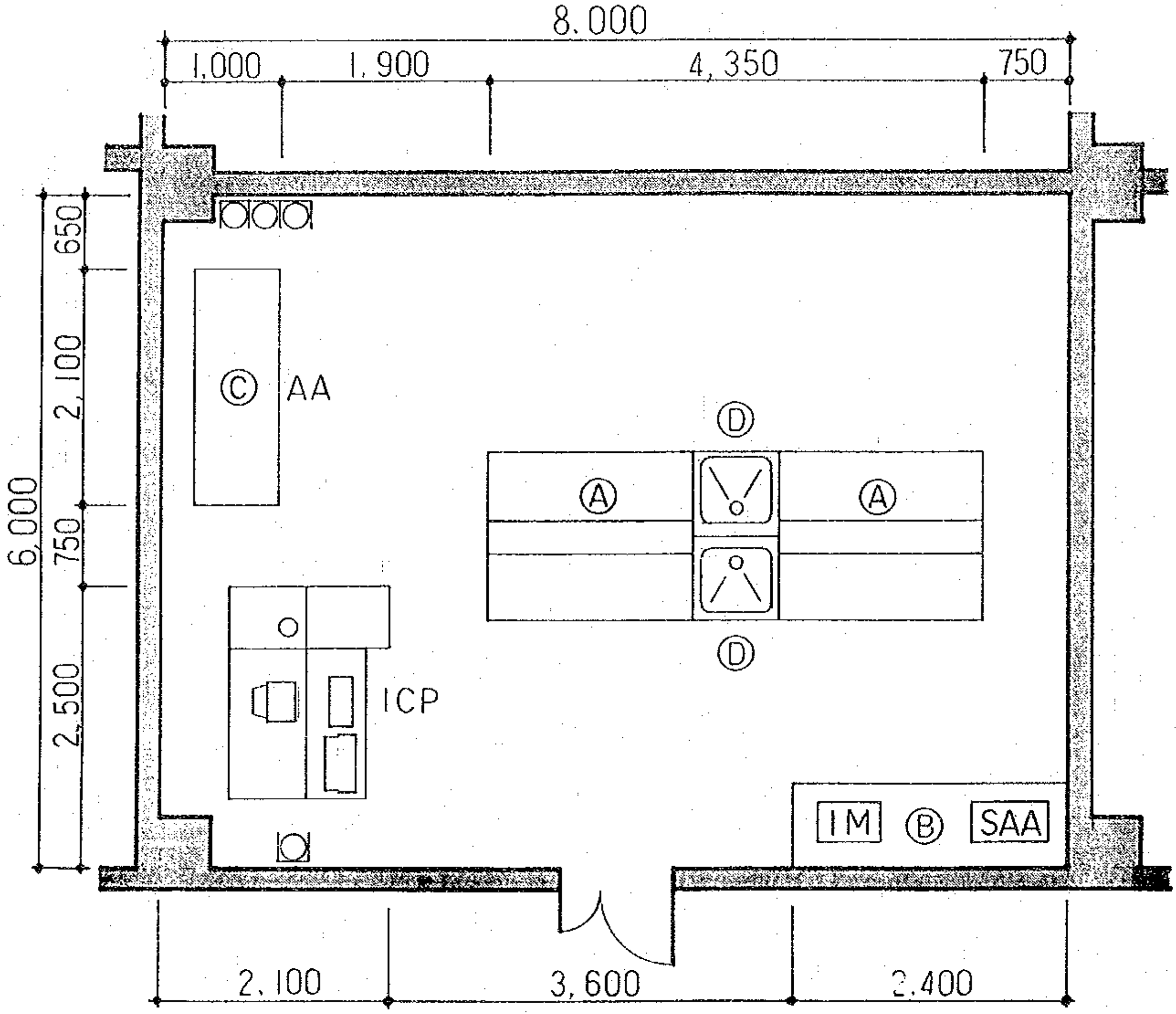
AA	Atomic Absorption Spectrophotometer
GC	Gas Chromatograph
SAA	Semi-automatic Analysing System
IM	Ion Meter
⌼	Gas Cylinder
Ⓐ	Double-sided Laboratory Table 1,800^{L} x 1,500^{W}
Ⓑ	Single-sided Laboratory Table 2,400^{L} x 750^{W}
Ⓒ	Single-sided Laboratory Table 2,100^{L} x 750^{W}
Ⓓ	Sink 1,000^{L} x 750^{W}

Fig. 4.4.1 Layout of Laboratory [Lucknow]



AA Atomic Absorption Spectrophotometer
TOC Total Organic Carbon Meter
SAA Semi-automatic Analysing System
IM Ion Meter
Ⓐ Double-sided Laboratory Table 1,800^L x 1,500^W
Ⓑ Single-sided Laboratory Table 2,400^L x 750^W
Ⓒ Single-sided Laboratory Table 2,100^L x 750^W
Ⓓ Sink 1,000^L x 750^W

Fig.4.4.2 Layout of Laboratory [Calcutta]



ICP Inductively-Coupled Plasma Spectrometer
AA Atomic Absorption Spectrophotometer
SAA Semi-automatic Analysing System
IM Ion Meter
Gas Cylinder
Ⓐ Double-sided Laboratory Table 1,800^L x 1,500^W
Ⓑ Single-sided Laboratory Table 2,400^L x 750^W
Ⓒ Single-sided Laboratory Table 2,100^L x 750^W
Ⓓ Sink 1,000^L x 750^W

Fig.4.4.3 Layout of Laboratory [Hyderabad]

dust should be taken to maintain those equipment free of trouble. Furthermore, all facilities necessary for the operation of the equipment shall be provided before the installation of the equipment, and sufficient units of working tables for pre-treatment and supporting works, and the devices and tools for maintaining the overall precision for the analysis should be carefully prepared.

4.4.3 Personnel Plan

(1) Requirements for the personnel of the equipment
Table-4.4.2 summarises the requirements for the operation and management of the equipment. In the end of the table, the requirement of the personnel is described in case ICP and AA, and SAA and IM are supposed to be used together.

(2) Personnel Plan for each Laboratory
The personnel plan for each laboratory is exhibited in Table-4.4.3 for the operation and management of the equipment prepared based on the requirements shown in Table-4.4.2. In the Table-4.4.3, A, B, and C stand for a person having the Degree better than M.S. for Chemistry, better than B.S. for Chemistry, and better than high school graduate for Chemistry. Those personnel can be considered to be assigned or promoted among the present CGWB personnel. Nevertheless, the personnel for GC may be required to have more experience with GC than any other equipment. Thus the following special consideration should be given:

1) To assign personnel to this who are suitable for GC. If it is difficult to assign such experienced person among CGWB personnel, it may be required to hire such a person from outside the organisation.

2) It may be necessary for such personnel to be assigned to a training programme for smooth introduction of GC technology.

3) The assigned personnel to GC shall be expected to be a central person to build a technical system for the Chromatography for determination of the concentrations of organic compounds.

Table-4.4.2 Operators' Job Description

	Operators	Job Description
ICP	Chief Operator (1)	Experience with AA and sufficient knowledge with AA Technology. B.S. in Chemistry or better. Freely operation of PC is desirable.
	Assistant Operator (1)	To arrange and divide, samples and wash glass devices. With experience of manual analysis and interests in PC. High school graduate or B.S. in Chemistry. More than three years experience.
AA	Chief Operator (1)	Experience with AA and Technological Imagination and technological capacity. B.S. in Chemistry or better. Operationable with PC freely.
	Operator (1)	To pre-treat the samples Chemically. Sufficient experience with colourimeter and with some experience with AA. Better than operationable with PC.
	Assistant Operator (1)	As same as assistant of ICP.
GC	Chief Operator (1)	Some experience and sufficient knowledge of GC and sufficient experience of organic compounds. M.S. in Chemistry or better. Operational of PC.
	Sub-Chief Operator (1)	Same carrier and technical capacity as chief operator. Aggressive attitude to a new scientific task experience with GC is desirable. Operational of PC freely. Overseas study is desirable.
	Operator (1)	To pre-treat the samples chemically. Sufficient experience of organic analysis is needed. B.S. in Chemistry or better.
TOC	Chief Operator (1)	Knowledge and technical capacity to understand the operator principals of TOC. Operational of PC. High school graduate in Chemistry or better.
	Assistant Operator (1)	To arrange, divide the samples and wash glass devices. A little experience of chemical analysis is OK. High school graduate in chemistry or better.
SAA	Chief Operator (1)	Sufficient experience of the colourimeter, understanding the operation of PC. B.S. in Chemistry or better.
	Assistant Operator (1)	To arrange, divide the samples and wash glass devices. Experience with the colourimeter. High school graduate in Chemistry or better.
IM	Operator (1)	Accustomed to the pH meters and understandable of PC. Experience with the colourimeter is desirable. High school graduate in Chemistry or better.
ICP/AA	Chief Operator (1)	Experience with AA, sufficient knowledge of AA Technology. B.S. in Chemistry or better. Operationable of PC.
	Operator (1)	To pre-treat the samples chemically. Sufficient experience of the colourimeter and some experience with AA. B.S. in Chemistry or better. Operationable of PC.
	Assistant Operator (1)	To arrange and divide the samples and wash glass devices. Experience with manual analysis, interests in PC operation. High school graduate or B.S. in Chemistry. More than three years experience.
SAA/IM	Chief Operator (1)	Sufficient experience with the colourimeter. Operationable of PC. B.S. in Chemistry or better.
	Assistant Operator (1)	To arrange and divide the samples and wash glass devices. Experience with the colourimeter is desirable. High school graduate in Chemistry or better.

Table-4.4.3 Personnel Plan

Laboratory	Lucknow				Hyderabad				Calcutta				Others			
Equipment	U*	A	B	C	U*	A	B	C	U*	A	B	C	U*	A	B	C
ICP + AA					(1)		2	1								
AA	(1)		2	1					(1)		2	1				
GC	(1)	2	1													
TOC									(1)		1	1				
SAA/IM	(2)		1	1	(1)		1	1	(1)		1	1	(1)		1	1
Total			4	2			3	2			4	3			1	1

"U*" indicates "Unit".
Number in parentheses means number of equipment.

4.4.4 Personnel Training Programme

The training programme for personnel can be classified as follows:

(1) Trainee Levels
Laboratory-in-charge, Equipment-in-charge, Equipment Operators

(2) Training Levels
Preparation Programme, On-the-job Training, Level-up Training, Trouble Shooting

(3) Courses
Principles, Operation, Analysis, Maintenance and Management

(4) Training Programme for
Laboratory, Equipment

(5) Trainers
From CGWB, from outside of CGWB (Intentional Experts, Local Experts, Manufacturer, etc.)

(6) Types of Training Programme
Commissioning, CGWB Programme, Regular Inspection

Actual training programme will be planned based on the combination of those elements described above, and it is necessary for CGWB to continue to provide such programmes for all the personnel concerned. Here the commissioning will be explained for rating the Equipment.

"The Commissioning" is a series of works to be conducted by the Supplier for the rating test of the Equipment. During this period, the Supplier shall provide inspection, installation, start-up test, and rating test for the equipment with the personnel assigned by CGWB. Therefore, the Commissioning is a period during this time the Supplier provides rating the Equipment for CGWB.

The programme shall include such items as inspection, installation, start-up test, and rating test for the Equipment. And the commissioning shall be taken place in Lucknow, Calcutta and Hyderabad.

4.4.5 Procurement Plan of Consumable Items

The procurement Plan shall be reviewed here for necessary consumable items for each equipment.

(1) ICP

1) Electric Power: The electric power consumption is 2.0 kW/hr in normal operation. And if the system is set at "pre-heat" status, the system can start very easily and can improve the system efficiency. The pre-heat needs the electric consumption of 10 kW for night time.

2) Gas: Purity 99.95% or better argon gas is needed. The liquefied argon gas shall be in most cases economical for operation because this type of equipment requires a large quantity of argon gas. The liquefied argon gas may be generally supplied for welding more than 99.95%. Thus, it may be economically supplied of liquefied argon gas for argon welding in India.

3) Consumable Items: The Molecular Sheave which is used as a filter of argon gas is generally in use in laboratories elsewhere, and it can be procured locally. It may not be difficult to change the Molecular Sheave in the case, and the change itself will not cause any problem for CGWB.

The Lube Oil for the Vacuum Pump has normally 2 to 3 years of durable life. In this study, it is assumed that CGWB will change the lube oil for the vacuum pump every 2 years.

Beakers for the auto-samplers can be bought at market if those are of 30 ml capacity. Normally those can be quite durable if they are taken good handling of.

The consumable items for printing like ink ribbons and printing papers shall be procured locally, because they can be purchased as standard items at market economically.

It may also procure economically the high purity metals and the nitric acid for chemical adjustment of standard reagents. No other reagents shall be needed.

4) Consumable Parts: the Quartz Plasma Torch will be consumed proportionally to the number of analysis. Those 4 pieces of the Plasma Torch will be consumed annually at normal operation conditions. They can be used for a longer time of 30 to 50% if it is used for analysis for cleaner water samples and no acid-treatment is required.

The narrow discharge mouth of Nebuliser should be careful not to let be clogged to prevent damage. The consumption of the Nebuliser will be normally with clean water sample once a year.

A set of the Sample Intake Tube may be used annually. The Ultrasonic Oscillator will be consumed proportionally to the using time. A set of the Ultrasonic Oscillator may be needed every two years supposing the Nebuliser will be utilised 20 to 30% in a year.

The high frequency coil may be damaged due to the extraordinary spark caused by the degrading of the Plasma Torch. A good care of small cracks of the Plasma Torch should be taken. A unit of Plasma Torch can be used for two years if it is replaced in a good interval.

5) Repairing: ICP can be used without trouble if the consumable items are replaced appropriately as mentioned above. However, it may cause serious problems if the samples are poured on the equipment or cleaning dusts out of the equipment is neglected. This type of equipment can be used without trouble more than 5 years and up to 10 years if attentions are paid to make clean the equipment, samples or reagents are wiped out when they are equipment quickly and a regular and periodical maintenance schedule is made. It is recommended to ask an engineering service company to have the regular and periodical inspection every year.

(2) AA

1) Electric Power: The electric power consumption will be increased, but the gas consumption will be reduced and detection sensitivity will be improved if the Furnace Method is employed. Therefore, it is assumed the 75% of the operation time for the equipment will be utilised with the Furnace Method and 25% with the Flame method. The electrical consumption will be 15.0 kW/hr for the Furnace Method and 4.0 kW/hr for the Flame Method. A long pre-heat may not be needed.

2) Gas: The argon gas of purity 99.95% or better is supposed to be used for 75% of running time as the carrier gas because the Furnace Method is assumed to be used that amount. The Flame Method is supposed to be used for 25% of the running time. And 12.5% each of C_2H_2 and H_2 are assumed to be used.

3) Consumable Items: The Sample Tubes can be used for a long time, if they are taken good care of and small size Test Tubes which can fit into the Auto-sampler can be purchased at market. The Thermal Papers shall be of the manufacturer's standard. The Reagents are the same as ICP.

4) Consumable Parts: the Graphite Tubes can be consumed because the 75% of the running time may be used for them. This can be running economically because such expensive gas as N_2O is not needed to use. Those 20 units of Graphite Tubes may be needed assuming it is needed to replace them every 1,200 to 1,500 times of analysis.

A unit of Deuterium Lamp may be needed every 2 years or more, and it is assumed to replace the Deuterium Lamp every 2 years.

Generally a unit if the Photo Multiplier can be used for 5 to 10 years, and here it is assumed to replace one unit of the Photo Multiplier every 5 years.

Normally the Hollow Cathode Lamp can be used for 4 to 5 years, and pre-caution should be paid to the handling of the Lamp because mishandling can reduce the life of the Lamps. Normally the life of the Lamp for as is considered to be very short as 1 to 2 years, and the average 10% of amortisation is considered.

5) Repairing: As same as ICP.

(3) GC

1) Electric Power: The electric power consumption will be 2.0 kW/hr. A long time pre-heat may not be needed.

2) Gas: 50% each of ECD and FPD for GC(A) and also 50% each of FID and FTD for GC(B) are supposed to be used. The gases which will be used in the Project shall be of high purity gases. The high purity gases can be purchased at market in India. For reference, a subsidiary company of Japan Oxygen Co., Ltd. is operating in India to manufacture the high purity gases for GC.

3) Consumable Items: The Sample Tubes with gum plug can be purchased in India which is for medical purposes although it may be expensive.

It may be difficult for CGWB to purchase at market the Capillary Column which has an excellent performance for low content analysis. However, the Capillary Column can be used for 3 to 4 years if the Capillary Column is used together with normal column. The normal column can be produced in India to meet the requirements of the objective items.

The Micro Syringe for GC can be purchased at market in India. However, it may be difficult to purchase the Syringe with specially bent needle.

The Thermal Papers shall be of manufacturer's specification. Such solvents as acetone and hexane to extrude the elements may be needed. In case it is difficult to procure high purity reagents although it is needed, the lower purity chemicals should be refined.

4) Consumable Parts: The injection glass joint of ECD/FPD for GC(A) shall be replaced twice a year because the injection glass joint will be sedimented with sampling injection.

Also the Injection Tubular shall be replaced with alkali beads at the injection port of FTD for GC(B) once a year because the consumption is proportional to the frequency of the analysis and the Injection Tubular shall be used half of the operation hours (FID:FTD=50:50) while the full use of FTD may need two sets of the Injection Tubular in a year.

5) Repairing: As same as ICP.

(4) TOC

1) Electric Power: The electric power consumption will be 1.0 kW/hr. A long time pre-heat may not be needed.

2) Gas: Air will be needed for burning the samples. Carbon free high purity air will be needed because TOC is very sensitive of

5 ppb. The Gas Cleaner is attached to TOC to purify the pure air which can be procured at local market economically in India.

3) Consumable Items: The Total Carbon (TC) Catalyst can be used for the concentrations of TC of higher than 10 ppm. Two TC Catalyst may be needed when it is operated continuously.

The High-sensitivity TC Catalysts also can be used for the concentrations of TC of lower than 10 ppm. The sample should be tested first with the TC Catalyst and then analysed with the High-sensitivity TC Catalyst for samples of lower than 10 ppm. Therefore, it may be needed to be replaced once a year with lower consumption rate than the TC Catalyst.

The Inorganic Carbon Reagent may be procured from domestic manufacturers or may be adjusted chemically inside of CGWB.

The Thermal Papers shall be of manufacturer's specification. Such reagents as Sodium Hydrogenphthalate, Sodium Hydrogencarbonate and Sodium Carbonate may be needed.

4) Consumable Parts: The Glass Cylinder for TC Catalyst, which is sedimented with burnt ash, will be replaced based on the number of analysis. It may be replaced twice a year at full operation.

5) Repairing: TOC can be run without any trouble provided the ordinary care and ordinary operation is made as same as ICP. The periodical inspection is recommended once a year to adjust the equipment. The inspection fee shall be less than ICP, AA and GC because of simpler mechanism.

(5) SAA

1) Electric Power: The electric power consumption will be 0.2 kW/hr. This piece of equipment can be operated outdoors with a small portable generator.

2) Consumable Items: The Sample Tube can be purchased at market as Test Tubes for the Auto-Samplers. The Thermal Papers shall be rolled one of manufacturer's specification.

Such reagents may be needed as Indian Phenol-blue, Ammonium Chromate all of which are currently in use in CGWB and can be purchased at local market economically.

3) Consumable Parts: It is assumed to replace the Halogen Lamp and the Deuterium Lamp every 2 years although both of them may be used 2 to 3 years.

Also it is assumed to replace the Photo Multiplier every 5 years although the Photo Multiplier may be used for 5 to 8 years.

4) Repairing: as same as TOC.

(6) IM

1) Electric Power: The electric power consumption will be 0.05 kW/hr.

2) Consumable Items: The Standard Reagents, the Ion Strength Adjuster, the Inner Solution, the pH Standards, the Fluoride Standard Buffer Solution can be adjusted. It is recommended that the Central Chemical Laboratory at Lucknow may established a Chemical Adjusting Centre to adjust, store, and distribute those standard chemicals. It is also recommended use the Standard Reagents which will be supplied at the shipment as standard accessories which shall be the standard of the reagents which CGWB adjusts.

The Thermal Papers shall be of manufacturer's specification.

3) Consumable Parts: It is assumed to replace 20% of total electrodes every year although each electrode is supposed to be used for more than 5 years. The major cause of shorter life is

mishandling of the electrode.

4) Repairing: The most popular cause of mechanical trouble is to pour the water samples or reagents on the equipment. It is very important for CGWB to keep the equipment clean all the time. The cost of repairing shall be as same as TOC.

(7) TWT

1) Electric Power: The capacity of treatment is about 25 lit. Most of waste can be treated with pH adjustment and limited amount of samples and the Standard Reagents which may contain high concentration of heavy metals and toxic elements. Therefore, the treating volume should be reduced by vapourising. It is assumed that the stored waste will be treated half a day in a month. The electric power consumption, therefore, will be 2.0 kW/hr, being 0.5 kW/hr x 4 hrs = 2.0 kW.

2) Consumable Items: The Activated Charcoal and the Chelate Resin Adsorbents can be procured at local market. Both of them can be replaced every two years supposing the treatment will be made once a month.

3) Repairing: This type of equipment is expected to be repaired by CGWB because of its simple mechanism.

4.4.6 Organisation for Project Implementation

The executing agency for implementation of the Project is CGWB, and it carries out the Project directly. CGWB will enter into a Consultancy Agreement with a Japanese Consultant firm regarding the Detailed Design, and the Procurement Supervision after the Exchange of Notes (E/N) exchanged between both Governments, and CGWB will carry out a packaged tendering for the procurement of the equipment under the Project for the Improvement of Equipment for Water Quality Monitoring in India with an assistance of the Consultant firm. As a result of evaluation on the tendering, CGWB will enter into a supply contract with a contractor. In accordance with the guideline of the Japanese grant aid system, the principal contractor shall be a Japanese firm.

CGWB is requested to perform those works for the implementation of the Project:

(1) Provision of spaces and related facilities at the Project Sites.
(2) Provision and assignment of personnel necessary.
(3) Preparation of the budget and procurement of materials necessary for the implementation of the Project.
(4) Clearance of regulations for radio isotope and high frequency radio in India.
(5) Smooth enforcement of administrative measures necessary for the implementation of the Project, the Banking Arrangement, an arrangement on duty clearance and tax exemption for the equipment, and tax exemption for the despatched engineers from Japan.

Japanese Side:

a. The Consultant

The Consultant shall enter into the consultancy agreement with CGWB for the services described below after the E/N is exchanged between the Governments regarding the grant aid of the Project:

(1) The Detailed Design for the procurement of the equipment and the preparation of the tender documents for the Project.
(2) The tendering services on behalf of CGWB and the evaluation on the tendering.
(3) The support and advice during the tendering process from the opening the tender to the contracting.
(4) The supervision on the procurement, transport and rating test for the Equipment performed by the engineer dispatched from Japan.
(5) The planning of the commissioning of the equipment.
(6) Inspection of the equipment.
(7) Reporting.

b. The Contractor

The Contractor shall procure the equipment in accordance with the supply contract and ship the equipment to the locations specified in the contract within the period contracted. Also the Contractor shall despatch engineers to the specified places for the rating test for the Equipment as per the Contract. The rating test includes inspection, installation, start-up test and rating of the Equipment.

4.4.7 Implementation Responsibilities

I. Responsibilities of the Japanese Side

(1) The procurement and transport of the equipment described in 4.3.
(2) Despatching engineers for rating test for the Equipment described in (1).
(3) The consultancy services for the above (1) and (2).

II. Responsibilities of the Indian Side

(1) The provision of spaces and facilities necessary for the installation and operation of the equipment at three Chemical Laboratories.
(2) Bearing commissions to the foreign exchange bank in Japan for the banking services based upon the Banking Arrangement.
(3) Smooth enforcement of administrative measures necessary for the implementation of the Project such as the obtaining exemptions or paying taxes and taking necessary measures for customs clearance of the equipment, furnishing data and information.
(4) Obtaining tax exemption related to the Japanese despatched from Japan for the implementation of the Project and protecting them by all possible means during their stay in India.
(5) Preparation of an appropriate managing and maintenance organisation with personnel and budget required for functioning properly the equipment to be procured.

4.4.8 Plan for the Technology Transfer

No technology transfer is required. It is advisable to select such equipment that a well established after sales services network is provided in India and/or neighbouring countries.

4.4.9 Implementation Schedule

The Project starts when the E/N is exchanged between the Government of Japan and the Government of India for the grant aid of the Project and is necessitated to be completed in the fiscal year. In case the completion of the Project deems impossible within the fiscal year, one year of extension can be allowed provided the verification by the Japanese Government.

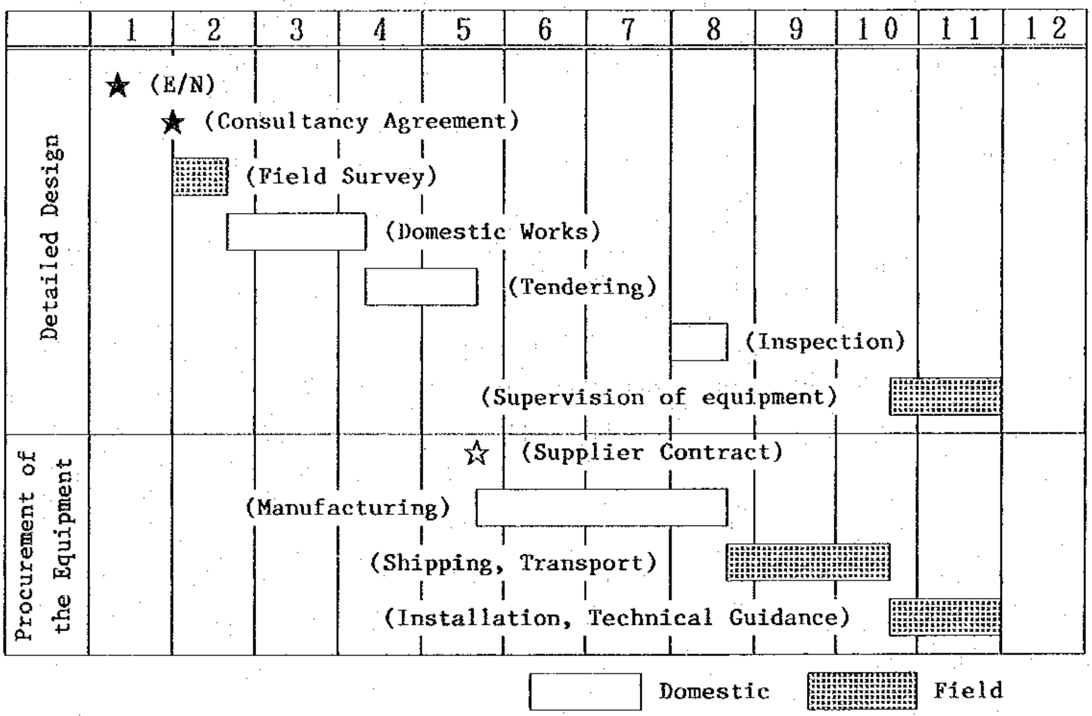
CGWB is as the executing agency to enter a Consultancy Agreement with a Japanese Consultant firm for the Project. The Consultant firm shall conduct the Detailed Design and prepare the tender documents after the verification of the Consultancy Agreement by the Japanese Government, and carry out the tendering on behalf of CGWB in Japan after the approval of the tender documents by both Governments. The Consultant firm will conduct procedures from the tendering to the contacting of the Supply Contract supporting or on behalf of CGWB, and during this period the firm will conduct the whole services of the tendering the evaluation of the tendering, the negotiation between CGWB and the successful tenderer, and the signing of the Supply Contract.

The Supply Contract shall be effective after the verification by the Government of Japan. It may take about 4 months until the signing of the Supply Contract after the E/N is exchanged.

The Contractor shall start procurement of the equipment after the verification of the Supply Contract. The Contractor shall need 4 months for delivery, 2 months for ocean transport, customs clearance and inland transport in India, and 1.5 months for the commissioning of the equipment (installation and rating test).

The implementation schedule is exhibited in Table-4.4.4.

Table-4.4.4 The Implementation Schedule



4.4.10 Procurement of the Equipment

CGWB shall procure the equipment related to the Project under the grant aid. The Contractor shall procure materials for the installation of the equipment directly contacted to the equipment and those materials shall be included in installation costs of the equipment. CGWB shall provide and prepare the space and facilities for the equipment before the installation. Estimated costs to be provided by CGWB are as follows:

Anti-dust measure cost:	248 thousand Rupees
Operation and maintenance cost:	1,261 thousand Rupees/year

4.5 MAINTENANCE AND MANAGEMENT PLAN

4.5.1 Maintenance and Management System

The equipment for water quality monitoring to be procured by the Project will be used for the analysis of groundwater samples in the entire India and the activities of the Project will be related to all the Chemical Laboratories of CGWB. If each chemical Laboratory is managed individually, the problems of the traceability of data and the loss of personnel, equipment and consumable materials. Therefore, the Project should be implemented under the united policies of CGWB and it is essential to provide an appropriate managerial and maintenance system for the equipment procured by the Project in order to sustain the equipment in a good condition a long period, to utilise the analysed results to prevent water pollution. Here, it is recommended to establish a Committee / Sub-Committee organisation to formulate the goals and long-term projections and to make necessary measures to obtain an effective and efficient managerial, operational and maintenance organisation under the goals and the long-term projections through standardisation. The maintenance and management system will be formed a part of this organisation. Asterisk (*) designates the maintenance and management. The Committee and Sub-committee organisation is explained briefly as follows:

(1) Operation Committee
  1) Long-Term Projections Sub-Committee
  2) Management Sub-Committee
  3) Analysis Sub-Committee
  4) Standardisation Sub-Committee
  5) Technical Sub-Committee (New Technology)
  6) Precision Control Sub-Committee
  7) Data-Bank Sub-Committee

(2) Long-Term Projections Sub-Committee
  1) Operation Goals
  2) Long-Term Projections

(3) Management Sub-Committee

1) Evaluation of Analysis Results
2) Evaluation of Equipment Control*
3) Equipment Plan
4) Personnel Plan and Training Plan*
5) Cost Control*

(4) Standardisation Sub-Committee

1) Analysis Procedures
2) Pre-treatment Study
3) Rational Adjustment of Reagents and Standard Reagents
4) Sampling Method and Storing Method of Samples
5) Data Analysis

(5) Materials Control Sub-Committee

1) Inventory Control*
2) Procurement of Consumable Materials and Consumable Parts*
3) Standardisation of Materials*

(6) Technical Sub-Committee

1) Training and Seminar Programme*
2) Improvement of Operation and Works*
3) Reporting Meeting

(7) Precision Control Sub-Committee

1) Inspection Manual and Periodical Inspection*
2) Provision of Equipment and Facilities for Precision Control*
3) Precision Control System from Sampling to Waste Treatment

(8) Data Bank Sub-Committee

1) Data for Operation of the Equipment*
2) Data for Samples
3) Data for Analysing Results
4) Data for Causes of Contamination
5) Data for Training and Personnel

4.5.2 Operation Costs

The operation costs can be calculated based on the procurement plan for the equipment (4.4.5.); the annual operation costs for each equipment is shown in Table-4.5.1. The operation costs consist of electric power, gases, consumable materials, consumable parts and repairing. The consumable parts for operation of 2 years shall be procured as spare-parts; therefore, the consumable parts may not be needed for the first 2 years.

Table-4.5.2 through 4.5.6 exhibit the annual operation costs at Lucknow, Calcutta, Hyderabad, and CGWB as a whole. Those tables contain depreciation of the equipment as 7 years of life. Those will be the costs if CGWB procures the equipment by itself.

Table-4.5.1 Annual Operation and Maintenance Cost for the Equipment

Rs./unit
(Yen)

	ICP	AA	GC(A)	GC(B)	TOC W/Purifier	SAA	IM	VZS	TWT
Electri-city	6,500.00 (22,295)	24,500.00 (84,035)	4,000.00 (13,720)	4,000.00 (13,720)	2,400.00 (823,200)	100.00 (343)	400.00 (1,372)	- (-)	24.00 (82)
Gas	360,000.00 (1,234,800)	77,250.00 (264,968)	14,375.00 (35,587)	6,250.00 (21,362)	- (-)	- (-)	- (-)	- (-)	- (-)
Regent Cost	4,111.00 (13,720)	4,600.00 (15,778)	3,600.00 (12,348)	3,600.00 (12,348)	1,200.00 (4,116)	1,680.00 (5,762)	9,000.00 (30,870)	- (-)	- (-)
Consumable Items	6,413.94 (22,000)	11,632.71 (39,900)	15,393.60 (52,800)	15,393.60 (52,800)	2,361.47 (8,100)	11,545.30 (39,600)	4,227.45 (14,500)	- (-)	932.95 (3,200)
Consumable Parts	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Repairing	8,000.00 (27,440)	8,000.00 (27,440)	8,000.00 (27,440)	8,000.00 (27,440)	4,000.00 (13,720)	2,000.00 (6,860)	2,000.00 (6,860)	- (-)	- (-)
Total	384,913.94 (1,320,255)	125,982.71 (432,121)	45,368.60 (141,895)	37,243.60 (127,746)	9,961.47 (34,168)	15,325.30 (52,565)	15,627.45 (53,602)	- (-)	956.95 (3,282)

Table-4.5.2 The Cost of Depreciation for the Equipment

(Rs./Unit)

Type of Equipment	Lucknow	Calcutta	Hyderabad
ICP	-	-	1,582,639
AA	680,351	680,910	678,115
GC(A)	294,478	-	-
GC(B)	329,996	-	-
TOC	-	284,132	-
SAA	95,358	-	-
IM	120,924	-	-
VZS	14,963	-	-
TWT	80,683	80,825	80,117

Table-4.5.3 Operation and Maintenance Cost at Lucknow

No.	Equipment	No.of Units	Operation and Maintenance Cost (a Year) 1,000 Rs/Unit		
			Depreciation	Cost of Consumable Items and Repairing	Sub-total
1	ICP	1	0	0	0
2	AA	1	680	126	806
3	GC(A)	1	294	45	339
4	GC(B)	1	330	37	367
5	TOC	0	0	0	0
6	SAA	2	190	31	221
7	IM	2	242	31	273
8	VZS	2	30	0	30
9	TWT	1	81	1	82
Grand-Total			1,847	271	2,118

Table-4.5.4 Operation and Maintenance Cost at Calcutta

No.	Equipment	No.of Units	Operation and Maintenance Cost (a Year) 1,000 Rs./Unit		
			Depreciation	Cost of Consumable Items and Repairing	Sub-total
1	ICP	0	0	0	0
2	AA	1	678	126	804
3	GC(A)	0	0	0	0
4	GC(B)	0	0	0	0
5	TOC	1	284	11	295
6	SAA	1	95	15	110
7	IM	1	121	15	136
8	VZS	2	30	0	30
9	TWT	1	80	1	81
Grand-Total			1,288	168	1,456

Table-4.5.5 Operation and Maintenance Cost at Hyderabad

No.	Equipment	No.of Units	Operation and Maintenance Cost (a Year) 1,000 Rs./Unit		
			Depreciation	Cost of Consumable Items and Repairing	Sub-total
1	ICP	1	1,583	385	1,968
2	AA	1	681	126	807
3	GC(A)	0	0	0	0
4	GC(B)	0	0	0	0
5	TOC	0	0	0	0
6	SAA	1	95	16	111
7	IM	1	121	15	136
8	VZS	2	30	0	30
9	TWT	1	81	1	82
Grand-Total			2,591	543	3,134

Table-4.5.6 Operation and Maintenance Cost at Whole CGWB

No.	Equipment	No.of Units	Operation and Maintenance Cost (per Year) 1,000 Rs./Unit		
			Depreciation	Cost of Consumable Items and Repairing	Sub-total
1	ICP	1	1,583	385	1,968
2	AA	3	2,039	378	2,417
3	GC(A)	1	294	45	339
4	GC(B)	1	330	37	367
5	TOC	1	284	11	295
6	SAA	13	1,235	203	1,438
7	IM	13	1,573	199	1,772
8	VZS	24	360	0	360
9	TWT	3	242	3	245
Grand-Total			7,940	1,261	9,201

The operation and maintenance cost per year is calculated to be 1,261 thousand Rupees for the cost of consumable items and repairing and to be 9,201 thousand Rupees as total. Those amounts are 0.2% and 1.7% to CGWB budget (550,000 thousand Rupees for 1994/95 shown in Table-3.3.2), respectively. CGWB is capable of provision of 1,261 thousand Rupees for the consumable items and repairing but it is advisable to collect analysing fees to recover the investment.

4.5.3 Considerations and Recommendations Regarding Maintenance

Considerations for maintenance of the Project equipment and recommendations for the implementation of appropriate maintenance of the Project equipment are shown in Table-4.5.7.

Table-4.5.7 Considerations and Recommendations Regarding Maintenance

Equipment	Considerations	Recommendation
ICP & AA	Sensitive to the dusts in the room to be taken in the samples and reagents because of high sensitivity measuring equipment.	(1)Rooms shall be floored with Linoleum or similar. (2)Outside shoes should be changed before entering. (3)Doors should be kept closed. (4)Utilise A/C.
	Vibration will affectt because the equipment is a sort of photo measuring equipment.	(1)To keep away from the vibration sources (roads, rail roads, compressor, etc.) (2)Better not to install on the top floor due to enlarged vibrations.
	Stability of electric power supply is important because the stable measurement can be obtained by the stable generation of high frequency wave.	(1)To receive the electric power within the range of voltage of variation which AVR can with stand.
AA	Some important parts are made of glass like Plasma Torch and Nebuliser and easy to be cracked by wears.	(1)Often and careful check on glass parts should be carried out.
	An over current may disturb the surrounding equipments with the same electric power with Furnace method because it requires a huge current for atomisation.	(1)Use special circuit
	Hollow Cathode Lamp is fragile and easy for damage.	(1)Careful handling is needed because major causes of failure are mistreatment during handling or storing.

Equipment	Considerations	Recommendations
GC	If low grade carrier gas is used the base of analysis becomes unstable and the life of the detector will be shortened.	The system should be carefully inspected together with suppliers to control the cylinder and regulators to avoid the contamination by the air.
	Column will degrade when it is used in a long period, then the base will be unstable and components shall be overlapped.	(1)To learn the judgement of the change in the performance appropriately. (2)To learn the skills to select appropriately. Type of Packing Method to suit the sample to be analysed.
TOC	TC catalyst is expensive and wears. High sensitivity TC catalyst will wear very rapidly when its concentration of the samples becomes higher.	First use the standard TC catalyst and determine the concentration. Secondly use the High Sensitivity catalyst to determine the low concentration. Opposite order is disastrous.
	The purity of the high purity air will determine the accuracy of analysis like GC.	(1)Use high purity air (2)Good care should be attended to handle the cylinder and regulators.
	The water sample can be contaminated easily with CO_2 and/or CH_4 in air (5 ppb inspection sensitivity)	(1)To avoid air contamination while sampling. (2)To avoid air contamination while analysis. Hydrogen Carbonates and CO_2 in the laboratory air can contaminate the sample.

Equipment	Considerations	Recommendations
SAA	Analysis results may depend upon the dispersing method, the injection method of reagents, and the preparation method of standard reagents.	(1)Reagents to be adjusted at Central Chemical Laboratory. (2)The analysing works should be standardised. (3)The standard reagents should be prepared at the Central Chemical Laboratory so that the precision of analysis can be controlled.
	Experience with the system determines the analysis efficiency.	For some elements, manual analysis may give higher efficiency. Therefore, CGWB is advised to be flexible regarding analysis method.
IM	Analysis results depend upon the cleanness of electrodes.	It is important to maintain system following operation manuals to secure cleanness of electrodes after analysis because the maintenance conditions affect the degradation of electrodes.
	Analysis accuracy depends upon the purity of reagents and standard reagents.	Central Chemical Laboratory should adjust and control reagents and standard reagents so that analysis accuracy can be controlled.
TWT	Operation costs depend upon the volume of water treatment.	The waste disposal should be selectively treated based on the contents; only wastes containing toxic elements such as Hg should be treated with this equipment; rest of wastes should be pH-adjusted and disposed after dilution. Also the operation costs should be minimised by evaporating the wastes for a period (eg. one month) to reduce the treatment frequency by decreasing the volume of treatment.

CHAPTER V

PROJECT EVALUATION AND CONCLUSION

CHAPTER V

PROJECT EVALUATION AND CONCLUSION

5.1 PROJECT EVALUATION AND CONCLUSION

It is clear that the Project is important and feasible for India who may need to establish urgent countermeasures against water pollution caused by the unsustainable development if the position and the priority of the supply of clean drinking water and the prevention of water pollution in the Eighth Five Year Plan is considered. The effects of the Project for CGWB who is carrying out the water quality monitoring for groundwater throughout the country and the 17 industrial estates specified by the Ministry of Environment and Forests can be summarised as shown in Table-5.1.1.

Table-5.1.1 Effects and Degree of Improvement in the Present Situation through the Implementation of the Project

	Current Problems	Project Solution	Effect of the Project and Degree of Improvement
Heavy Metals	CGWB is currently using AA for Heavy metal analysis. However, the number of water samples analysed with AA seems to be approximately 20% of the required capacity. The improvement of the analysis capacity is desired.	Supply 1 ICP and 3 AAs.	By using ICP for simultaneous analysis of multiple elements, and AA for single element analysis for special elements, CGWB will be able to analyse heavy metals for a large number of water samples with high accuracy.
Organic Compounds	Although the groundwater pollution by the industrial waste and pesticides is reportedly observed in India, CGWB has seemingly conducted few analyses for organic compounds which are likely to be the major pollutants due to the lack of effective equipment for organic compound analysis.	Supply 2 GCs and 1 TOC	It is recommended that CGWB be equipped only with GC and TOC which allows high accuracy analysis for organic compounds in this stage, and that CGWB shall concentrate on the construction of the Chromatographical technology because this equipment is new to CGWB. More sophisticated analysis equipment such as Ion Chromatograph, High Performance Liquid Chromatograph, GC/MS shall be introduced after CGWB builds-up sound foundation along with the accumulation of technology and experience of GC.
Elements and Inorganic Compounds	The accuracy and the capacity of the analysis is a problematic area for CGWB because basically the manual analysis is being employed.	Supply 13 SAAs and 13 IMs	It will be possible to improve in both capacity and accuracy of analysis. And it will be possible to analyse many water samples close to the sampling points. This may lead to the technical improvement of Chemical Laboratories.

5.2 EXAMINATION OF FEASIBILITY

It is, therefore, concluded as being feasible to implement the Project under the grant aid scheme since the implementation of the Project will have foreseeable, important and urgent effects and a marginal budget for CGWB for the implementation of the Project will be 0.2% of their budget, CGWB is evaluated to be able to provide the budget for the operation and maintenance for the Project, and CGWB is also evaluated to provide management and technical capabilities fo the implementation of the Project. At the same time, the Project is considered to contribute to an improvement in the health and sanitation environment in India through monitoring for heavy metals and organic compounds. Thus, it is concluded that the Project is feasible and appropriate as a grant aid programme.

5.3 RECOMMENDATIONS

It is recommended that CGWB take the following measures in order to effectively and smoothly implement the Project.

(1) Provision of Spaces for the Equipment

It is necessary to provide spaces where the equipment supplied in the Project will be installed. The present Chemical Laboratories in Lucknow, Calcutta and Hyderabad can be the locations because the equipment of the Project need regular type of air conditioning and all of the Chemical Laboratories are equipped with such air conditioners. In such cases, minor reforms shall be needed which include anti-dust measures like the dust tight door, the use of room shoes, etc, because ICP and AA are high precision photo analysis equipment. CGWB has the construction plans of Regional Offices in Lucknow and Calcutta. The construction works were approved in March 1994, and CGWB considers that the construction works will be completed in March 1995. It is requested to provide the back-up generation system in addition to the supply of water and electricity.

(2) Provision of Budget

The Project will be the starting point for CGWB for the full-scale equipment analysis; this means CGWB may need budget for new items and may also need a significantly increased budget. Since all these are necessary, CGWB is requested to provide sufficient budget for operation and maintenance including repairing costs for regular inspections and spare parts beforehand.

(3) Recruiting Personnel

As a general rule, the personnel necessary to conduct equipment analysis can be recruited from the present employees of CGWB, and it is desirable to select those based the requirements explained in 4.4.3.

Since GC is new to CGWB, the priority of employee selection should be given to those who have the experience.

(4) Formulation of Committee / Sub-committee

The implementation of the Project is to improve the water quality monitoring system for groundwater in India and to enact the formulation not only for CGWB but also the entire India. Therefore, it is recommended to formulate and conduct a committee / sub-committee system, formed by 12 Chemical Laboratories, to establish the goals and long term projections, and manage the water quality monitoring system based on the goals and projections, and the effective and efficient management, operation, and maintenance of the water quality monitoring shall be conducted through standardisation.

(5) Maintenance Programme

It is recommended for CGWB to conduct a regular examination at least once a year. Therefore, it is recommended for CGWB to establish an effective control system by preparing a regular examination manual and examination system with control ledgers. Also, it is recommended for CGWB to provide a manual for regular inspection once a month and inspection before beginning work, and it is requested for CGWB to conduct inspections according to the manual.

(6) Supply of Consumable Goods

It is recommended for CGWB to provide the supply plan for consumable goods, such as various gases, reagents, standard reagents along with a budget calculated behorehand and a control system which facilitates the steady supply of the necessary goods to each Chemical Laboratory with an appropriate control ledgers. It is recommended for CGWB to adjust and prepare standard reagents (standard) within CGWB, and establish an internal supply system to deliver them on a regular basis to the Chemical Laboratory. It is necessary for CGWB to ensure the traceability of the analysis results.

(7) Provision of Job Manuals

It is recommended for CGWB to prepare the managers' manuals for Laboratory-in-charge so that the Laboratory-in-charge can conduct their managerial jobs for chemical analysis and the operators' manuals so that the equipment operators can understand their jobs properly and maintain and improve their skill levels progressively.

(8) Establishing Task Force for Emergent Accidental Water Pollution

It is necessary for CGWB to establish a mobile system by which CGWB can take proper action against the emergent disposal of industrial wastes. Therefore, it is necessary for CGWB to provide a mobile system with appropriate equipment like the portable ion meter which can be taken to the fields and used effectively in cases of accidents.

(9) Overall Accuracy Management

It is recommended for CGWB to check and maintain the whole process in a high standard, from collecting samples to data storing via analyses and data processing. CGWB may need to make some improvements in sampling method (examination of sample bottle), coordination of the sampling plan and the analysis plan, transportation and storing management of samples as well as the improvement in analysis technology.

(10) Examinations of Sampling Time

The period for water sampling is concentrated between April and May (pre-monsoon) at hydrographic stations. However, if the water samples are taken during other seasons, at hydrographic stations or at areas where element concentration is not influenced by the season, this will be useful in balancing the volume of analysis and the water quality monitoring easier.

(11) Examinations of Cost Recovery

It is highly recommended for CGWB to examine the possibility of the beneficiaries to pay for the analysis costs. If it is possible, CGWB may have more possibility of depreciating the equipment and of the renewal of those.

APPENDICES

MINUTES OF DISCUSSIONS
BASIC DESIGN STUDY ON THE PROJECT FOR EXPLOITATION OF GROUNDWATER IN INDIA

In response to a request from the Government of India, the Government of Japan decided to conduct a Basic Design Study on the Subject of Exploitation of Groundwater in India (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent a study team to India, which is headed by Dr. Yuji Maruo, Senior Development Specialist, JICA, and is scheduled to stay in the country from December 1 to December 20, 1993.

The team held a series of discussions with the concerned officials in the Central Ground Water Board (hereinafter referred to as "Indian Side") and conducted a field survey of the proposed project area.

During the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The team will proceed to further works and prepare the Basic Design Study Report.

New Delhi, 19th January, 1994

Mr. Minoru SASAGO
Resident Representative
JICA India Office

M.L. Chaurasia
Chief Engineer & Member
Central Ground Water Board
Ministry of Water Resources

ATTACHMENT

To the Minutes of Discussions dated 20, December, 1993
Concerning the Project "Exploitation of Groundwater in India"

1. Objective

The objective of the Project is to provide adequate and sustained supplies of water for meeting the requirements of drinking, domestic and other various uses and to strengthen the facilities for monitoring groundwater quality/pollution in the country.

2. Project Sites

The major Project Sites are as follows:

(1) For Water Quality Monitoring and Environment Protection Equipments:
3 to 4 Places, tentatively identified as Laboratories/offices of CGWB at Faridabad, Lucknow, Calcutta and Hyderabad

(2) For Mud Circulation Type Direct Rotary Drilling Rig: for the operation in alluvial areas

3. Executing Agency

Central Ground Water Board (CGWB) under the Ministry of Water Resources is responsible for the administration and execution of the Project.

4. Items requested by the Government of India

After discussions with the Basic Design Study Team, the following items were finally requested by the Indian side. The respective items are shown in Annex-I.

(1) Provision of Water Quality Monitoring and Environment Protection Equipments.

(2) Provision of Direct Rotary Drilling Rig and Tools. Accessories and spare parts

However, the final components of the Project will be decided after further studies.

5. Japan's Grant Aid System

(1) The Central Ground Water Board has understood the system of Japanese Grant Aid explained by the Team.

(2) The Central Ground Water Board will take necessary measures, described in Annex II for smooth implementation of the Project, after the Grant Aid Assistance by the Government of Japan is extended to the Project.

6. Schedule of the Study

(1) The Consultants will proceed to conduct further studies in India until December 20, 1993.

(2) Based on the Minutes of Discussions and technical examination of the study results, JICA will complete the final report and send it to the Central Ground Water Board, Government of India through JICA India Office by the end of March, 1994.

ANNEX-I

To the Minutes of Discussions dated 20, December, 1993

LIST OF REQUESTED EQUIPMENT

The following items of equipment are requested by Central Ground Water Board (CGWB). CGWB placed the first priority on A. and the second priority on B. of the following items.

A. WATER QUALTY MONITORING AND ENVIORONMENT PROTECTION EQUIPMENTS:

S.No.	Item of Equipment
1.	Inductively Coupled Plasma for heavy Metal (rare elements) Analysis.
2.	Gas Chromatograph for Analysis of Organic Elements a) To be equipped with Electron Capture Detector (ECD) . b) To be equipped with Flame Ionization detector (FID), Flame Photometric Detector (FPD) and Flame Thermo-ionic Detector (FTD)
3.	Auto-analyzer with multichannel system (2 to 3 channels)
4.	Atomic Absorption Spectrophotometer
5.	Selective Ion Meter with 12 electrodes (Two sets of 12 electrodes to be provided with each unit)
6.	Vadose Zone Samplers (with Semi-permeable membranes)
7.	Total Organic Carbon Analyser
8.	High Performance Liquid Chromatograph

B. DRILLING EQUIPMENTS:

Direct Rotary Mud-circulation Rotary Table type drilling rig capable of 204 mm diameter borehole upto a depth of 900 m using 4-1/2" drill rods. The rig should be mounted on a heavy duty truck and spare parts for at least 3 year requirements

ANNEX-II

To the Minutes of Discussions Dated 20, December, 1993

OBLIGATIONS OF CENTRAL GROUND WATER BOARD

The following measures are requested to be taken by the Indian side in case the Japan's Grant Aid is executed.

1. To secure the site for the Project.

2. To bear commissions to the foreign exchange bank in Japan for the banking services based upon the Banking Arrangement.

3. To obtain exemptions or pay taxes and take necessary measures for customs clearance of the materials and equipment brought for the Project at the ports of disembarkation.

4. To obtain exemption from payment of all taxes and duties on all goods, equipment and personal effects of the Japanese Consultants and Suppliers brought under the Project.

5. To accord Japanese Nationals whose services may be required in connection with the supply of products and the services under the Verified Contracts such facilities as may be necessary for their entry into India and stay therein for the performance of their work.

6. To ensure that the products purchased under the Grant

   a. be maintained and used properly and effectively for the execution of the Project.

   b. be operative in a laboratory with sufficient space and air conditioning.

   c. be supplied with necessary consumable materials like Ar, He for the execution of the Project.

   d. be secured from the regulations for radioisotope, high frequency radio, water and air treatments, and so on.

7. To provide all the counterpart personnel and bear all their expenses under the Project.

8. To bear all the expenses other than those covered by the Grant, necessary for the execution of the Project.

ANNEX-III

To the Minutes on Discussions dated 20, December, 1993

LIST OF PARTICIPANTS

JAPAN INTERNATIONAL COOPERATION AGENCY

1. Dr. Yuji MARUO — Team Leader
   Senior Development Specialist
   JICA

2. Mr. Masaru NAKAYAMA — Equipment Planner
   Japan Techno Co., Ltd.

3. Mr. Makoto YASUDA — Hydrogeologist
   Japan Techno Co., Ltd.

CENTRAL GROUND WATER BOARD

1 Dr. R. K. PRASAD
  Chairman
  Central Ground Water Board

2 Mr. M. L. CHAURASIA
  Cheif Engineer & Member, CGWB

3 Mr. S. C. SHARMA
  Secretary, CGWB

4. Mr. S. S. CHAUHAN
   Superintending Engineer, CGWB

5. Mr. S. R. TAMTA
   Scientist, CGWB

6. Mr. K. RAJAGOPALAN
   Scientist, CGWB

APPENDIX-2 LIST OF STUDY TEAM MEMBER

Yuji MARUO	Team Leader	Senior Development Specialist, JICA
Masaru NAKAYAMA	Equipment Planner	Japan Techno Co.,Ltd.
Makoto YASUDA	Hydrogeologist	Japan Techno Co.,Ltd.

APPENDIX-3 ITINERARY OF FIELD SURVEY

No.	Date	Day	Schedule	Activities
1	Dec. 1	Wed	Depart Tokyo Arrive Delhi	Depart from Tokyo for Delhi by AI-305
2	2	Thu	Delhi	Courtesy Call to the Embassy of Japan, JICA India Office, Ministry of Finance and Ministry of Water Resources. Discussion with CGWB.
3	3	Fri	Delhi	Discussion with CGWB.
4	4	Sat	Ambala	Site Visit (Division II Office)
5	5	Sun	Paonta Sahib	Site Visit (Phase-1, Part-2 sites)
6	6	Mon	Delhi Lucknow	Discussion with M. of Water Resources CI409 (17:20) DEP
7	7	Tue	Lucknow	Site Visit (Northern Regional Office)
8	8	Wed	Lucknow Delhi	CI436 (19:25) ARR Discussion with CGWB
9	9	Thu	Delhi	Discussion with CGWB
10	10	Fri	Delhi	Discussion with CGWB
11	11	Sat	Delhi Haldwani	Site Visit (Phase-1, Part-1 Sites)
12	12	Sun	Haldwani Delhi	Site Visit (Phase-1, Part-1 Sites) Discussion with CGWB
13	13	Mon	Delhi	Discussion with CGWB Meeting with JICA
14	14	Tue	Delhi Calcutta	Discussion with CGWB [Nakayama] Site Visit (Eastern R.O.) [Yasuda]
15	15	Wed	Delhi Calcutta Hyderabad	Discussion with CGWB [Nakayama] Site Visit (Eastern R.O.) [Yasuda]
16	16	Thu	Delhi Hyderabad	Discussion with CGWB [Nakayama] Site Visit (Eastern R.O.) [Yasuda]
17	17	Fri	Delhi	Discussion with CGWB
18	18	Sat	Delhi	Discission with CGWB
19	19	Sun	Delhi	Inner Meeting
20	20	Mon	Delhi	Discussion with CGWB Meeting with EOJ, JICA
21	21	Tue	Depart Delhi Arrive Tokyo	Depart from Delhi for Tokyo

APPENDIX-4 LIST OF PERSONS VISITED

Embassy of Japan in India

Mr. Katsutoshi Hama,	First Secretary
Mr. Hajime Matsuo,	First Secretary

Japan International Cooperation Agency India Office

Mr. Minoru Sasago,	Resident Representative
Mr. Masahiro Nomura,	Deputy Resident Representative
Mr. Toshifumi Sakai,	Deputy Resident Representative

Ministry of Finance

Department of Economic Affairs

Mrs. Rama Murali,	Joint Secretary

Ministry of Water Resources

Mr. Abhay Prakash,	Joint Secretary
Mrs.Promila Bharwaj,	Deputy Secretary

Central Ground Water Board (CGWB)

Dr. R.K. Prasad,	Chairman
Mr. M.L. Chaurasia,	Chief Engineer
Mr. S.C. Sharma,	Secretary
Mr. S.S. Chauhan,	Superintending Engineer

CGWB Division II (Ambala)

Mr. K.B. Biswas,	Executive Engineer
Mr. Malik,	Driller in Charge
Mr. Amar Chand,	Driller in Charge

CGWB Division III (Varanasi)

Mr. C.P. Gawri,	Executive Engineer
Mr. Yl.L. Goswami	Assistant Driller Cum Mechanics

CGWB Northern Regional Office (Lucknow)

Mr. S. Mukharajee,	Director
Mr. S.R. Tanta,	Scientist C. (Chemist)
Mr. K. Rajagopalan,	Scientist C. (Chemist) (Kerala Regional Office)
Mr. B.K. Singh,	Scientist C. (Hydrogeologist)
Dr. P.C. Chandra,	Scientist C. (Hydrogeologist)
Mr. V.N. Dube,	Scientist C. (Hydrogeologist)
Dr. S.B. Singh,	Scientist C. (Hydrogeologist)

CGWB Eastern Regional Office (Calcutta)

Mr. Sinha Ray,	Director
Mr. Banner Ges,	Scientist C. (Hydrogeologist)
Mr. P.C. Ghosh,	Scientist C. (Chemist)
Mr. S. Chaklandar,	Scientist C. (Hydrogeologist)

CGWB Southern Regional Office (Hyderabad)

Mr. Rao Mohan,	Director
Dr. A.N. Bhowmich,	Scientist D. (Geophist)
Mr. G. Dhoolappa,	Scientist D. (Hydrogeologist)
Mr. M.B. Rajo,	Scientist C. (Chemist)

Ministry of Environment and Forests, Department of Environment

Dr. Y.P. Kakar,	Director

APPENDIX- 5 LIST OF COLLECTED DATA

Name of Document	Publisher
CENSUS OF INDIA 1991 FINAL POPULATION TOTALS PAPER-1 OF 1992 VOL. I	Ministry of Water Resources
CENSUS OF INDIA 1991 FINAL POPULATION TOTALS PAPER-1 OF 1992 VOL. II	ditto
CENSUS OF INDIA 1991 FINAL POPULATION TOTALS PAPER-2 OF 1992 VOL. II	ditto
EIGHTH FIVE YEAR PLAN 1992-97 VOL. I	Planning Commission
EIGHTH FIVE YEAR PLAN 1992-97 VOL. II	ditto
ANNUAL REPORT 1990-91	Ministry of Water Resources
ANNUAL REPORT 1991-92 FARIDABAD	Central Ground Water Board
ANNUAL REPORT 1992-93 FARIDABAD	ditto
THE WATER (PREVENTION AND CONTROL OF POLLUTION) ACT,1974	Central Pollution Control Board
INDIA 1992	Ministry of Information & Broadcasting

APPENDIX - 6 COUNTRY DATA

1. Basic Indicators

①Country Name : India
②Capital City : New Delhi, Population of 290,000 (1991)
③Independence Day : August 15, 1947
④Land Area : 3,287,263 km²
⑤Population : 897,400,000 (est. 1993)
⑥Population Density : 273/km²
⑦Population Growth Rate : 2.1% (est. 1993)
⑧Urban Population Ratio : 25.7% (1991)
⑨Birth Rate : 31.0‰ (est. 1993)
⑩Infant Death Rate : 91.0‰ (est. 1993)
⑪Death Rate : 10.0‰ (1991)
⑫Average Life Span : 60 years (1991)
⑬Form of Government : Federal Republic System
⑭Sovereign : President Shanker Dayal Sharma (1994)
⑮Religion : Hindu (82.6%), Islam (11.4%), Christian (2.4%), Sikh (2.0%), Buddhists (0.7%), Jains (0.5%), Others (0.4%)
⑯Language : Hindi as official language, English as official language, 14 Regional official languages
⑰Trives : 7 trives, Turkish-Iranian, Indian-Aryans and others
⑱Education : Adult literacy Rate : Male 61.8% (1990)
Female 33.7% (1990)
All 48.2% (1990)
Primary School Attendance : 97%(1990)
⑲Currency : Rupee
: Exchange Rate against US$

1988	14.949/1 US$
1989	17.035/1 US$
1990	18.073/1 US$
1991	25.834/1 US$
1992	26.200/1 US$
1993	30.900/1 US$

APPENDIX-7 SUMMARY OF POLLUTION STUDIES IN INDIA
from CGWB's Annual Report (1992-1993)

14.0 POLLUTION STUDIES

CGWB is evaluating the impact of disposal of urban, industrial wastes and use of fertilizers, pesticides and insecticides on ground water regime. For this purpose a special study directorate has been set up. Regional Directorates are also carrying out these studies as special problem studies. Details are given below -

14.1 Ground Water Pollution Directorate

Ground water Pollution Directorate, Lucknow was actively engaged in collection and analysis of available data on ground water quality and studies related to groundwater pollution through activities like industrial, urban and Domestic waste etc. 50 monitoring stations (10 each) have been set up in KAVAL TOWN (Kanpur, Allahabad, Varanasi, Agra and Lucknow) of UP for periodic monitoring of groundwater pollution. Detailed water sampling was carried out in Agra district.

14.1.1 Industrial Pollution

Groundwater Pollution Studies in NOIDA, U.P. (200 sq kms).

Studies were carried out in NOIDA Phase I & II to study the effect of Industrial effluents on the ground water regime in the area. Since the area is in the stage of industrial development, it is essential to keep a constant monitoring of the ground water quality and obtain background quality data of the areas hitherto unaffected by industrial pollution. Ground water quality in top shallow aquifer is better than the underlying aquifer and quality further deteriorates with increase in depth.

Ground water pollution studies in Naini Industrial area, District Allahabad, U.P. (215 sq.km.)

Detailed studies in the area reveal nitrate pollution (55-980 mg/l) in more than 10 monitored wells. The maximum nitrate content (980 mg/l) has been observed in dugwell water of Dhanuha, due to intensive use of sewage water for irrigation in the area. In other areas, nitrate pollution may be due to poor sanitation and civic facilities.

Ground water pollution studies around Panki Thermal Power Plant, Kanpur (U.P.) (250 sq.km.)

It was observed that effluents from Thermal Power Plant, Fertilizer Factory (ICI), Lohia Machines Ltd., paint industries and other small scale industries are being discharged into Pandu river which is grossly polluted. Detailed analysis of 40 water samples collected from different monitoring stations reveal nitrate pollution (58-162 mg/l) in ground water whereas canal and river water posses very little nitrate (.2-3.6 mg/l). The main reason appears to be percolation of sewage water in ground water system. 7 water samples have also show chromium pollution

(0.18-6.35 mg/l)

15.1.2 Pollution due to urban & domestic wastes

Ground water pollution studies in Urban settlements of Varanasi City, UP (250 sq.km.)

Detailed analysis of water samples collected shows high nitrate concentration (66-284 mg/l) in dugwells. In an isolate case very high nitrate concentration (342 mg/l) was encountered in a hand pump which is located adjacent to sewage drain.

Ground water pollution studies in Urban settlement of Jaunpur City, UP (250 sq.km.)

In this area also, nitrate pollution was observed due to lack of sewage disposal system and use of nitrogen fertilizer around the city. Nitrate levels in dugwells range from 68-1250 mg/l, majority of samples falling in the range of 100 - 560 mg/l. In hand pumps (40 m depth) observed nitrate level range from 79-410 mg/l and in a deep tubewell (200 m depth) nitrate was observed as high as 560 mg/l.

14.2 Regional Directorates

Studies were carried out in Nakkavagu sub-basin around Pattanchuvu in Hyderabad Metropolitan.

Ground water pollution studies were carried out in 300 sq.km. area affected by Tannery pollution in North Arcot and Ambedkar Districts of Tamilnadu state. An area of 265 sq.km. was studied which is affected by Tannery pollution.

Studies were undertaken in and around Patna city, Bihar. Shallow aquifer is contaminated by bacteriological contamination, however, deep aquifer was not found affected.

Studies were carried out for determination of Arsenic content in Calcutta and Malda area of West Bengal. Arsenic content ranging from 0.06 - 0.29 ppm has been recorded from tubewell water (40-60 m.depth) in Kalichak, English Bazar and Manikchak blocks of Malda district. Ground water in these granular zones generally do not contain Arsenic except in few cases in Kalichak I & II. Arsenic content beyond permissible limit (0.1 mg/l) was recorded at Navanagar in a tubewell (42-45 m depth).

Investigation for ground water pollution in and around Jagiroad paper Mill, Assam were carried out.

Investigations are carried out in an area of 50 sq.km. in and around Greater Cochin area in Kerala state to find out pollution caused by effluents from Fertilizers and Chemicals Ltd. (Fact.). Analysis of 2 water samples from Irumbanam area shows that water is highly acidic in the wells situated close to the river, where the effluents are discharged from the FACT.

APPENDIX-8 OPERATION RECORD OF CABLE PERCUSSION RIGS PROCURED BY THE PHASE - 1 PROJECT AS OF DECEMBER 1993

Stage 1 (1989 Budget)	Haldwani, UP State
Rig. No. 1 (Open-hole Drilling)	
Site 1 (Ramdi Ansingh) Commissioned with Japanese Engineer	
Drilling Commenced	: 1991. 09. 20
Drilling Completed	: 1991. 12. 17
Total Depth	: 301.00 m
Commissioning Completed	: 1991. 12. 24
Pumping Test	: More than 2 m^3/min of pumping rate was confirmed.
Present Stuation	: Handed-over to UP State Government.
Site 3 (Khandelwal Park 1) Drilling Works by CGWB	
Drilling Commenced	: 1992. 07. 31
Drilling Completed	: 1993. 02. 05
Total Depth	: 135.25 m
Present Situation	: 18" Bit was stuck on 05 Feb.,1993 at the depth of 135.25 m in sticky clay which started at the depth of 114.00 m. The wire was slipped out from the Bit while CGWB was fishing the Bit on 10 Feb.,1993. Abandaned on 06 Jul.,1993.
Site 3' (Khandelwal Park 2) Drilling Works by CGWB. About 40 m apart from Site 3.	
Drilling Commenced	: 1993. 11. 29
Visited Date	: 1993. 12. 12
Depth	: 8.60 m
Present Situation	: Drilling with 24" Bit.

Rig No.2 (Cased-hole Drilling)	
Site 2 (Pataliya) Drilling Works by CGWB after Commissioned with Japanese Engineer.	
Drilling Commenced	: 1992. 02. 25
Commissioning Completed	: 1992. 06. 04
Depth	: 66.24 m
Drilling Completed	: 1993.11.15
Total Depth	: 150.60 m
Pumping Test	: More than 2 m^3/min of pumping rate was confirmed.
Present Situation	: Casing Pipes were set at the depth of 110.00 m. Handed over to UP State Government.
Site 4 (Gulzar Pur Bahki) Drilling Works by CGWB	
Drilling Commenced	: 1993. 08. 04
Visited Date	: 1993. 12. 12
Depth	: 30.90 m
Present Situation	: Drive Casing Pipes were set at 29.30 m.

Stage 2 (1990 Budget)	Paonta Sahib, Himachal Pradesh State

Rig No. 1 (Cased-hole Drilling)

Site 1 (Akalgarh) Drilling Works by CGWB after Commissioned with Japanese Engineer

Drilling Commenced	: 1992. 04. 30
Commissioning Completed	: 1992. 07. 30
Depth	: 23.30 m
Drilling Completed	: 1994. 02. 15
Total Depth	: 137.00 m
Present Situation	: Casing, Screens and Gravels were set. Development works were being made.

Rig No. 2 (Cased-hole Drilling)

Site 2 (Gondpur) Drlling Works by CGWB after Commissioned with Japanese Engineers.

Drilling Commenced	: 1992. 04. 30
Commissioning Completed	: 1993. 07. 30
Depth	: 38.25 m
Drilling Completed	: 1993. 06. 07
Total Depth	: 123.65 m
Present Situation	: Casing Pipes were installed at the depth of 110.00 m on 18 Jul.,1993. Development works were completed on Aug. 26, 1993. Pumping Test is to be tested. Rig was moved on 25 Sep.,1993.

Site 3 (Dhaulakuwa) Drilling Works by CGWB.

Drilling Commenced	: 1993. 10. 12
Visited Date	: 1993. 12. 05
Depth	: 13.50 m
Present Situation	: Drilling in a Boulder Loyer.

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