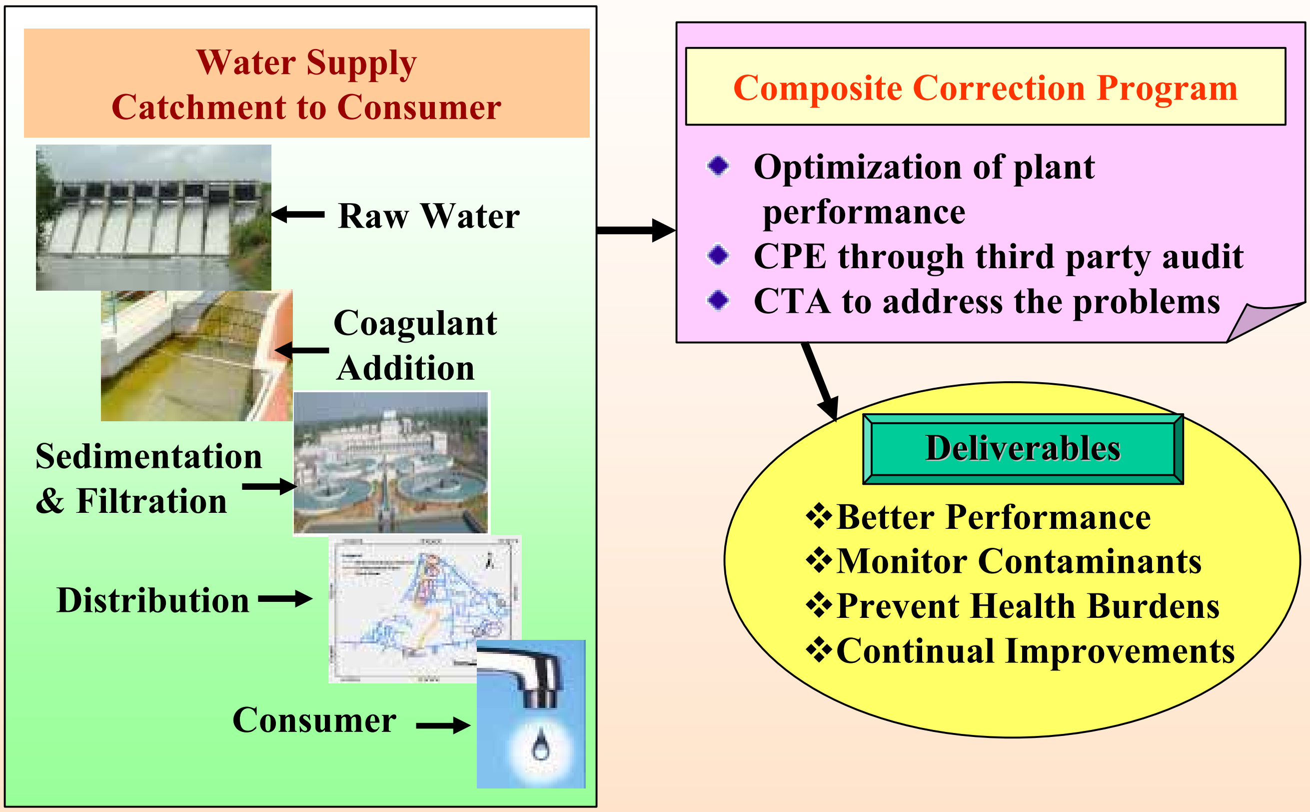
Final Report

Application of Composite Correction Programme for Improvement in Efficiency of Water Treatment Plant



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World Health Organization (WHO)

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Hyderabad Metropolitan Water Supply & Sewerage Board

Pune Municipal Corporation (Pune Water Works Authority)

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Executive Summary

1.0 Preamble

Safe drinking water is a basic need of all humans. To protect the human health, community water supply must be reliable, adequate, of assured quality and readily accessible to all segments of the consumers. In India as well as in many countries, the expected level of progress in providing one of the most basic services to the people viz., safe and affordable drinking water and sanitation have not yet been achieved. The current practices of water purification are seldom adequate to produce secured water supply. It is essential to develop various tools to improve water purification and distribution system to achieve the goal of providing safe drinking water.

Maintaining health protection at water supply systems has become more challenging in the recent years with the resistance of some pathogens to disinfection using chlorination and an increase in the immuno-compromised population (e.g., people with HIV, organ transplant patient, the elderly). Providing safe drinking water is mandatory to all water supply authorities. This goal can be achieved through implementation of modern approaches like Composite Correction Programme (CCP) and Water Safety Plans (WSP).

CCP is a water treatment plant optimization program that improves water treatment operation with limited capital investment by optimizing particle removal from water treatment plants. It has been reported that many microbial pathogens, particularly Cryptosporidium, are recalcitrant to disinfection due to their resistance to chlorine or escapes conventional treatment due to small size. With the application of achieving proper particle removal by improving water treatment processes, these pathogens can be removed and safe drinking water for citizens can be ensured.

On other hand Water safety plan (WSP) has wider approach to protect and provide safe drinking water. It attempts to address the overall issue of complete programme wherein a source to delivery of water to the consumers is mapped through different means to assess the risk of contamination at various levels. Formulation and implementation of WSP helps achieve better quality water in a sustainable manner by eliminating the possibilities of any risk of contamination. It leads to enormous health benefits as ensuring safe water supply provides high levels of health morbidity reduction in urban areas. Though these concepts are easily applicable to urban centers, it can also be applied in rural areas with piped water supply.

1.1 Concept of CCP

United States Environmental Protection Agency (USEPA) has been working towards developing regulation to control contamination from microbial pathogens in drinking water while concurrently addressing other issues as well. These new regulations are moving the water supply industry toward meeting more stringent water treatment requirements. Results of research and fieldwork support the concept of optimizing particle removal from water treatment facilities to maximize public health protection due to microbial contamination. After the development of Composite Correction Program (CCP), it has been demonstrated as a method of optimizing surface water treatment plant performance with respect to protection from microbial pathogens in a cost effective way in shorter time period.

The approach of CCP is based on diagnostic methods for effective use of the available water treatment processes to minimize particles (turbidity) to the finished water. Specific **performance goals** are used by the CCP approach to define optimum performance for key treatment processes such as sedimentation, filtration and disinfection. Strong evidence exists in support of maximizing public health protection by optimizing particle removal in a plant. Optimized water treatment performance for protection against microbial pathogens is defined by specific measurements and goals. These goal setting for water treatment are based on CCP field work performance. Some possible examples of setting performance goals are given below:

Specific Performance Goals for Unit Processes in Water Treatment

Process	Effluent Turbidity (NTU)	Inactivation of microbial population	Remarks
Sedimentation	<2.0 (95 percent of the time)*	-	
Filtration	<0.1 (95 percent of the time)	-	0.3NTU post backwash upto 15 min.
Disinfection	-	Giardia, Crystosporidium and viruses	#

* Settled water turbidity <1 NTU 95 % of the time when annual average raw water turbidity is < or equal to 10 NTU. Settled water turbidity < 2 NTU 95 % of the time when annual average raw turbidity is greater than 10 NTU

Concentration and Time (CT) values to achieve required log inactivation of Giardia and viruses.

Despite variability in source water quality, surface water treatment plants must produce consistently high quality finished water. Since inactivation of cryptosporidium is difficult to achieve with chlorine disinfection, maximizing particle removal could represent the most cost effective and viable option for maximizing public health protection from this microorganism.

PHASES OF CCP

- Comprehensive Performance Evaluation (CPE) or an Audit is carried out to review and analyze the plant's administrative, operational, and maintenance practices.
- Based on the factors causing suboptimal performance identified during the CPE, the *Comprehensive Technical Assistance (CTA)* is carried out to systematically address problems to improve plant performance.

BENEFITS

- Minimization of microbial health risks to public
- Improved control and operation of treatment works
- Improved water quality achieved with minimal capital outlay and minor changes to existing facility; with Cost effective performance improvements

1.2 Protection of Public Health from Microbial pathogens

Microbial pathogens including protozoan parasites, bacteria, and viruses, can be physically removed as particles during flocculation, sedimentation, and filtration. Effective use of these processes as part of multiple barriers strategy for microbial safety represents an operational approach for water system that chooses to optimize performance **(Figure 1)**. Consequently, the level of protection achieved in above processes can be increased by proper operation of the disinfection processes. The relationship between optimized water treatment plant performance and protection of public health from microbial pathogens can be evaluated through CCP. Turbidity monitoring is the most common method of assessing particle removal in surface water system, performance goals based on this parameter have been developed for the CCP to define optimized system performance.

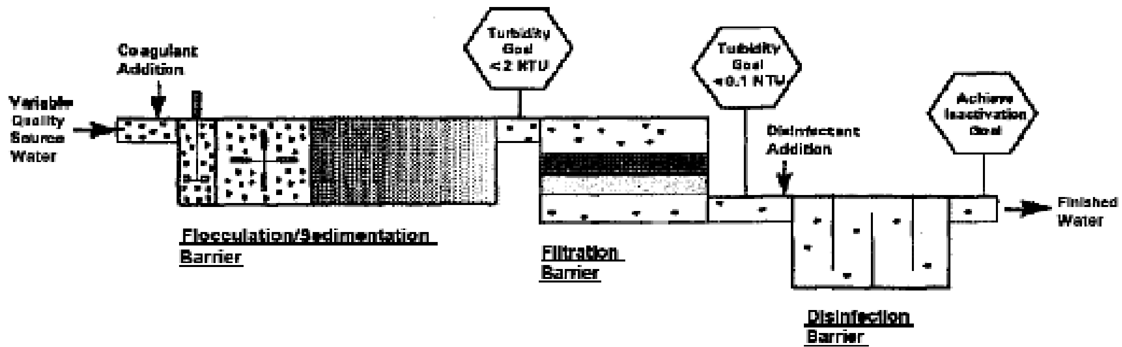


Figure 1: Multiple Barrier Strategy for Protection against Microbial Contamination

In 1996, the American Water Work Association Research Foundation conducted an optimization workshop with national water quality and treatment experts from throughout the industry. As a result of this workshop, a self-assessment handbook was published by AWWARF. This handbook, which follows the CCP approach, is intended to be a resource for water utilities that choose to conduct assessment to improve programmed.

2.0 Water Security Programmes in India: Case Studies

The National Environmental Engineering Research Institute (NEERI), a constituent laboratory of CSIR, in collaboration with USEPA is engaged in improving drinking water quality in India by facilitating the demonstration of the Composite Correction Program (CCP). With a view to demonstrating the efficacy of CCP, a study was initiated with following objectives:

- Initiate work on water quality and safety, improve water treatment performance, and reduce microbial contamination by demonstration of the Composite Correction Program.
- Improve water quality and thereby reduce the health burden of water-related diseases through enhanced safety of public drinking water supplies in 3 Indian cities.

The activity on WSP was taken up in Hyderabad city with the supply of WHO and USEPA. WSP is based upon preventive risk management as applied through “Hazard Analysis and Critical Control Points (HACCP) technique” utilized by the food manufacturing industry to effectively monitor and manage potential contamination of water and prevent public health burdens before they occur.

The main objective of this study is preparation of Water Safety Plan for Water Distribution System using Integrated Risk Assessment – Water Distribution System (IRA-WDS) software to predict the leakages in the under ground distribution system. Appropriate remedial measures can be undertaken with minimum efforts through WSP. The study covers identification of safety measures to protect the health of the user community. A complex modeling and risk assessment protocols are used to delineate the WSP based areas of improvement.

3.0 Selection of cities for CCP Study

Under this study programme, it was decided to carry out the composite correction programme in a water treatment plant in three different cities with varying systems of treatment plants operations.

The criteria of selection of the three cities were based on the willingness of the respective water supply agencies to undertake and support the CCP activity, logistics and infrastructure availability for carrying out the theoretical and practical activities in the treatment plant, ease of any temporary modification necessitated by the activity; and in view of their willingness to implement the recommendations proposed later in the CTA activity.

The engineering information of the water treatment plants have been collected for the performance evaluation of the unit processes to evaluate the adequacy of the treatment. The secondary data on water quality is collected and analyzed for assessment of status of water supplied to the beneficiaries and possible health risk. PSW software is used to evaluate the water quality. Details of CCP activities and responsibilities are presented in **Table 1**.

Table 1: Details of CCP activities

Project Task	Project Activity	Outcome/ Result
Identify teams of all three cities and collate information about Treatment plants for CCP	Each city water supply entity identifies three members of various levels including managerial, supervisory and operation.	Each city identifies their team
Organize workshop at each city	Invitation and participation of all cities and EPA expert.	Workshops
Run preliminary assessment of Treatment plant at each city	Initial visit by CCP experts to treatment plants.	• To assess basic issues with the treatment plant • Set up data monitoring to conduct to CCP
3/4-day workshop to conduct CCP in each city	• Conduct audit of plant with auditors from two additional cities. • Provide equipment to treatment plant to make necessary measure.	To improve water treatment plant performance

Table 1 (Contd..): Details of CCP activities

Project Task	Project Activity	Outcome/ Result
Follow up session to enact CTA	Suggestions for implementation of technical changes based on CCP audit.	To understand operational reasons for sub optimal performance and suggests technical improvement
write a report for CCP based on Hyderabad, Pune and Delhi studies	Write report for CCP based on how the program was implemented.	To adapt USEPA's CCP material to the Indian context
Organize workshop to discuss report invite other cities in carrying out CCP	Invite the participation of several Indian cities to provide feedback for report. Discuss and refine the report for future use.	To produce a report for water treatment optimization that can be used throughout India.

In consultation with the respective water supply agencies, the three selected cities are Hyderabad, Pune and Delhi. For conducting CCP, workshops were held in all the three cities along with all the steps of CPE followed up by CTA. Steps of CCP, typically followed are given below:

- First Workshop was conducted in collaboration with and assistance of Hyderabad Metropolitan Water Supply & Sewerage Board (HMWS&SB) during May 14-17, 2007 at Asifnagar Water Treatment Plant, Hyderabad.
- Second workshop was held in collaboration with and assistance of Pune Municipal Corporation (PMC) during February 11-13, 2008 at Parvati Water Works, Pune.
- Third Workshop in the series was held in collaboration with and assistance of Delhi Jal Board during September 22-24, 2008 at Haiderpur Treatment Plant, New Delhi.

One of the objectives of the project was to carry out CPE and establish the trend of turbidity in raw and filtered water through continuous online monitoring equipment. CCP involves a 3-city round-robin, whereby engineers from two cities visit the water treatment facility of the third city to carry out an audit. These select engineers from all three plants visited all three cities in rotation. By the end, the treatment plant in each of these three cities got audited by two external agency, and the engineers of each plant have developed capability to carry out audits in future for other plants within their own cities or elsewhere.

Steps for a Comprehensive Performance Evaluation are:

1. Assessment of plant performance
2. Evaluation of major unit processes
3. Conducting the Interview
4. Identification and prioritization of performance limiting factors
5. Reporting results of the evaluation
6. The data required for carrying out CCP

The valuable inputs for above workshops provided by respective Water Works authorities and external audit have resulted in fruitful suggestions for improvement.

3.1 Hyderabad

Hyderabad, the capital of Andhra Pradesh state has a population of 7.3 millions. The city had faced severe water crisis in the past. However, Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) have succeeded in improving the water supply status of the city by tapping various sources from long distance reservoirs. Asifnagar WTP was constructed in year 1921, with water supply coming from Osmansagar. The treatment plant has conventional treatment processes as shown in **Figure 2** and **3**.

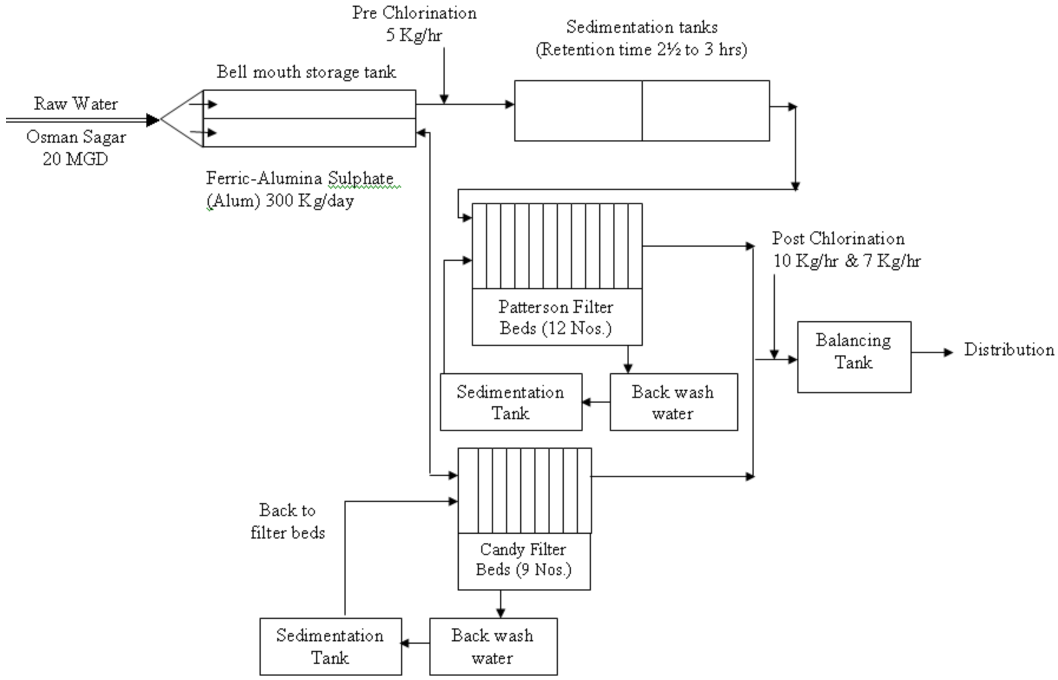


Figure 2: Flow Chart of Asif Nagar Water Treatment Plant

Figure 3: Sedimentation Basin and Elevated Service Reservoir at Asif Nagar Water Treatment Plant

Observation based on Secondary data

The performance data for Asifnagar water treatment plant during April 2006 to march 2007 was collected for evaluation. The analysis of the data on pH and turbidity of raw water is presented in **Figure 4**.

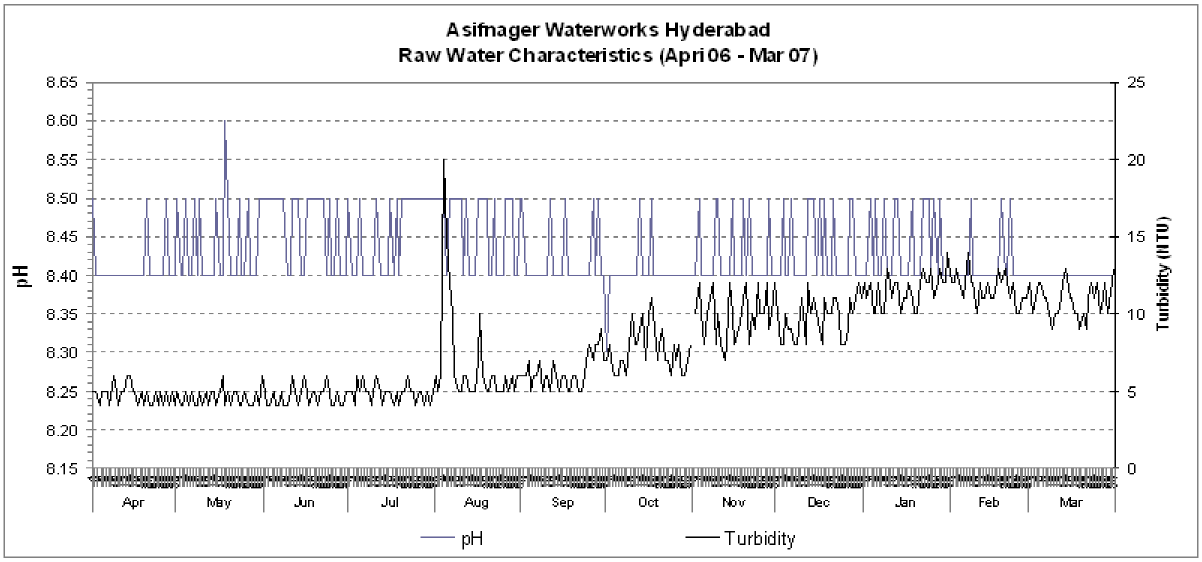
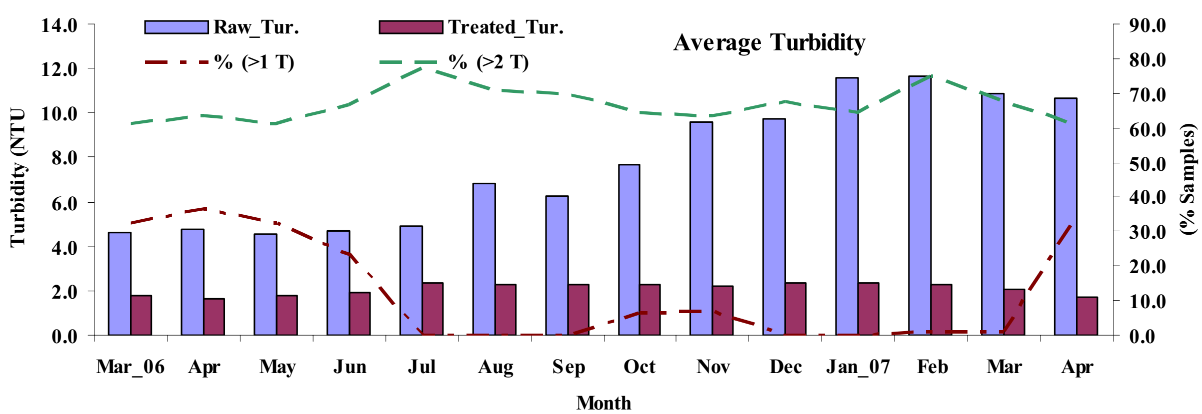


Figure 4: Raw Water Characteristics at Asifnagar Water Treatment Plant

It can be observed that the raw water turbidity was fairly low throughout the year ranging from about 4 to 14 NTU. However, the minimum values are observed during monsoon months and higher values during winter and pre monsoon period. The reasons for such trend need to be identified which may be either the change of methodology of determination or modifications in raw water inlet channel from source to water treatment plant. The filtrate quality has always complied with BIS 10500 standards for drinking water. However, the best performance with turbidity of finished water as 1 NTU was observed in less than about 30% of the samples. The frequency distribution with turbidity of 2 NTU and less was better ranging from 60 to 75 percent. The overall quality of filtrate was good while considering pH, turbidity and total coliform count.



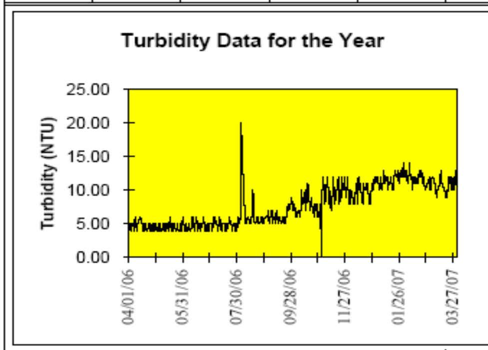
Partner for Safe Water (PSW) software was developed by American Water Works Association (AWWA) et al which provides major unit performance potential spreadsheet, graphs and treatment summary along with percentile distribution. The calculations provided with this software were not suitable for compliance with regulatory requirements. They were only to be used for assessing the relative / theoretical capacity of unit treatment processes as per of the PSW.

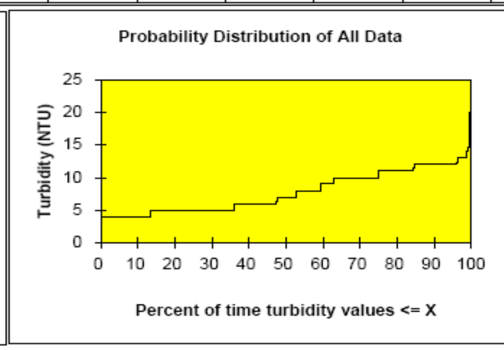
A percentile analysis can also be made using the data to determine the percent of time that raw, settled and finished water quality is equal to or less than certain turbidity. This information can be used to assess the variability of raw water turbidity and the performance of sedimentation and filtration unit processes. The percentile analysis of settled and finished water quality is useful to project a plant's capability to achieve optimized performance objectives.

The software was used to carry out performance evaluation of Asif Nagar water treatment plant based on one-year raw water turbidity data. It is observed that 80% of the times turbidity was below 10 NTU **(Figure 5)**.

HMW

Percentile	Yearly	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
50	7.00	5.00	4.00	5.00	5.00	6.00	6.00	7.00	10.00	10.00	12.00	12.00	11.00
75	10.25	5.00	5.00	5.00	5.00	6.00	7.00	8.00	11.00	11.00	12.00	12.00	12.00
90	12.00	5.10	5.00	5.10	6.00	10.00	8.00	10.00	12.00	11.00	13.00	13.00	12.00
95	12.00	6.00	5.50	6.00	6.00	13.50	8.00	10.00	12.00	11.50	13.00	13.00	12.50
96	12.00	6.00	5.80	6.00	6.00	14.40	8.00	10.00	12.00	11.80	13.00	13.00	12.80
97	13.00	6.00	6.00	6.00	6.00	15.50	8.13	10.10	12.00	12.00	13.10	13.19	13.00
98	13.00	6.00	6.00	6.00	6.00	17.00	8.42	10.40	12.00	12.00	13.40	13.46	13.00
99	13.37	6.00	6.00	6.00	6.00	18.50	8.71	10.70	12.00	12.00	13.70	13.73	13.00
Avg	7.75	4.73	4.55	4.67	4.87	6.81	6.23	7.68	9.93	9.74	11.55	11.64	10.90
Min	4.00	4.00	4.00	4.00	4.00	5.00	5.00	6.00	7.00	8.00	10.00	10.00	9.00
Max	20.00	6.00	6.00	6.00	6.00	20.00	9.00	11.00	12.00	12.00	14.00	14.00	13.00
RSD	39.2%	13.3%	13.5%	13.9%	12.5%	48.6%	16.9%	17.9%	15.2%	13.0%	9.3%	8.0%	10.0%





Start Year 2006 365 = Total Days
Month 4 12.00 = Total Months
Day 1

Utility Name	WTP
Plant Name	Asifnagar
Plant Street Address	Asifnagar
Plant City, State, Zip	Hyderabad
Plant Contact Name	Mr. Narsappa
Plant Phone	040-
Plant E-mail Address	0

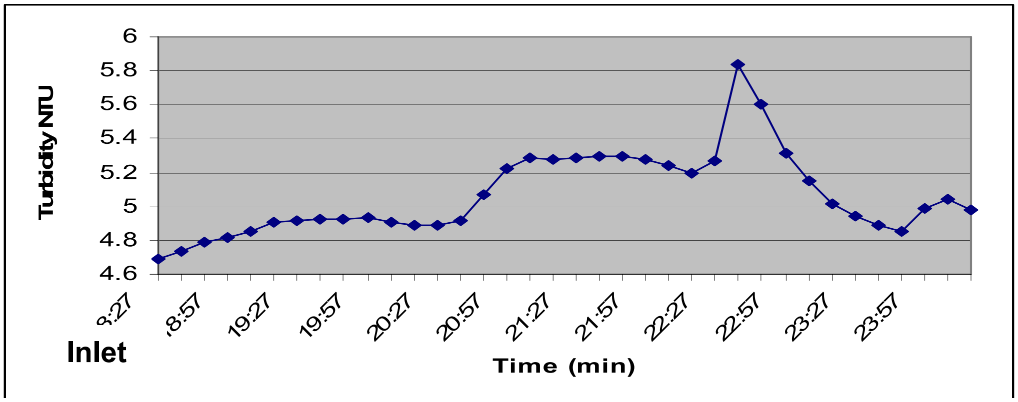
1Entry_Per_Day Hyderabad Statistical Results 5/20/2009

Figure 5: Turbidity data for raw water and probability distribution for Hyderabad Water Treatment Plant

Observation based on Primary data

Online continuous monitoring turbidity meter was installed at treatment plant filter beds for 24 hours recordings. The resulting output was presented in **Figure 6**.

The performance of filter bed under evaluation was very good with filtrate quality, turbidity always less than 1.2 NTU, when raw water turbidity was ranging from 4 to 14 NTU. The limited observations of one single battery of filters indicate that each filter bed behaves differently resulting in higher finished water turbidity as reflected by the plant data for 12 months. This observation clearly identifies the need for critical evaluation of each filter bed to meet best performance. Achieving low turbidity (<1 NTU) will give better confidence about maximum removal of microbial and biological indicator and pathogenic organisms.



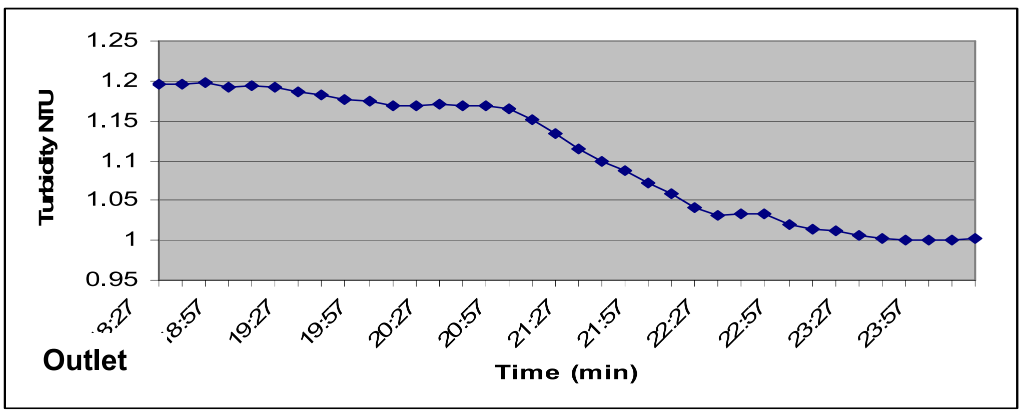


Figure 6 : Online continuous monitoring turbidity at Water Treatment Plant

Summary

The following salient observations and recommendations were made by the participants and communicated to the Managing Director, HMWSSB with a request to take up the identified issues for remedial measures.

Observations

- Necessity of raw water inflow measurement
- Implementation of Quality assessment and Quality control programme
- Essential tests (Jar Test and Chlorine demand) should be performed daily for proper chemical dosing
- Improvement in desludging methodology by enhancing frequency
- Renovations of filters for head loss measurements, troughs, inspection box cover etc.
- Water quality check for microbiology may be outsourced.

Recommendations

- Quality control department should store data for catchments to consumer in computer for checking the performance.
- Safety and disaster management plan should be prepared for plant operators
- Safety measurement plan for chlorine storage.
- Factory storage license for chlorine procurement.
- Capacity enhancement for balancing tank.
- Evaluation of reasons for high pH which hampers effective chlorination
- Online measurement of important quality parameters.
- Strengthening manpower with fresh technicians.

3.2 Pune

Pune is second largest city in the state of Maharashtra with the population of about 3.5 million. Pune Municipal Corporation provides treated water at the rate of 195 lpcd to 100 % population. There are six water treatment plants with total capacity of 1031 MLD. Parvati water work commissioned in two stages in year 1969 and in 1972 with Khadakwasala dam as source of supply was selected for the study. The plant has conventional treatment processes as shown in **Figure 7**.

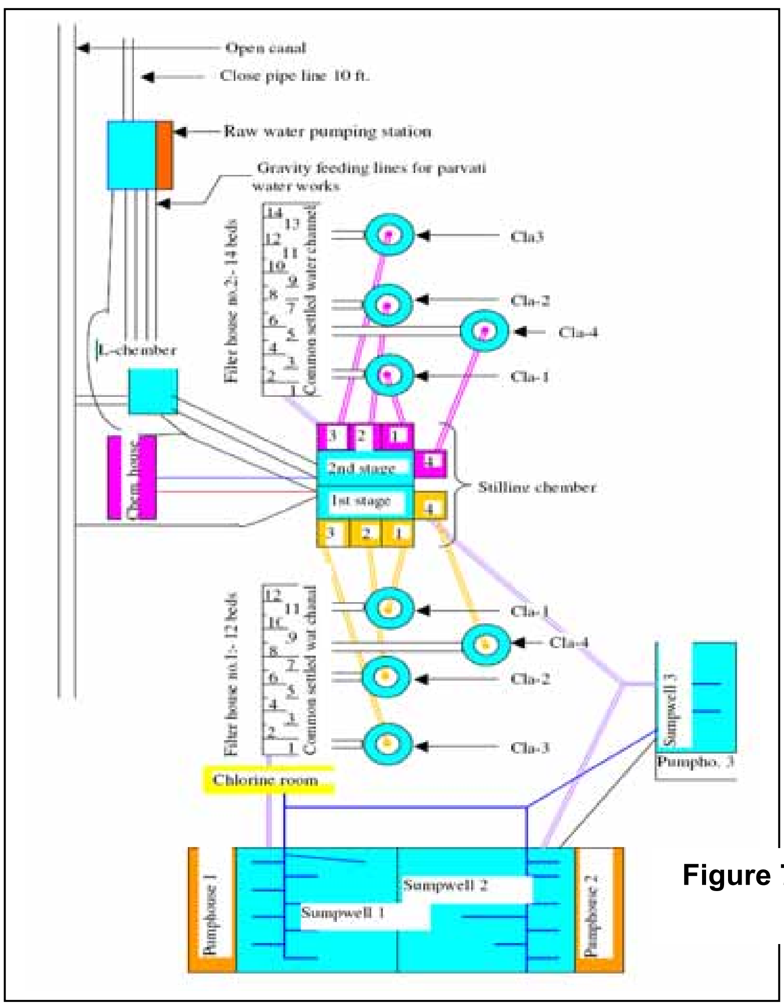


Figure 7: Flow sheet of Unit Processes at Parvati Water Works

Observation based on Secondary data

The performance data for Parvati Water Works during February 2007 to March 2008 was collected for evaluation. The analysis of the data on pH and turbidity of raw water is presented in **Figure 8**.

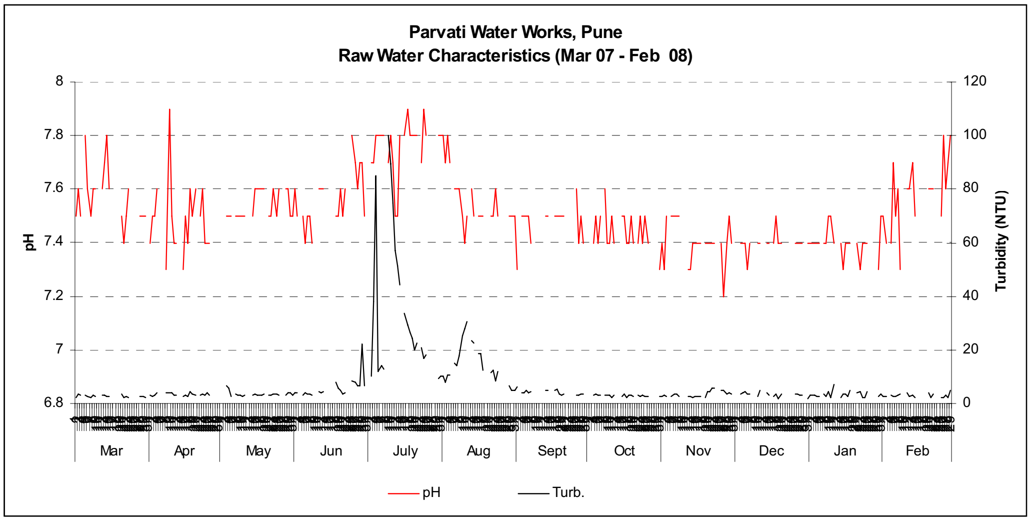


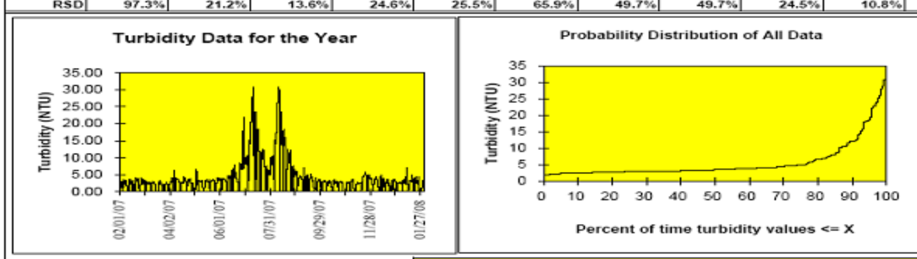
Figure 8: Raw Water Characteristics at Parvati Water Treatment Plant

From the data it is evident that raw water was characterized by low turbidity and slightly alkaline pH. Microbial count was found to be in the range of 80 to 1800+. Maximum turbidity of 100 NTU was recorded in July. Filtered water turbidity was in the range of 0.3-2.0 NTU in fare season. During monsoon the filtered water quality was poor with turbidity ranging from 1 to 25 NTU. Occasionally high TC values were also recorded indicating inadequate post chlorination.

The evaluation of water quality based on one-year raw water turbidity data using PSW software showed that 80% of the times turbidity was below 10 NTU **(Figure 9)**.

PMC

Percentile	Yearly	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08
50	3.50	3.30	2.70	3.10	3.20	4.60	12.20	12.20	4.08	2.90	2.90	3.40	2.89
75	4.91	3.68	2.90	3.88	3.55	6.81	18.45	18.45	4.85	3.01	4.30	3.70	3.89
90	12.10	3.96	3.13	4.19	4.08	7.89	24.86	24.86	5.38	3.28	4.80	4.01	4.30
95	18.42	4.12	3.41	4.49	5.54	8.56	27.81	27.81	6.19	3.40	5.52	4.35	4.78
96	21.16	4.13	3.42	4.79	5.80	10.74	28.41	28.41	6.39	3.43	5.62	4.44	5.15
97	22.89	4.15	3.44	5.17	5.97	13.55	28.98	28.98	6.60	3.47	5.67	4.54	5.61
98	25.00	4.17	3.46	5.54	6.15	16.37	29.56	29.56	6.80	3.52	5.71	4.64	6.08
99	28.10	4.18	3.48	5.92	6.32	19.18	30.13	30.13	7.00	3.56	5.76	4.73	6.54
Avg	5.56	3.18	2.71	3.41	3.49	5.90	14.53	14.53	4.30	2.90	3.47	3.28	3.34
Min	1.80	1.80	2.10	2.50	2.70	3.00	4.91	4.91	3.00	2.18	2.20	1.80	2.10
Max	30.70	4.20	3.50	6.30	6.50	22.00	30.70	30.70	7.20	3.60	5.80	4.83	7.00
RSD	97.3%	21.2%	13.6%	24.6%	25.5%	65.9%	49.7%	49.7%	24.5%	10.8%	30.3%	22.4%	32.9%



Start Year	2007	365	= Total Days
Month	2	12.00	= Total Months
Day	1		

Utility Name	WTP
Plant Name	Parvati
Plant Street Address	Parvati
Plant City, State, Zip	Pune
Plant Contact Name	Nirbhavne
Plant Phone	020-
Plant E-mail Address	-

1Entry_Per_Day PMC Raw

Statistical Results
5/20/2009

Figure 9: Turbidity data for raw water and probability distribution for Parvati Water

Observation based on Primary data

Primary data on turbidity of water samples at various stages was collected on hourly basis during first week of February 2008 is presented in **Figure 10**.

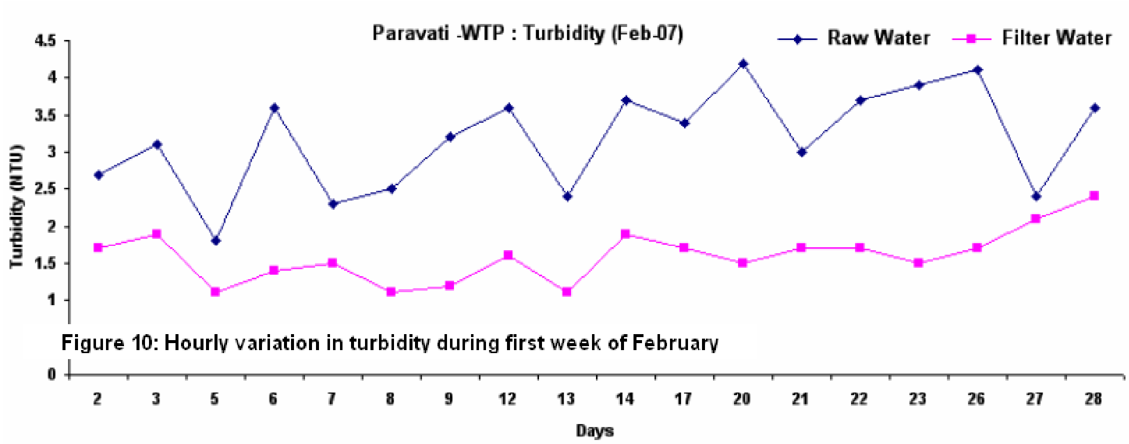


Figure 10: Hourly variation in turbidity during first week of February

The turbidity of raw water ranged between 4.0 to 7.2 NTU indicating effective settlement of suspended solids flushed from catchments area runoff in to Khadakwasla dam. The finished water turbidity though meets the BIS standards of 5 NTU, does not show expected performance i.e. turbidity < 1 NTU as the targeted value of CCP. It was also observed that raw water was microbiologically contaminated as indicated by high counts of Total Coliform. This observation clearly identifies the need for critical evaluation of each unit process to meet the best performance.

Summary

The following salient observations and recommendations made by the participants and the organizers of the workshop were communicated to the Development Engineer, PMC with request to take up the identified issues for remedial measures.

Observations

- The raw water source is very clean but there is possibility of contamination during conveyance of water to Parvati Water Works mainly through open channel. Close conduit could be preferable.
- It is essential to install flow meters to define exact quantity of inflow and outflow of the plant for proper control of chemical dosing, treatment and water audit.
- Frequency of Jar test should be strengthened. Improvement in chemical feeding is needed. The liquid coagulant should be added through perforated pipe placed along the length of the mixing chamber. Proper testing of chlorine demand is essential to avoid overdosing.
- Sedimentation unit is overloaded resulting in poor efficiency. Engineering evaluation is required to find out the extent of overloading. Improvement in the performance of sedimentation basin and clarifloculator during low turbidity is required which will also reflect positively in the performance of the filters.

- The filter media is quite old and finer fraction of sand might have been lost during backwashing over the period of time. There is an urgent need to replace the sand.
- Maintenance should be improved. Provision for recycling of back wash water is advised to avoid water losses. The practice of recycling of backwash water will also provide nuclei for better coagulation with low turbidity waters.
- Overall condition of the Balancing reservoir is very poor. Roof is damaged and broken, therefore, there is every possibility of contamination. Immediate repair is needed by re-roofing or adopt other alternatives. In pump house for finished water, installation of pumps as per good engineering practices is advised.

Recommendations

- The existing system of storage of chlorine cylinders is not scientific and safe and may lead to accidents. Presently chlorine cylinders are stacked in two rows, one over other. While storing chemicals, the instruction for safety measured should be displayed and followed. Post chlorination should result in the residual chlorine up to 0.5 mg/l. If chlorination is not practiced at ESR, the dose can be even more to protect the water quality at the tail end of the distribution system.
- SOPs and guidelines for physico-chemical and bacteriological analysis are recommended. Essential Quality testing staff should be available for 24 hours, for emergency purpose. Modern testing equipments like on line turbidity meter, SCADA system, microbial testing facilities via membrane filter technique etc. should be acquired.
- All staff should be well acquainted with do’s and don’ts in emergency conditions while handling hazardous chemicals. Mock drill should be conducted once in year. All valves and pumps should be colour coded for better understanding of laborer. Well-operated alarm or siren system must be implemented. Safety norms are to be adopted. The existing safety programme needs to be review and strengthen to overcome gaps and shortfalls.
- In house training programme to the staff at all levels should be organized for better performance. Also staff should be deputed for proper training programmes conducted by PHE departments.
- The human resource, administrative and financial procedures need to be more liberal and relax at least for the procurement of spares, which are required on urgent basis for proper operation and maintenance.

3.3 Delhi

Delhi is situated along a perennial source of water, the river Yamuna. The population of Delhi has seen phenomenal growth and has crossed the figure of 150 lacs, apart from the floating population of 4 to 5 lacs. The Delhi Jal Board (DJB) is entrusted with the responsibility of procurement and distribution of water in Delhi. The Delhi Jal Board treats raw water from various sources like the river Yamuna, Bhakhra storage, upper Ganga canal and groundwater.

The Haiderpur waterworks is located in Western Delhi on the outer Ring Road near Prashant Vihar, Rohini Sector 15 on the bank of Western Jamuna Canal originating from Tajewala Head Works Haryana. The plant is about 5km from GT-Karnal Bypass and 4 km from Madhuban Chowk.

The installed capacity of water treatment plants is 2839.5 MLD and by further extraction (through tube wells and other resources), about 2925 MLD potable water is supplied as against the present requirement of over 18225 MLD.

Haiderpur Treatment plant was selected for CCP due to the fact that it is the single largest plant in Asia with a capacity of 900 MLD. In view of the availability of infrastructure/logistic facilities for conducting the CCP activity, both - theoretical and practical exercises, personnel interviews, installing additional monitoring equipment, etc**.** This plant was considered a proper plant of CCP exercise. The Haiderpur waterworks has two independent treatment plants of 450 MLD each. The treatment flow scheme is same for both as given in schematic diagram **(Figure 11)**. A common laboratory has been provided in the waterworks.

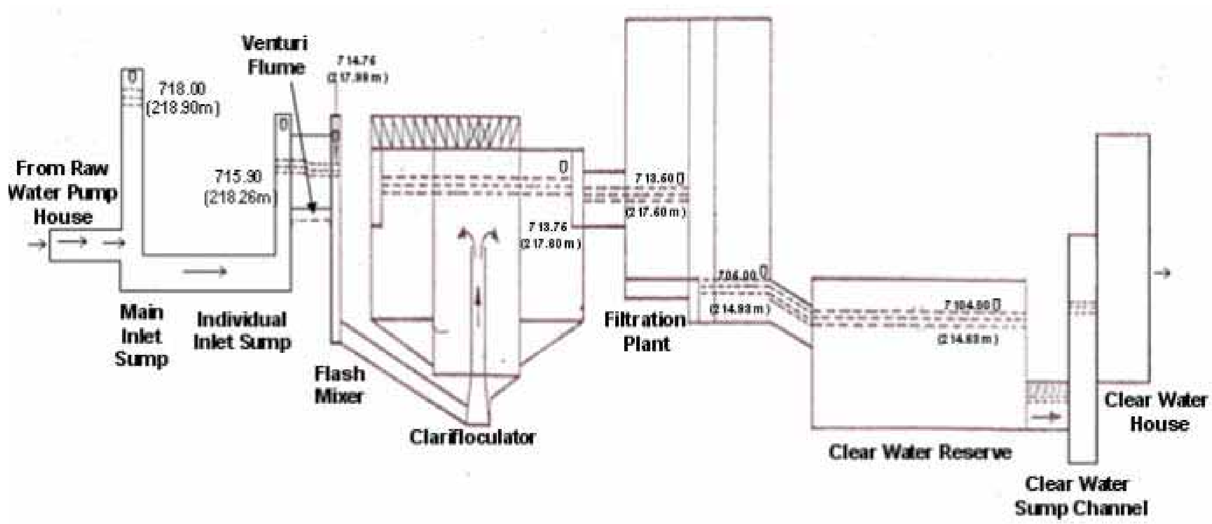


Figure 11 : Flow sheet of the water treatment plant, Haiderpur

Observation based on Secondary Data

The performance data for Haidarpur Water Treatment Plant during January 2007 to December 2007 was collected for evaluation. The analysis of the data on pH and turbidity of raw water is presented in **Figure 12**. From the data it has been observed that raw water has high turbidity NTU and alkaline pH. Microbial count was in the range of 11 to 2400^{+}. Maximum turbidity of 4500 NTU was recorded in August. Filtered water turbidity was in the range of 0.3-2.0 NTU in fare season.

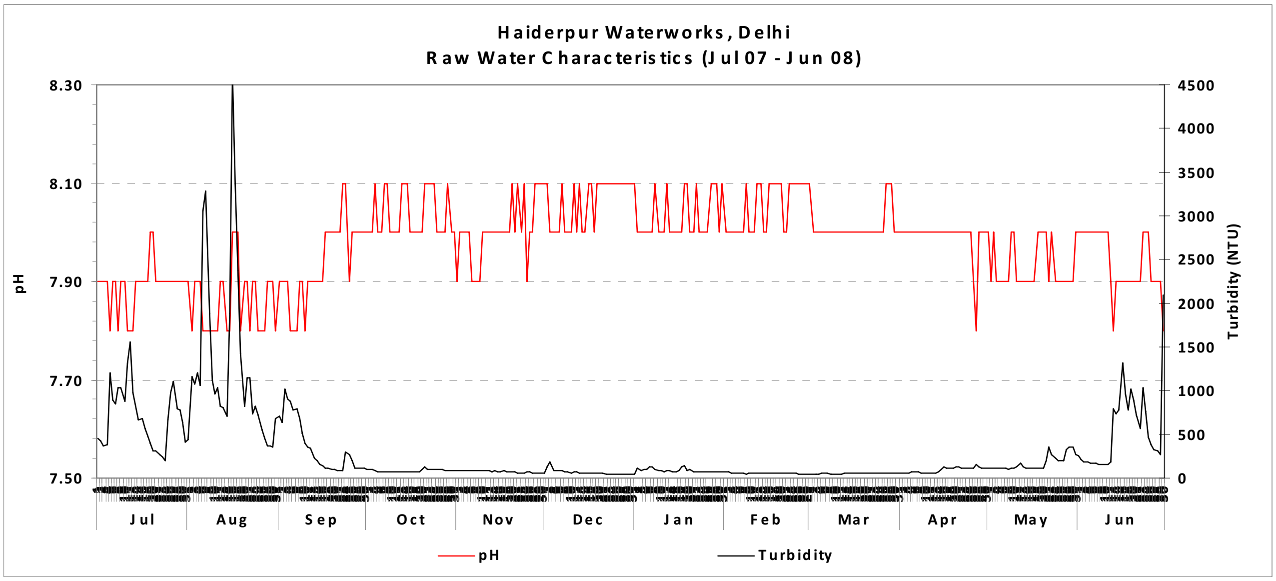
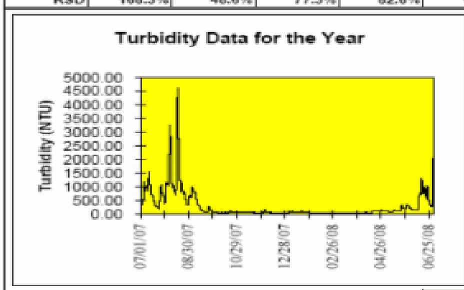


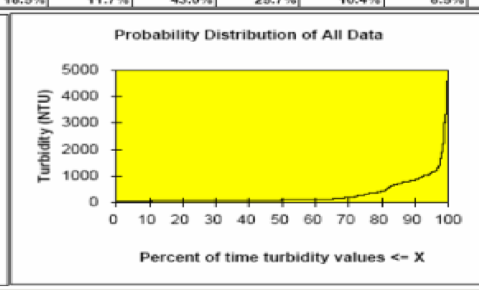
Figure 12: Raw water characteristics of Haiderpur Water Works during Jan 2007-Dec 2007

The one-year raw water turbidity data was used to run the PSW software, which indicated that the raw water turbidity was very high **(Figure 13)**.

DJB

Percentile	Yearly	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
50	95.73	670.42	1037.50	215.94	83.96	74.48	58.54	78.13	56.67	55.21	103.54	118.75	344.02
75	303.59	932.60	1311.46	604.58	96.67	80.63	71.04	92.92	59.38	57.50	114.58	196.67	777.40
90	837.29	1109.17	3062.50	798.50	102.83	81.90	81.25	124.58	62.00	58.54	123.10	331.04	1017.21
95	1101.77	1259.39	3327.08	891.93	103.96	82.08	104.48	129.79	63.25	59.17	128.77	350.88	1185.73
96	1153.75	1295.49	3354.58	898.88	104.08	82.08	116.92	132.42	63.60	59.42	128.89	351.35	1266.08
97	1310.87	1342.94	3496.71	918.04	106.92	82.16	131.04	135.38	63.80	59.65	132.52	352.29	1413.20
98	1782.44	1413.07	3868.08	952.23	115.17	82.35	148.54	139.00	63.88	59.83	140.47	354.17	1642.48
99	2615.63	1483.20	4239.46	986.43	123.42	82.53	166.04	142.63	63.96	60.02	148.42	356.04	1871.76
Avg	300.31	699.27	1304.21	354.80	84.53	72.78	64.49	86.14	55.62	53.81	92.67	170.02	545.17
Min	41.67	199.17	355.83	85.17	66.88	58.75	41.67	46.52	41.71	45.42	56.50	105.83	150.63
Max	4610.83	1553.33	4610.83	1020.63	131.67	82.71	183.54	146.25	64.05	60.21	156.38	357.92	2101.04
RSD	168.3%	48.6%	77.3%	82.6%	18.5%	11.7%	43.0%	25.7%	10.4%	8.5%	31.7%	48.7%	81.0%





Start Year 2007 366 = Total Days
Month 7 12.00 = Total Months
Day 1

Utility Name WTP
Plant Name Haiderpur
Plant Street Address Haiderpur
Plant City, State, Zip Delhi
Plant Contact Name GP Mittal
Plant Phone 011-
Plant E-mail Address -

1Entry_Per_Day

Statistical Results
5/20/2009

Figure 13: Turbidity data for raw water and probability distribution for Delhi Water Treatment Plant

Observations Based on Primary data

The continuous turbidity profile of filtered water was obtained using the online Hach turbidity monitor during September 21-22, 2008. The output of online monitoring is presented in following **Figure 14**.

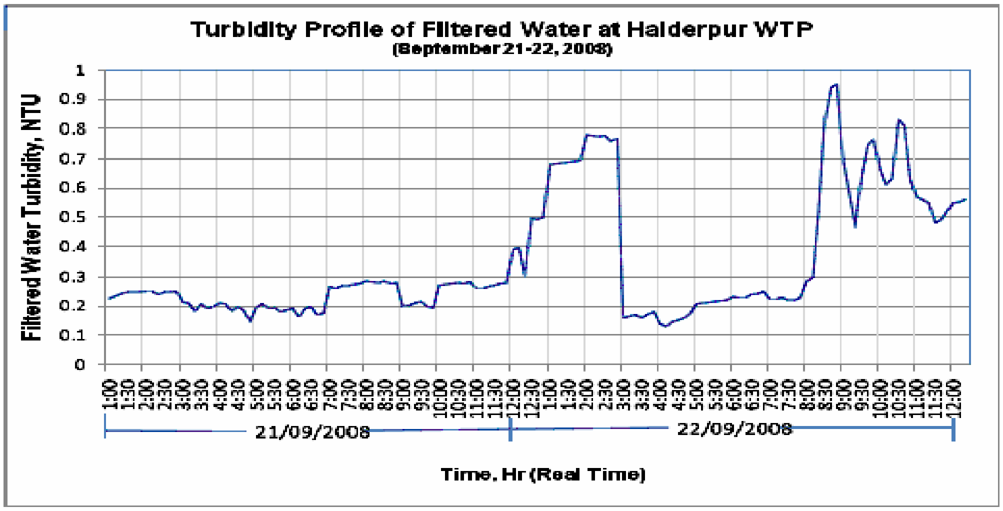


Figure 14: Turbidity profile of filtered water at Haiderpur WTP

It was observed that generally the turbidity remained around 0.3 NTU except during short time period between 1:00AM to 3:00AM and 8:30AM to 11:00AM when the filtered water turbidity increased to about 1 NTU. This could be attributed to some local disturbances and/or backwash operation, etc.

Summary

The following salient observations and recommendations made by the participants and the organizers of the workshop were communicated to higher officials of DJB with request to take up the identified issues for remedial measures.

Observations

- Raw water source and flow measurement: There is inadequate source protection and the 103 km long open canal is susceptible to environment pollution. The records indicate high bacterial contamination in the raw water. The raw water turbidity is also very high and it fluctuates, the raw water turbidity measured on 23/09/2008 was 3000 NTU.
- Raw water flow measuring devices have not been installed.
- Conjunctive use of alum and PAC effectively reduces the cost of chemicals, better level control is possible with PAC as also better particle removal. A stock of about three months is available.
- Coagulation and Flocculation are observed to be good. However, one of the bridges is moving at a faster rate, which might be breaking the flocs thereby affecting the removal efficiency.
- Floating matter finding its way in to the clarifier section. The steel V-notches were found to be rusted due to pre-chlorination.
- Filter House: Filter house was kept well. However, the filter appurtenances such as head loss meter, rate setter, etc. were not functioning and the backwash of filters is taken up on the basis of service time.

Each filter bed is backwashed in 48 hrs. and total water used for backwashing is about 2% of water production. The backwash water is not recycled.

- The clear water reservoirs are underground and soil topping is provided to grow lawns. But the wild grass growing there may contaminate the treated water due to development of cracks and seepage.

Recommendations

- An energy audit had been conducted by TERI, which should be made a regular practice. The power factor needs to be improved and brought to near 1.0.
- A new closed conduit is under construction, which is expected to remove these problems.
- Since the employees feel that there are less promotional avenues, there is a general dissatisfaction among them, which affects the efficiency. An Award / Reward scheme is recommended.
- The auditors also felt that water audit of the plant should also be undertaken.
- Barricading along the raw water channel is suggested.
- V notch may be replaced with fiber.
- CWR is covered by jungles, it should be maintained.
- Empty chlorine toners (cylinders) are to be kept in shade.
- The general housekeeping was found to be satisfactory.

Chapter 1
Introduction

1.0 Preamble

Providing safe drinking water is mandatory to all water supply authorities. This goal can be achieved through implementation of modern approaches like Composite Correction Programme (CCP) and Water Safety Plans (WSP).

Composite Correction Programme (CCP) is a water treatment optimization program that improves water treatment operations with limited capital investment by optimizing particle removal from water. Many microbial pathogens, particularly cryptosporidium, are difficult to eliminate due to their resistance to chlorine or their small size. By ensuring proper particle removal through improving water treatment processes, these pathogens can be removed to ensure safe drinking water.

1.1 Background of the Concept

Maintaining public health protection at water supply systems has become more challenging in the recent years with the resistance of some pathogens to disinfection using chlorination and an increase in the immuno-compromised population (e.g., people with HIV, organ transplant patient, the elderly). Surface Water Treatment Rule of USA (SWTR) does not always assure maximum protection of the public from waterborne diseases. Based on this United States Environmental Protection Agency (USEPA) is a developing regulation to control contamination from microbial pathogens in drinking water while concurrently addressing other issues as well. These new regulations are moving the water supply industry toward meeting more stringent water treatment requirements. Results of research and fieldwork support optimizing particle removal from water treatment facilities to maximize public health protection from microbial contamination. After the development of Composite Correction Program (CCP), it is demonstrated as a method of optimizing surface water treatment plant performance with respect to protection from microbial pathogens.

The approach is based on establishing effective use of the available water treatment processes against passage of particles to the finished water. Specific performance goals are used by the CCP approach to define optimum performance for key treatment processes such as sedimentation, filtration and disinfection. These include a maximum sedimentation basin effluent turbidity goal of less than 2 nephelometric turbidity units (NTU) to assure that the integrity of these processes is consistently maintained and provide a low particle loading to the filter. Filtered water turbidities less than 0.1 NTU with a maximum post backwash “spike” to 0.3NTU and returning to less than 0.1NTU in less than 15 minutes. The disinfection goal has been based on achieving the inactivation requirement for Giardia and /or viruses described in the SWTR guidance.

The Composite Correction Program is carried out in two phases viz.

- ***Comprehensive Performance Evaluation (CPE)*** or an Audit is carried out to review and analyze the plant's administrative, operational, and maintenance practices.
- Based on the factors causing suboptimal performance identified during the CPE, the ***Comprehensive Technical Assistance (CTA)*** is carried out to systematically address problems to improve plant performance.

  The benefits accruing from implementation of the CCP at the water treatment plants include:

  - Minimization of microbial health risks to public;
  - Effective with high risk water systems;
  - Improved control and operation of treatment works;
  - Improved water quality achieved with minimal capital outlay and minor changes to existing facility; and
  - Cost effective performance improvements are possible.

1.2 International Scenario

Based on the state of Montana's successful use of the CCP approach for improving compliance of their mechanical water treatment facilities, state personnel evaluated the feasibility of using the CCP to optimize the performance of surface water treatment facilities. With financial assistance from USEPA, nine Comprehensive Performance Evaluation (CPEs) and three Comprehensive Technical Assistance (CTAs) were completed until September 1990. Through these efforts, each of the existing facilities where CTAs were implemented showed dramatic improvements in the quality of finished water turbidity. Additionally, improved performance was achieved at three plants where only the evaluation phase (CPE) of the program was completed. The encouraging results from Montana's adoption of the CCP approach to surface water treatment plants.

USEPA decided to further develop and demonstrate use of the CCP approach as it applied to compliance with drinking water regulation to ensure its nation- wide applicability. In pursuit of this goal, a cooperative project was initiated between USEPA Office of Ground Water and Drinking Water, Technical Support Center (TSC) and office of Research and Development, Technology Transfer and Support Division, National Risk Management Research Laboratory (NRMRL). This project provides resource to: conduct an additional twelve CPEs in the state of Ohio, Kentucky, West Virgina, Maryland Montana, Vermont, and Pennsylvania; prepare a summary report; and develop the CCP Handbook. Following these initial efforts, work continued, through a cooperative agreement between TSC and the university of Cincinnati, on further refinement and development of the CCP approach. Formal effort was implemented to incorporate the CCP in the programs. It was anticipated that application of the CCP by state regulatory personnel would achieve desired performance levels with a minimum financial impact on the utilities in their jurisdiction. Pilot programs were implemented in eight states (West Virginia, Massachusetts, Maryland, Rhode Island, Kentucky, Pennsylvania, Texas, and Colorado), which focused on developing CPE capability for state staff. A progressive training process was developed within the state. The process includes the completion of a seminar followed by three CPEs conducted by the state core team that was facilitated by USEPA and process applications. Typically, state regulatory staff selected the CPE candidate plants based on their perception of the plants inability to meet the SWTR turbidity requirements.

The progressive training approach proved to be successful. However, other issues and challenges related to implementation within the existing state regulatory program structure became apparent. As the state pilot programs progressed, these challenges to implementation became known collectively as institutional barriers.

1.3 Protection of Public Health from Microbial pathogens

1.3.1 Background

One of the major objectives of water supply system is to provide consumer with drinking water that is sufficiently free of microbial pathogens and prevent waterborne diseases. Water supply system can achieve this level of public health protection by providing treatment to assure that pathogens found in the raw water supply are removed or deactivated. The relationship between optimized water treatment plant performance and protection of public health from microbial pathogens is elaborated here in the following chapters.

1.3.2 Waterborne Disease History

Several well-documented disease outbreaks were associated with the use of untreated surface water, contaminated well water and treatment plant deficiencies. Contamination of the distribution system is a very common phenomenon in many countries. The most common suspected causes of waterborne disease outbreak were the protozoa parasites Giardia lamblia, and Cryptosporidium parvum. These parasites exist in the environment in an encysted form where the infectious material is encapsulated such that they are resistant to inactivation by commonly used disinfectants. These parasites are transmitted to their hosts by ingestion of cysts that have been excreted in the feaces of infected human or animals. Infection can occur through ingestion of fecally contaminated water or food or contact with fecally contaminated surfaces. Recent studies have indicated that these parasites are routinely detected in the surface water supplies throughout North America. They can enter surface water supplies through natural runoff, wastewater treatment discharges, and combines sewer overflow.

A recent review of waterborne disease in the U.S. during the period 1993 through 1994 identified 30-disease outbreak associated with drinking water. The outbreak caused over 400, 0000 people to become ill-the majority from a 1993 outbreak in Milwaukee. Twenty-two of the outbreaks were known or suspected to be associated with infectious agents and eight with chemical contaminants. **Giardia or cryptosporidium** was identified as the causative agent for 10 of the outbreak and six of these systems were associated with a surface water source. All six systems provided filtration. In the filtered system, deficiencies in the distribution system were identified for one outbreak, in inadequate filtration for one, and on apparent defiencies were identified in two cases

Cryptosporidium presents a unique challenge to the drinking water industry because of its resistance to chlloration and its small size, making it difficult to remove by filtration. Cryptosporidiosis is the diarrhea illness in human caused by **Cryptosporidium parvum** Cryptosporidiosis outbreak from surface water supplies have been documented in the United States, Canada and Great Britain. A summary of U.S outbreak associated with surface water supplies is shown in **Table 1.1**. Five of the out breaks were associated with filtered drinking waters. Three systems (Carroll, Jackson-Talent, and Milwaukee) were experiencing operational deficiencies and high finished water turbidities at the time of outbreak. All three plants utilized conventional treatment processes that included rapid mix, flocculation, sedimentation, and filtration. The Clark country outbreak associated with filtered drinking water for which no apparent treatment deficiencies were noted. All five systems were I compliance with federal drinking water regulations in effect at that time.

Table 1.1 : U.S Outbreak of Cryptosporidiosis in Surface Water Supplies

Location	Year	Type of System	Estimated Number of cases
Bernalillo country, New Mexico	1986	Untreated surface water supply	78
Carroll country, Georgia	1987	Treated surface water supply	13,000
Jackson country, Oregon	1992	Medford-chlorinated spring-treated surface water	15,000
Milwaukee country, Wisconsi	1993	Treated surface water supply	4,03,000
Cook country, Minnesota	1993	Treat surface water supply	27
Clark country, Nevada	1994	Treated surface water supply	78

Recent research has shown that free chlorine and monochloramine provide minimal disinfection of **cryptosporidium** cysts at the dosage and detention time condition found at most treatment facilities**.** Disinfection requirements based on Concentration and Time in 1989 SWTR guidance were developed solely on in activation of **Giardia lamblia** cysts. Research conducted by Finch showed approximately 0.2 log or less inactivation of **cryptosporidium** when free chlorine was used alone (5 to 15 mg/l@60 to 240 min). Monochloramine was slightly more effective than free chlorine. Inactivation of **cryptosporidium** through the use of stronger disinfectant (e.g., ozone, chlorine dioxide) and combined disinfectants are currently being investigated by water industry and research institution.

The recent incidence of waterborne disease associated with protozoan parasites and the resistance of some pathogens to conventional disinfection presents challenges to the water industry. Use of a single barrier, such as disinfection alone, or operation of a conventional treatment plant that had not been optimized has contributed to several diseases outbreaks. For surface supplied plants, minimizing consumers risk from microbial pathogens will required a protective approach to treatment, including plant optimization.

1.4 Relationship between Optimized Performance and Public Health Protection

1.4.1 Multiple Barrier strategy

Microbial pathogens including protozoan parasites, bacteria, and viruses, can be physically removed as particles in flocculation, sedimentation, and filtration. Consequently, the level of protection achieved in above processes can be increased by proper operation of the disinfection processes. In a conventional plant, the coagulation step is used to develop particles that can be physically removed by sedimentation and filtration processes. Effective use of these processes as part of multiple barriers strategy for microbial safety represents an operational approach for water system that chooses to optimize performance. Particle removal through a water treatment process can be monitored and assessed by various methods including turbidity, particle counting, and microscopic particulate analysis (MPA). An increasing number of water systems treating surface water have online turbidimeters installed to monitor the process. Some systems are supplementing microscopic particulate analysis however, because turbidity monitoring is the most common method of assessing particle removal in surface water system, performance goals based on this parameter have been developed for the CCP to define optimized system performance.

The role of multiple treatment barriers in optimizing water treatment for protection from microbial pathogens and the associated performance goals are shown in **Figure 1.1**. Despite variability in source water quality, surface water treatment plants must produce consistently high quality finished water. To meet this objective, each treatment process must consistently produce treated water of a specific quality. To this end, performance goals have been established for each of the treatment barriers in a plant.

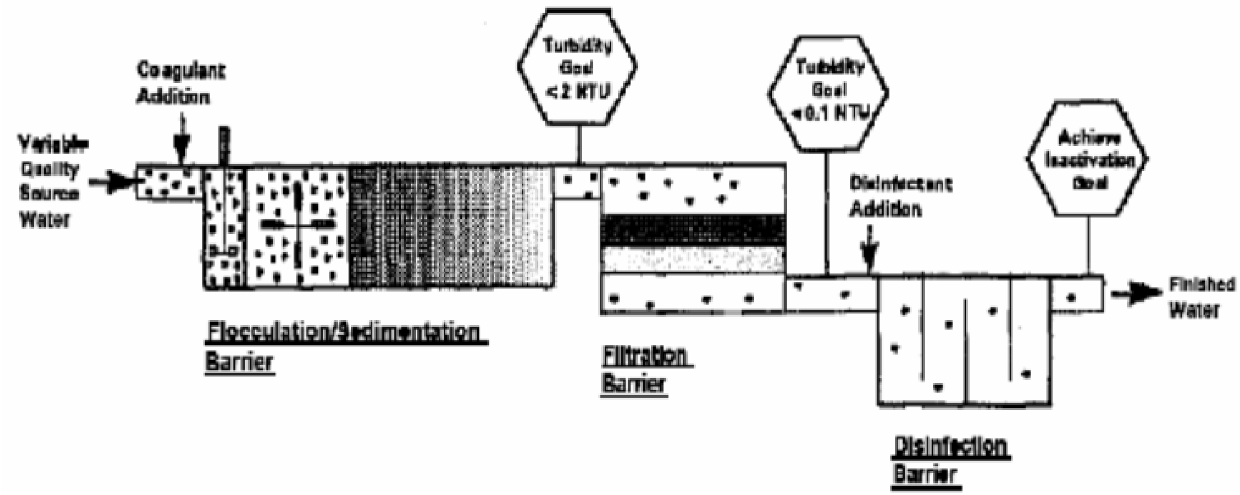


Figure 1.1 : Multiple Barrier Strategy for Protection Against Microbial Contamination

When plants include a sedimentation process, the maximum sedimentation basin effluent turbidity goal of less than 2NTU is used to define optimum process performance. A sedimentation performance goal ensures the integrity of the barrier and provides a consistent particle loading to the filtration process. With Respect to optimum particle removal for the filtration process, the optimum goals is defined as achieving individual filter effluent turbidities of less than 0.1NTU.

The performance of the disinfection barrier is based on the log inactivation requirement for Giardia and virus, as established by the surface water treatment rule guidance manual. The amount of log inactivation, and hence the Concentration and Time (CT) value that the plant must achieve, is based on SWTR guidance. Inactivation requirements for cryptosporidium based on CT have not been established but would be significantly higher than those for Giardia and virus. Since inactivation of cryptosporidium is difficult to achieve with chlorine disinfection, maximizing particle removal could represent the most cost effective and viable option for maximizing public health protection from this microorganism.

1.4.2 Basis for Optimization Goals

Strong evidence exists in support of maximizing public health protection by optimizing particle removal in a plant. Recent supportive evidence from water treatment research and field evaluations is summarized below.

- Pilot study work conducted by Patania showed that when treatment conditions were optimized for particle removal, very effective removal of both cryptosporidium and Giardia was observed. Cryptosporidium removal ranged from 2.7 to 5.9 logs, and giardia removal ranged from 3.4 to 5.1 logs during stable filter operation. Under the condition tested, meeting a filter effluent turbidity goal of 0.1

NTU was indicative of treatment performance producing the most effectible cyst and oocyst removal. A small difference in filter effluent turbidity (from 0.1 or less to between 0.1 and 0.3 NTU) produce a large difference (up to 1.0 log) cyst and oocyst removal.

- Pilot study and full–scale plant work performed by Nieminski demonstrated that consistent removal rates of giardia and cryptosporidium were achieved when the treatment plant was producing water of consistently low turbidity (0.1-0.2 NTU). As soon as the plant's performance changed and water turbidity fluctuated, a high variability in cyst concentration was observed in treated samples. The pilot study confirmed by full-scale plant studies, showed that in a properly operated treatment plant producing finished water of 0.1 to 0.2 NTU, either conventional treatment or direct filtration can achieve 3- log removal of giardia cysts.
- An extensive amount of water filtration research was conducted at Colorado state university on low turbidity water. Using field- scale pilot filters, researches demonstrated greater than 2-log Giardia removal when proper chemical coagulation was practised on low turbidity raw water (0.5 to 1.5 NTU), resulting in filtrate turbidity values of less than 0.1 NTU.
- Filter plant performance evaluations conducted by Consonery at 284 Pennsylvania filtration plants over the past eight years have included a testing of efficiency through the measurement of turbidity, particle counting, microscopic particulate analysis to assess the performance. Evaluations results have shown that when filter effluent turbidity was less than or equal to 0.2 NTU, 60 percent of the plants were given an acceptable rating. When filter effluent turbidity was greater than or equal to 0.3 NTU, only 11 percent of the plants were given an acceptable rating. Although this work did not assess plants performance at the 0.1 NTU level, the increased acceptable rating that occurred when effluent turbidity was less than 0.2 NTU versus 0.3 NTU indicates the benefit of lowering finished water turbidity.

An extensive amount of research and field work results support a filtered water "turbidity goal of 0.1 NTU". It is important to understand that achieving this level of filter performance (i.e., 0.1 NTU) does not guarantee that microbial pathogens will not pass through filter. However, it represents the current best practice for water treatment plants to achieve the greatest level of public health protection. Particle counting can be used to support and enhance turbidity measurements, and can be especially useful when source water turbidity is low (< 5 NTU). At low source water turbidity levels, it is difficult to assess the level of particles reduction being achieved in the filtration process with turbidity measurement alone. This is due to the insensitivity of turbidimeter at extremely low turbidity measurements (i.e., below about 0.05 NTU)

1.4.3 Optimization performance Goals

Optimized water treatment performance for protection against microbial pathogens is defined by specific measurements and goals. These goals for surface water treatment system are based on CCP fields work performance.

1.4.3.1 Minimum Data Monitoring Requirements

- Daily raw water turbidity
- Settled water turbidity at 4-hour time increments from each sedimentation basin
- On-line (continuous) turbidity from filters
- One filter backwash profile each month from each filter

1.4.3.2 Individual sedimentation basin performance goals

- Settled water turbidity less than 1 NTU 95 percent of the time when annual average raw water turbidity is less than or equal to 10 NTU
- Settled water turbidity less than 2 NTU 95 percent of the time when annual average raw turbidity is greater than 10 NTU

1.4.3.3 Individual Filter Performance Goals

- Filtered water turbidity less than 0.1 NTU 95 percent of the time (excluding 15minute period following backwashes) based on the maximum values recorded during 4-hour time increments.
- Maximum filtered water measurement of 0.3 NTU.
- Initiate filter backwash immediately after turbidity breakthrough has been observed and before effluent turbidity exceeds 0.1 NTU.
- Maximum filtered water turbidity following backwash of less than 0.3 NTU.
- Maximum backwash recovery period of 15 minutes (e.g. return to less than 0.1 NTU).

1.4.3.4 Disinfection Performance Goals

- CT values to achieve required log inactivation of Giardia and viruses.

1.4.4 Role of the water treatment plant staff in public health protection

The information presented in the chapter demonstrates that the quality of water leaving a water treatment plant has the potential to directly impact the health of the consumers of its finished water. All staff associated with plant, from the operator to the highest level administrator, has an important role in protection public health and responsibility to provide finished water that minimizes the possibility of a disease outbreak. Experience gained from implementing CCP optimization activities at plants has demonstrated that, in most situations, once utility staff becomes aware of the importance of achieving optimized performance goals, they have enthusiastically pursued these goals through a variety of activities.

1.5 Broad-scale application of CCP: Concepts

The optimization concepts included within the CCP approach have been expanded to a variety of water industry and regulatory activities. The Partnership for Safe Water is a voluntary program for enhancing water treatment to provide higher quality drinking water. Organization involved in the partnership include the U.S Environmental Protection Agency, American Water Agencies, National Association of Metropolitan Water Agencies, National Association of water companies, Association of state drinking administrators, and the American Water Work Association Research Foundation. The partnership utilized the CCP as the basis of its phase-III comprehensive water treatment self-assessment. Use of the CCP is also being considered for the phase-IV third party assessment of participating utilities. As of May 1998, 217 water utilities serving nearly 90 million people are participating in the partnership for safe water.

In 1996, the American Water Work Association Research Foundation conducted an optimization workshop with national water quality and treatment experts from throughout the industry. As a result of this workshop, a self-assessment handbook was published by AWWARF. This handbook, which follows the CCP approach, is intended to be a resource for water utilities that choose to conduct assessment to improve programmes. (Ref of book)

1.6 Water Safety Plans

Water safety plan (WSP) has wider approach to protect and provide safe drinking water. It attempts to address the overall issue of complete programme wherein a source to delivery of water to the consumers is mapped through different means to assess the risk of contamination at various levels. Formulation and implementation of WSP helps achieve better quality water in a sustainable manner by eliminating the possibilities of any risk of contamination. It leads to enormous health benefits as ensuring safe water supply provides high levels of health morbidity reduction.

WSP emphasizes risk assessment and management of a water supply from catchments to consumer. WSPs are based on preventative risk management utilized to effectively monitor and manage potential contamination of water to prevent public health burdens before they occur.

1.6.1 Elements of Water Safety Plan

Water Safety Plans comprises the following key components / elements:

- ***Health-based outcomes***: improving water quality based upon the health impacts of current levels of contamination. Utilizing health-based outcomes will assist in identifying the how best to verify and analyze changes to the water supply.
- ***System assessment***: the system assessment will analyze the current risks for contamination in water supply beginning from the catchments, to the treatment and storage facilities, the distribution system, and finally at the level of the household itself. The system assessment will also identify the potential controls for each identified risk.
- ***Operational monitoring***: Once risks have been identified, the controls must be operationalized to understand how the control should be implemented. Operational limits for factors such as residual chlorine, dissolved oxygen, or pH should be determined as a part of the performance measures.
- ***Management plans***: Management plans will formalize the corrective action necessary in case the operational limit is surpassed.
- ***Independent surveillance:*** While not a direct part of the WSP, a means for independent surveillance by an agency must be established to ensure that the WSP is reaching its pre-established targets in terms of health-based outcomes or water quality.

1.7 Composite Correction Programme in India

The National Environmental Engineering Research Institute (NEERI), a constituent laboratory of CSIR, in collaboration with USEPA is engaged on improving drinking water quality in India by facilitating the demonstration of the Composite Correction Program (CCP). With a view to demonstrating the efficacy of CCP, the project was started with following objectives.

- To initiate work on water quality and safety, improve water treatment performance, and reduce microbial contamination by demonstration of the Composite Correction Program.
- In the longer term, to improve water quality and thereby reduce the health burden of water-related diseases through enhanced safety of public drinking water supplies in 3 Indian cities.

1.8 Selection of cities for CCP Study

Under this study programme, it was decided to carry out the composite correction programme in one water treatment plant in three different cities in view of the available funds to carry out the exercises.

The criteria of selection of the three cities were based on the willingness of the respective water supply agencies to undertake and support the CCP activity, logistics and infrastructure availability for carrying out the theoretical and practical activities in the treatment plant, ease of any temporary modification necessitated by the activity; and in view of their willingness to implement the recommendations proposed later in the CTA activity.

Accordingly, in consultation with the respective water supply agencies, the three select cities are Hyderabad, Pune and Delhi. The following CCP workshops were held.

- First Workshop was conducted in collaboration with and assistance of Hyderabad Metropolitan Water Supply & Sewerage Board (HMWS&SB) during May 14-17, 2007 at Asifnagar Water Treatment Plant, Hyderabad.
- Second workshop was held in collaboration with and assistance of Pune Municipal Corporation (PMC) during February 11-13, 2008 at Parvati Water Works, Pune.
- Third Workshop in the series was held in collaboration with and assistance of Delhi Jal Board during September 22-24, 2008 at Haiderpur Treatment Plant, New Delhi.
- The Final Workshop was conducted with the stockholders and water supply planners to disseminate the experience generated during previous studies at three cities on June 16, 2009 at CSIR Science Centre (Vigyan Kendra), New Delhi.

The detailed programme of workshops and list of participants are given in **Appendix 1**.

Chapter 2
Implementation of Composite Correction Programme

2.0 Background

Based on the experiences on application of CCP concept to the existing surface water treatment plants, the study has been initiated in India with USEPA coordination. Three cities have been selected having impounded and river water sources. Detailed discussions were held with the water supply authorities. The objectives of the programme have been explained for receiving cooperation for effective implementation of the project. Details of CCP activities and responsibilities are presented in **Table 2.1**.

Table 2.1: Details of CCP activities

Project Task	Project Activity	Responsibilities	Outcome/ Result
Identify teams of all three cities and collate information about Treatment plants for CCP	Each city water supply entity identifies three members of various levels including managerial, supervisory and operation.	NEERI to coordinate and communicate	Each city identifies their team
Organize workshop at each city	Invitation and participation of all cities and EPA expert.	NEERI team	Workshops
Run preliminary assessment of Treatment plant at each city	Initial visit by CCP experts to treatment plants.	NEERI will coordinate CCP expert visit to plants	• To assess basic issues with the treatment plant • Set up data monitoring to conduct to CCP
3/4-day workshop to conduct CCP in each city	• Conduct audit of plant with auditors from two additional cities. • Provide equipment to treatment plant to make necessary measure.	NEERI will organize workshop with the water supply agency	To improve water treatment plant performance
Follow up session to enact CTA	Suggestions for implementation of technical changes based on CCP audit.	Water supply agency will evaluate proposed changes and provide feedback	To understand operational reasons for sub optimal performance and suggests technical improvement

Table 2.1 (Contd..) : Details of CCP activities

Project Task	Project Activity	Responsibilities	Outcome/ Result
NEERI writes report for CCP based on Hyderabad, Pune and Delhi studies	Write report for CCP based on how the program was implemented.		To adapt USPEA's CCP material to the Indian context
NEERI convenes workshop to discuss report invite other cities in carrying out CCP	Invite the participation of several Indian cities to provide feedback for report. Discuss and refine the report for future use.	NEERI will organize the workshop	To produce a report for water treatment optimization that can be used throughout India.

2.1 Methodology

CCP not only improves water treatment performance, but also builds local capacity to carry out audits of water treatment plants and strengthen a regional network of water safety professionals. The engineering information of the water treatment plant has been collected for the performance evaluation of the unit processes to evaluate the adequacy of the treatment. The secondary data on water quality is collected and analyzed for assessment of status of water supplied to the beneficiaries and possible health risk. PSW software is used to evaluate the water quality. The workshop is organized in 3 selected cities to audit the existing performance of the treatment plants.

One of the objectives of the project was to establish the trend of turbidity in raw and filtered water through continuous online monitoring equipment. However, limited data could be generated due to constrain faced for procuring the online turbidimeter. CCP involves a 3-city round-robin, whereby engineers from two cities visit the water treatment facility of the third city to carry out an audit. These select engineers from all three plants rotate to all three cities to carry out audits on all three plants. By the end, the treatment plant in each of these three cities has been audited by an external agency, and the engineers of each plant now have the capability to carry out audits in future. Each facility would also have its own team who would take the process further and maintain the continuity.

2.2 CPE Elements

The CPE elements for plant performance are presented below.

First element – A kick off meeting with treatment plant administration/ management and operators. During this element the process is described to the audience and a schedule with proposed activities is explained. Also, arrangements are made to interview appropriate operators and managers.

Second element- A plant tour from source water intake, through the chemical addition and treatment processes. During this tour please take the opportunity to question the operator (s) about any potential factors that may be limiting performance.

Third element- A compilation of the performance data. Trend graphs are constructed from the historical turbidity records such that we can identify what performance problems may exist (if any). We will have some of this on the computer using software development for this purpose.

Fourth element- Development of the performance potential graph. This is the graph that we will use to determine how the physical plant capacity is being utilized. During this process we will assign acceptable design loading rates for flocculation, sedimentation, and filtration and prepare a graph to assist us in interpreting results.

Fifth element- Next conduct interview of the operators and managers that have anything to do with the decision making process for this plant. We will be asking questions in the area of design, operation, maintenance and administration. Questions should be related to the performance limiting factors identify in your handout.

Sixth element – Now we meet and take all of our results (graphs, interviews, and plant tour perception) and review the list of 50+ performance-limiting factors and develop a list we will performance limiting at Asifnagar. Once we have our list we will prioritize our factors as type A (major impact all the time), type B (minor impact all the time or a major impact all the time) or typeC (really minor impact)

Seventh element- This last element involves presenting our results to the plant staff and managers and answering any question that they may have. Normally we provide paper copies of our graphs and performance limiting summaries to the plant staff.

2.3 Steps for a Comprehensive Performance Evaluation

Steps for a Comprehensive Performance Evaluation are presented below:

1. ***Assessment of plant performance***
    - Define performance goals/standards
    - Develop historical turbidity charts and turbidity profiles
    - Measure on-site performance

2. ***Evaluation of major unit processes***
   - Evaluate performance measures for flocculation, sedimentation, filtration and disinfection
   - Calculate unit process rated capacity
   - Determine peak instantaneous flows
   - Write Comprehensive Performance Evaluation report
3. ***Conducting the Interview***
   - Conduct interviews with administration, operations, support, and maintenance personnel.
4. ***Identification and prioritization of performance limiting factors***
   - Based on interviews and performance assessment, determine limiting factors
   - Rate factors to determine which impact the performance the most
5. ***Reporting results of the evaluation***
   - Present findings to plant and administrative personnel and prepare and distribute CPE report
   - The auditor's comments are consolidated as observations to be considered for further action from the plant authorities to rectify the lapses and implement corrective measures

6. ***The data required for carrying out CCP***

- Plant performance charts like

  a) Raw water turbidity: daily and maximum value

  b) Sedimentation basin effluent turbidity: daily and maximum value

  c) Filter effluent turbidity: daily and maximum for each filter

- Water system monthly reports
- Sanitary Surveys
- Evaluation of laboratory quality control, particularly, calibration of turbidimeters

The performe for collecting plant information, conducting CPE, guidelines for assessment and determining rated capacity are given in **Annexure 2.1.**

For evaluation of major unit processes, determination of rated capacities and the detailed methodology with case studies is presented in **Annexure 2.2.**

Chapter 3
Application of CCP in 3 Cities

3.1 Asifnagar Water Treatment Plant, Hyderabad

3.1.1 Water Supply in Hyderabad

Hyderabad is capital of Andhra Pradesh with the population 73 lacs. The city had faced water crisis in the past. However Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) have succeeded in improving the water supply status of the city by tapping various sources from long distance reservoirs. The constitution and organization of HMWSSB is given in **Figure 3.1**. The details of water supply along with their capacity are given in **Table 3.1**.

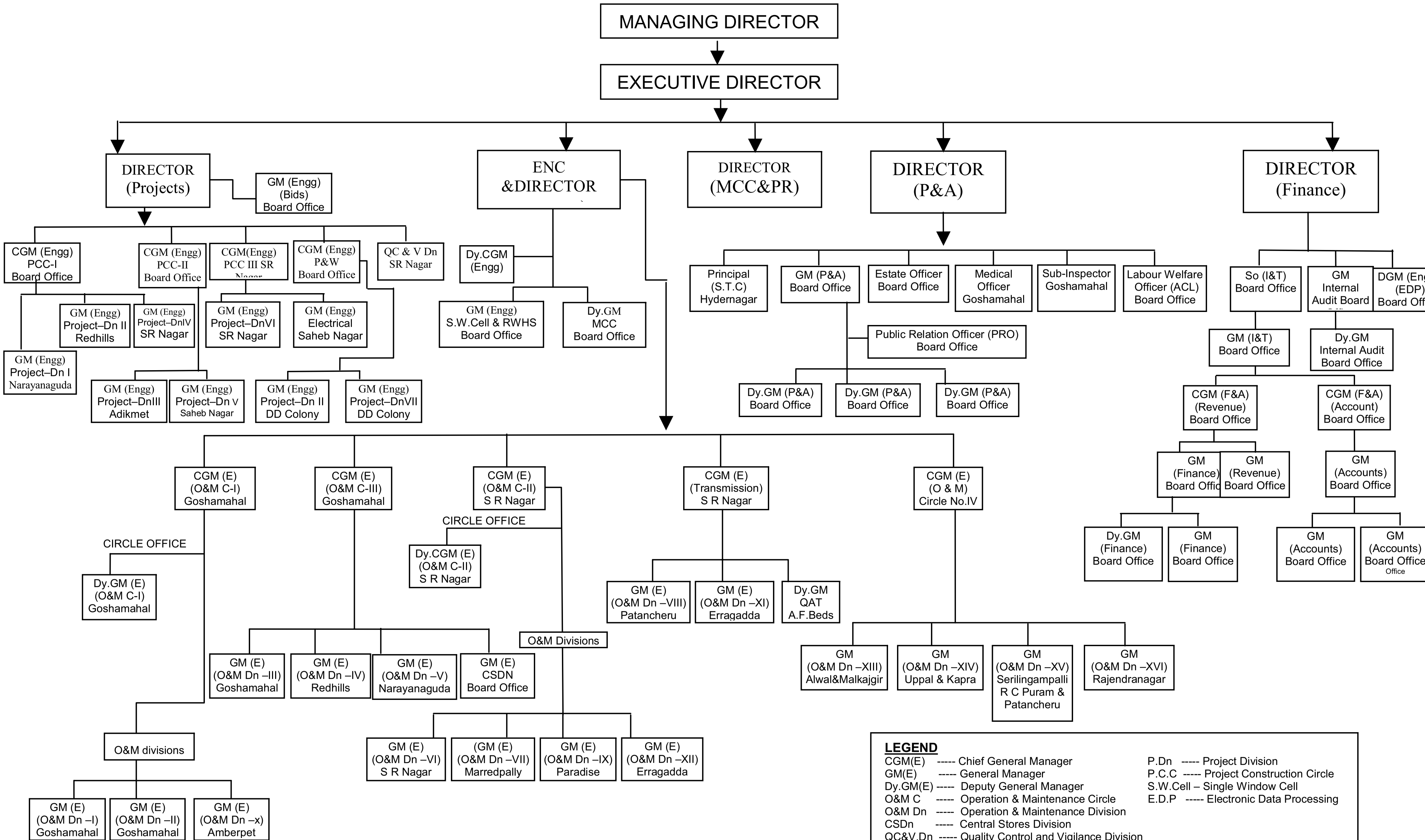
Table 3.1 : Details of Water Supply Along with Their Capacity at Hyderabad

Source	Year Commissioned	Water Supply (MLD)	Mode of Supply
Osman Sagar On Musi River	1920	113	Gravity
Himiyath Sagar on Esi River	1927	90	Gravity
Manjira Phase –I (Manjira Barrage)	1965	67	Gravity / Pumping
Manjira Phase –II (Manjira Barrage)	1981	134	Gravity / Pumping
Manjira Phase –III (Singur Dam)	1991	337	Gravity / Pumping
Manjira Phase –IV (Singur Dam)	1993	337	Gravity / Pumping
Krishna Water Supply Phase-I & II Akkampally	2004 & 2007	670	3 Stage Pumping / Gravity

Water tapped from various sources is treated at different treatment plants of varying capacity which are given in **Table 3.2**

Table 3.2 : Water Treatment Plants at Hyderabad

Location of Water Treatment Plants	Capacity (MLD)
Asif Nagar	81
Miralam	9
Shaikpet	4.5
Rajampet- Phase I	81
Kalabgoor- Phase II	148
Peddapur- Phase III	148
Peddapur- Phase IV	148
Kodandapur	600



LEGEND

CGM(E) ----- Chief General Manager
GM(E) ----- General Manager
Dy.GM(E) ----- Deputy General Manager
O&M C ----- Operation & Maintenance Circle
O&M Dn ----- Operation & Maintenance Division
CSDn ----- Central Stores Division
QC&V.Dn ----- Quality Control and Vigilance Division
QAT ------ Quality Assurance and Testing
M.C.C ----- Metro Customer Care
Dy.C.F. ----- Deputy Conservator of Forest
P.Dn ----- Project Division
P.C.C ----- Project Construction Circle
S.W.Cell – Single Window Cell
E.D.P ----- Electronic Data Processing

Figure 3.1 : Hyderabad Metropolitan Water Supply & Sewerage Board
ORGANISATION CHART

Asifnagar Water Treatment Plant

It was constructed in year 1921 following the completion of Osmansagar dam across Musi River **(Plate 3.1)**. The source of supply to Asifnagar WTP is from Osmansagar, which is 14 km away. A masonry open conduit channel is provided from Osmansagar to Asifnagar Water Treatment Plant.

Plate 3.1 : Osmansagar Dam

The organizational structure of Asifnagar filter beds is presented in **Figure 3.2**.

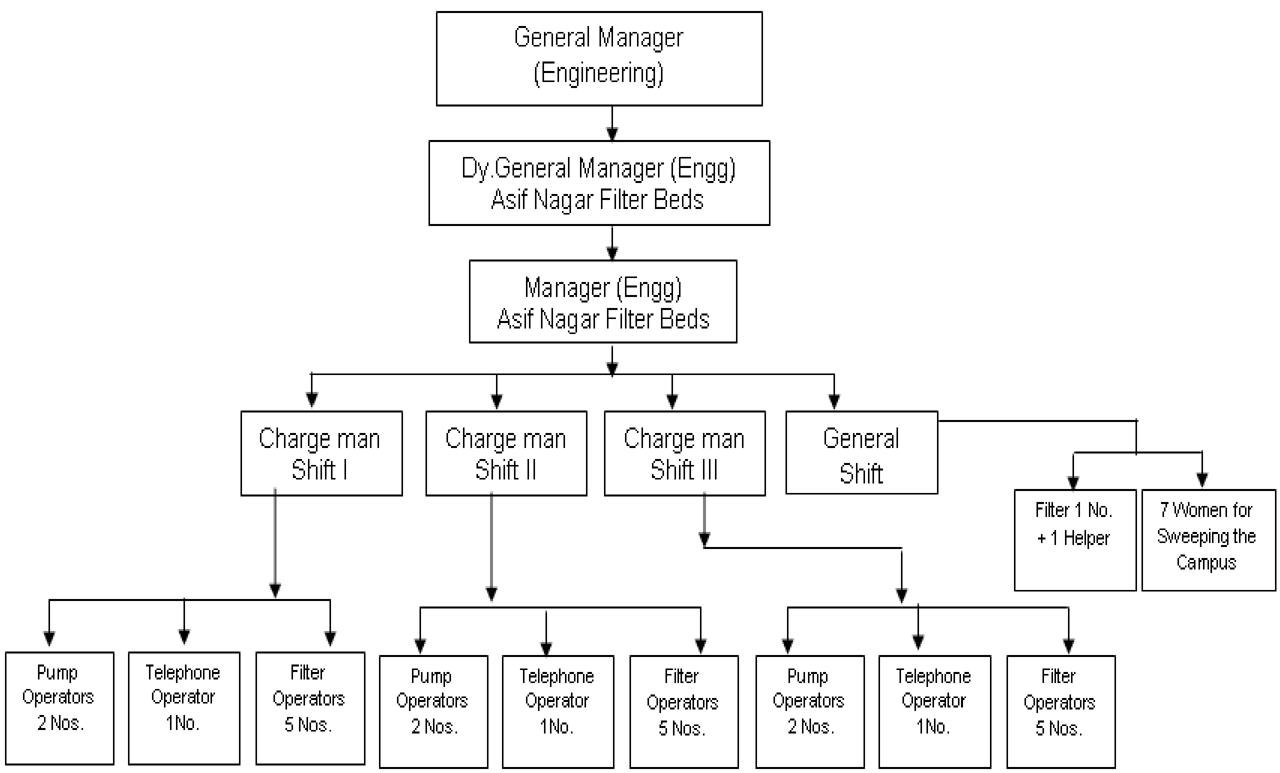


Figure 3.2 : Organization Chart of Asifnagar Filter Beds

The raw water from Osmansagar is carried up to Asifnagar WTP by gravity. Raw water entering Asifnagar plant is tested for chemical and bacteriological parameters and accordingly quantity of chemical is decided. Initially Patterson Company of London have constructed 12 filter beds with a capacity of 8.5 MGD for a population of below 5 lakhs in 1921. Thereafter, as the population increased an additional 8 beds were constructed in late 40's with a capacity of 10MGD increasing the capacity of plant to 18.5MGD till 1964 when an additional 2 MGD capacity filter bed was constructed making the total capacity to 20.5 MGD. Due to demand a 6 MGD pneumatic plant comprising of 3 Nos. filter beds of 2 MGD capacity each were constructed. Since all the chemical and bacteriological parameters of the raw water from Osmansagar are within the permissive limits, the conventional treatment followed i.e., (1) Sedimentation (2) Filtration (3) Chlorination processes. WTP lay out and Flow chart is given in **Figure 3.3 and Figure 3.4**. Inlet and baffle mixing- Bell mouth tank is provided from where alum dose is applied.

Sedimentation: For removal of turbidity (dirt, mud, silt, suspended and settlelable particles) an optimum dose of Ferric Aluminum sulphate (Alum) is added against the turbidity. Alum gets mixed through baffles and hydraulic flow and alum mixed water enters sedimentation tank. Then the water enters hopper bottom sedimentation tanks and remains for a period of 2 ½ to 3 hours to enable the alum to act with the turbidity and allow flocks agglomerated to form during coagulation process, settles down in the sedimentation tanks. In the course of sedimentation the amount of sediment known as sludge accumulated every time is periodically desludged and removed. After sedimentation 70% to 90% of the impurities such as all settleable particles and other impurities are removed. Sedimentation tanks at Asifnagar Water Treatment Plant are shown in **Plate 3.2**.

Plate 3.2 : Sedimentation tanks at Asifnagar Water Treatment Plant

Filtration: The settled water from the sedimentation tanks is passed through a sand filter bed containing 3' 6'' filter media. The settled water when passes through the above layers 99% of the impurities including dreadful microorganisms, bacteria, virus etc, are completely removed.

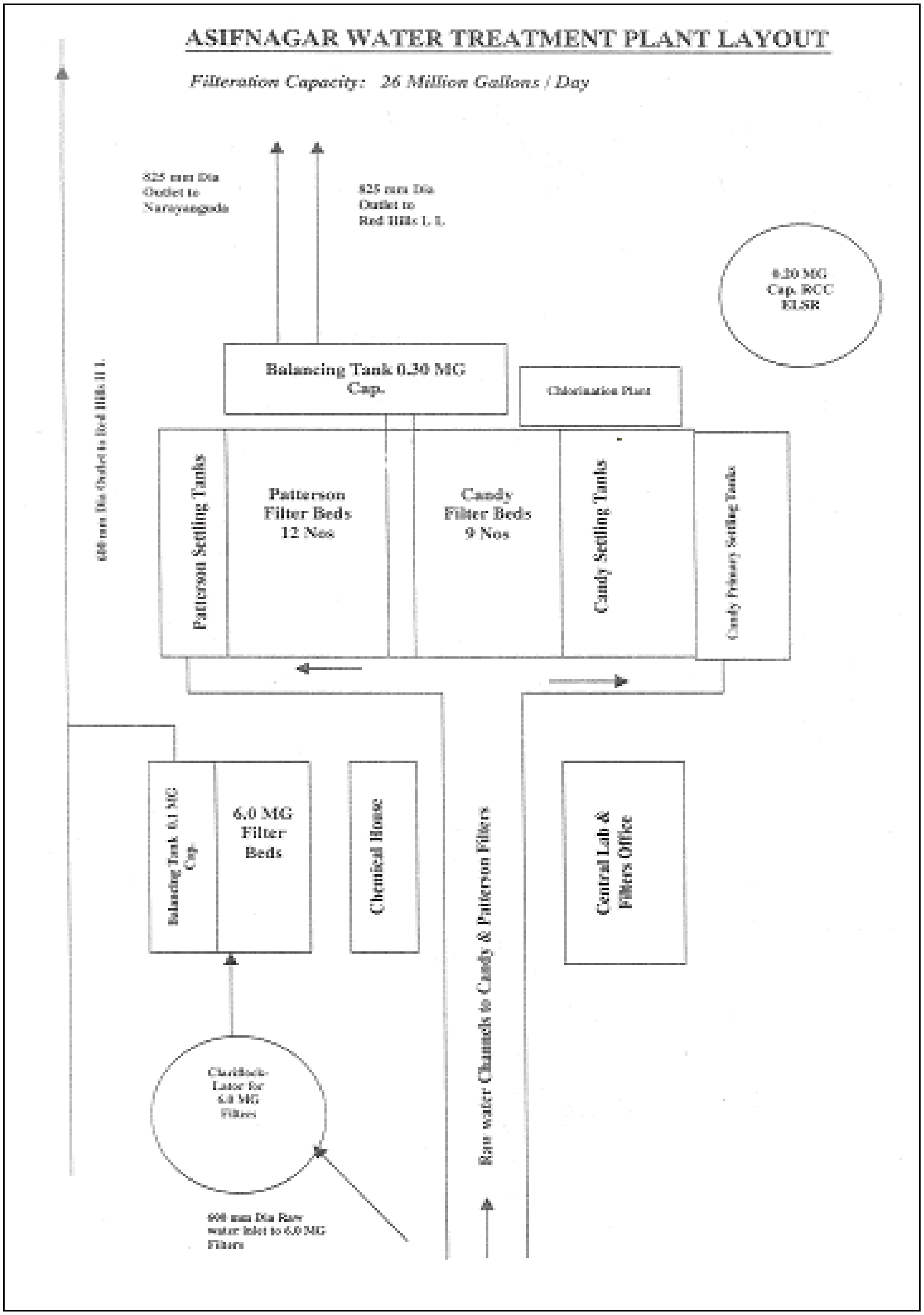


Figure 3.3 : Layout of Asifnagar Water Treatment Plant

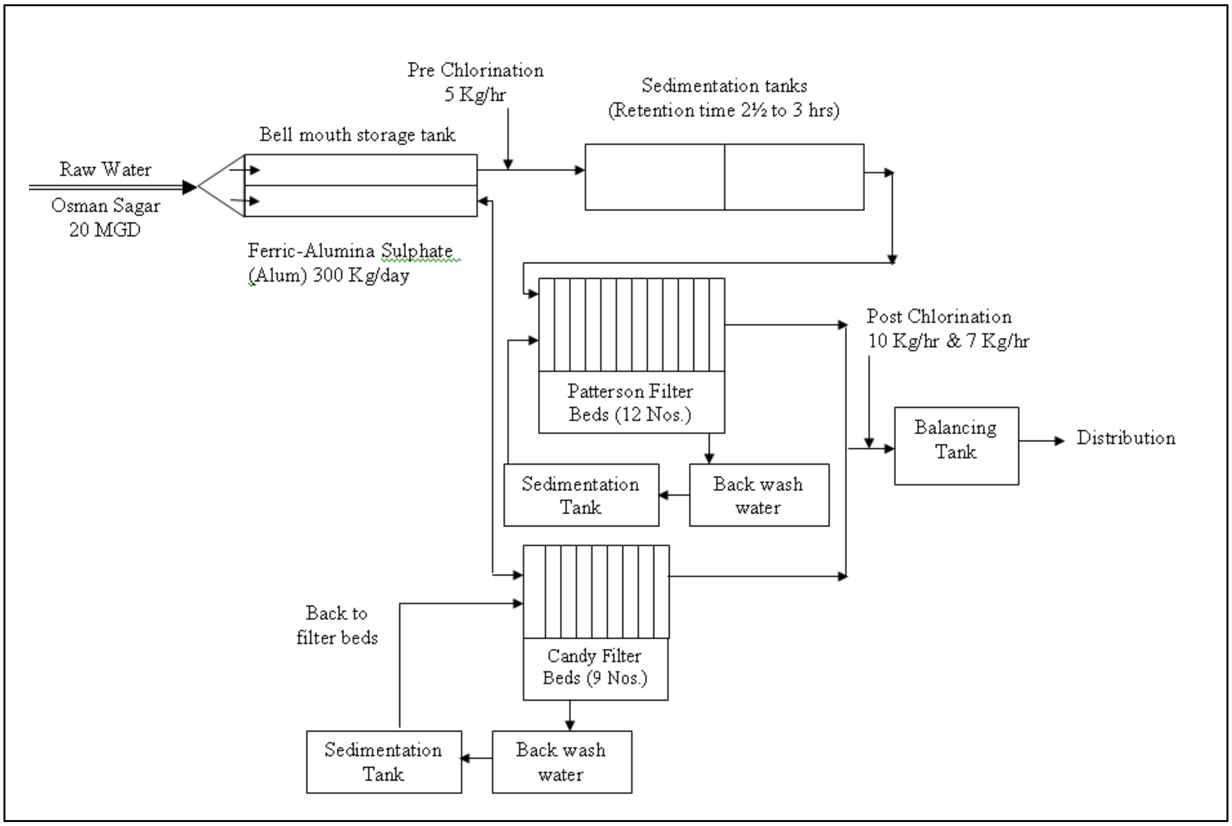


Figure 3.4 : Flow Chart of Water Treatment Plant (Asif Nagar)

Chlorination: The filtered water is then disinfected with chlorine to oxidize all the organic matter and disease-causing microorganisms if any left in the filtered water. The filtered water after chlorination is retained in the balancing tank for half an hour to allow the chlorine to oxidize and kill the remaining microorganisms. After contact period the water is supplied to Red hills reservoir, Adikmet reservoir, Chilkalguda reservoir and a part of it supplied to Mehdipatnam, Badabazar and Masab tank areas. Therefore everyday a quantity of 25MGD of water is treated adhering to the WHO drinking water standards and supplied to the twin cities. Since 1921, the residents of Hyderabad and Secunderabad are enjoying the water treated from Asifnagar WTP. The salient feature of engineering data is presented as **Table 3.3**.

Table 3.3 : Salient Feature of engineering data of Asifnagar water treatment plant

Details of Pattersons Filter Beds	
No. of Beds	12
Length	20’-0”
Breadth	18’-0”
Rate of filtration	90 gals/sft/hour
Filtration capacity per Beds	7,77,600gal/day
Total Capacity per Bed	93,31,200gal/day
Total depth of 12 filters	3’- 6”
Quartz Pebble and gravel Coarse sand Fine sand	3”×4”- 0’ 6” 1”×1/8” 10/20mesh -0’-4” 20/25mesh-1’-8”
Frequency of washing Pressure of air for scouring Quantity of wash water	48hours 5lb/Sq inch (psi) 20,000 gal/bed
Settling tanks for Patterson filter	
No. of tanks Length of tank Width of tank Depth Retention period	20 Nos. 120’-0” 95’-0” 10’-0” 2 to 3hours
Balancing tank for Patterson filter	
Length Width Depth Total capacity Contact period	138’-0” 58’-3” 6’-0” 300000gals 22minutes
Details of Candy Filter Beds	
No. of beds Length Breadth Rate of filtration Filtration capacity per Bed	8+1=9 27’-0” 20’-0” 95gal/sft/hour 1.23 MG/day 2.0MG/day-Bed No.9
Total capacity of 9 filters Total depth of filter	11.84 MG/day 3’-6”
Pebbles Gravel Coarse sand Fine sand Frequency of washing Pressure of air for scouring Quantity of wash water	½ “ to ¾”-0’-4” ¼” to ½”-0’-4” 10/20 mesh-0’-4” 25/30 mesh-2’-6” 40hours 5Lb/Sqinch/sec 30,000gal/bed
Settling Tank for Candy Filters	
No. of tanks primary-9Nos.	17’×-6”×17’-6”×19’-6”
Secondary-4Nos	43’-0”×35’-0” × 19’-6”
Retention period	2 to3 hrs

Table 3.3 (Contd..) : Salient Feature of engineering data of Asifnagar water treatment plant

6 MGD Pneumatic plant	
1. Details of Clary flocculators	
Diameter	120'-0"
Depth of center	15'-0"
Depth at sides	11'-0"
Retention period	30 minutes
2. Details of 6 MGD filter Beds	
No. of Beds	3Nos.
Length	31'-6"
Width	27'-6"
Rate of filtration	110/gal/sft/hour
Filtration capacity/bed	2MGD
Total cap: of 3 beds	6MGD
Total depth of filter media:	3'-6"
Pebbles	½" TO ¾"-0'-4"
Gravel	¼" TO 3/8"-0'-4"
Sand	30/40 2'-10"
Frequency washing	72 hours
Pressure of air scouring	540Cuft
Quantity of wash water required	40,000gallons
3. Details of balancing tank:	
Length	143'-6"
Width	50'-0"
Depth	6'-0"
Cap of balancing tank	1,00,000 gallons
Contact period	20 minutes

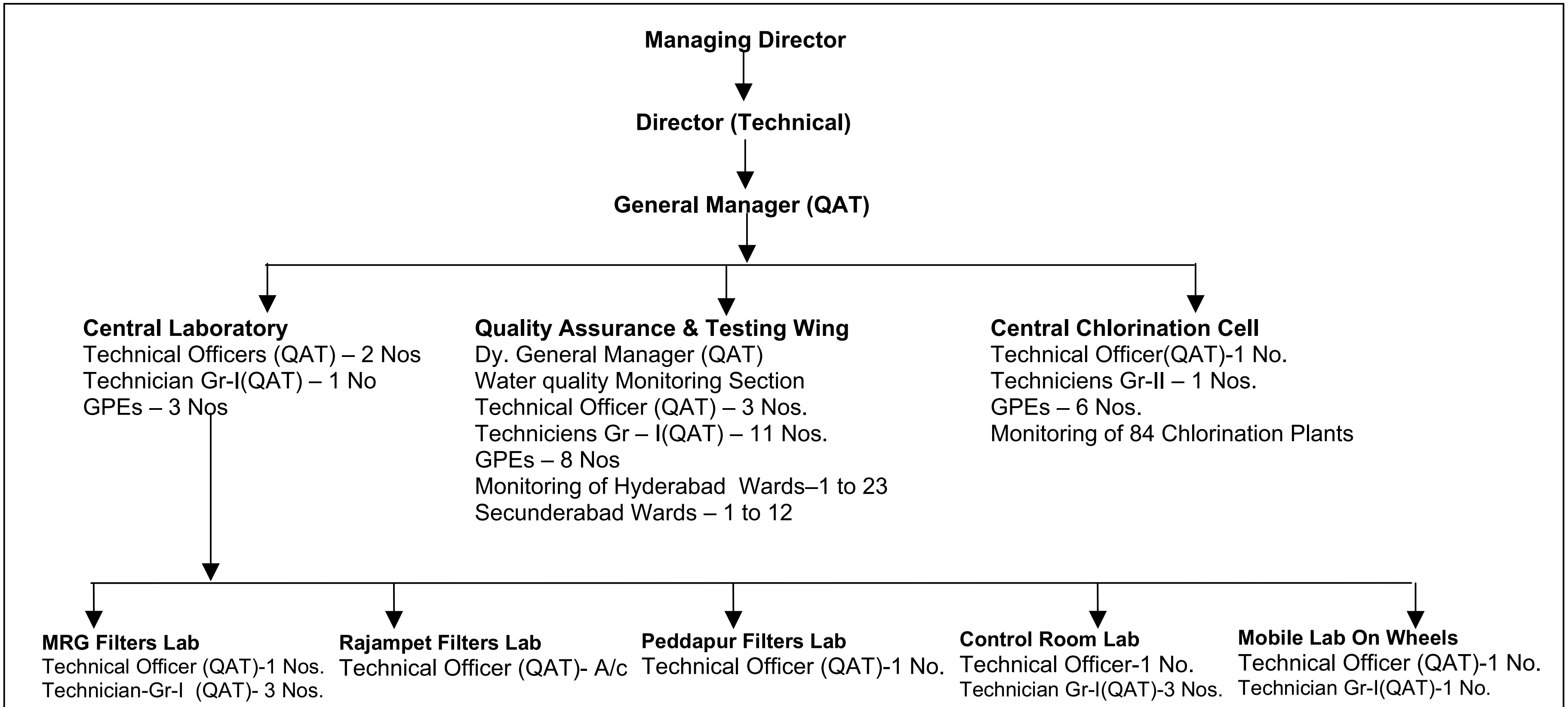
The general water treatment plant physico-chemical parameters to be analyzed for estimating the efficiency of the treatment and quality of treated water are given below:

Daily	Weekly				
'pH	Temperature	Conductivity	Total Hardness	Nitrite	Manganese
Turbidity	Colour	TDS	Fluorides	Nitrate	Sulphate
Residual cl_2	Odour	Alkalinity	Chloride	Iron	Jar test
	Chlorine Demand Test				

Operation and Maintenance: The backwash treatment is carried out for individual filter beds on 24 hourly basis in monsoon and 48 hours in other seasons. The backwash water is supplied at a high pressure for 20-30 min and is cleaned subsequently to put into operation. The high turbid backwashed water is sent to balancing tank for storage and further sent to sedimentation tank for recirculation.

Ferric aluminum sulphate is added as a coagulant in the raw water for proper mixing. The dose of the alum is in the range of 300-500 kg/day. During rainy season the alum dose is maintained 2-3 times more than in other seasons.

The plant is maintained and operated by various skilled and managerial staff. The existing organizational chart of Quality Assurance testing wing is enclosed in **Figure 3.5**.



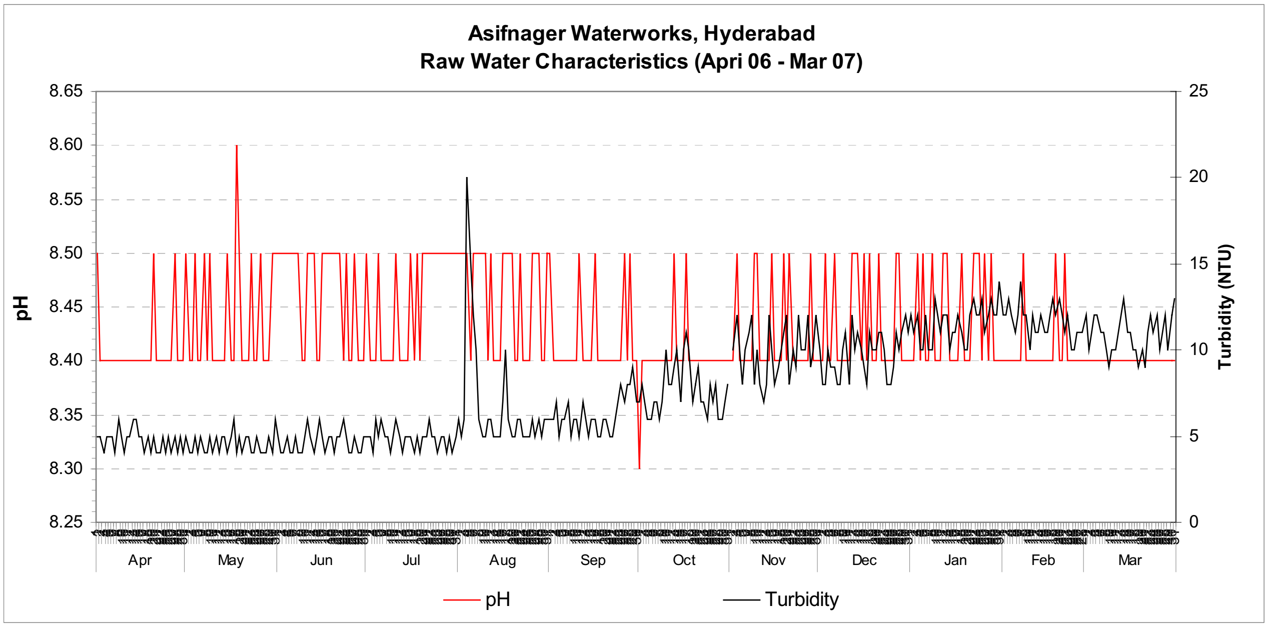
QAT Wing – Staff Working Strength:

General Manager (QAT)	**1 No**
Dy.General Manager (QAT)	1 No.
Technical Officer (QAT)	10 Nos
Technician Gr-I (QAT)	18 Nos
Technician Gr-II	4 Nos.(on OD)
GPEs	14 Nos.(on OD)
Total	48 Nos.

Figure 3.5 : Existing Organizational Chart of "Quality Assurance Testing (QAT) Wing" at Asifnagar Water treatment Plant

3.1.2 Water treatment plant analytical data (Secondary)

The performance data for Asifnagar water treatment plant during April 2006 to March 2007 is collected for evaluation. The comparison of raw and treated water characteristics (pH and turbidity) is presented in **Figure 3.6** and the analytical results of pH, turbidity and bacteriology for raw and treated water is given in **Table 3.4**.



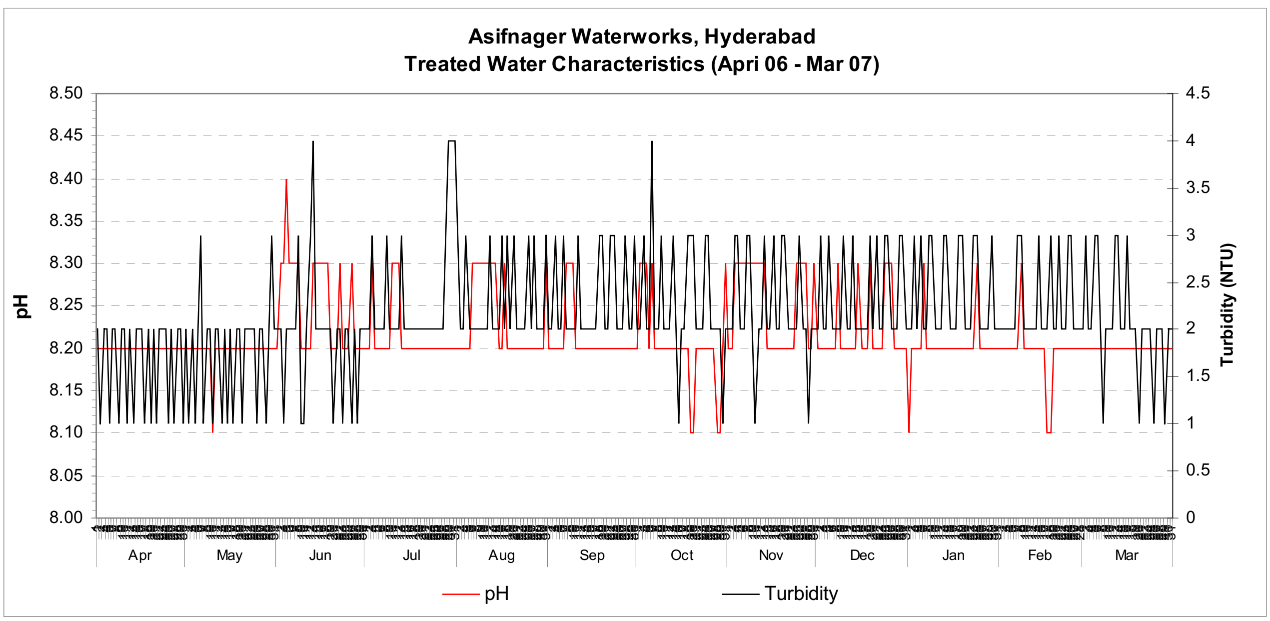


Figure 3.6 : Comparison of Raw and Treated Water Characteristics (pH and turbidity)

Table 3.4 : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	April 2006						May 2006						June 2006					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.5	5	2400	8.2	2	NIL	8.5	5	2400	8.2	2	NIL	8.5	5	2400	8.2	2	NIL
2	8.4	5		8.2	1		8.4	4		8.2	1		8.5	4		8.3	2	
3	8.4	4		8.2	2		8.4	4		8.2	2		8.5	4		8.3	1	
4	8.4	5		8.2	2		8.5	5		8.2	1		8.5	5		8.4	2	
5	8.4	5		8.2	1		8.4	4		8.2	2		8.5	4		8.3	2	
6	8.4	5		8.2	2		8.4	5		8.2	3		8.5	4		8.3	2	
7	8.4	4		8.2	2		8.5	4		8.2	1		8.5	5		8.3	2	
8	8.4	6		8.2	1		8.4	4		8.2	2		8.5	4		8.3	3	
9	8.4	5		8.2	2		8.5	5		8.2	2		8.4	4		8.2	1	
10	8.4	4		8.2	2		8.4	4		8.1	1		8.4	5		8.2	1	
11	8.4	5		8.2	1		8.4	5		8.2	2		8.5	6		8.2	2	
12	8.4	5		8.2	2		8.4	4		8.2	2		8.5	5		8.2	3	
13	8.4	6		8.2	1		8.4	5		8.2	1		8.5	4		8.3	4	
14	8.4	6		8.2	2		8.4	5		8.2	2		8.4	5		8.3	2	
15	8.4	5		8.2	2		8.5	4		8.2	1		8.4	6		8.3	2	
16	8.4	5		8.2	2		8.4	5		8.2	2		8.5	5		8.3	2	
17	8.4	4		8.2	1		8.4	6		8.2	1		8.5	4		8.3	2	
18	8.4	5		8.2	2		8.6	4		8.2	2		8.5	5		8.3	2	
19	8.4	4		8.2	1		8.5	5		8.2	2		8.5	5		8.2	2	
20	8.5	5		8.2	2		8.4	4		8.2	1		8.5	4		8.2	1	
21	8.4	4		8.2	1		8.4	5		8.2	2		8.5	5		8.2	2	
22	8.4	4		8.2	2		8.4	5		8.2	2		8.5	5		8.3	2	
23	8.4	5		8.2	2		8.5	4		8.2	2		8.4	6		8.2	1	
24	8.4	4		8.2	2		8.4	4		8.2	2		8.5	5		8.2	2	
25	8.4	5		8.2	1		8.4	5		8.2	1		8.4	4		8.2	2	
26	8.4	4		8.2	2		8.5	4		8.2	2		8.4	4		8.3	1	
27	8.5	5		8.2	1		8.4	4		8.2	2		8.5	5		8.2	2	
28	8.4	4		8.2	2		8.4	4		8.2	1		8.4	4		8.2	1	
29	8.4	5		8.2	2		8.4	5		8.2	2		8.4	4		8.2	2	
30	8.4	4		8.2	1		8.5	4		8.2	3		8.4	5		8.2	2	
31							8.5	6		8.2	2							

Table 3.4 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	July 2006						August 2006						September 2006					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.5	5	2400	8.2	2	NIL	8.5	6	2400	8.2	3	NIL	8.5	6	2400	8.2	2	NIL
2	8.4	5		8.2	2		8.5	5		8.2	2		8.4	6		8.2	2	
3	8.4	4		8.3	3		8.5	6		8.2	2		8.4	7		8.2	3	
4	8.4	6		8.2	2		8.5	20		8.2	3		8.4	5		8.2	2	
5	8.5	5		8.2	2		8.4	15		8.2	2		8.4	6		8.2	2	
6	8.4	6		8.2	2		8.5	12		8.3	2		8.4	6		8.2	3	
7	8.4	5		8.2	2		8.5	10		8.3	2		8.4	7		8.3	2	
8	8.4	5		8.2	3		8.5	6		8.3	2		8.4	5		8.3	2	
9	8.4	4		8.2	2		8.5	5		8.3	2		8.4	6		8.3	2	
10	8.4	5		8.3	2		8.5	5		8.3	2		8.4	6		8.2	2	
11	8.5	6		8.3	2		8.4	6		8.3	2		8.5	5		8.2	3	
12	8.4	5		8.3	2		8.5	6		8.3	3		8.4	7		8.2	2	
13	8.4	4		8.2	3		8.4	5		8.3	2		8.4	6		8.2	2	
14	8.4	5		8.2	2		8.4	5		8.3	2		8.4	5		8.2	2	
15	8.4	5		8.2	2		8.4	5		8.2	2		8.4	6		8.2	2	
16	8.5	5		8.2	2		8.5	7		8.2	3		8.5	6		8.2	2	
17	8.4	4		8.2	2		8.5	10		8.3	2		8.4	5		8.2	2	
18	8.5	5		8.2	2		8.5	6		8.2	3		8.4	5		8.2	3	
19	8.4	4		8.2	2		8.5	5		8.2	2		8.4	6		8.2	3	
20	8.5	5		8.2	2		8.4	5		8.2	3		8.4	6		8.2	2	
21	8.5	5		8.2	2		8.4	6		8.2	2		8.4	5		8.2	2	
22	8.5	6		8.2	2		8.5	6		8.2	2		8.4	5		8.2	3	
23	8.5	5		8.2	2		8.4	5		8.2	2		8.4	6		8.2	3	
24	8.5	5		8.2	2		8.4	5		8.2	2		8.4	7		8.2	2	
25	8.5	4		8.2	2		8.4	5		8.2	3		8.4	8		8.2	2	
26	8.5	5		8.2	2		8.5	6		8.2	2		8.5	7		8.2	2	
27	8.5	5		8.2	2		8.5	5		8.2	3		8.4	8		8.2	3	
28	8.5	4		8.2	3		8.5	6		8.2	2		8.5	8		8.2	2	
29	8.5	5		8.2	4		8.4	5		8.2	2		8.4	9		8.2	2	
30	8.5	4		8.2	4		8.4	6		8.2	2		8.4	7		8.2	3	
31	8.5	5		8.2	4		8.5	6		8.3	3							

Table 3.4 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	October 2006					
	Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.3	7	2400	8.2	2	NIL
2	8.4	8		8.3	2	
3	8.4	7		8.3	3	
4	8.4	6		8.3	2	
5	8.4	6		8.2	2	
6	8.4	7		8.3	4	
7	8.4	7		8.2	2	
8	8.4	6		8.2	2	
9	8.4	7		8.2	3	
10	8.4	10		8.2	2	
11	8.4	8		8.2	2	
12	8.4	8		8.2	2	
13	8.5	9		8.2	3	
14	8.4	10		8.2	2	
15	8.4	7		8.2	1	
16	8.4	10		8.2	2	
17	8.5	11		8.2	2	
18	8.4	10		8.2	3	
19	8.4	7		8.1	3	
20	8.4	8		8.1	3	
21	8.4	9		8.2	2	
22	8.4	7		8.2	2	
23	8.4	7		8.2	2	
24	8.4	6		8.2	3	
25	8.4	8		8.2	3	
26	8.4	7		8.2	2	
27	8.4	8		8.2	2	
28	8.4	6		8.1	2	
29	8.4	6		8.1	2	
30	8.4	7		8.2	1	
31	8.4	8		8.3	2	

Date	November 2006					
	Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.4		2400	8.2	2	NIL
2	8.4	10		8.2	2	
3	8.5	12		8.3	3	
4	8.4	10		8.3	3	
5	8.4	8		8.3	2	
6	8.4	10		8.3	2	
7	8.4	11		8.3	3	
8	8.4	12		8.3	3	
9	8.5	8		8.3	2	
10	8.5	10		8.3	1	
11	8.4	8		8.3	2	
12	8.4	7		8.3	2	
13	8.4	8		8.3	3	
14	8.4	12		8.2	2	
15	8.5	10		8.2	2	
16	8.4	8		8.2	3	
17	8.4	9		8.2	2	
18	8.4	10		8.2	2	
19	8.5	11		8.2	3	
20	8.4	12		8.2	3	
21	8.5	8		8.2	2	
22	8.4	10		8.2	2	
23	8.4	9		8.2	2	
24	8.4	12		8.3	2	
25	8.4	10		8.3	3	
26	8.4	10		8.3	2	
27	8.4	12		8.3	2	
28	8.5	9		8.2	1	
29	8.4	10		8.2	2	
30	8.4	12		8.3	2	
31						

Date	December 2006					
	Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.4	10	2400	8.2	2	NIL
2	8.4	8		8.2	3	
3	8.5	8		8.2	2	
4	8.4	10		8.2	2	
5	8.4	9		8.2	3	
6	8.5	9		8.2	2	
7	8.4	8		8.2	2	
8	8.4	8		8.3	2	
9	8.4	10		8.2	2	
10	8.4	11		8.2	3	
11	8.4	8		8.2	2	
12	8.5	12		8.2	2	
13	8.5	10		8.2	3	
14	8.5	11		8.2	2	
15	8.4	10		8.3	2	
16	8.5	9		8.2	2	
17	8.4	8		8.2	2	
18	8.5	11		8.2	2	
19	8.4	10		8.3	3	
20	8.4	10		8.2	2	
21	8.5	11		8.2	3	
22	8.4	11		8.2	2	
23	8.4	10		8.2	2	
24	8.4	8		8.3	3	
25	8.4	8		8.3	3	
26	8.4	9		8.3	2	
27	8.5	11		8.2	2	
28	8.5	10		8.2	2	
29	8.4	11		8.2	3	
30	8.4	12		8.2	3	
31	8.4	11		8.2	2	

Table 3.4 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	January 2007						February 2007						March 2007					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.4	12	2400	8.1	2	NIL	8.4	12	2400	8.2	2	NIL	8.4	12	2400	8.2	2	NIL
2	8.4	11		8.2	2		8.4	12		8.2	2		8.4	10		8.2	3	
3	8.5	12		8.2	3		8.4	13		8.2	2		8.4	11		8.2	2	
4	8.4	10		8.2	2		8.4	12		8.2	2		8.4	12		8.2	2	
5	8.5	10		8.2	3		8.4	11		8.2	2		8.4	12		8.2	3	
6	8.4	12		8.3	2		8.4	12		8.2	2		8.4	11		8.2	3	
7	8.4	10		8.2	2		8.4	14		8.2	3		8.4	11		8.2	2	
8	8.5	10		8.2	3		8.5	12		8.3	3		8.4	10		8.2	1	
9	8.4	13		8.2	3		8.4	12		8.2	2		8.4	9		8.2	2	
10	8.4	12		8.2	2		8.4	10		8.2	2		8.4	10		8.2	2	
11	8.4	11		8.2	2		8.4	12		8.2	2		8.4	10		8.2	2	
12	8.5	12		8.2	2		8.4	11		8.2	2		8.4	11		8.2	3	
13	8.5	12		8.2	3		8.4	11		8.2	2		8.4	12		8.2	3	
14	8.4	10		8.2	3		8.4	12		8.2	3		8.4	13		8.2	2	
15	8.4	11		8.2	2		8.4	11		8.2	2		8.4	11		8.2	2	
16	8.4	11		8.2	2		8.4	11		8.2	2		8.4	11		8.2	3	
17	8.4	12		8.2	2		8.4	12		8.1	2		8.4	10		8.2	2	
18	8.5	11		8.2	3		8.4	13		8.1	3		8.4	10		8.2	2	
19	8.4	10		8.2	3		8.5	12		8.2	2		8.4	9		8.2	2	
20	8.4	10		8.2	2		8.4	13		8.2	2		8.4	10		8.2	1	
21	8.4	12		8.2	2		8.4	12		8.2	3		8.4	9		8.2	2	
22	8.5	13		8.2	2		8.5	11		8.2	2		8.4	11		8.2	2	
23	8.5	12		8.2	3		8.4	12		8.2	2		8.4	12		8.2	2	
24	8.5	12		8.3	3		8.4	10		8.2	3		8.4	11		8.2	2	
25	8.4	13		8.2	2		8.4	10		8.2	3		8.4	12		8.2	1	
26	8.5	11		8.2	2		8.4	11		8.2	2		8.4	10		8.2	2	
27	8.4	12		8.2	2		8.4	11		8.2	2		8.4	11		8.2	2	
28	8.5	13		8.2	2		8.4	11		8.2	2		8.4	12		8.2	2	
29	8.4	12		8.2	3								8.4	10		8.2	1	
30	8.4	12		8.2	2								8.4	12		8.2	2	
31	8.4	14		8.2	2								8.4	13		8.2	2	

Observations

It has been observed that the raw water turbidity was fairly low throughout the year ranging from about 4 to 20 NTU. However, the minimum values are observed during monsoon months and higher values during winter and pre monsoon period. The reasons for such trend needs to be identified which may be either the change of methodology of determination or modifications in raw water inlet channel from source to water treatment plant. The filtrate quality has always complied with BIS 10500 standards for drinking water. However, the best performance with turbidity of finished water as 1 NTU was observed in less than about 30% of the samples. The frequency distribution with turbidity of 2 NTU and less was better ranging from 60 to 75 percent. The overall quality of filtrate was good while considering pH, turbidity and total coliform count. Performance of filters in terms of turbidity is depicted in **Figure 3.7**.

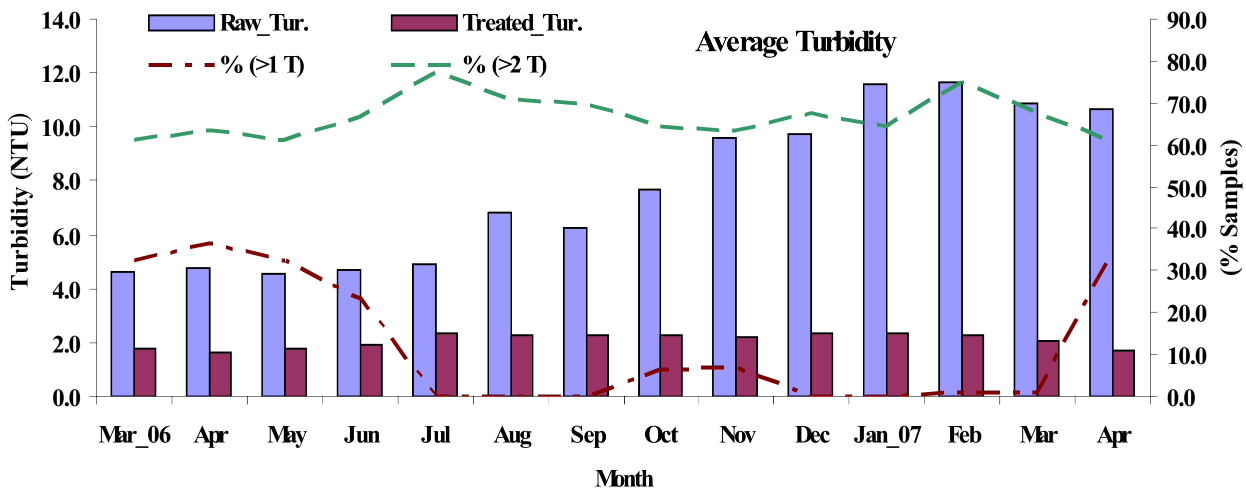


Figure 3.7 : Performance of Filters in Terms of Turbidity

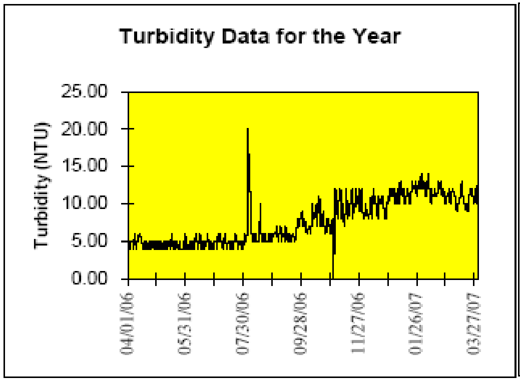
3.1.3 Evaluation Based on Partnership for Safe Water (PSW) software

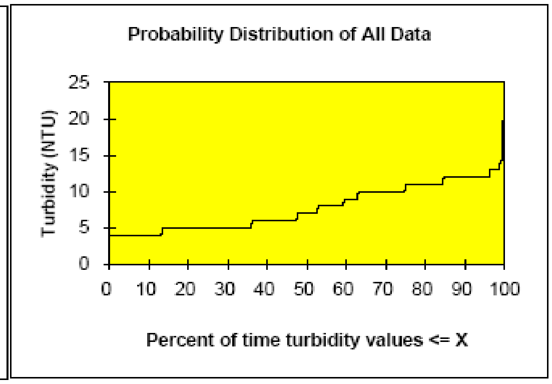
Partnership for Safe Water (PSW) software was developed by American Water Works Association (AWWA) et al which provides major unit performance potential spreadsheet, graphs and treatment summary along with percentile distribution. The calculations provided with this software were not suitable for compliance with regulatory requirements. They were only to be used for assessing the relative/ theoretical capacity of unit treatment processes as per of the PSW.

A percentile analysis can also be made using the data to determine the percent of time that raw, settled and finished water quality is equal to or less than certain turbidity. This information can be used to assess the variability of raw water turbidity and the performance of sedimentation and filtration unit processes. The percentile analysis of settled and finished water quality is useful to project a plant's capability to achieve optimized performance objectives. The software was used to carry out performance evaluation of Asif Nagar water treatment plant based on one-year raw water turbidity data. It is observed that 80% of the times turbidity was below 10 NTU. Comparison of raw and treated water turbidity is depicted in **Figure 3.8**.

Hyderabad Metropolitan Water Supply & Sewerage Board - (Raw Water)

Percentile	Yearly	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
50	7.00	5.00	4.00	5.00	5.00	6.00	6.00	7.00	10.00	10.00	12.00	12.00	11.00
75	10.25	5.00	5.00	5.00	5.00	6.00	7.00	8.00	11.00	11.00	12.00	12.00	12.00
90	12.00	5.10	5.00	5.10	6.00	10.00	8.00	10.00	12.00	11.00	13.00	13.00	12.00
95	12.00	6.00	5.50	6.00	6.00	13.50	8.00	10.00	12.00	11.50	13.00	13.00	12.50
96	12.00	6.00	5.80	6.00	6.00	14.40	8.00	10.00	12.00	11.80	13.00	13.00	12.80
97	13.00	6.00	6.00	6.00	6.00	15.50	8.13	10.10	12.00	12.00	13.10	13.19	13.00
98	13.00	6.00	6.00	6.00	6.00	17.00	8.42	10.40	12.00	12.00	13.40	13.46	13.00
99	13.37	6.00	6.00	6.00	6.00	18.50	8.71	10.70	12.00	12.00	13.70	13.73	13.00
Avg	7.75	4.73	4.55	4.67	4.87	6.81	6.23	7.68	9.93	9.74	11.55	11.64	10.90
Min	4.00	4.00	4.00	4.00	4.00	5.00	5.00	6.00	7.00	8.00	10.00	10.00	9.00
Max	20.00	6.00	6.00	6.00	6.00	20.00	9.00	11.00	12.00	12.00	14.00	14.00	13.00
RSD	39.2%	13.3%	13.5%	13.9%	12.5%	48.6%	16.9%	17.9%	15.2%	13.0%	9.3%	8.0%	10.0%



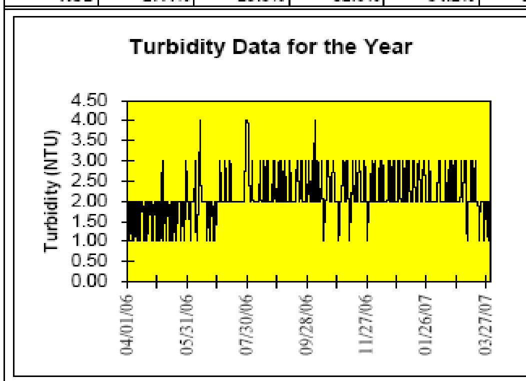


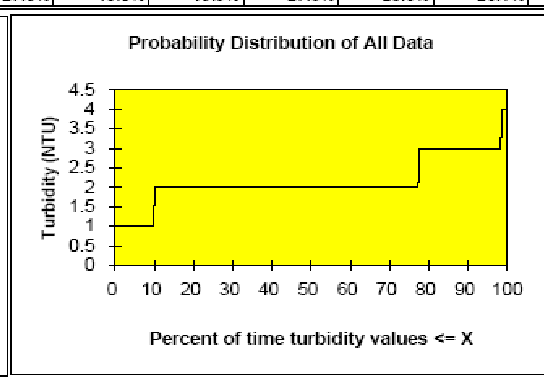
Start Year	2006	365	= Total Days
Month	4	12.00	= Total Months
Day	1		

Utility Name	WTP
Plant Name	Asifnagar
Plant Street Address	Asifnagar
Plant City, State, Zip	Hyderabad
Plant Contact Name	Mr. Narsappa
Plant Phone	040-
Plant E-mail Address	0

Hyderabad Metropolitan Water Supply & Sewerage Board - (Treated Water)

Percentile	Yearly	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07
50	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
75	2.00	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.25	2.00
90	3.00	2.00	2.00	2.10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
95	3.00	2.00	2.50	3.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
96	3.00	2.00	2.80	3.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
97	3.00	2.00	3.00	3.13	4.00	3.00	3.00	3.10	3.00	3.00	3.00	3.00	3.00
98	3.00	2.00	3.00	3.42	4.00	3.00	3.00	3.40	3.00	3.00	3.00	3.00	3.00
99	4.00	2.00	3.00	3.71	4.00	3.00	3.00	3.70	3.00	3.00	3.00	3.00	3.00
Avg	2.14	1.63	1.74	1.90	2.32	2.29	2.30	2.26	2.23	2.32	2.35	2.25	2.06
Min	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	2.00	2.00	2.00	1.00
Max	4.00	2.00	3.00	4.00	4.00	3.00	3.00	4.00	3.00	3.00	3.00	3.00	3.00
RSD	27.4%	29.5%	32.5%	34.2%	27.6%	19.8%	19.9%	27.5%	25.0%	20.1%	20.3%	19.2%	27.3%





Start Year	2006	365	= Total Days
Month	4	12.00	= Total Months
Day	1		

Utility Name	WTP
Plant Name	Asifnagar
Plant Street Address	Asifnagar
Plant City, State, Zip	Hyderabad
Plant Contact Name	Mr. Narsappa
Plant Phone	040-
Plant E-mail Address	0

Figure 3.8 : Turbidity data for raw and treated water along with probability distribution for Asifnagar Water Treatment Plant

3.1.4 Online experimental studies (Primary data)

All the external water treatment plant experts from New Delhi, Pune, Kolkata and Hyderabad carried out plant evaluation during the CCP workshop. Online continuous monitoring turbidity meter was installed at treatment plant filter beds for 24 hours recordings. Possible locations for sampling taps on adjacent individual filters were considered to provide raw water flow to the continuous analyzers. The turbidity, pH and conductivity probes were identified and submerged in to the filter bed inlet and filter bed outlet locations. Continuous monitoring was carried out from 12:30 pm of 15th May 2007 till 11:30 am of 16th May 2007.

The input and output data was collected for pH, turbidity and conductivity and graphical representations were made to establish the efficiency of filter beds. **Figure 3.9** presents the results of online experimental studies.

Observations based on Online Experiments

The performance of filter bed under evaluation was very good with filtrate quality, turbidity always less than 1.2 NTU, when raw water turbidity was ranging from 4 to 14 NTU. The limited observations of one single battery of filters indicate that each filter bed behaves differently resulting in higher finished water turbidity as reflected by the plant data for 12 months. This observation clearly identifies the need for critical evaluation of each filter bed to meet best performance. Achieving low turbidity (< 1 NTU) will give better confidence about maximum removal of microbial and biological indicator and pathogenic organisms

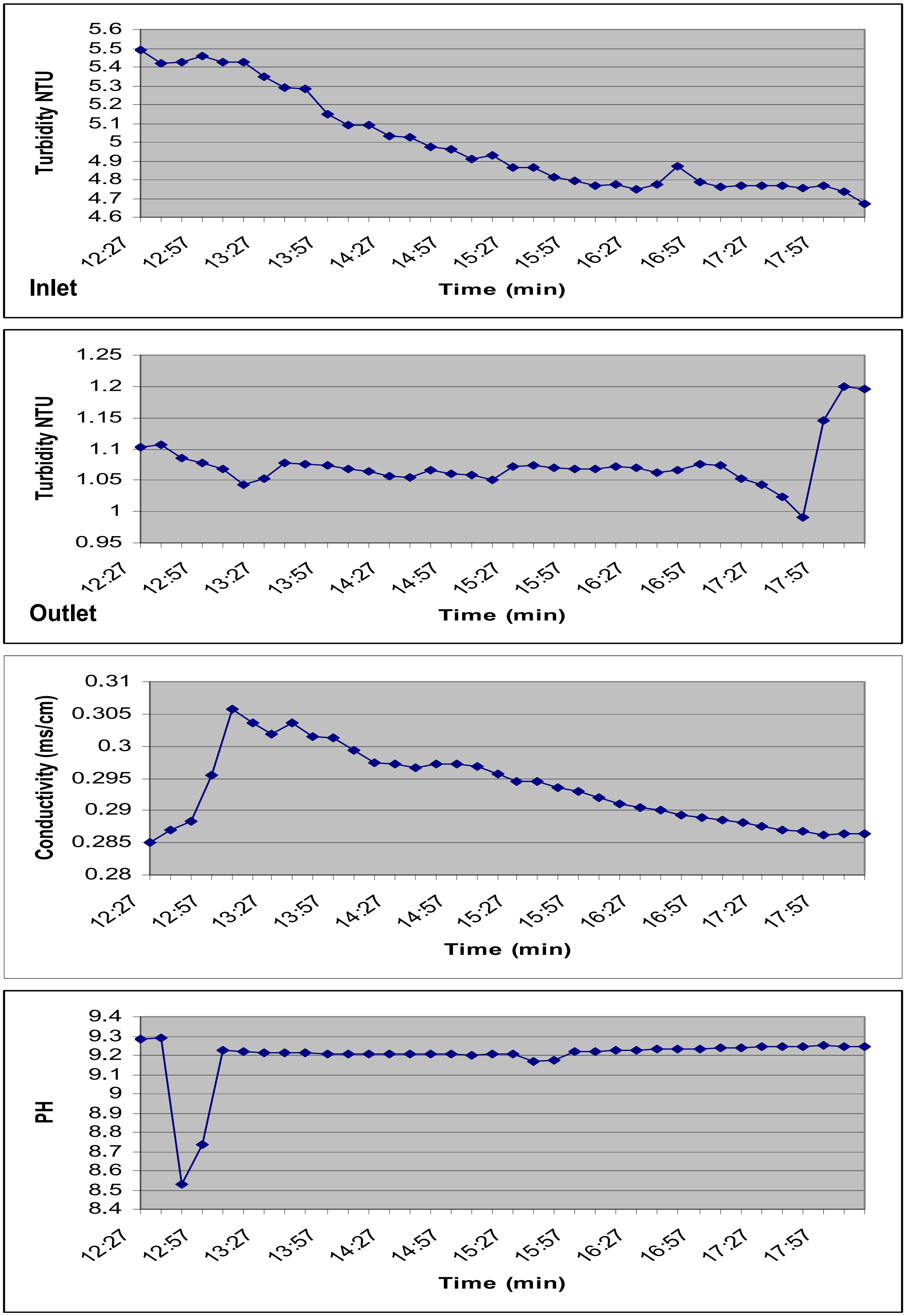


Figure 3.9 : Online Performance of Asif Nagar Water Treatment Plant

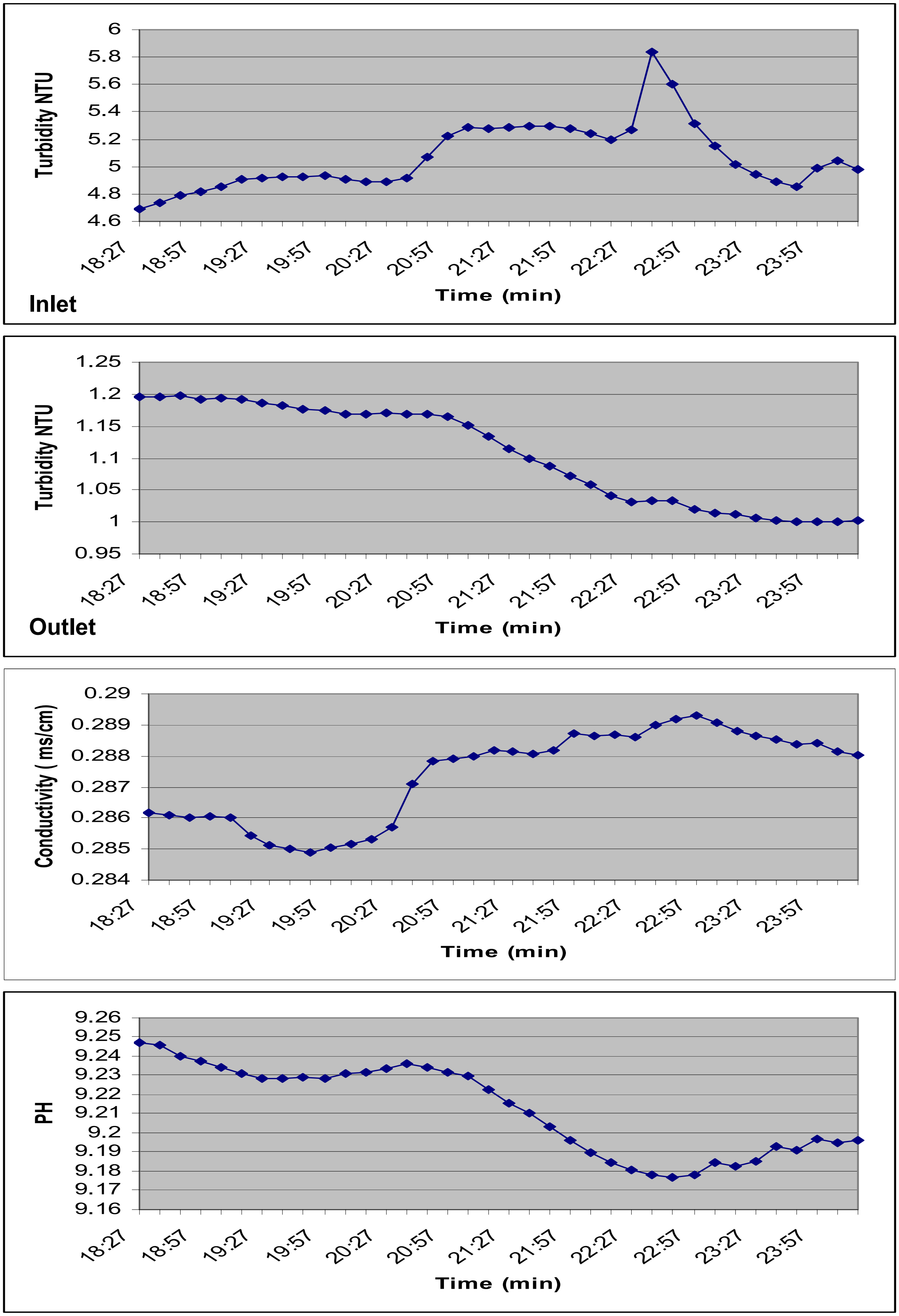


Figure 3.9 : Online Performance of Asif Nagar Water Treatment Plant

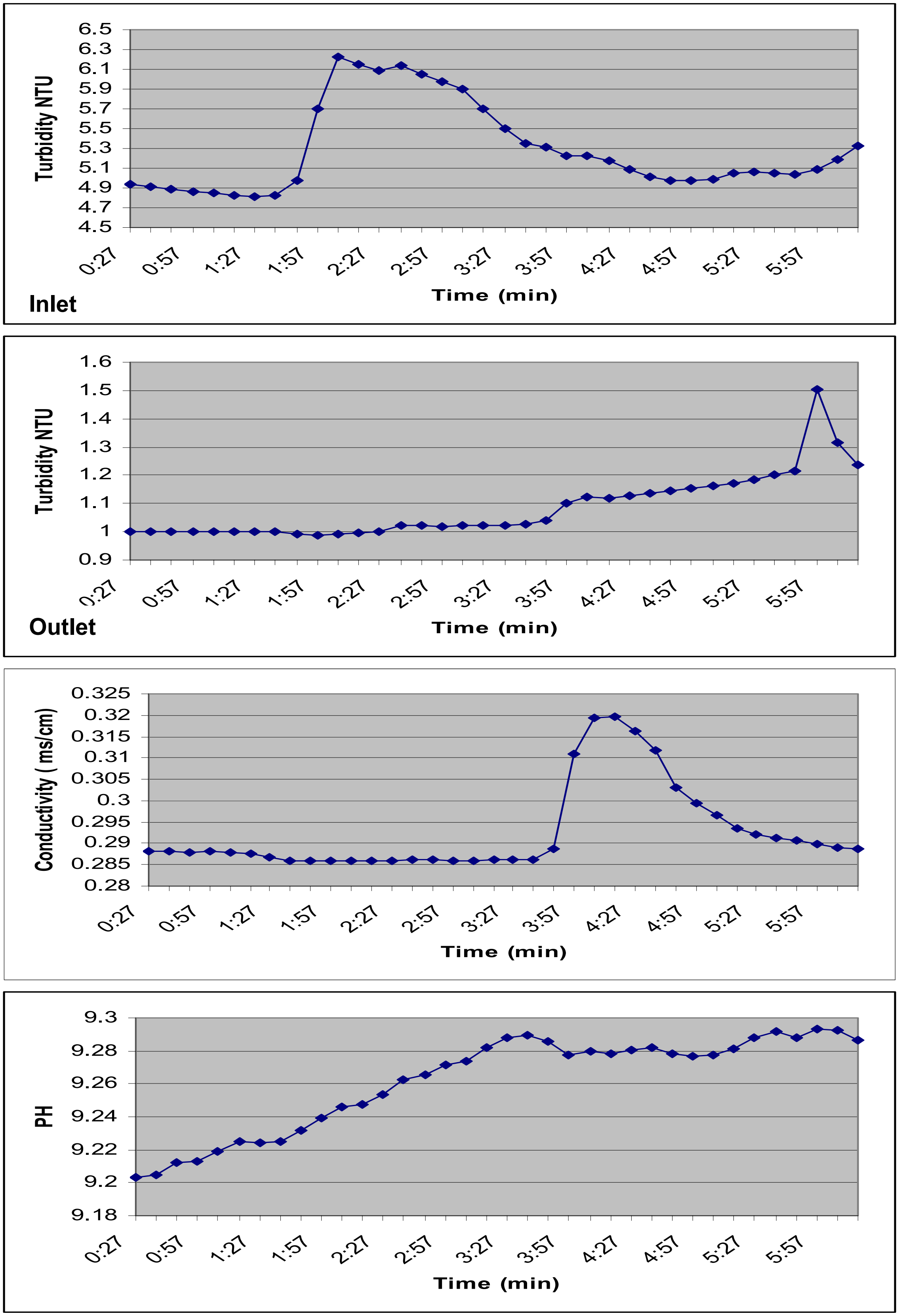


Figure 3.9 : Online Performance of Asif Nagar Water Treatment Plant

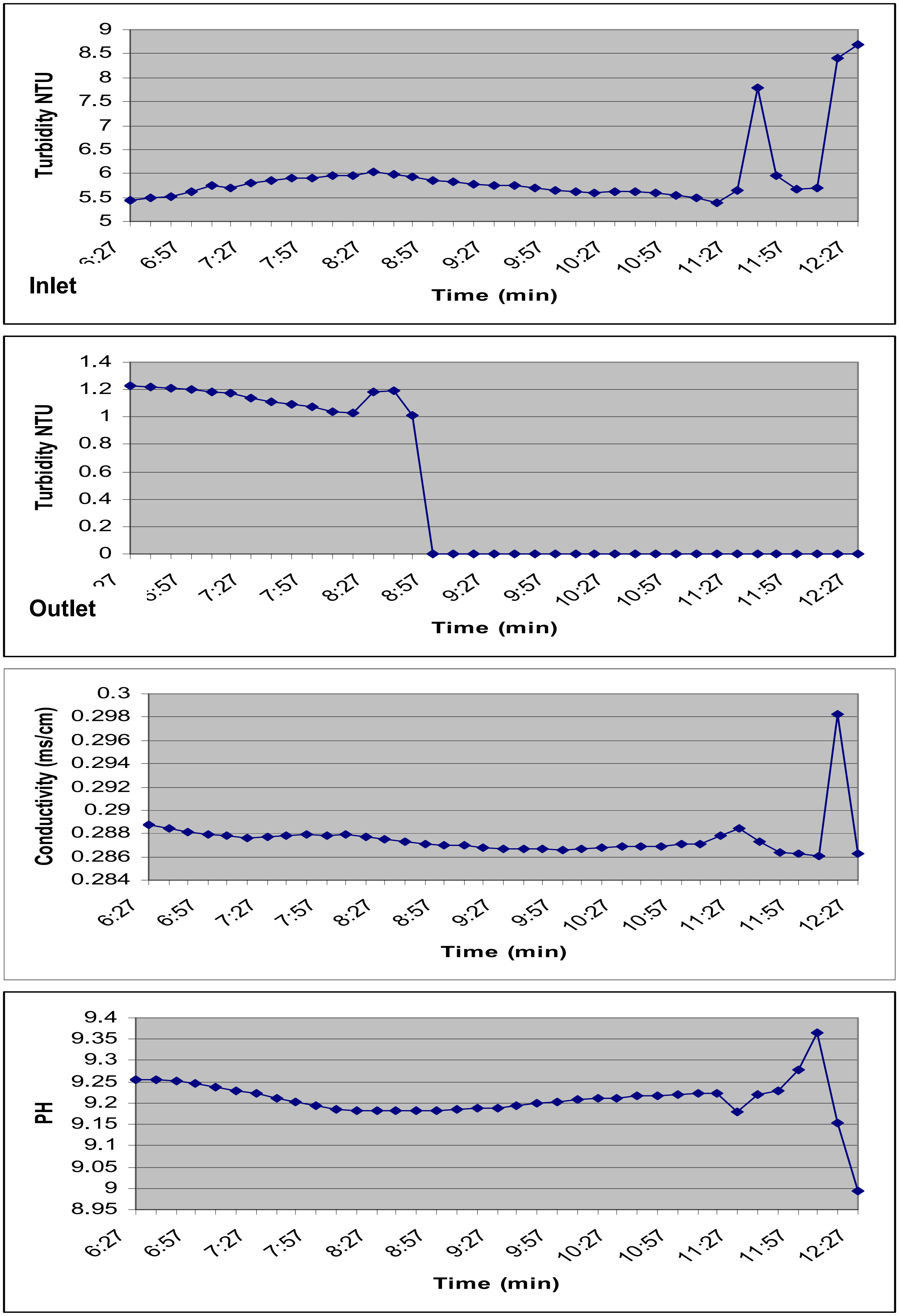


Figure 3.9 : Online Performance of Asif Nagar Water Treatment Plant

3.1.5 Comprehensive Performance Evaluation (CPE) from Auditors:

The summary of auditors comment on comprehensive performance evaluation and performance limiting factors and rating are presented in **Table 3.5 and Table 3.6**. The detailed proformae are in **Annexure 3.1 (A).**

Auditors Special comments

1. Mr. Somdutt from Delhi Jal Nigam Limited
   - pH and Alkalinity in raw and settled water should be monitored to find out the dose of Alum applied.
   - Then there should be continuous de-sludging of sedimentation tanks
   - Backwashing should be with chlorinated water
   - Water quality check for microbiology.
   - Data generated should be fed in computer for checking the performance.
   - Microbiological analysis may be outsourced to other agencies.
   - Quality control department should keep data for catchments to consumer
   - Safety plan and disaster management plan should be prepared for plant operators
   - Blending of experienced and fresh staff is required
   - Staff is adequate but inadequate finance

2. Mr. Arya from Delhi Jal Nigam Limited
   - Measurement of raw water essential to feed proper chemical dose
   - Jar test, chlorine demand and complete physico-chemical analysis should be done daily.
   - Increase the minimum parameters and their frequency.
   - Reason for higher pH in treated water needs to be investigated.
   - Communication between O&M persons with laboratory persons should be enhanced

3. Mr. David from USA
   - Formulate programme for water quality with due consideration for selected parameters and their frequency.
   - Renovate filters

Table 3.5 : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
A) Source protection and conveyance to plant	• To Prevent ugly formation in Raw Water	• To Prevent ugly formation in raw water &maintain the pH of the raw water between 7.5-8.5	• Have adequate monitoring by outside agencies also; there are no social activities around the source. However the possibility of contamination cannot be ruled out.	--	--
B) Raw water quality	--	--	• There is problem of growth of algae in the Osmansagar reservoirs, which residues the filter output.	• At every stage guidelines of BIS1050-1993 for drinking water quality be strictly followed. Step must be taken to monitor quality of water right from raw water treatment plant up to consumer point	--
C) Measurement of raw and treated water flow	• No Flow measurement for intake & outlets. • No Flow meters put up for outgoing reservoirs. • No venture meter for each beds to measure flow • (Loss of head or Rate of flow measurement).	• Needs flow meter for intake filter water as well as outlet point	• Measurement devices for raw water entering into the system must. But there is no measurement of treated unit quantity leaving from its treatment plant.	• Flow meters, not in existence Raw water quality in settling tank to, feed exact quality of Alum/chlorine	--
D) Chemical storage for alum, chlorine and PAC	• Only minor material available • Alum storage capacity should be improved • Quality of supplied Alum should also be tested in government laboratory	--	• There is one chemical store having inadequate storage capacity. • The feeding device is inadequate manually for alum also.	• Lack of proper dosing of Alum & Disinfection chlorine. • In each shift laboratory need for application	• Cl_2, alum and other chemicals not stored properly. Machine parts and effective equipment have to protect properly to avoid accident.

Table 3.5 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
E) Consumption of chemicals eg. Alum, chlorine and PAC	--	--	• There is no regular conduct of alum dose requirement by jar tester apparatus. Chlorine is added per chlorine demand examined in the laboratory in day shift.	--	• Chemical feeding is not calibrated properly
F) Flocculation, coagulation and sedimentation	• Continuous sludge removal should be there	• Detention time should be same throughout the every season to prepare the healthy flocks for better quality of filtered water • For higher turbidity season detention period increase in the system process.	• The plant is getting raw water more than the sedimentation capacity. • The mixing of chemicals is by hydrate fall in the channel therefore, thus is for flocculation and sedimentation • Sedimentation tanks have a provision to remove the sludge by scoring but the rates do not operate due to common and very old. Therefore it is removed normally and annually i.e. after monsoon every year.	• Require prevention of undesired greenish color and growth of "Algae" & filter chocking cell requires regular sludge removal system i.e. "Scouring" unit to put in working order.	• Premonsoon and after monsoon cleaning is required • Flocculation has limited hydraulic mixing but apparent in adequate to get good floc formation • No continuous sludge removal capability exists in sedimentation basin. • NOTE: This in conjunction with in frequently cleaning results in the builds of sludge deposits and increased Alum consumption. • Some lab data indicated that pH raised over recent year to high is the coagulant best suited for the high pH treatment. • Use of coagulant aids or other coagulants may prove more effective, reduce sludge volumes, or reduce costs.

Table 3.5 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
G) Filter O & M and Back washing	• History card/ record must be kept after each every maintenance for each bed/ valves/chlorinators etc. • Should have separate maintenance team.	--	• Back washing is done with one minutes and scouring and backwash water by over head tanks. Surface washing is done with unchlorinated water	--	• Backwash is done in every 48 hours, rating is not measured. • Filter bed through function well now but require resetting in near future to get stable rate of filtration. • Material system is to be introduced Recycle backwash water (water treatment) to one. • NOTE: could result in concentration of microbial pathogens at this point.
H) Disinfection	• Requires chlorine neutralization plant.	• Pre chlorination should be applied as the RC at filter bed up to 0.1ppm-0.2ppm to neutralize the algae growth at filter. • Post cl_2 gets reduced to 1.5ppm in city reservoir. • Maintain up to 1.5ppm to protect the system of the treatment. • To check the pollution in this distribution maintains up to 0.5 ppm at the consumer point.	• Chlorine is used for disinfection of water. It is added in two stages i.e., prechlornation and post chlorination. Being the hazardous chemicals, no safety arrangement in units	--	--
I) Balancing reservoir	--	--	• This is only one balancing tank& inadequate capacities are not hold water if sudden break down occur in the plant operation.	--	--

Table 3.5 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
J) Safety devices or measures	--	• For loading & unloading the chlorine cylinders should be at the sites • Alarming systems should be provided • Chlorine Absorption system should be at the chlorine point.	--	• Chlorine machines of m/semitone make, already installed are ok but racking safety arrangement during any possible leakage of chlorine	--
k) Training Programme	--	--	--	--	• At the operating levels trained personnel with certification to be provided. • Second line of defense in operating level should be created, blending fresh with experienced one.
L) Laboratory	• Jar Test must take every day. • Model flocculators equipment must be in a lab. Settle water (sedimentation) turbidity must taken • pH value of Raw water is high • Modern technology should be adopted	• Alum dosing Jar test should be in every shift • Latest testing equipment should be in the lab as Spectrophotometer. • Residue Alumina listing should be in two times in every shift (4hrs) • To control the pH of filter water &maintain the flow rate of filtered water or to reduce the bacteriologic load at filter beds.	• The treatment process is not related with the chemical parameter testing report only, laboratory staff available in day shift. • There is no provision of out sourcing of water quality checks.	• Required Lab instruments to determine turbidity of raw water, finished water, residual chlorine up to consumer end. Require full-fledged laboratory with sophisticated instrument.	• Lab is equipped with chemicals but not with digital measuring devices. • Process control testing is done test not in regular basis. • Data not available

Table 3.5 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
L) Laboratory (Contd..)	--	--	--	• It should work round the clock (in three shift) to ensure treatment /purification process Alum and chlorine application and any possible pollution raw water source. • Daily recording must exercised while application of quantity of Alum in raw water Chlorine at pre &post effort should be made to make surveillance of water quality by enhancing daily sampling.	• It seems during monsoon contamination the reduction in microorganisms are not done properly • Outside, independent verification of test results such as with the center/lab; finished water turbidity data is rounded and should be reported to nearest 0.1NTU. • Lack of periodic outside. independent verification of data and testing accuracy, Standardized operating procedures were not found for much major plant operation. • NOTE: sops help provide greater consistency and uniformity of operation. Also are benefited for the training of new employed.
M) Planning/ interaction with other agencies	--	--	• It being submitted to the authority but no action has been takes and help in plenty for along time which hinders the performance of the plant	• It would be significant if plant persons are allowed to visit other metro city to exchange or no entire system	--

Table 3.5 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
N) Budget (Planning)	• Get only 4-5 lacs rupees for maintenance • Requires budget for development works. • High budget for major (outsourcing) repairs & replacement (Development)	• Get only 4-5 lacs rupees for maintenance • Requires budget for development works. • High budget for major (outsourcing) repairs & replacement (Development)	• An usually budget is provided but inadequate to keep the units in order. • Painting & lubrication.	• To maintenance up keep of plant 's Unit followed by efficient result that quality and quantity of potable water adequate budget is needed.	• Capital cost is realized but fund required for renovation and establishment of existing plant, conveyance system. • Pond getting allocation required. No reserve fund is created to copy with emergency requirement.
O) Housekeeping/ Supervision	• Require more effective supervision. • Require chemist in each shift. • More coordination required among departments. • Requires more attention.	• History record must be kept after every maintained for each bed/valve should have separate maintenance team. Require more effective supervision. • Require chemist in each shift required local network to contact every staff immediately &put the information immediately for better result. • More coordination required among departments.	• Adequate staff for operation of filter beds are available, but for laboratory. • Inadequate to come in shifts. Adequate, staffs are required for operation of the plant.	• Lack of consistent maintenance i.e. day to day minor maintenance, which cause malfunctioning of system followed by adverse affect on result quality control. • Laboratory person to be deployed to supervise entire process of treatment by purification in three shift • Almost, all chamber, were filtered water is being collected are uncovered which is contrary to the safeguard of water quality.	• Plant has good coverage of available water but very old required through over turbidity of filter bed, valves, building fresh with experienced one. • Staffing does not allow for routine laboratory testing during shifts other than day shift. • NOTE: Does not allow rapid detection of treatment and/or water quality problem.

Table 3.5 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Shrikant Bhanage & Mr. Nitin Bagul	Mr. R.D. Sharma	Mr. Somdutt	Er. D.R. Arya	Mr. D. Mandal
P) Evaluation requirements	--	--	--	--	• Facilitates the development of optimization performance goals. • Conduct engineering evaluation to replace filters or work toward implement of prior study recommendation. • Facilitates laboratory quality assurance measures with outside lab to validate and ensure quality of data. • Facilitate the development of SOP in order to improve overall uniformity and consistency operations. • Facilitate evaluation feasibility of sending backwash recycle prior to rapid mix/Alum feed. • Evaluate potential improvement during the flocculation /coagulation process due to “seeding” of turbidity. • Facilitate the evaluation of coagulant aids or alternative for possible cost reduction and performance improvements.

Table 3.6 : Comprehensive Performance Evaluation- Limiting Factor- Rating

Issues	Mr.Bhange/Bagul	Mr. R.D.Sharma	Dr. Somdutt	Mr. D.R.Arya	D.Mondal
A. Source protection and conveyance to plant	A	-	A	B	-
B. Raw water quality testing	B	-	C	B	-
C. Measurement of raw and treated water flow	A	B	B	B	-
D. Chemical storage for alum, chlorine and PAC	B	-	B	-	-
E. Consumption of chemicals eg. Alum, chlorine and PAC	-	-	C	-	-
F. Flocculation,, coagulation and sedimentation	A	B	A	B	B
G. Filter O & M and Back washing	-	-	B	-	B
H. Disinfection	A	B	A	A	-
I. Balancing reservoir	-	-	B	-	-
J. Safety devices or measures	-	-	-	-	-
K. Training Programme	-	-	-	-	-
L. Laboratory Staff adequacy Equipment SOP Testing & calibration	-	B	B	A	A
M. Pumping	-	-	-	-	-
N. Housekeeping	B	B	-	B	B
O. Policies and Planning	-	-	-	-	-
P. Validation of water quality	-	-	B	B	-
Q. Supervision	B	A	C	-	-
R. Operation and Maintenance	B	A	-	B	-
S. Process control	-	B	A	-	A
T. Administration	-	-	-	-	-
U. Budget planning	A	B	B	A	A
V. Lack of formalized preventive maintenance programme	-	-	-	-	-

Rating Description: A- Major effect on long-term repetitive basis,
B- Moderate effect on a routine basis or major effect on periodic basis
C-Minor effect

3.1.6 Field interviews with staff and mitigation plans

During the workshop on CCP, interviews were held with the staff at various levels working in Water Treatment Plant as per the guidelines presented in **Annexure 3.2** and the opinion expressed by them is as under.

1. N. Ramesh, Deputy General Manager

He is responsible for attending problems related to quality and quantity of water. He is also looking after operation and maintenance and minor repairs. He indicated that major repairs are carried out through outsourcing. There is a proposal for the rehabilitation of the plant.

Regarding availability of raw water he expressed that if Osman Sagar reservoir is filled to Full Supply Level in the coming Monsoon (3.9 TMC) then there will not be any problem of shortage of raw water for next 2 years.

He also informed that it is not possible to replace the old valves because they are embedded with in the structure. The budget for maintenance is about 4 to 5 Lakhs per annum. Major breakdowns are reported to General Manager. There is good water protection within 10 km radius and EPTRI are monitoring the reservoir and prevention of pollution. The report on analytical results is available at EPTRI. Daily records for maintenance are available at plant and log books are maintained properly. Mr.Ramesh is also attending any shortcomings reported with in the plant. Minor spares are available with the plant authority.

2. Filter Operator: Mr.Asar Aktar, Sr. Grade Technician

He is ITI passed with 34 yrs of experience. He informed that there are six filter operators and 4 persons for filter backwash. The backwashing is carried out generally after 48 hours in fair season and after 24 hrs in rainy season. All the operators are well versed with filter washings. The procedure of filter washing includes 1.5 to 2.0 minutes of air scoring followed by 6 minutes of water wash. Once the filter is put to operation immediate filtrate turbidity is not monitored. The sand in the filter beds is changed in 1998. Mr. Aktar was of the opinion to carryout modifications for automatic system of filter backwash. 5% Alum solution is used for coagulation. Filter backwash water re-circulated after independent treatment of settling with 80% reuse.

3. Mr. J. Suneel Kumar, Technical Officer for Quality Assurance and Testing

He is a science graduate and joined the Organization in 1992. He is responsible for surveillance of physico-chemical water quality monitoring at distribution network. 5 samples per day are collected which are tested for residual chlorine at site. Conventional physico-chemical parameters are considered for analysis and specific parameters when contamination is expected. With in the plant laboratory Jar test and

Chlorine demand procedures are carried out at the interval of weekly / fortnightly. Even though pre-chlorination is practiced there is no residual chlorine observed in the settled water passing on filter beds. The chemist stays with in the campus and is available for emergency needs.

4. Mr. Raja, Plant Manager

He looks after the overall management of plant maintenance and safety. He reported that there are no measures available for the safety for accident due to chlorine leakage. Raw water is conveyed through closed conduit and there are chances of seepage along the path. Flow measurements are not made daily and there is a ready reckoner table for raw water flow measurement to treatment plant. The weir reading in inches is correlated to MGD. Rehabilitation plan from inlet of raw water to out let of treated water has been prepared and quotations for the same are called for. There is no power shut down. The balancing time capacity is limited and needs to be enhanced. There is no payment for the raw water and hence the treated water is provided at the cheaper rate compared to other treatment plants.

Interlinking of 6 MGD and 20 MGD plant is available but the balancing time is used for the other purpose and hence not used for 20 MGD plant when excess of water and shortage of clear water sample capacity is experienced. The proposal for rehabilitation does not include automation.

Operation & Maintenance of Plant

1. 9 X 3 = 27 Persons as charge men for filtration
2. 2 Pump operators
3. 5 Persons for cleaning of filters
4. 1 Telephone operator

Plant Laboratory

Five technical officials available between 10.00 AM and 5.00 PM. The sample takers assist in collection of samples. The Deputy General Manager supervises the functioning of the laboratory.

3.1.7 Conclusion and Recommendations

The following salient observations and recommendations made by the participants and the organizers of the workshop were communicated to Mr. Jawahar Reddy, M.D., HMWSSB with request to take up the identified issues for remedial measures.

- Necessity of raw water inflow measurement
- Implementation of Quality assessment and Quality control programme
- Essential tests like Jar Test and Chlorine demand should be performed daily for proper chemical dosing
- Improvement in desludging methodology by enhancing frequency
- Renovations of filters for head loss measurements, troughs, inspection box cover etc.
- Safety measurement plan for chlorine storage.
- Factory storage license for chlorine procurement.
- Capacity enhancement for balancing tank.
- Evaluation of reasons for high pH which hampers effective chlorination
- Online measurement of important quality parameters.
- Strengthening manpower with fresh technicians.

Mr. K.S. Narsappa, General Manager, QAT explained the situation analysis for following aspects.

- Distribution system evaluation for slums, low lying areas and small hutments
- Improper location of sewage discharges
- Limitations in thickly populated areas
- Necessity for replacement of old pipelines
- Increase the pressure to provide adequate water at tail enders
- Minimize political interventions.

3.2 Parvati Water works, Pune

3.2.1 Water Supply in Pune

Pune is second largest city in the state of Maharashtra. It is situated on the banks of Mula and Mutha. These rivers originate along the eastern flank of Western ghats of Maharashtra. The population of the city is about 3.5 million. Pune Municipal Corporation attempts to provide basic amenities to 100 % population. There are six water treatment plants with total capacity of 1031 MLD. These plants are located at Pune Cantonment area, Parvati, Holkar, Wagholi, Wadgaon and Warje Water Works. The raw water is drawn from Khadakwasla dam. Treated water is supplied at the rate of 195 lpcd. The details of the water treatment plants are presented in **Table 3.7**.

Table 3.7 : Municipal Waterworks Capacity and Year of Commissioning

Water works	Commissioning year	Capacity (MLD)
Parwati	1969	430
Cantonment	1893	350
Holkar	1919	25
Warje	1999	100
Wagholi	2000	26
Wadgaon	2007	100
	Total	**1031**

Parvati Water Works

This Plant is commissioned in two stages. First stage is commissioned in year 1969 (By Candi filters) & second in year 1972 (By Hindustan Construction. Company). Both stages are functionally identical, the only difference is in their water purification capacity. The first stage is having water purification capacity of 48 MGD i.e. 218 MLD and second stage has capacity of 70 MGD i.e. 318 MLD. The total capacity of Parvati Water Works is 118 MGD i.e. 535.72 MLD. This plant runs completely under gravity.

Sources

Khadakvasla dam is the direct source of raw water **(Plate 3.3)**. It is a moderate sized dam on the Mutha river in Haveli taluka, located about 20 km southwest of the city of Pune. It has 374 Mm^3 storage capacity and was constructed in 1869. The length and height of the dam is 1939 m and 31.79 m respectively. It is named after the nearby village of Khadakwasla. This dam is one of the main sources of water for the city of Pune. Catchment of Khadakwasla near Sinhagad fort and surrounding area is being developed with the Forest Department wherein PMC is spending aboun Rs. 3 crores for soil and water conservation. PMC has also initiated work on provision of security for the protection of Khadakwasla dam to reduce the contamination of water throughpublic interference. Just a few kilometers up, lays the Sinhagad

Fort and the dams of Panshet, Temghar and Varasgaon which also supply water for irrigation. In 1961, the Khadakwasla dam had been blown, as the Panshet Dam overflowed, causing devastating floods in the city of Pune. The dam was later rebuilt. There are three outlets for Khadkvasla dam first one is Mutha right canal, second is baby canal now instead of baby canal there is a close MS pipeline measuring 10 ft, or 3.03 m in diameter. The third outlet opens in to the river.

Plate 3.3 : Khadkwasla Dam

The organization structure of Parvati Water Works is presented in **Figure 3.10.**

Water Treatment Plant at Parvati consists of following unit processes.

1. Reception of the raw water
2. Pre chlorination
3. Flash mixing or coagulation
4. Flocculation
5. Clarification or Settling
6. Filtration
7. Disinfection
8. Clear water storage and Pumping from Master Balancing Tank

The layout of unit process at Parvati Water Works is presented in **Figure 3.11**.

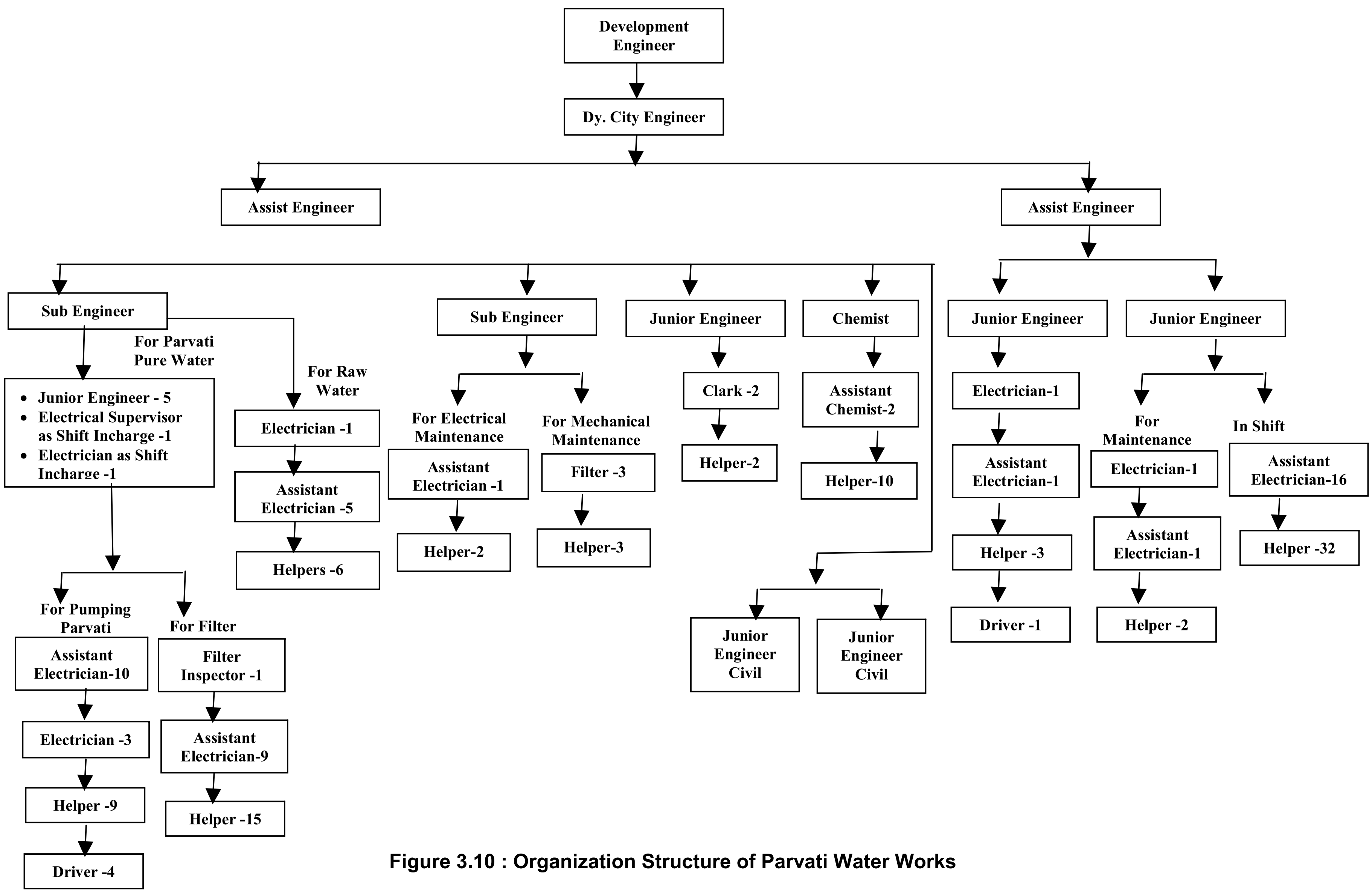


Figure 3.10 : Organization Structure of Parvati Water Works

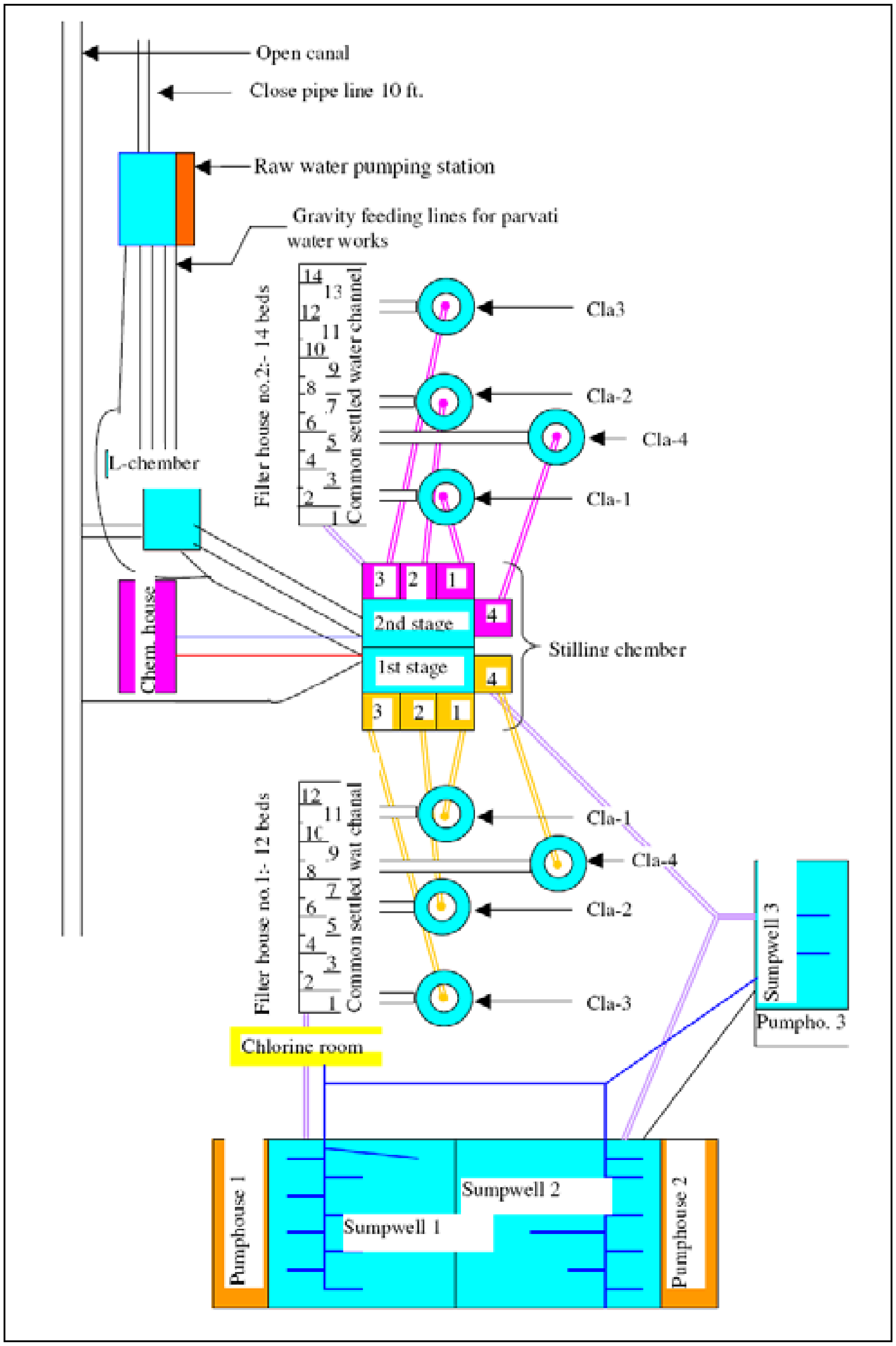


Figure 3.11 : Layout of Unit Processes at Parvati Water Works

1. Reception of the Raw Water at L-Chamber

L shaped chamber is the first recipient point for raw water at P.W.W. A 10 ft diameter close pipeline is installed, which comes directly from Khadakwasla dam. This pipeline terminates in a chamber at PMC raw water pumping station, which located adjacent to P.W.W. This pumping station is meant to pump raw water for purification, at Cantt. W.W. & Holkar W.W. from the same chamber where the close pipe line terminates. Five pipe lines will be feeding pipe lines for P.W.W. Out of these five pipe lines four pipe lines measures 1200 mm in diameter & one measures 1535 mm in diameter. The four 1200 mm pipelines are connected to the L- Shaped chamber & gate valves are fixed on these pipes at L- chamber. The fifth line is connected to the one of the out let of L- chamber & a butterfly valve is fixed to this pipe to control the flow of the water from pipe. The main function of L- chamber is to control the inflow of the raw water i.e. when enough stock of purified water is available raw water supply can be curtailed from L- chamber. During shortfall of a supply flow can be raised from L-chamber.

Before installation of close pipe line, raw water used to travel through open baby canal before reaching to the P.W.W. Close pipeline is laid at the place of baby canal **(Plate 3.4)**. Other open canal which runs adjacent to baby canal is Mutha right canal. This canal is mainly for irrigation purpose.

Plate 3.4 : Pipeline carrying Raw Water from Khadakwasla

In case of shortfall of raw water from close pipe, raw water is taken from this open irrigation canal. We have three intakes (one measuring 54 inch in diameter & other two measuring 36 inch in diameter) at canal, which can be controlled by gate valves. Out lets of L-Chamber are connected to the Flash mixing zone i.e. stilling chamber.

2. Prechlorination & Coagulation

Outlets of L-chamber are connected to the flash mixing zone. Pre chlorination & Coagulation both processes take place in this zone. Here raw water is prechlorinated by means of solution of gaseous chlorine with water. The dose of chlorine, which is applied for prechlorination, is 225 Kg per day, this comes to as 0.5 to 0.6 mg/lit. The dosing is done by means of two PVC pipelines. In flash mixing zone, water coming from L- chamber & from open canal is divided in two different streams, where one part (Lower) of flash mixing chamber supplies water to the first stage (the stage which is commissioned first is called first stage), while other part (Upper) supplies water to second stage (the one which in commissioned later). Further this flash mixing zone is divided into subpart each part is called as flash mixing chamber. There are four flash mixing chambers for each side i.e. in all has eight flash mixing chambers. Large screens are affixed near the intake of this flash mixing chamber. These screens are meant to remove large debris, grass etc.

Exactly opposite to the flash-mixing zone is chemical house. There are six overhead storage tanks for chemicals. Liquid alum or Liquid polyaluminium chloride either of these two chemicals is used as coagulant. Normally in monsoon season when high turbidity of raw water is expected, Polyaluminium chloride is used. Otherwise liquid alum is used for about 8 to 9 months in a year. Coagulants are dosed through PVC pipelines by gravity. There are two PVC pipeline approaching to each flash-mixing chamber one is for Liq. Alum & other is for Liq. Polyaluminium Chloride. Dosing of either of the coagulant is done after determining the amount of coagulant needed for coagulation, in Parvati Laboratory. Each flash-mixing chamber is 14 feet deep & at the bottom of each flash-mixing chamber is a 3 feet diameter pipeline, which comes out from the middle of the clarifier (i.e. clariflocculator). This three feet dia. pipeline is a feeding pipeline for clarifiers. From flash mixing chambers coagulated water comes out from the central portion of the clarifier.

3. Clarifloculators

The process of flocculation & clarification takes place in eight clarifloculators (clarifiers) at Parvti Water works, 4 at first stage & 4 at second stage. A design of clarifloculator is shown in **Figure 3.12**.

As per the design of the clarifiers the number of flocculaters may change. At first stage of parvati water works there are 4 floculaters one for each clarifier &second stage have two flocculaters for each clarifier. Floculaters rotates with very slow speed normally 2 to 3 rotations per min. Here at clarifiers the speed of the water is reduced & floculaters do gentle mixing. The retention period of water at flocculation chamber is app. 20 min.

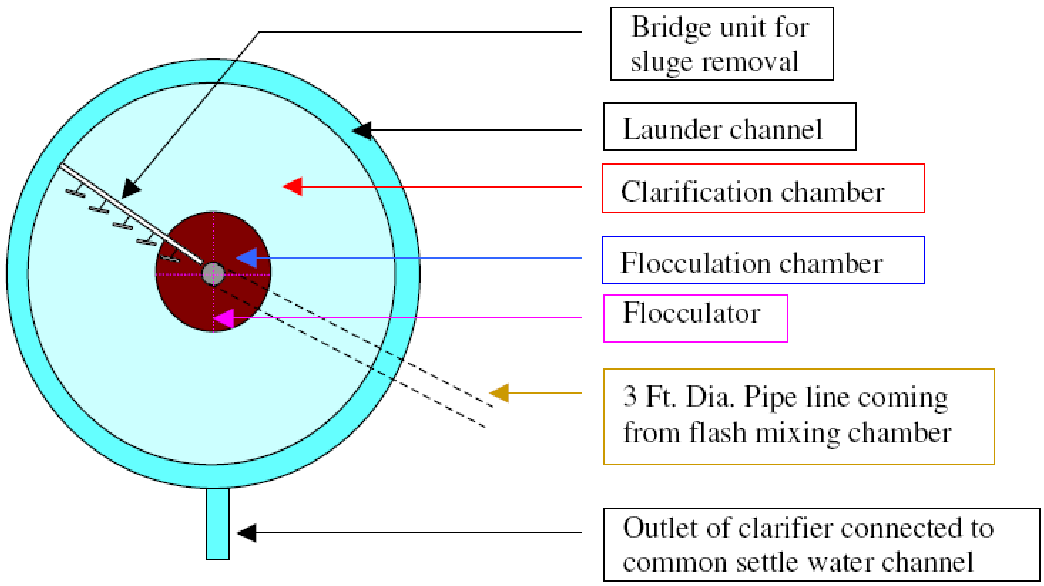
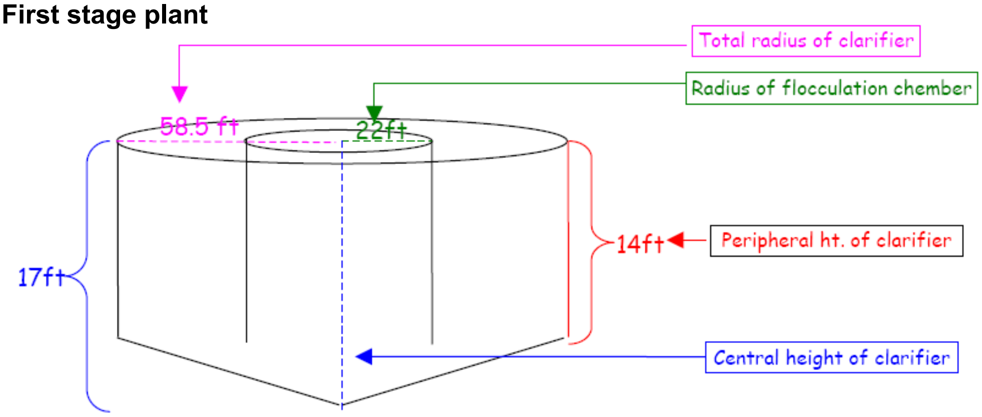


Figure 3.12: Design of Clariflocculator

Clarification chamber is next to flocculation chamber, to allow passage of water from flocculation chamber to Clarification chamber there are eight openings at bottom of dividing wall between two **(Plate 3.5)**. To remove sludge or floc, which accumulated at the bottom of clarifier, a fabricated structure called as bridge unit is employed at all clarifiers. Typically a bridge unit has steel platform, which is located on the top of the clarifier, & it has arms, which run towards the bottom of clarifier. At the bottom these arms have large angled blades. Basically all clarifiers are cylindrical structures with conical base, the slope of the cone being toward centre of the clarifier. When bridge unit is rotated, because of the angle of blades all sludge is pushed towards the centre of the clarifier. Bridge unit rotates very slowly it completes its one rotation in 45 minutes. At the center exactly adjacent to feeding pipe witch comes from flash mixing chamber, there is drain channel & chamber, sludge is gathered into this chamber. Once the outlet valve on the drain chamber is opened all the sludge will be drained off. Engineering details of clarifiers at first and second stage plant is presented in **Figure 3.13**.

At Parvati water works the retention period of water at clarifier is approximately 1 hr. & 30 minutes to 2 hours. After settling clarified water is then collected into the Launder channel. Supernatant clarified water is collected into launder channel by means of openings near the periphery of the clarifier. Outlet of all clarifiers are connected to the common settled water channel i.e. clarified water from all clarifiers is collected into this collecting channel. This channel is a feeding channel for filter beds.

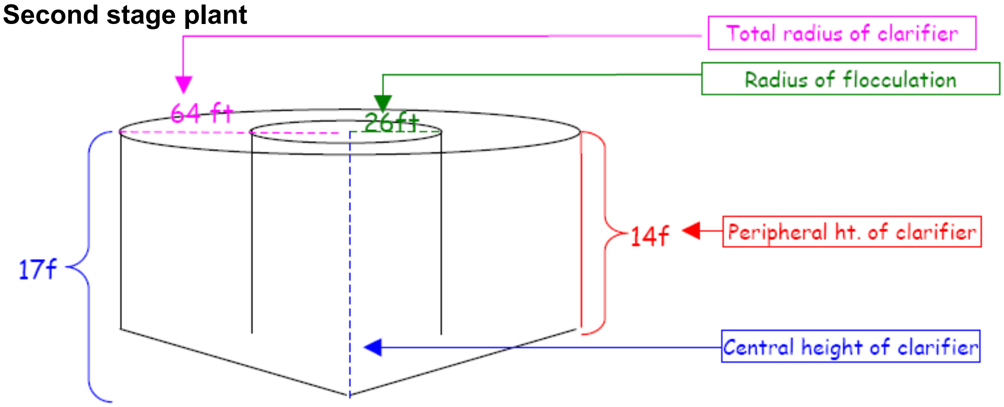
First stage plant



Volume of clarifier: - 161269.7 cuft. = 4565.96 m^3 = 1.000 MG= wat. hold. cap.

Retention period of clarifier: - 2 hrs.

Second stage plant



Volume of clarifier: - 193019.5 cuft. = 5464.877m^3 = 1.200 MG= wat. hold. cap.

Retention period of clarifier: - 1.64 hrs. i.e. app 1 hr & 40 min

Figure 3.13 : Engineering details of clarifiers at first and second stage plant

Plate 3.5 : Clarifloculater at Parvati Water Works

4. Filtration

Settled water collected into the common settled water channel is then taken over the filter beds. At Parvati water works there are 26 filter beds, 12 at first stage & 14 at second stage **(Figure 3.14)**. All are rapid sand filter beds. Filter sand beds are made up of different layers of sand media. Bottommost layer is made up of pebbles; middle layer made up of gravels & the topmost layer is made up of sand. Filter sand is of special quality. Under drain system is the network of pipelines constituting one header & several laterals. Each filter bed is divided into two parts, by a central drain channel. Wash water gutters are laterally connected to this drain channel.

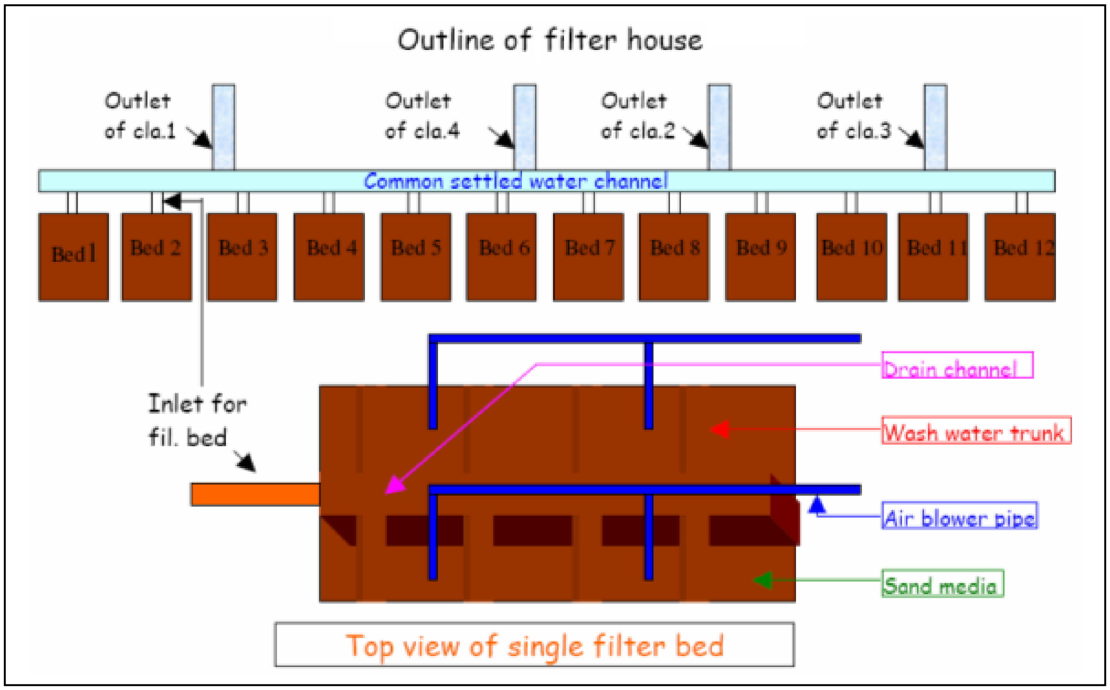


Figure 3.14 : Outline of filter house

Outlets of an each filter bed are connected to the Inspection chamber. Excluding monsoon season i.e. heavy turbidity season all 26 filter beds are back washed once in 24 hours. Hence in non-turbidity season the frequency of back washing is once in 24 hours. In high turbidity season frequency of back washing depends upon quality of the clarified & filtered water. At Parvati Water Works the process of automation of filter beds is being initialized. Filter beds constitutes number of valves. Each filter bed constitutes 1 inlet valve, 2 outlet valves, 1 drain valve, 2 air blower valves. 2 wash water valves & all of them needs to operate during the back washing of filter bed. It is a tiresome work to operate valves manually. Hence automation of filter beds at second stage filter house has been started. Currently some of the filter beds at second stage can be back washed manually as well as pneumatically.

Filter bed details

First stage: 12 filter beds

Area of each filter bed: 960 sqft.

Area for filtration of each filter bed: 840 sqft. = 77.12 m^2

Filtration capacity of each filter bed: 4 MGD

Rate of filtration for each filter bed: = 902 lit/Sqft./hr. = 9825 lits/M^2 / hr.

Second stage: 14 filter beds

Area of each filter bed: 1200 sqft.

Area for filtration of each filter bed: 1100 sqft. = 101 m^2

Filtration capacity of each filter bed: 5 MGD

Rate of filtration for each filter bed: = 860 lit/Sqft./hr. = 9378 lits/M^2 / hr.

All inspection chambers are connected to the common filter water channel, which in turn is connected to underground storage tank/sump well.

Filter media gradation is as follows:
Top layer: -fine sand Depth: - 2ft.1 inch

2nd layer: - 1/8 to 1/10 " gravel Depth: - 4 inch

3rd layer: - 3/8 to 1/8 " gravel Depth: - 4 inch

4th layer: - 1/2 to 1/4 " gravel Depth: - 4 inch

Bottom layer: - 2" to 1 &1/2 " pebbles Depth: - 3 inch

5. Disinfection

Disinfection is achieved in sump well. There are three sump wells all are internally connected. A solution of gaseous chlorine is prepared at Chlorine room. Chlorinators are fixed at chlorine room which gives us flexibility in adjustment of the chlorine dose. 900 Kg capacity chlorine tuners are used to prepared chlorine solution. Chlorinators are connected to the tuners at one end & at other end they are connected to the charged water pipeline; this allows mixing chlorine with water. The solution of chlorine is then carried over into the network of PVC pipeline, which in turn doses the solution at selected points at sump well. Dose of chlorine given is adequate to give a necessary residual concentration to take care of any recontamination in distribution system. Booster chlorination is done at some points to ensure disinfection throughout the distribution system.

6. Pumping

The disinfected water is then pumped to different Elevated or Service Reservoir. At P.W.W there are 28 pumps ranging from 150 HP capacity to 550 Hp capacity. At pick hours maximum 14 to 15 pumps are running and 100% standby pumps are available. The area supplied under parvati water works is, Katraj, Bibvewadi, Indiranagar, Sahakarnar, Mukundnagar, Dhankawdi, Padmavati, Chavannagar, Parvati

Gaothan, Dattawadi, Khadki, Senapati bapat rd., Bhandarkar road, Law college rd., Janta Vasahat, Central Portion of the Pune city i.e. all peths, Deccan, Kothrude, Shivjinagar, Karvenagar, Erendvane, Paud Phata, ect. The per capita water supply from Parvati Water Works is 195 lpcd.

7. Water Analysis

Water system should be monitored at frequency that is sufficient to ensure that the system is under control & continues to produce water of an acceptable quality. Hence samples are taken from representative locations within the treatment & distribution system. Laboratory at P.W.W. is a central laboratory & water purified at Parvati W.W., Holkar W.W., Warje W.W., Chikhali W.W., and New Warje W.W. is tested at this laboratory. Water supplied to the additional villages under PMC is also tested at P.W.W. Laboratory. At Parvati W.W. samples from raw water, filter & treated water are taken for analysis. Daily about 80 samples are collected from all over the city, which includes overhead & service reservoirs, intermediate connections in distribution network & maximum tail end points.

The testing of drinking water is based on the specifications of Indian Standards for drinking water i.e. as per I.S.: 10500. The highest raw water turbidity recorded in last 12 years is presented below. Since natural water is getting impounded in influent to water treatment plant has low turbidity even in worst period of rainy season.

Year	Highest Turbidity
1996	89 NTU
1997	20 NTU
1998	85 NTU
1999	39.9 NTU
2000	11.8 NTU
2001	--
2002	10 NTU
2003	18 NTU
2004	97.2 NTU
2005	89.2 NTU
2006	71 NTU

- **Chemical Analysis of the Water**

Other parameters, which are analyzed at P.W.W., are as following, Nitrates, Nitrites, Sulphide, Chlorides, Fluorides, Calcium, Magnesium, Sodium, Potassium, Lead, Cyanide, Aluminum, Iron, Phosphates, TDS, and Alkalinity.

- **Microbiological Examination of water**

Microbiological examination of drinking water is an attempt to determine the relation of the possible transmission of water borne disease. It is usually not practical to examine water supplies for various pathogens that may be present. Therefore, the routine monitoring of water is based on the testing of indicator organisms viz Total Coliform.

- **Residual chlorine test**

Residual chlorine has great significance in defining presence or absence of microorganisms. Chlorine solution is used as a disinfectant at P.W.W. Residual chlorine can be defined as the amount of excess or residue of chlorine that remains in the water after disinfection. This residual chlorine must present in water throughout distribution system, as it will take care of any recontamination of water. As per IS there should minimum 0.2 ppm of residual chlorine must be present at user end. Hence PMC`S any running tap must contain minimum of 0.2ppm residual chlorine. All samples collected by Parvati laboratory or send by any other office are preliminary tested for their residual chlorine content.

The salient features of engineering data is presented in **Table 3.8**

Table 3.8 : Salient features of engineering data of Paravati Water Works

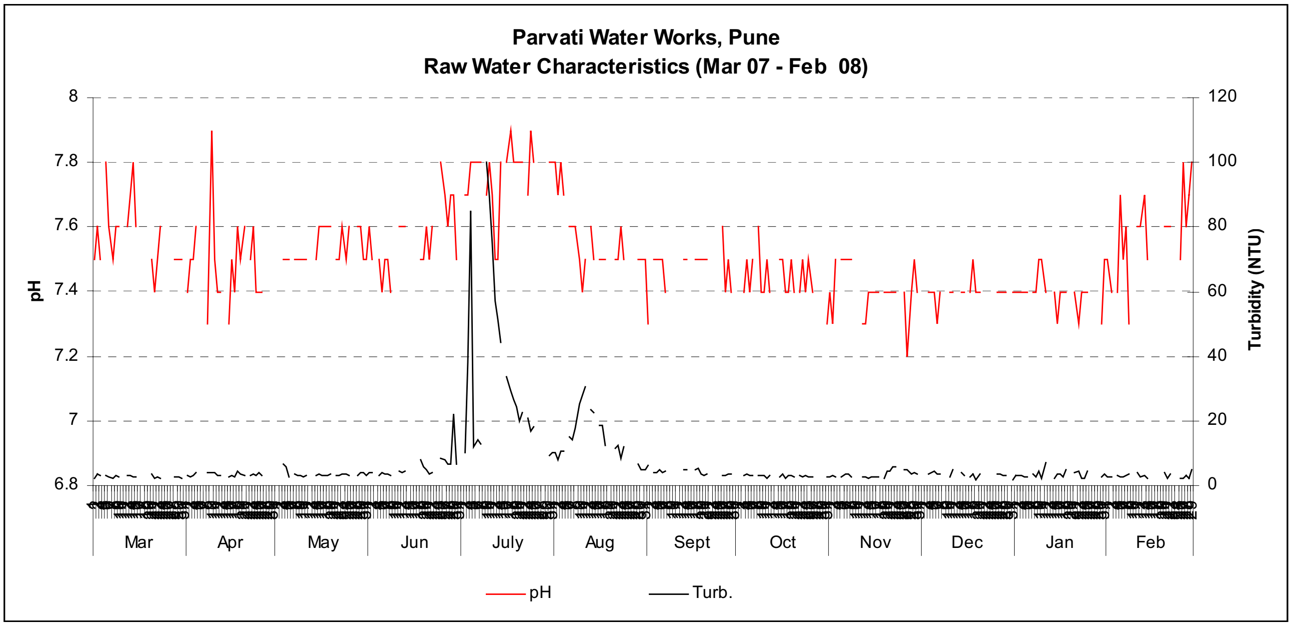
1. Reception of the Raw Water at L-Chamber	
a. Source	Khadakwasla dam to pumping station (10 ft diameter close pipeline)
b. Feeding Pipelines to L Chamber	Five pipe lines from Pumping station to P.W.W 4 pipe lines of 1200 mm in diameter 1 pipe line of 1535 mm in diameter
2. Flash Mixing	
a. Flash mixing Chamber	Total Eight flash mixing chambers Stage I - Four (Total Vol. 90 m^3) Stage II - Four (Total Vol. 178 m^3) Depth : 14 feet
b. Pre Chlorination	Gaseous chlorine (dose 0.5 to 0.6 mg/lit)
3. Chemical House	
a. Storage Tank	Six
b. Coagulant	1. Liquid alum 2. Liquid polyaluminium chloride (Monsoon) One feeding Pipe for each
4. Clarifloculation	
a. No. of clarifloculators	Eight (4 at first stage & 4 at second stage)
b. Volume	Stage I : 4566 m^3 Stage II : 5465 m^3
C. Retention period	Stage I : 2 Hrs. Stage II : 1 hr & 40 min

Table 3.8 (Contd..) : Salient features of engineering data of Paravati Water Works

5. Filtration	
a. Type	Rapid Sand Filter
b. No. of Filters	Total 26 (Stage I = 12 ; Stage II = 14)
c. **Stage I**	
i. Number of filters	12
ii. Area of each filter	10464 m^2
iii. Area for filtration of each filter	77.12 m^2
iv. Rate of filtration for each filter	9825 lits/M^2 / hr.
v. Filtration capacity of each filter	4 MGD
Stage II	
i. Number of filters	14
ii. Area of each filter	13080 m^2
iii. Area for filtration of each filter	101 m^2
iv. Rate of filtration for each filter	9378 lits/M^2 / hr.
v. Filtration capacity of each filter	5 MGD
d. Filter media gradation	Top layer: -fine sand Depth: - 2ft.1 inch 2nd layer: - 1/8 to 1/10 " gravel Depth: - 4 inch 3rd layer: - 3/8 to 1/8 " gravel Depth: - 4 inch 4th layer: - 1/2 to 1/4 " gravel Depth: - 4 inch Bottom layer: - 2" to 1 &1/2 " pebbles Depth: - 3 inch
6. Sump Well Details	
a. Capacity	Sump Well No. I – 1MG Sump Well No. II – 2.20 MG Sump Well No. III – 2.00 MG
7. Disinfection	Using gaseous chlorine
8. Pumping	
a. Total No. of Pumps	28 pumps
b. Capacity	Ranging from 150 HP capacity to 550 Hp capacity

3.2.2 Water Treatment Plant Analytical Data (Secondary)

The data on pH, turbidity and bacteriology of raw and treated water during the period of March 2007 to February 2008 at Parvati water works is presented in **Table 3.9.** The comparison of raw and treated water characteristics (pH and turbidity) is presented in **Figure 3.15.**



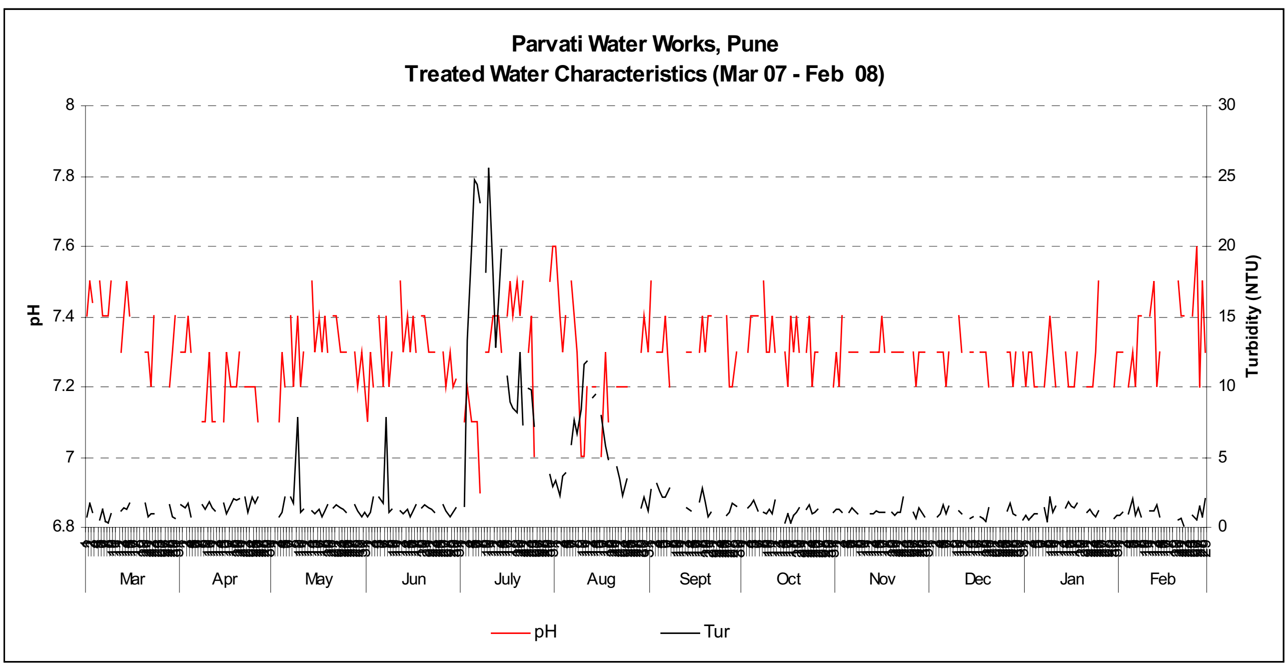


Figure 3.15 : Comparison of Raw and Treated Water Characteristics (pH and turbidity) at PWW

Table 3.9 : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water, Pune

Date	March 2007						April 2007						May 2007					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	7.5	2.3	35	7.4	0.7	-						-						-
2	7.6	3.5	1800+	7.5	1.7	-	7.4	3.0	250	7.3	1.6	-						-
3	7.5	2.9	350.0	744.0	1.1	-	7.5	2.7	1800+	7.3	1.4	-	7.5	6.5	1800+	7.1	0.7	-
4							7.5	3.1	350	7.4	1.7		7.5	5.7	1800+	7.3	1.1	
5	7.8	3.1	1800+	7.5	0.5	-	7.6	4.2	1800+	7.3	0.8	-	7.5	2.7	1800+	7.2	2.1	-
6	7.6	2.7	900	7.4	1.3	-						-						-
7	7.5	2.3	1800+	7.4	0.4	-	7.5	6.3	900	7.1	1.3	-	7.5	3.4	250	7.4	2.2	-
8	7.6	2.9	1800+	7.4	0.3	-						-	7.5	3.0	1800+	7.2	1.7	-
9	7.6	2.8	250	7.5	1.0	16+	7.3	4.1	1800+	7.1	1.6	16+	7.5	3.1	1800+	7.4	7.9	-
10							7.9	3.9	50	7.1	1.3		7.5	2.7	1800+	7.2	1.1	-
11							7.5	3.8	1800+	7.3	1.8		7.5	3.3	1800+	7.3	1.3	-
12	7.6	2.9	35	7.3	1.2	-	7.4	3.0	350	7.1	1.4	-						
13	7.7	3.1	1800+	7.4	1.4	-	7.4	2.9	1800+	7.1	1.2	-						-
14	7.8	2.5	35	7.5	1.3	-						-	7.5	2.9	900	7.5	1.2	-
15	7.6	2.5	1800+	7.4	1.7	-						-	7.6	3.5	1800+	7.3	1.0	-
16			50			-	7.3	2.7	35	7.1	1.7	-	7.6	3.3	25	7.4	1.3	-
17			1800+			-	7.5	2.9	1800+	7.3	1.0	-	7.6	2.9	1800+	7.3	0.8	-
18							7.4	2.5	25	7.2	1.6		7.6	3.1	1800+	7.4	1.2	-
19							7.6	4.5	1800+	7.2	2.0		7.6	3.6	1800+	7.3	1.6	-
20	7.5	3.4	50	7.3	1.7	-	7.5	3.4	130	7.2	1.9	-						
21	7.4	2.4	1800+	7.3	0.8	-	7.6	3.1	1800+	7.3	2.0	-	7.5	3.0	350	7.4	1.4	-
22	7.5	2.7	1800+	7.2	1.0	-						-	7.5	3.2	550	7.4	1.6	-
23	7.6	2.3	1800+	7.4	1.0	-	7.5	2.9	25	7.2	2.2	-	7.6	3.4	1800+	7.3	1.4	-
24							7.6	3.6	1800+	7.2	1.1		7.5	3.7	1600	7.3	1.3	-
25							7.4	3.0	80	7.2	2.1		7.6	2.9	1800+	7.3	1.1	-
26	7.5	2.4	1800+	7.3	1.1	-	7.4	3.9	1800+	7.2	1.7	-						-
27							7.4	3.1	550	7.1	2.1							-
28	7.5	2.7	1800+	7.2	1.6	-						-	7.6	3.0	1800+	7.3	1.6	
29	7.5	2.6	250	7.3	0.7	-						-	7.6	4.1	1800+	7.2	1.2	-
30	7.5	2.1	1800+	7.4	0.6	-	7.4	2.5	1800+	7.1	1.1	-	7.5	4.0	1800+	7.3	0.7	-
31													7.5	3.2	1800+	7.2	1.1	-

Table 3.9 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water, Pune

Date	June 2007						July 2007						August 2007					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC
1	7.6	4.0	1800+	7.1	0.7	-							7.8	10.1	1800+	7.6	3.3	350
2	7.5	4.0	1800+	7.3	1.1	-	7.7	10.1	1800+	7.1	1.5	550	7.7	7.9	1800+	7.4	2.3	35
3				7.2	2.1		7.7	38.1	1800+	7.2	13.3	900	7.8	10.5	1800+	7.3	3.7	-
4	7.5	3.1	900			-	7.8	85.0	1800+	7.1	19.9	130	7.7	10.6	1800+	7.4	3.9	800
5	7.4	4.0	1800+	7.4	2.2	-	7.8	12.0	1800+	7.1	24.7	550						
6	7.5	3.6	1800+	7.2	1.7	-	7.8	14.0	1800+	7.1	24.4	1800+	7.6	15.2	170	7.5	5.9	170
7	7.5	3.7	1800+	7.4	7.9	-	7.8	12.9	1800+	6.9	23.1	1800+	7.6	14.2	1800+	7.4	7.6	900
8	7.4	3.0	250	7.2	1.1	-							7.6	17.9	1800+	7.3	6.7	-
9				7.3	1.3		7.7	99.9	1800+	7.3	18.2	45	7.5	25.2	1800+	7.0	8.4	4
10							7.8	89.6	1800+	7.3	25.6	1800+	7.4	28.1	1800+	7.0	11.6	17
11	7.6	4.6	1800+			-	7.7	75.0	550	7.4	18.1	110	7.5	30.7	1800+	7.2	11.8	-
12	7.6	3.8	250	7.5	1.2	-	7.5	57.1	1800+	7.4	12.8	130						
13	7.6	4.6	1800+	7.3	1.0	-	7.5	51.5	1800+	7.4	16.1	1600	7.6	23.5	1800+	7.2	9.3	170
14			550	7.4	1.3	-	7.8	44.4		7.3	19.8		7.5	22.6	1800+	7.2	9.44	140
15			1800+	7.3	0.8	-												
16	7.7	6.9	1800+	7.4	1.2	-	7.8	33.6	1800+	7.4	10.8	550	7.5	18.4	1800+	7.0	7.95	-
17				7.3	1.6		7.9	29.2	1800+	7.5	8.9	250	7.5	18.5	1800+	7.3	5.82	50
18	7.5	7.9	1800+			-	7.8	26.5	550	7.4	8.5	350	7.5	12.2	1800+	7.1	4.89	17
19	7.5	5.8	1800+	7.4	1.4	-	7.8	24.5	1800+	7.5	8.20	350						
20	7.6	4.7	1800+	7.4	1.6	-	7.8	20.1	1800+	7.4	12.5	350						
21	7.5	3.7	1800+	7.3	1.4	-	7.8	22.4	350	7.5	7.36	11	7.5	11.5	1800+	7.2	4.28	1800+
22	7.6	3.9	1800+	7.3	1.3	-							7.5	12.4	1800+	7.2	3.42	30
23				7.3	1.1		7.7	20.8	1800+	7.3	9.90	900	7.6	8.5	1600	7.2	2.28	225
24							7.9	17.0	1800+	7.4	9.77	11	7.5	12.1	1800+	7.2	3.45	-
25	7.8	8.6	1800+			250	7.8	18.2	1800+	7.0	7.20	350						
26	7.7	7.8	1800+	7.3	1.6	4			1800+			120						
27	7.6	6.7	1800+	7.2	1.2	6			1800+			350	7.5	7.6	1800+	7.3	2.97	225
28	7.7	6.6	1800+	7.3	0.7	1800+												
29	7.7	22.0	1800+	7.2	1.1	900							7.5	6.6	1800+	7.3	1.42	-
30	7.5	6.8	1800+	7.22	1.4	130	7.8	9.3	1800+	7.5	3.8	350	7.5	4.9	900	7.4	2.1	60
31							7.8	10.2	1800+	7.6	2.9	-	7.5	5.0	1800+	7.3	1.15	170

Table 3.9 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water, Pune

Date	September 2007						October 2007						November 2007					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC	'pH	Tur*	TC
1	7.3	6.1	1800+	7.5	2.7	-	7.4	3.1	1800+	7.3	1.2	250	7.4	2.6	1800+	7.3	1.3	70
2													7.3	2.9	1800+	7.2	1.3	250
3	7.5	4.1	1800+	7.3	3.1	-	7.4	2.9	1800+	7.3	1.4	-	7.5	2.7	1800+	7.4	1.1	350
4	7.5	4.0	1800+	7.3	2.6	1800+	7.5	3.4	1800+	7.4	1.6	80						
5	7.5	4.7	350	7.3	2.2	50	7.4	2.9	1800+	7.4	1.9	35	7.5	2.7	1800+	7.3	1.1	550
6	7.5	4.0	1800+	7.4	2.1	4	7.5	3.1	1800+	7.4	1.2	130	7.5	3.4	1800+	7.3	1.4	-
7	7.4	4.5	1800+	7.2	2.8	1800+							7.5	3.6	1800+	7.3	1.2	1800+
8							7.6	3.0	1800+	7.5	1.1	900	7.5	2.8	1800+	7.3	1.0	-
9							7.4	2.9	1800+	7.3	1.0	5						
10	7.4	7.2	1800+	7.2	1.9	1800+	7.4	3.3	1800+	7.3	1.3	550						
11			1800+			1800+	7.5	2.4	1800+	7.4	1.0	80						
12			1800+			140	7.4	3.0	1800+	7.3	1.9	1800+	7.3	2.6	1800+	7.3	1.0	80
13	7.5	4.9	1600	7.3	1.4	350							7.3	2.7	1800+	7.3	1.0	250
14	7.5	5.0	1800+	7.3	1.2	900							7.4	2.2	1800+	7.3	1.2	350
15							7.5	2.7	1800+	7.3	0.3	250	7.4	2.6	1800+	7.3	1.1	1600
16							7.5	3.6	1800+	7.2	1.0	550	7.4	2.5	1800+	7.4	1.1	900
17	7.5	4.8	1600	7.3	1.8	6	7.4	2.2	900	7.4	0.3	11	7.4	2.7	1800+	7.3	1.1	25
18	7.5	5.2	1800+	7.4	2.8	350	7.4	3.0	1800+	7.3	0.9	900						
19	7.5	3.5	1800+	7.3	1.8	30	7.5	3.0	1800+	7.4	1.1	550	7.4	2.4	1800+	7.3	1.1	110
20	7.5	3.1	1800+	7.4	0.8	1800+	7.4	2.6	550.0	7.3	1.4	14	7.4	4.5	1800+	7.3	0.9	2
21	7.5	3.4	1800+	7.4	1.1	900							7.4	4.6	1800+	7.3	1.1	35
22							7.4	2.9	1800+	7.3	1.3	350	7.4	5.6	1800+	7.3	1.1	170
23							7.5	2.7	350	7.4	1.6	5	7.4	5.8	1800+	7.3	2.1	80
24	7.5	4.1	1800+	7.4	1.6	900	7.4	3.0	140	7.2	1.0	-						
25							7.5	2.6	900	7.3	1.1	-						
26	7.6	3.0	1800+	7.4	0.9	2	7.4	2.7	1800+	7.3	1.3	1800+	7.4	4.8	1800+	7.3	1.1	45
27	7.4	3.2	1800+	7.2	1.1	350							7.2	4.8	900	7.2	0.6	-
28	7.5	3.6	1800+	7.2	1.7	350							7.4	3.7	1800+	7.3	1.4	250
29	7.4	3.4	1800+	7.3	1.5	900			1800+			250	7.5	4.1	1800+	7.3	1.1	130
30									1800+			4	7.4	3.4	1800+	7.3	0.7	900
31							7.3	2.7	1800+	7.2	1.1	170						

Table 3.9 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water, Pune

Date	December 2007						January 2008						February 2008					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	7.5	2.5	1800+	7.3	0.8	35	7.4	2.9	900	7.2	0.9	-	7.5	2.5	1800+	7.3	0.9	250
2							7.4	2.9	250	7.3	0.5	-	7.4	2.7	350	7.3	1.1	-
3	7.4	3.4	1800+	7.3	0.8	550	7.4	2.9	1600	7.3	0.7	170						
4	7.4	3.8	1800+	7.3	1.0	70	7.4	2.5	250	7.2	1.0	-	7.4	3.1	350	7.2	1.0	-
5	7.4	4.3	1800+	7.3	1.6	-	7.4	2.8	900	7.2	1.0	80	7.7	2.7	1800+	7.3	2.0	-
6	7.3	3.4	1800+	7.2	1.0	35							7.5	2.8	900	7.2	0.9	-
7	7.4	3.7	1800+	7.3	1.5	130	7.4	3.5	350	7.2	1.4	-	7.6	3.1	1800+	7.4	1.4	-
8							7.4	2.5	550	7.3	0.4	-	7.3	3.4	250	7.4	0.7	-
9							7.5	4.3	1800+	7.4	2.2	1800+						
10	7.4	2.5	550	7.4	1.2	130	7.5	2.4	1800+	7.3	1.1	50						
11	7.4	4.8	1800+	7.3	1.0	35	7.4	7.0	550	7.2	1.5	-	7.6	4.2	1800+	7.4	1.2	1
12			250			80							7.6	2.7	1800+	7.5	1.2	350
13			1800+			-							7.7	2.9	1800+	7.2	1.6	-
14	7.4	4.0	1800+	7.3	0.6	45	7.4	2.1	900	7.3	1.4	110	7.5	2.0	550	7.3	0.8	14
15	7.4	3.1	1800+	7.3	0.8	5	7.3	3.4	350	7.2	1.8	-						
16							7.4	3.4	900	7.2	1.5	5	7.7	2.8	1800+	7.5	1.1	13
17	7.4	2.7	250	7.3	0.7	140	7.4	2.7	1600	7.2	1.4	-						
18	7.5	3.7	1800+	7.3	0.6	-	7.4	4.8	1600	7.3	1.7	-	7.6	2.4	1800+	7.4	0.6	1800+
19	7.4	1.8	1800+	7.3	0.4	-												
20	7.4	3.5	1800+	7.2	1.4	35							7.6	4.1	250	7.5	0.5	175
21							7.4	4.0	900	7.2	1.1	-	7.6	2.3	1800+	7.4	0.6	-
22							7.3	4.3	1800+	7.2	1.3	250	7.6	3.5	900	7.4	0.1	9
23							7.4	2.4	900	7.2	1.0	-						
24	7.4	3.2	1800+	7.3	1.4	900	7.4	2.2	1800+	7.3	0.7	110						
25							7.4	4.3	1800+	7.5	1.2	-	7.5	2.3	1800+	7.4	0.9	-
26	7.4	3.6	1800+	7.3	1.2	70							7.8	2.4	250	7.6	0.5	80
27	7.4	3.4	1800+	7.3	1.7	30							7.6	3.0	1800+	7.2	1.5	6
28	7.4	3.2	140	7.2	1.0	110			900	7.3	1.1	80	7.7	2.0	900	7.5	0.8	-
29	7.4	3.1	1600	7.3	0.9	-			1800+			-	7.8	4.8	80	7.3	2.0	-
30							7.3	2.8	1600	7.2	0.6	50						
31	7.4	1.9	175	7.3	0.5	14	7.5	3.4	550	7.3	0.9	-						

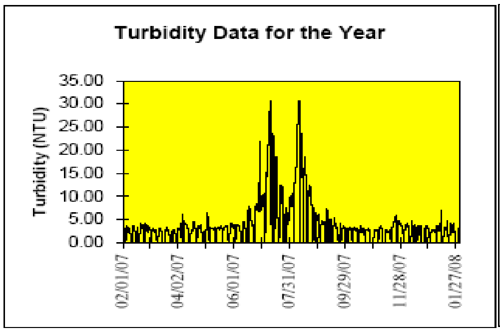
Observations

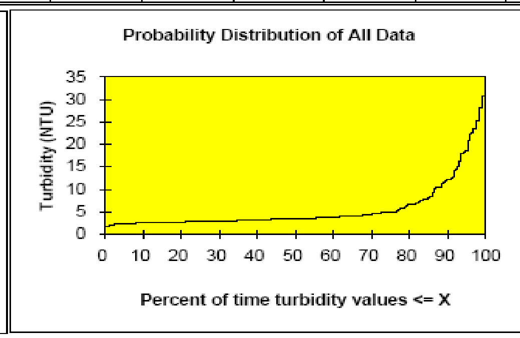
From the data it is observed that raw water is characterized by slightly alkaline pH, low turbidity and microbial count in the range of 80 to 1800+. Maximum turbidity of 100 NTU was recorded in July. Filtered water turbidity was in the range of 0.3-2.0 NTU in fare season. During monsoon the filtered water quality was poor with turbidity ranging from 1 to 25 NTU and Total Coliform count from 10 to 1000 MPN/100ml.Occasionally high TC values were also recorded indicating inadequate post chlorination.

3.2.3 Evaluation Based on PSW

The software was used to carry out performance evaluation of Parvati water treatment plant based on one-year raw water turbidity data. It is observed that 80% of the times turbidity was below 10 NTU. Comparison of raw and treated water turbidity is depicted in **Figure 3.16** respectively.

Percentile	Yearly	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08
50	3.50	3.30	2.70	3.10	3.20	4.60	12.20	12.20	4.08	2.90	2.90	3.40	2.89
75	4.91	3.68	2.90	3.88	3.55	6.81	18.45	18.45	4.85	3.01	4.30	3.70	3.89
90	12.10	3.96	3.13	4.19	4.08	7.89	24.86	24.86	5.38	3.28	4.80	4.01	4.30
95	18.42	4.12	3.41	4.49	5.54	8.56	27.81	27.81	6.19	3.40	5.52	4.35	4.78
96	21.16	4.13	3.42	4.79	5.80	10.74	28.41	28.41	6.39	3.43	5.62	4.44	5.15
97	22.89	4.15	3.44	5.17	5.97	13.55	28.98	28.98	6.60	3.47	5.67	4.54	5.61
98	25.00	4.17	3.46	5.54	6.15	16.37	29.56	29.56	6.80	3.52	5.71	4.64	6.08
99	28.10	4.18	3.48	5.92	6.32	19.18	30.13	30.13	7.00	3.56	5.76	4.73	6.54
Avg	5.56	3.18	2.71	3.41	3.49	5.90	14.53	14.53	4.30	2.90	3.47	3.28	3.34
Min	1.80	1.80	2.10	2.50	2.70	3.00	4.91	4.91	3.00	2.18	2.20	1.80	2.10
Max	30.70	4.20	3.50	6.30	6.50	22.00	30.70	30.70	7.20	3.60	5.80	4.83	7.00
RSD	97.3%	21.2%	13.6%	24.6%	25.5%	65.9%	49.7%	49.7%	24.5%	10.8%	30.3%	22.4%	32.9%





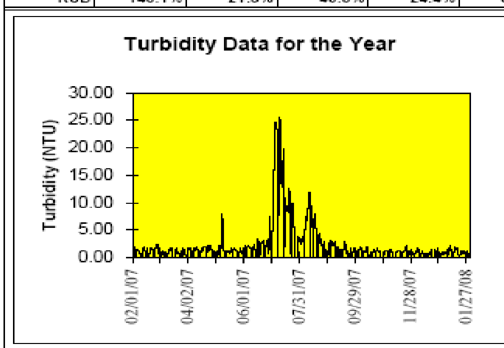
Parvati Water Works – (Raw Water)

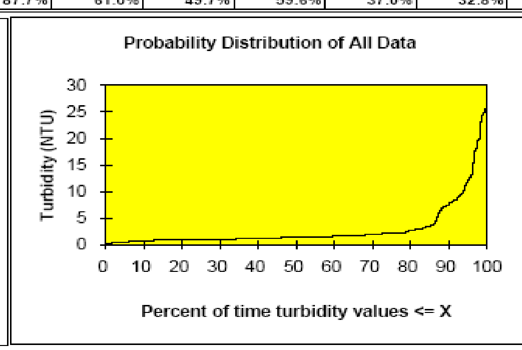
Start Year	2007
Month	2
Day	1

365 = Total Days
12.00 = Total Months

Utility Name	WTP
Plant Name	Parvati
Plant Street Address	Parvati
Plant City, State, Zip	Pune
Plant Contact Name	Nirbhavne
Plant Phone	020-
Plant E-mail Address	-

Percentile	Yearly	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08
50	1.40	1.65	1.05	1.60	1.30	2.05	12.50	4.28	1.80	1.16	1.10	0.98	1.10
75	2.10	1.70	1.33	1.88	1.60	2.75	19.00	7.78	2.40	1.38	1.18	1.26	1.40
90	7.46	1.96	1.70	2.09	2.02	3.19	24.14	9.41	2.80	1.60	1.38	1.48	1.66
95	11.63	2.15	1.70	2.10	2.19	3.39	24.67	11.38	2.83	1.89	1.42	1.62	1.79
96	12.72	2.20	1.70	2.12	2.88	4.04	24.81	11.62	2.88	1.90	1.50	1.64	1.85
97	16.68	2.25	1.70	2.14	4.14	4.88	25.01	11.67	2.94	1.90	1.65	1.66	1.94
98	19.58	2.30	1.70	2.16	5.39	5.72	25.20	11.71	2.99	1.90	1.80	1.68	2.02
99	23.66	2.35	1.70	2.18	6.65	6.56	25.40	11.76	3.05	1.90	1.95	1.69	2.11
Avg	2.87	1.60	1.06	1.57	1.59	2.25	13.60	5.32	1.85	1.18	1.13	1.00	1.15
Min	0.30	1.10	0.30	0.80	0.70	0.40	2.90	0.90	0.80	0.30	0.56	0.37	0.40
Max	25.60	2.40	1.70	2.20	7.90	7.40	25.60	11.80	3.10	1.90	2.10	1.71	2.20
RSD	148.1%	21.3%	40.5%	24.4%	87.7%	61.0%	49.7%	59.6%	37.0%	32.8%	24.7%	36.7%	36.8%





Parvati Water Works – (Treated Water)

Start Year	2007
Month	2
Day	1

365 = Total Days
12.00 = Total Months

Utility Name	WTP
Plant Name	Parvati
Plant Street Address	Parvati
Plant City, State, Zip	Pune
Plant Contact Name	Nirbhavne
Plant Phone	020-
Plant E-mail Address	-

Figure 3.16 : Turbidity data for treated water along with probability distribution for Parvati Water Works

3.2.4 Primary Data

Primary data on turbidity of water samples at various stages was collected on hourly basis during first week of February and is presented in **Table 3.10 and Figure 3.17**.

Table 3.10: Hourly Turbidity Data at Various Stages

Date	Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.02.08	Stage I																								
	Raw Water	3.8	4.5	4.1	3.4	3.5	4.3	4.5	2	1	2	1.8	1.3												
	Clarifier1 (Settle)	3.9	4.1	3.6	3.7	3.5	3.1	3.4	1.1	0.9	1.5	1.6	1.6												
	Inspection Chamber (Filter 9)	1.9	1.9	1.8	1.5	1.5	1.6	1.8	0.6	0.5	1.4	0.8	0.9												
	Stage II																								
	Raw Water	3.3	3.2	3	3.2	3.2	3.1	3.1	3.6	3.8	1.5	1.3	1.7												
	Clarifier1 (Settle)	3.3	3.3	3.2	3.3	3.3	3.4	3.6	1.1	1.8	0.7	1.2	1.2												
	Common Filter No. 1	1	0.8	0.6	0.5	0.9	0.8	0.7		0.4	0.1	0.1	0.1												
	Sump 1	1.9	2	2	1.5	2	2.1	2.4	0.4	1.1	0.7	0.9	0.7												
	Sump 2	1.2	1.6	1.1	1.7	1.3	1.3	1.5	0.3	0.6	0.7	0.5	0.4												
	Sump 3	2.6					1.9	1.8		0.3	1.6	0.4	0.4												
2.02.08	Stage I																								
	Raw Water	1.1	1.2	2.1	2.2	2	1.7	1.3	2.7	2.9	2	2.1	2.5	2.9	2.8	2.4	3.3	3.1	3.4	2.7	2.7	2.6	2.4	3.8	1.6
	Clarifier1 (Settle)	1.7	1.2	1.7	1.7	1.7	1	0.8	1.4	1.1	1.9	2	2.4	2.5	2.4	2.3	3.2	3.0	3.1	2.0	1.4	1.2	1.4	1.6	2.6
	Inspection Chamber (Filter 9)	0.7	1.2	1	0.8	0.8	0.2	0.2	0.1	0.1	0.2	0.2	0.7	1.1	0.7	0.4	3	2.9	3.3	1.3	1.0	0.8	1.1	1.2	2.3
	Stage II																								
	Raw Water	1.5	1.8	1.5	1.3	1.3	0.6	1.2	1.2	1.0	1.8	1.7	1.8	2.3	1.9	1.7	2.6	2.5	2.8	1.6	0.4	0.7	0.6	1.1	1.5
	Clarifier1 (Settle)	1.5	1.2	1.6	1.2	1.3	0.7	1.3	0.9		1.7	1.8	1.8	2.0	1.8	2.0	2.8	2.8	2.6	1.5	4.6	2.4	2.8	3.1	1.1
	Common Filter No. 1		0.1	0.3	0.1	0.2								0.1	0.2		0.8	0.8	0.7	0.3	0.6	0.5	0.6	0.6	0.4
	Sump 1	0.8	0.9	1.0	0.9	1.0	0.9	0.3	0.4	0.3	0.6	0.5	1.2	0.8	0.6	1.4	1.6	1.5	1.8	0.6	1.5	0.3	1.4	1.9	1.2
	Sump 2	0.3	0.3	0.4	0.4	1.9	0.3	0.1	2.3	1.6	0.7	0.6	0.5	0.4	0.3	1.2	1.0	1.1	1.1	0.9	0.5	0.8	0.6	0.9	1.1
	Sump 3		0.1	3.6	2.8	1.3	3.8								2.5	2.9	2.3	2.5				1.2			

Table 3.10 (Contd..) : Hourly Turbidity Data at Various Stages

Date	Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
3.02.08	**Stage I**																								
	Raw Water	3.5	2.3	2.4	3.6	3.5	3.9	4.7	4.9	3.7	1.8	2.5	2.6	2.4	1.9	1.9	2.1	4.0	4.1	1.7	1.5	1.6	1.7	1.5	1.7
	Clarifier1 (Settle)	1.5	1.6	2.7	1.9	2.0	3.6	1.9	1.9	2.7	3.1	2.2	2.3	2.7	3.6	3.0	2.5	3.1	3.4	0.9	0.7	0.9	1.0	1.1	1.2
	Inspection Chamber (Filter 9)	1.4	2.3	1.9	1.3	1.1	0.3	1.0	0.8	0.7	0.4	2.8	1.9	2.9	6.3	2.4	0.9	2.1	3.1	0.7	0.8	1.1	1.2	0.7	0.8
	Stage II																								
	Raw Water	1.3	0.8	2.5	1.2	1.2	2.4	2.9	2.7	2.5	2.3	1.7	1.4	2.5	2.4	3.1	2.9	3.4	2.8	1.1	1.2	1.3	1.4	1.1	1.3
	Clarifier1 (Settle)	2.3	1.0	3.4	2.3	2.8	1.8	1.9	2.4	1.6	1.8	1.9	2.1	3.4	1.8	2.1	1.5	2.1	4.2	1.2	1.0	1.2	1.3	1.2	1.1
	Common Filter No. 1	0.5	0.5	0.3	0.1	0.2	0.8	0.4	0.7	0.9	0.5	0.6	0.3	0.3	0.8	0.9	1.8	1.9	1.7	1.0	1.1	1.0	1.1	1.0	1.7
	Sump 1	2.1	1.4	1.7	1.5	1.8	0.6	1.6	0.9	1.3	0.3	0.4	0.4	1.7	0.6	1.3	2.1	2.7	3.3	1.0	0.9	1.1	0.9	0.8	1.0
	Sump 2	0.3	0.2	1.6	0.4	0.1	1.3	0.4	0.6	0.3	1.0	1.3	1.1	1.6	1.3	0.9	0.6	0.9	1.4	1.3	1.2	1.0	1.2	1.1	1.2
	Sump 3				1.5	1.8	2.9	3.7	4.3	4.7				5.8	2.9	3.7	4.2	3.9	4.4	1.6	1.3	1.2	1.3	1.4	1.2
4.02.08	**Stage I**																								
	Raw Water	2.2	1.2	2.2	2.1	2.1	1.9	1.6	1.1	1.6	3.3	4.0	3.7	3.8	3.5	3.7	3.6	3.3	4.5	1.9	1.2	1.2	1.6	1.4	1.7
	Clarifier1 (Settle)	1.6	1.2	1.7	1.6	1.6	1.7	1.8	1.3	3.9	3.4	3.3	2.2	3.6	3.1	3.3	3.3	2.9	2.9	4.6	2.5	2.7	1.9	1.9	1.5
	Inspection Chamber (Filter 9)	2.4	1.2	0.8	0.7	0.7	0.9	0.6	0.7	1.6	1.7	1.8	3.2	2.5	2.0	1.9	2.3	1.4	2.7	1.6	3.2	2.8	1.8	1.7	1.5
	Stage II																								
	Raw Water	1.7	1.8	1.3	1.3	1.3	1.6	1.3	1.1	2.8	3.0	3.0	3.4	3.3	3.2	3.1	3.0	2.8	2.7	4.0	0.9	1.7	1.2	2.0	1.7
	Clarifier1 (Settle)	0.9	1.2	1.2	1.1	1.1	1.4	1.2	1.0	2.9	3.1	3.2	3.0	3.2	3.1	3.5	3.6	3.1	4.7	3.6	1.1	1.1	0.7	0.6	0.5
	Common Filter No. 1	0.7	0.1	0.1	0.2	0.2	0.7	0.8	0.7	1.3	1.2	1.2	2.4	1.8	2.0	2.2	1.9	2.7	3.0	4.8	1.4	1.6	0.1	1.1	1.2
	Sump 1	1.3	0.9	0.9	0.8	0.8	0.7	0.9	0.8	2.0	1.9	2.0	2.6	2.6	2.2	2.4	2.5	2.3	2.7	2.6	1.2	1.2	3.3	3.4	2.6
	Sump 2	0.8	0.3	0.4	0.5	0.5	0.5	0.6	0.5	1.9	1.7	2.3	2.2	1.9	1.8	1.9	2.2	1.6	1.7	2.7	1.0	1.0	2.8	2.9	2.6
	Sump 3	3.4	0.1	2.8	2.5	2.5	2.1	2.0	NA	2.3	6.9	2.0	2.6	3.4	3.0	1.9	2.3	2.4	4.0	1.9	2.9	2.8	1.1	1.8	2.9

Table 3.10 (Contd..) : Hourly Turbidity Data at Various Stages

Date	Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
5.02.08	Stage I																								
	Raw Water	1.3	2.6	2.4	3.2	3.2	3.4	4.1	3.8	3.7	3.3	3.2	3.3	1.8											
	Clarifier1 (Settle)	1.9	3.1	1.9	2.8	2.6	3.0	3.2	1.3	1.2	3.0	1.7	1.6	2.7											
	Inspection Chamber (Filter 9)	1.1	1.0	0.9	2.5	1.0	1.3	1.3	1.2	1.1	1.6	3.1	1.4	0.2											
	Stage II																								
	Raw Water	1.8	2.0	1.9	1.9	2.4	2.6	3.2	2.4	2.2	2.6	3.1	1.7	2.4											
	Clarifier1 (Settle)	3.0	1.8	2.0	2.6	2.4	0.9	2.9	3.4	3.1	2.8	3.2	3.8	3.0											
	Common Filter No. 1	2.2	0.4	0.5	0.7	0.8	1.1	1.3	2.7	2.5	1.4	1.7	1.7	2.9											
	Sump 1	1.6	0.9	0.8	1.3	1.4	1.4	1.9	2.5	2.2	2.1	2.0	1.7	0.7											
	Sump 2	1.2	0.9	0.7	1.1	0.8	0.9	1.5	1.5	1.6	1.5	1.4	0.3	1.5											
	Sump 3	1.2	0.9	0.7	2.1	0.8	1.7	3.3	2.6	2.4	2.1	1.9	2.1	1.1											
6.02.08	Stage I																								
	Raw Water	2.8	3.1	4.8	3.7	3.4	3.2	3.0	2.8	3.3	3.4	3.2	3.1	0.9											
	Clarifier1 (Settle)	1.1	1.0	4.1	2.8	2.8	2.7	3.6	3.2	2.8	2.9	2.7	3.9	3.7											
	Inspection Chamber (Filter 9)	1.3	1.2	2.8	1.2	1.2	1.1	1.6	1.7	1.1	1.8	1.8	1.1	1.5											
	Stage II																								
	Raw Water	2.8	2.7	2.5	2.5	2.7	2.6	2.6	2.4	2.6	2.6	2.5	4.3	3.6											
	Clarifier1 (Settle)	2.4	3.0	2.5	3.2	2.8	2.7	2.1	1.9	2.9	2.6	2.6	3.1	0.9											
	Common Filter No. 1	2.5	2.6	2.0	0.9	1.7	1.6	1.0	1.1	1.1	1.1	1.2	1.2	2.9											
	Sump 1	1.2	1.2	1.3	1.1	1.0	1.1	1.6	1.4	1.6	1.7	1.6	3.0	1.1											
	Sump 2	2.8	2.8	2.2	1.0	1.1	1.0	1.1	1.2	1.2	1.1	1.2	1.3	2.5											
	Sump 3	0.5	0.5	2.3	1.5	2.4	2.3	2.8	2.4	3.8	1.5	1.3	3.3	1.3											

Table 3.10 (Contd..) : Hourly Turbidity Data at Various Stages

Date	Hours	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
7.02.08	**Stage I**																								
	Raw Water	2.3	2.4	5.8	1.8	2.3	2.1	2.5	3.8	2.7	3.4	3.1	0.8	2.3											
	Clarifier1 (Settle)	2.1	2.2	2.3	1.7	2.3	1.7	2.4	2.5	2.2	3.0	2.8	0.7	1.3											
	Inspection Chamber (Filter 9)	2.0	2.0	1.0	1.0	0.7	0.6	1.0	0.6	0.8	1.6	1.7	2.5	0.5											
	Stage II																								
	Raw Water	1.7	1.8	2.9	2.8	1.8	1.7	2.7	1.9	1.9	2.6	2.8	1.2	0.9											
	Clarifier1 (Settle)	2.2	2.1	2.0	1.2	2.0	1.7	2.1	2.1	2.4	2.7	2.6	0.7	2.1											
	Common Filter No. 1	0.7	0.5	1.4	0.7	0.6	0.5	0.7	0.9	0.9	1.6	1.4	1.7	1.6											
	Sump 1	1.5	1.9	1.1	0.1	1.1	1.2	1.2	0.9	0.8	1.9	1.9	1.5	1.4											
	Sump 2	0.2	0.1	1.6	0.2	0.6	0.7	0.9	0.8	1.0	1.8	1.7	1.5	1.3											
	Sump 3	2.0	2.3	1.1	0.7	2.6	2.2	1.1	1.6	1.5	1.3	1.5	1.8	1.8											
8.02.08	**Stage I**																								
	Raw Water	2.8	2.7	3.6	3.1	2.6	2.9	2.8	2.8	2.8	2.6	2.7	2.6	3.5											
	Clarifier1 (Settle)	1.1	1.6	2.0	2.0	2.3	2.5	2.4	2.5	2.4	1.8	0.7	2.8	1.0											
	Inspection Chamber (Filter 9)	1.3	0.8	1.2	1.3	1.2	1.1	1.2	1.6	0.9	0.7	3.6	1.4	2.6											
	Stage II																								
	Raw Water	2.8	1.1	1.5	1.7	1.9	1.9	1.8	1.9	2.2	2.6	2.5	3.2	1.6											
	Clarifier1 (Settle)	2.4	2.1	2.6	2.0	1.8	1.9	1.9	2.2	2.6	2.1	1.6	2.4	3.3											
	Common Filter No. 1	2.5	1.2	0.9	1.1	1.3	1.0	1.1	0.9	0.8	2.8	1.5	2.3	0.8											
	Sump 1	1.2	0.3	0.6	1.1	1.5	1.4	1.5	1.3	1.4	0.9	1.0	1.3	2.1											
	Sump 2	2.8	1.0	1.0	0.9	0.7	0.8	0.7	0.8	0.9	1.5	1.7	1.8	1.0											
	Sump 3	0.5	2.6	0.4	1.0	0.9	1.8	0.9	0.9	1.4	0.7	1.6	1.4	1.9											

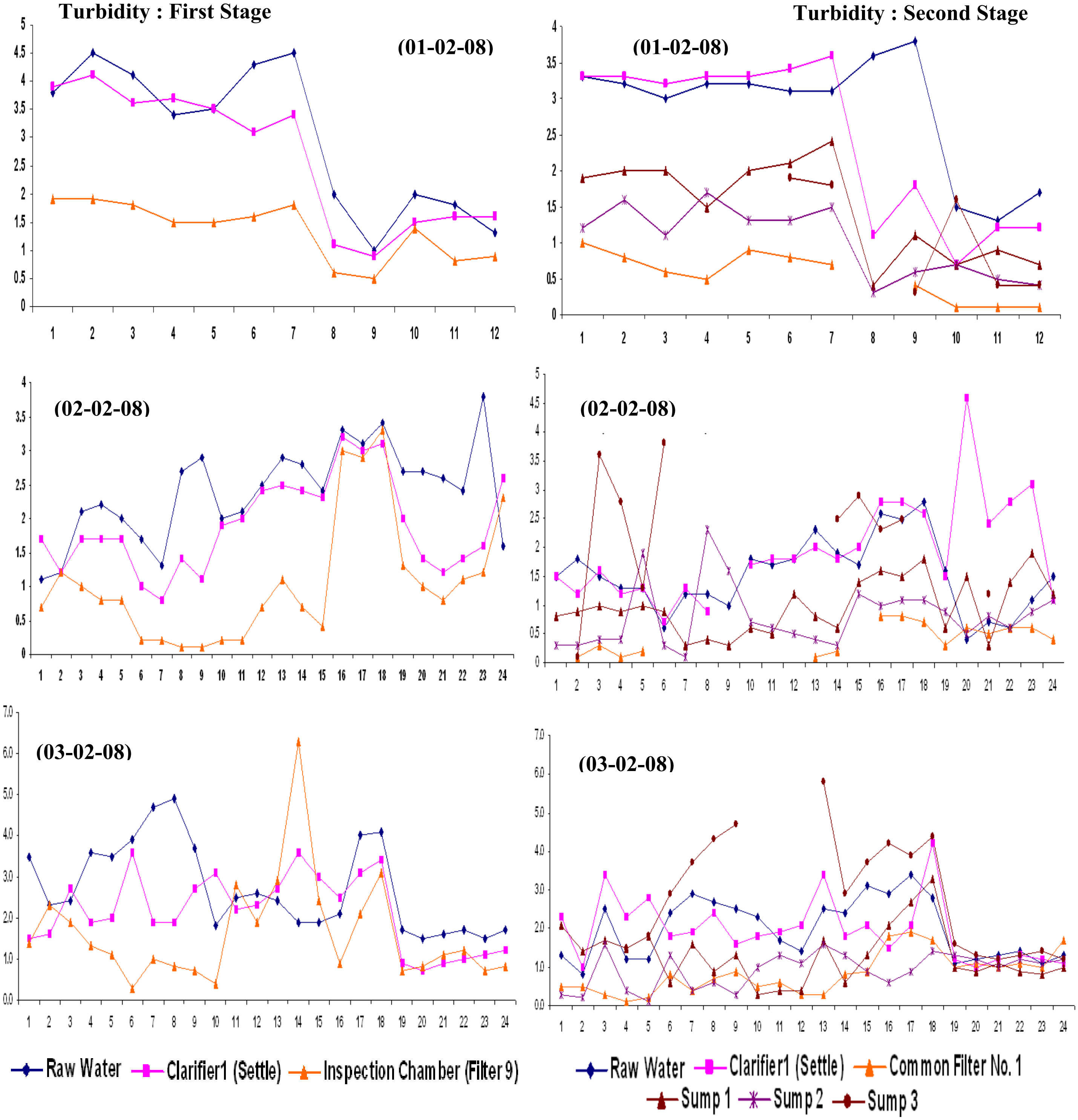


Figure 3.17 : Hourly Turbidity of Water Samples at Various Stages of PWW

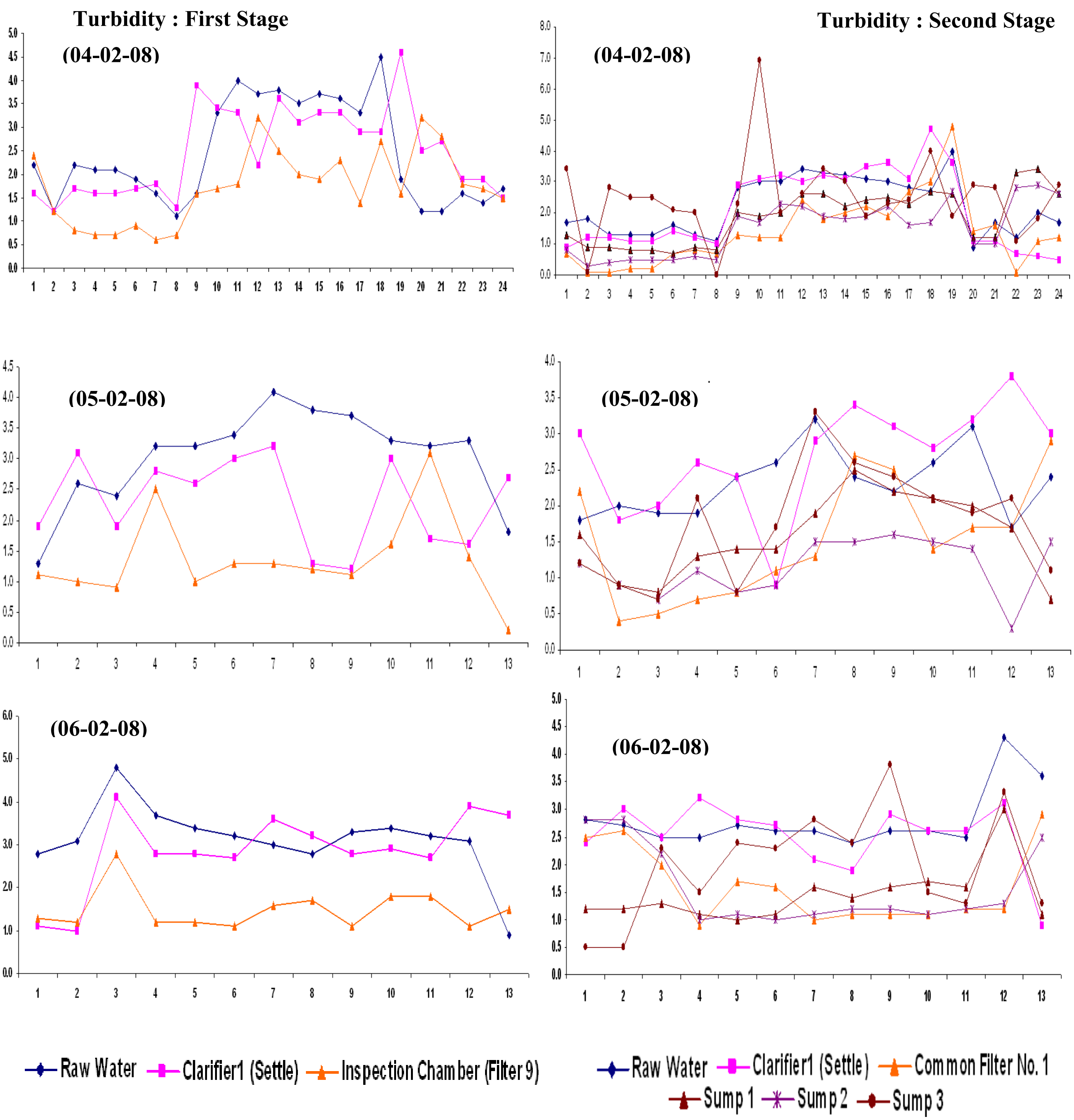


Figure 3.17 (Contd..) : Hourly Turbidity of Water Samples at Various Stages of PWW

Observations :

The turbidity of raw water range from 4.0 to 7.2 NTU indicating effective settlement of suspended solids flushed from catchments area runoff in to Khadakwasla dam. The finished water turbidity though meeting the BIS standards of 5 NTU, does not show expected performance i.e. turbidity < 1 NTU as the targeted value of CCP.

3.2.5 Comprehensive Performance Evaluation from Auditors

After successful evaluation of Parvati Water Works the invited auditors has submitted the impression regarding functioning of Water Works and offered suggestions for improvement. The summary of auditors comment on comprehensive performance evaluation and performance limiting factors and rating are presented in **Table 3.11 and Table 3.12**. The detailed proformae are in **Annexure 3.1(B).**

Auditors Special Comments

Dr. Somdutt

- Raw water quality is monitored only in day shift
- No determination of residual aluminum
- Provision of outside agency should be made for checking water quality
- Adequate staff should be appointed for controlling processes
- Construct recycling water treatment plant to save 10% water loss
- Keep a proper record of all tests done

Mr. R.D. Sharma

- Maintenance should be done before break down of system
- Civil work should be done properly well in time
- Require better local communication network for immediate contact with staff and take action immediately on the information received for better results
- Require more effective supervision
- Require chemist in each shift

Er. J.K. Bassin

- Purchase procedures adopted for even small items needed on day-to-day basis for repair and maintenance is causing delay leading to prolonged down time of machinery.
- No leak detection programme
- No water audit
- Manpower reduced due to superannuation.
- Automation helped to tackle the problem of shortage of manpower.
- More attention needs to be provided for clarifier designing

Mr. David

- Lack of preventive maintenance programme which could reduce cost of repairs and emergency purposes
- Justify capital expenditure through cost tracking
- Overall filters operate well
- Some sand may be migrating and plugging under drains
- Monitoring and reconstruction of filters when needed may be appropriate
- Online turbid meter should be provided to give insight into potential problems or short duration events

Mr. Sunil Kumar

- Shortage of staff
- Res. Chlorine levels are to be enhance to 2 mg/l, to have a sufficient chlorine at tail end point

Mr. S.P. Andey

- Increase in limit of expenditure without tender to avoid delay in repair
- Employment of staff on the vacancy due to retirement as per requirement

Mr. Subhash Chandra

- It has been observed that all the staff is well conversant in their jobs.
- They have sufficient knowledge and experience for doing their jobs.
- Still more scope for imparting technical knowledge
- Wind socks should be installed

Er. P. S. Kelkar

- No specific problems mentioned by O & M staff

Er. N. Ramesh

- Process control satisfactory
- There is no provision for out sourcing of water quality checks
- Increase amount up to 50,000/- for attend electric repairs day to day problems
- Supervision of the treatment process is doing satisfactorily
- Essential Planning to be made

Table 3.11 : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Dr. Somdutt	Mr. R.D. Sharma	Mr. Subhash Chandra	Er. J.K. Basin	Mr. C. Raja
A) Source protection and conveyance to plant	• Out of two carrying systems- close conduct system is OK as there is no contamination during transmission • In open canal contamination is possible due to effluent discharges and domestic uses enroute	• No contamination at source		• Elaborate Water quality monitoring programme, to be undertaken to ensure consistent quality of water through both channels	• Possibility of contamination into open channel due to slums
B) Raw water quality	• Raw water drawn from dam, therefore no significant variation in parameters except turbidity • Regular monitoring is recommended	• No Raw water contamination. Quality of water is best		• Quality difference observed in stilling chamber • Due to Change in quality, frequent adjustments in plant operating parameters is required	• Monitor the quality of raw water
C) Measurement of raw and treated water flow	• At present no provision for it, therefore chemical doses can not be applied as per requirement • Installment of flow meter recommended	• Need flow meter as early as possible	• Install flow meter	• Actual flow Measurement would be desirable along with records for adjustment of chemical doses	• Measuring devices are not available and unable to specify actual quantity of water drawn
D) Chemical storage for alum, chlorine and PAC	• Inadequate storage capacity • Find out the suitable place for storage • Minimum storage for one month should be available			• Safety aspect should be looked into • Chlorine storage should be appropriate and need attention	• Chlorine cylinders are stacked in two rows, one over other and drawl of chlorine is been done through bottom row, it will be difficult to arrest the leakages and also dangerous
E) Consumption of chemicals eg. Alum, chlorine and PAC	• Chemical dose as per jar test done once a day. • Frequency of Jar test should be strengthened/enhanced by Testing in remaining in two shifts also				• Alum and chlorine demand of raw water and clean water is calculated based on approximate values of inflows • Finding it difficult to apply uniform doses of chemicals

Table 3.11 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Dr. Somdutt	Mr. R.D. Sharma	Mr. Subhash Chandra	Er. J.K. Basin	Mr. C. Raja
F) Flocculation,, coagulation and sedimentation	• Concept of Stopping the functioning of flocculator and scrapping bridge during low turbidity is not advisable. It should be avoided • Flocculators and flash mixers should run continuously • Scraping bridge should be operated in a shift II or III	• Detention period should be same throughout every season to make heavy flocs for better settlement • for higher turbidity season, detention time should be increased		• Plant overloaded. • Needs engineering evaluation • More attention for clarifier design and functioning particularly for 2nd stage plant, • Checking should be done during post monsoon with higher turbidities	• Clariflocculators are overloaded resulting in less retention period • Quality of filtered water may vary based on the efficiency of clarifiers
G) Filter O & M and Back washing	• Done properly at adequate pressure • Design of a filter bed is very old with no provision of siphon. Hence, backwash water requirement is more			• Re-circulate water from back washing with adequate safety	
H) Disinfection	• Addition of disinfection chemicals is not done as per norms. • Pre stage disinfection should be improved, so that 0.2 to 0.5 mg/L chlorine is available at top of filter beds • Post chlorination is done in balancing reservoir which is not advisable			• Maintain the residual chlorine up to 0.5 mg/l. • With short supply of chlorine cylinders, use bleaching powder solution of proper strength • Supernatant should be used, as direct addition of bleaching solution may result in higher turbidity	• Chlorine is added in two stage for disinfection • Clear water reservoir is open at places and chances of evaporation of chlorine
I) Balancing reservoir	• It is in bad physical condition • Repair should be done at priority • Great possibility of contamination				• Roof /slab of clear water reservoir is broken and damaged

Table 3.11 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Dr. Somdutt	Mr. R.D. Sharma	Mr. Subhash Chandra	Er. J.K. Basin	Mr. C. Raja
J) Safety devices or measures	• No provision made for safety of labors • Safety norms provided by explosive department, factory inspector should be strictly followed	• Chlorine cylinders should be stored properly and handled carefully • Alarming system must be provided • Chlorine absorbance system should be incorporated to handle incidental leakages	• Conduct a mock drill once in a year • All sirens should be properly operated	• All staff should be well acquainted with a precaution and do's and don't in emergency conditions while handling the hazardous chemicals like chlorine. PAC should be handled carefully	
k) Training Programme	• Send staff for proper training programme regularly conducted by various organizations. Eg. PHE epts.. At Kolkatta, Chennai, Mumbai etc.	• Quality control Staff should be trained			
L) Laboratory	• Require strengthening • Methodology according to prescribed standards should be adopted • Microbiological parameters should be checked regularly for raw, clarified, filtered and finished water • Test maximum parameters as applicable at regular prescribed frequency	• Latest testing equipments should be acquired • Quality testing staff should be in every shift		• Water quality assurance may be performed regularly • Emergency laboratory staff should be available throughout • Communication to plant operation should be there.	
M) Pumping			• Close installation of pumps with less working place • Installation of Pumps should be as per good engineering practices • Standby motor should be kept in right manger		• Pumps Stored with old motor in pathway leaving little space for movement
N) Housekeeping		• Require more attention	• Painting to equipment is required		• Clarifloculator's side wall are leaking at several places • Growth of scrub all around clarifloculator

Table 3.11 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Sunil Kumar	Er .N .Ramesh	Er. P.S.Kelkar	Er. S.P.Andey	Mr. David
A) Source protection and conveyance to plant		• Raw water channel is open, possibility of contamination	• Very clean • Pollution is expected in open channel		Water supply from canal is not as high quality as reservoir
B) Raw water quality		• Water quality is good • More frequent monitoring essential during monsoon period	• Low turbidity except monsoon		
C) Measurement of raw and treated water flow		• No flow measurement	• No flow measurement devices • Flow by gravity	• Absence of raw water flow measurement	• Improved flow monitoring will allow control of chemical dosing and treatment
D) Chemical storage for alum, chlorine and PAC		• Feeding system should be strengthen			• Existing chlorine storage cylinders should be changed
E) Consumption of chemicals eg. Alum, chlorine and PAC		• Chlorine is added based on the demand examined in laboratory during day shift only	• As directed by chemist • Manually operated and single point application of coagulant • Mixing adequate		• Dosage control is difficult during low turbidity • Improvement in chemical feeding systems should be considered.
F) Flocculation, coagulation and sedimentation			• Performance of individual clarifloculator is to be judged • Equal distribution of water all along the periphery of clarifier • No testing of SOR done	• Provide suitable alum solution feeder for constant dose of alum • Alum solution should be added through perforated pipe placed along the length of mixing unit • Improve the coagulation and flocculation during low turbidity	• Sedimentation basins are under designed, need to evaluate cost benefit of additional sedimentation basin capacity • Calculation of hydraulic detention time is needed

Table 3.11 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Sunil Kumar	Er .N .Ramesh	Er. P.S.Kelkar	Er. S.P.Andey	Mr. David
G) Filter O & M and Back washing			• Uniform back wash flow • Automation is done	• Save the backwash water through recycle and reuse	• Overall condition of filters appears to be fair with proper distribution of backwash water. No holing or mounding of filter media observed. • Continued strong emphasis on monitoring of filter bed condition is warranted with corrective maintenance or reconstruction as needed. • Stated design flow rate for filters may be on the high side based on condition and operation of filters.
H) Disinfection		• Chlorine is used	• Available chlorine is 1.5 mg/l • Good ventilation	• Proper method of chlorination by bleaching powder in absence of chlorine cylinders should be followed	
I) Balancing reservoir	• Hole on the top of reservoirs, which may reduce the residual chlorine due to evaporation	• Roof is damage, immediate protection is needed by re-roofing or other alternative	• Made of three compartment • Roof is in depleting conditions, therefore urgent need of repair for which shut down must be undertaken		• Badly disintegrated due to corrosion from chlorine. Sections of one roof have collapsed allowing the potential for entry of contaminated storm runoff into sumpwell. Needs immediate attention. • Screens on roof, ventilation structures are badly corroded and need to be replaced

Table 3.11 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Sunil Kumar	Er .N .Ramesh	Er. P.S.Kelkar	Er. S.P.Andey	Mr. David
J) Safety devices or measures	• No color coding of operating valve • No siren system • No knowledge of safety equipments		• No mock drilling • No color coding		• Existing 1-ton chlorine cylinders are stored in a stacked position one on top of other leading to difficulty in attending leaks • Overall Safety programme should be review and strengthened including training.
K) Training Programme	• Training is needed	• Training should be given for better performance	• No training is given	• Organize in-house training programme	• Staff needs to be provided with sufficient training • Emphasis on lab standardization and calibration needed • Develop Standard Operating Procedures (SOPs) for operations, maintenance and emergency response and use in training. • Some training available but needs strengthening
L) Laboratory	• No standard guidelines		• No Standard operating procedures • No guidelines for maintenance • Adequate physico-chemical and bacteriological analysis has to be done		• Need to evaluate additional personnel especially with respect to microbiology • Limited staff availability exists for 24 hours, 7 days a week monitoring for emergency purpose • Increase emphasis should be placed on assurance of laboratory data quality

Table 3.11 (Contd..) : Consolidated Comprehensive Performance Evaluation – Performance limiting factors

Issue	Mr. Sunil Kumar	Er .N .Ramesh	Er. P.S.Kelkar	Er. S.P.Andey	Mr. David
M) Pumping			• Very congested • Standby motor available		
N) Housekeeping	• Growth of vegetation surrounding clarifier				• Painting is needed in many areas. • Significant leakage is occurring through clarifier sidewalls despite apparent recent repairs of deteriorating concrete.

Table 3.12: Comprehensive Performance Evaluation – Limiting Factor Rating

Issues	Rating								
	Dr. Somdutt	**Mr. R.D.Sharma**	**Er. J.K.Basin**	**Mr. C. Raja**	**Er. N. Ramesh**	**Er. P.S. Kelkar**	**Er. S.P. Andey**	**Mr. David**	
A) Source protection and conveyance to plant	A	-	B	A	B	B	-	A	4
B) Raw water quality	A	-	B	B	C	A	-	-	
C) Measurement of raw and treated water flow	B	B	B	B	A	B	A	A	1
D) Chemical storage for alum, chlorine and PAC	B	C	B	A	A	B	-	-	
E) Consumption of chemicals eg. Alum, chlorine and PAC	A	-	-	B	B	B	B	B	8
F) Flocculation,, coagulation and sedimentation	A	B	-	B	B	B	-	A	3
G) Filter O & M and Back washing	B	-	A	-	B	A	B	C	12
H) Disinfection	A	A	B	B	B	A	B	-	
I) Balancing reservoir	A	-	-	A	B	B	-	A	2
J) Safety devices or measures	B	-	A	-	-	C	-	B	10
k) Training Programme	B	-	-	-	-	B	C	B	
L) Laboratory	A	B	B	-	-	B	C		
Staff adequacy								C	11
Equipment								B	6
SOP								B	7
Testing & calibration								A	5
M) Pumping	-	-	-	-	-	B	-	-	
N) Housekeeping	-	B	-	B	-	-	-	-	
O) Policies and Planning	-	A	-	-	B	-	B	-	
P) Validation of water quality	A		-	-	B	-	-	-	
Q) Supervision	B	A	-	-	C	-	-	-	
R) Operation and Maintenance	-	-	B	-	-	-	-	-	
S) Process control	A	-	-	-	B	-	-	-	
T) Administration	-	B	-	-	-	-	-	-	
U) Plant coverage	-	A	-	-	-	-	-	-	
V) Lack of formalized preventive maintenance programme								B	9

Note: A- Major effect on long-term repetitive basis, B-Moderate effect on a routine basis or major effect on periodic basis, C-Minor effect

3.2.6 Field Interviews with Staff

The staff of various levels was interviewed to know their opinion and understanding about plant performance, their contribution to run the plant effectively and following points are noted during interviews.

- Group of Filter inspectors feel that a proper training should be given in the beginning. They find manual operation of filter is easy over automatic one because during power failure or pressure drop automatically operated plants have many problems.
- Sub engineers of different units pointed that no SOP or guidelines are available for maintenance. They also reported that sometimes, higher officials are not listening the problems, which cause delay in repairs. According to them siren system for chlorine gas leakage was present previously but now it is under repairs. They noted that tendering system makes the delay even in simple maintenance work.
- Chemical dosing operators states that they have to do the work anywhere in pumping and filtration unit as per higher officials' order. They reported that the workload is varying depending up on season. During rainy season there is heavy workload as compare to non-monsoon season. They also states that the staff is not adequate.
- Valve men reported problem of heavy workload during rainy season and power failure. They do not have any other problem regarding administration.
- According to senior chemist, proper dosing of chemicals is difficult in rainy season. Also chemical calculations for required dosing are not very accurate, as exact flow rate of incoming water is not known.

3.2.7 Conclusion and Recommendations

During Composite Correction Programme engineers from Delhi Jal Board, Hyderabad Metropolitan Water Supply and Sewerage Board (HM & WSSB) and NEERI had audited Parvati Water Works and the summary of performance limiting factors is presented below.

- The raw water source is very clean but there is possibility of contamination during conveyance of water to Parvati Water Works specifically through open channel.
- At present there is no provision for raw and treated water flow measurement. It is essential to install flow meters to define exact quantity of inflow and outflow of the plant. This information is also required for proper control of chemical dosing and treatment.
- The existing system of storage is not scientifically acceptable and likely to lead accidents. Presently chlorine cylinders are stacked in two rows, one over other and drawl is been done through bottom row, which will make it difficult to arrest the leakages. It is very dangerous and hence storage of chemicals needs urgent attention. While storing chemicals, safety aspects should be looked in to. The instruction for safety measured should be displayed near the storage.

- Chemicals for treatment viz. Alum and PAC are added based on laboratory tests using Jar test conducted once that too only during day shift. This practice renders difficulty in applying required doses of chemicals during other two shifts and the variation in raw water is not taken into consideration. Therefore frequency of Jar test should be strengthen in remaining two shifts also. Addition of chemicals is manually operated through single point application. During low turbidity, dose control is difficult. Improvement in chemical feeding is needed. The liquid coagulant should be added through perforated pipe placed along the length of the mixing chamber. Prechlorination dose is also decided once and fixed quantity is added every day. Proper testing of the requirement of chlorine is essential to avoid overdosing.
- Sedimentation unit is overloaded resulting in low retention time and poor efficiency. Engineering evaluation is required to be done to find out the extent of overloading. The design aspects of the second stage clarifier needs more critical evaluation as it has the predominant problem of overloading leading to less detention time. Improvement in the performance of sedimentation basin and clarifloculator during low turbidity is required to get better quality of settled water which will also reflect positively in the performance of the filters.
- Filtration and back washing is done properly with adequate pressure of air and water. But maintenance should be improved. Provision for recycling of back wash water is advised to avoid water losses. The practice of recycling of backwash water will also provide nuclei for better coagulation with low turbidity waters. The filter media is quite old and finer fraction of sand might have been lost during backwashing over the period of time. There is an urgent need to replace the sand.
- Disinfection is mainly done by using chlorine gas. During the shortage of chlorine cylinders, bleaching powder solution is used. Postchlorination should result in the residual chlorine up to 0.5 mg/l. If chlorination is not practiced at ESR, the dose can be even more so as to protect the water quality at the tail end of the distribution system.
- Balancing reservoir has 3 compartments to store water. Overall condition of the reservoir is in very bad. Roof is damaged and broken therefore there is every possibility of contamination. Immediate repair is needed by re-roofing or other alternatives.
- Regarding safety, all staff should be well acquainted with do’s and don’ts in emergency conditions while handling hazardous chemicals. Chlorine cylinders should be stored properly to avoid accidental hazards. Mock drill should be conducted once in year. All valves and pumps should be colour coded for better understanding of laborer. Well-operated alarm or siren system must be implemented. Safety norms are to be adopted.
- The existing safety programme needs to be review and strengthen to overcome gaps and shortfalls.
- In house training programme to the staff at all levels should be organized for better performance. Also staff should be deputed for proper training programmmes conducted by PHE departments.

- Following SOPs or guidelines for physico-chemical and bacteriological analysis is recommended. Quality testing staff should be available in every shift. Essential staff should be available for 24 hours, 7 days a week for emergency purpose. Modern testing equipments like on line turbidity meter, SCDA system, microbial testing facilities via membrane filter technique etc. should be acquired. An increased emphasis is needed on assurance of laboratory data collection for quality control.
- In pump house for finished water, pumps are installed close to one another with less place for movement. Stand by motors are available. Installation of pumps as per good engineering practices is advised.
- House keeping should be improved as far as cleanliness is concern.
- The human resource, administrative and financial procedures need to be more liberal and relax at least for the procurement of spares, which are required on urgent basis for proper operation and maintenance.

3.2.8 Information Provided by Mr. V. G. Kulkarni, Development engineer for Water System

Mr. V.G. Kulkarni, Development engineer had addressed the group on 13th February 08. He was briefed about the auditor's observations about the performance of the plant. He provided information on some of the points raised by the auditors.

- The provision of closed pipeline for raw water conveyance along with the flow meter is already planned and the administrative formalities are in progress.
- On the issue of improper storage of chlorine cylinders, immediate action was taken.
- The advertisement for additional staff is already placed and new persons will be appointed soon. With increased staff, additional tests suggested by the auditors can be performed to improve the efficiency.
- The existing clarifiers are proposed to be modified with the technology of tube settlers. This will definitely improve the efficiency of settling with existing civil structure.
- The job of replacement of sand is also taken up and the purchase formalities are in progress.
- Tenders for provision of recycling and reuse of backwash water have been called. This facility will be operational within a period of next 2 years.
- The repair works of balancing reservoirs is already taken up. He expressed that there is no scope for direct pumping. Also due to limited capacity of the elevated service reservoirs, the total area of the balancing tank cannot be taken for repairs at a time. Hence repair work is taken up in stages.
- The suggestions for improved efficiency through proper training, safety practices, maintaining SOPs for all equipments, modernization of laboratory, good house keeping, procurement of equipments were well taken and he assured to take up all matters at an earliest. He also requested NEERI and WHO experts to extend the technical support while improving the plant performance.

3.3 Haidarpur Water Treatment Plant, Delhi

Delhi is situated along a perennial source of water, the river Yamuna. The river divides the city into East Delhi known as Trans Yamuna Area, and New Delhi. The National Capital Territory of Delhi (NCTD) has an area of 1483 km^2 and comprises of three constituents MCD (1297.29 km^2), NDMC (42.74 km^2) and DCB (42.97 km^2). Water supply system, present status of production and demand, extent of coverage and agencies involved in transmission and distribution of water are discussed in following sections. Raw water is available from various sources like the river Yamuna, Bhakra Storage, Upper Ganga Canal and ground water.

3.3.1 Constitution & Organization of Delhi Jal Board

The Delhi Jal Board (DJB) is entrusted with the responsibility of procurement and distribution of water as well as treatment and disposal of sewage in Delhi. It provides water in bulk to New Delhi Municipal Council (NDMC) and Delhi Cantonment Board for redistribution in their respective areas. The Delhi Jal Board treats raw water from various sources like the river Yamuna, Bhakhra storage, upper Ganga canal and groundwater. The Organizational structure of DJB is given in **Figure 3.18**.

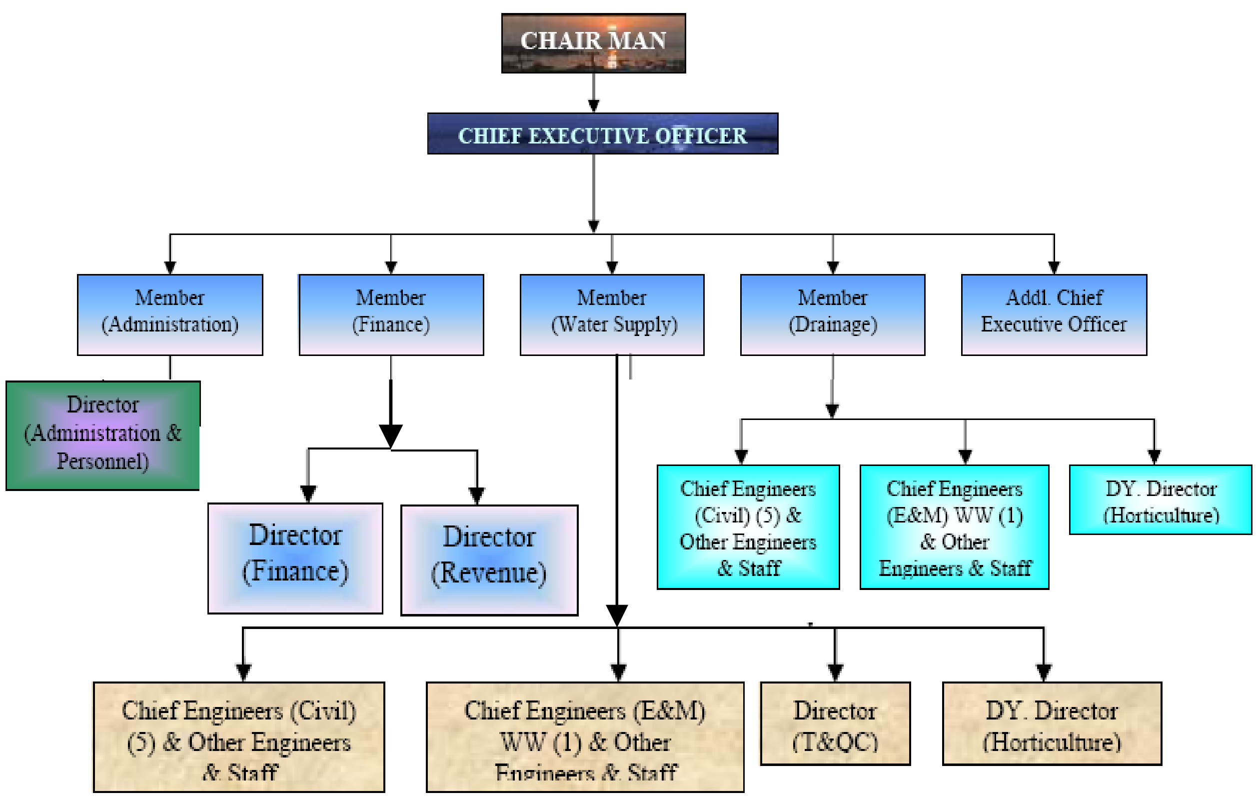


Figure 3.18: Organizational Structure of Delhi Jal Board

3.3.2 Present Water Supply Scenario

- **Installed Treatment Capacity**

For over five decades, Delhi Jal Board has been meeting the need of potable water for the capital city of Delhi. The installed capacity of water treatment plants is 631 MGD and by further extraction (through tube wells and other resources), about 650 MGD potable water is supplied as against the present requirement of over 900 MGD. The population of Delhi has seen phenomenal growth and has crossed the figure of 150 lacs, apart from the floating population of 4 to 5 lacs. Through systematic planning and implementation the board has ensured average availability of 50 gallons of per capita per day filtered/ treated water for the residents of Delhi through a pipeline network of about 10000 kms of water mains lines. Production of water during last year was around 790 MGD. **Table 3.13** presents the water treatment capacity indicating source of raw water.

Table 3.13: Treatment Capacity indicating Source of Raw Water

Source of Raw water	Name of water Treatment plant	Installed capacity MGD	Production by optimization MGD
River Yamuna	Chandrawal I & II	90	105
River Yamuna	Wazirabad I, II & III	120	124
Bhakra Storage / Yamuna	Haiderpur I & II	200	210
Bhakra Storage	Nangloi	40	21
River Yamuna	Bawana	20	Nil
Upper Ganga Canal	Bhagirathi	100	110
Upper Ganga Canal	Sonia Vihar	140	65
Ground water	Ranney Wells and Tube Wells	100	100
	Total	**790**	**735**

Delhi Jal Board has taken various steps to augment drinking water supply in the city. With a view to rationalise the distribution of water, Delhi Jal Board has drawn an elaborate plan for construction of under ground reservoirs and booster pumping stations (UGR/ BPS). During the year 2001 the UGR/ BPS at Dakshinpuri, Faridpuri, Shadipur, Mangolpuri and Chitranjan Park have been completed and commissioned. The work on 13 UGR/ BPS is in progress. On completion of the augmentation works, the DJB will be equipped to produce 919 MGD of water which is presented in **Table 3.14**.

Table 3.14 : Projected Water Capacity of Various Treatment Plants

S.No.	Water Treatment Plants	Capacity MGD (2006)	Capacity MGD (2011 / 2021)
1.	Wazirabad I II & III	120	130
2.	Chandrawal I & II	90	100
3.	Haiderpur I & II	200	216
4.	Bhagirathi	100	110
5..	Dwarka	--	40
6.	Sonia Vihar	65	140
7.	Nangloi	40	40
8.	Bawana	--	20
9.	Okhla	--	20
10.	Ranney Wells & Tubewells	100	91
11.	Ranney Wells for Okhla	--	12
	Total	**715**	**919**

Source: CDP Delhi, JNNURM – Chapter 8: Water Supply

Estimated demand @60 GPCD for a population of 190 lakhs is 1140 MGD by 2011 with a shortfall of 221 MGD while estimated demand @ 60 GPCD for a population of 230 lakhs is 1380 MGD by 2021 with a shortfall of 461 MGD.

Raw Water Sources

River Yamuna, Western Jamuna Canal (a carrier of Yamuna waters as also Bhakra waters) and the Upper Ganga Canal, are surface water sources for Delhi. Around 446 tube wells have been drilled in Yamuna bed and different areas in the city to meet the water requirement.

The present sources of raw water available to Delhi are as under:

- Yamuna Water - 750 cusec (Includes 130 cusec transit losses from Tajewala to Haiderpur)
- Ganga Water - 200 cusec at Bhagirathi Water Works
- BBMB Water - 225 cusec (Ex. Nangal 371 cusec).
- BBMB Water - 40 cusec (Ex. Nangal 60 cusec)
- Ground Water - 185 cusec.

Major Ongoing Projects pertaining to water supply are as under

- Design, build and operate 140 MGD Water Treatment Plant (WTP) at Sonia Vihar
- Design and build 33.948 km of clean water transmission mains from WTP Sonia Vihar
- Providing raw water conduit from Murad Nagar to Sonia Vihar
- Construction of underground reservoir (UGR) and booster pumping station (BPS) at Jagatpuri, Malviya Nagar, and Surajmal Vihar
- Construction of a booster pumping station at Jagatpuri
- Design and build clear water mains for south Delhi from Sonia Vihar WTP with total length of 16 km

Haiderpur Water Treatment plant

Haiderpur Water Treatment plant is the single largest plant in Asia with a capacity of 200 MGD. It is located in Western Delhi on the outer Ring Road near Prashant Vihar, Rohini Sector 15 on the bank of Western Jamuna Canal originating from Tajewala Head Works Haryana. The plant is about 5km from GT-Karnal Bypass and 4 km from Madhuban Chowk. It has two independent treatment plants of 100 MGD each. The treatment flow scheme is same for both. A common laboratory has been provided in the waterworks.

Raw water is drawn from two sources, viz. the Western Jamuna Canal (WJC) and the Bhakra Storage.

Western Jamuna Canal (WJC): - It originates from Tajewala Head Works, upstream Yamuna Nagar and then passes through Karnal, Munak, Panipat, Khubru, Kakroi and Bawana to Haiderpur Water Works.

Bhakra Storage: Delhi Jal Board receives water from Bhakra Storage through Bhakra Nangal canal which joins WJC near Karnal and carries fresh water for Delhi Water Supply.

Plate : Clariflocculator at Haiderpur Water Treatment Plant

Plant Capacity and Supply Area Coverage for Haiderpur Water Treatment Plant is as follows :

a. Haiderpur 1st 100 MGD

Capacity:	100 MGD
Commissioned:	1973/79
Optimised Production:	100 MGD
Raw Water:	10 Nos. pumps of 22 MGD each
Flow Metering	Bulk flow meter installed in incoming channels
Pre-chlorination machine	40 kg / hr.
Clarifloculators (8 Nos.):	each of 12.5 MGD (51.5 m dia X 4m depth)
Filter House (2 Nos.):	each of 50 MGD capacity Total 40 Nos. rapid sand filters of size 10.3m X 9.5m X 3m (2.5 MGD) each
Backwash Pump	125 HP centrifugal type
Air blower	60 HP
Population served:	18 Lakh approx.

Rising Mains (95km):	North-West Mains	1100mm	PSC	21.5 km
	West Delhi Mains	1100mm	PSC	18.0 km
	Pitampura Mains	1200mm	PSC	7.5 km
	Mangolpuri Mains	1000mm	PSC	17.5 km
	Khyala Mains	900mm	PSC	22.0 km
	Naraina Mains	800mm	PSC	8.5 km

Area served	Pitampura, Shalimar bagh, Saraswati vihar, Deepali Paschim Vihar, Madipur, Jwala Heri, Raghubir Nagar, Raja Garden, Rajouri Garden, Moti Nagar, Ramesh Nagar, Shadipur, Subhash Nagar, Naraina Inderpuri, North West Delhi, West Delhi, Karol Bagh, Delhi Cantt.

b. *Haiderpur 2nd 100 mgd*

Capacity :	100 MGD
Commissioned :	1993/94
Optimised Production	100 MGD
Raw Water	9 Nos. pumps of 22 MGD each
Flow Metering	Bulk flow meter installed in incoming channels
Pre-chlorination machine	40 kg / hr.
Clarifloculators (8 Nos.):	each of 12.5 MGD (51.5 m dia X 4m depth)
Filter House (2 Nos.):	each of 50 MGD capacity Total 40 Nos. rapid sand filters of size 10.3m X 9.5m X 3m (2.5 MGD) each
Backwash Pump	125 HP centrifugal type
Air blower	60 HP
Population served	25 Lakh approx.
Rising Mains (81km):	South Mains 1500mm 35.0 km West Mains 1500mm 15.0 km South Mains 1000mm 25.0 km Rohini Mains 1100/800mm 5.0 km RWS Mains 1000mm 1.0 km
Area served	Rohini sectors 1 to 9, 11,13 to 18, Rithala, Shahabad, Daulatpur, Badli, Holumbi, Mangolpuri, Vikaspuri, Maj.Bhupender Singh Nagar, Tilaknagar, Janakpuri, Sagarpur, Delhi Cantt. NDMC area, R.K. Puram, VasantVihar, Motibagh, Vasant Kunj, Munirka, J.N.U., Mehrauli, IIT, Green Park, Safdarjung Enclave

Common salient technical details for both stage of the Haiderpur water treatment plant are given in **Table 3.15**. The layout plan of Haiderpur waterworks is given in **Figure 3.19** while the treatment flowsheet is shown in **Figure 3.20**.

Table 3.15 : Salient Technical details of Haiderpur Water Treatment Plant

1. Feed Channel From WJC	Length: 100 ft Width: 12ft-6inch Height 7ft
2. Raw Water Pump House	
a. Silt-Chamber	145ft x 20 ft
b. Sump	152ft x 20ft
c. Pump House with ANNEXE	80 x 16
d. Raw water pumps	10 Nos.
e. Capacity	110 kw 22MGD each
f. Raw water main	4 Nos.---1100 mm dia Length-100ft

Table 3.15 (Contd..) : Salient Technical details of Haiderpur Water Treatment Plant

3. Pre-treatment	
a. Main inlet sump_ (2 Nos.)	16ft x 16ft
b. Flash mixer------- (8 Nos.)	8ft x 8ft
Detention Period	30 sec
c. Clariflocculators	8 Nos.
Capacity	12.5 MGD
Size	160ft dia SWD 12ft-6inch 66ft inner dia SWD 17 ft 7 inch
Detention Period	Flocculating Chamber - 20 min. Clarifier - 2.5 hrs.
Surface loading	750 gallons/ sq ft/ day
4. Chemical House	
A. Area	500 sq ft
B. Maximum Alum Dose	60 ppm
C. Capacity of Each tank	(11 ft x 11ft x 6 ft) 4 hrs. @ 5% solution
D. 12 Nos. Tanks	4500 gallons
5. Alum Godown	600 MT each
6. Filtration Plant	
Filter House	2 Nos. (348 x 100 ft)
Number of Filters	25 x 2 (26 x 35 ft each)
Capacity of Filters	2 MGD each
Rate of Back Washing	10 gal / sq ft / min
Rate of Air Sourcing	2 cft/min
Working Area of Each Filter	836 sq ft
Rate of Filteration	100 gal / sq ft / hour
Blower in each Plant	3 Nos. (840 cft / min)
Back Washing Pumps	4 Nos. (2800 gal/ min)
7. Filter Sand Media	
Fine Sand	1/32 to 1/16 inc = 24 inch
Coarse Sand	1/16 to 1/8 inc = 6 inch
Gravel	1/8 to 1/4 inc = 4 inch
Gravel	1/4 to 1/2 inc = 2 inch
Fine Gravel	1/2 to 1 inc = 2 inch
Coarse gravel	1 to 2 inch = 2 inch
8. Balancing Reservoir	
Capacity	2.4 MG each (5 Nos.)
Volume	200 x 200 x 10 ft

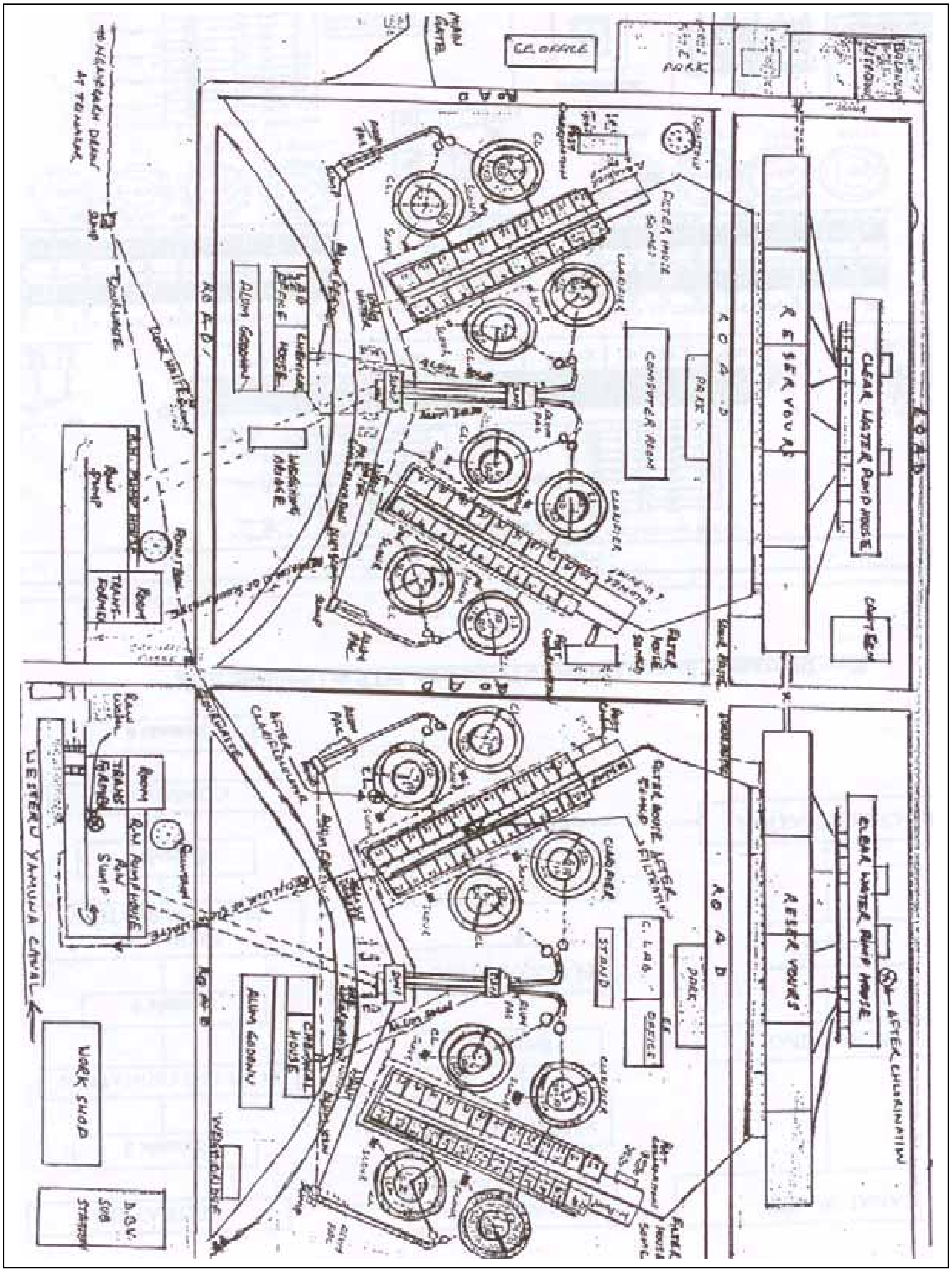


Figure 3.19 : Plant overview and Layout plan of the water treatment plant, Haiderpur

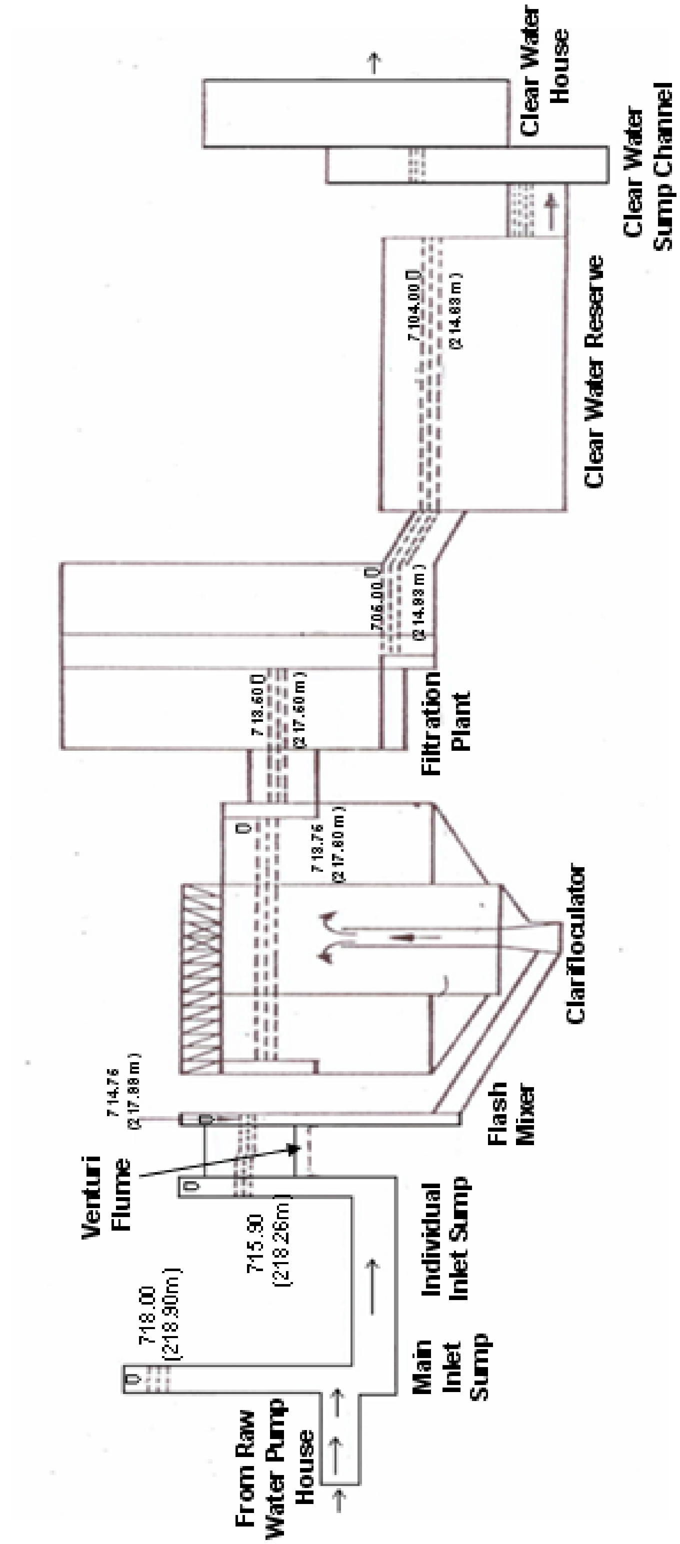
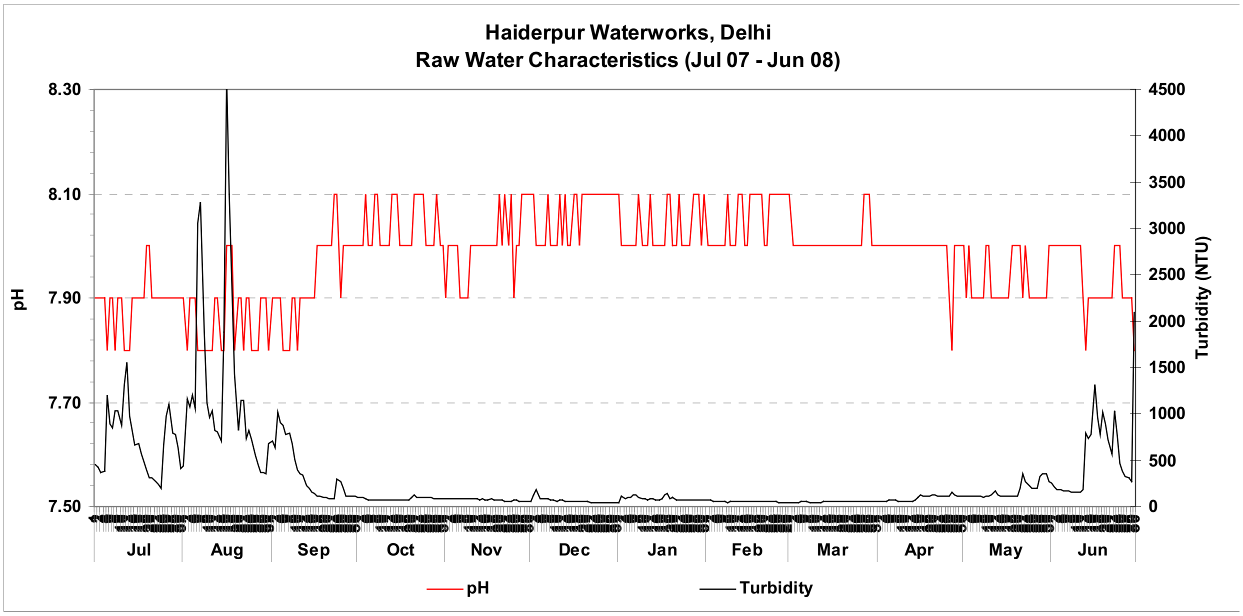


Figure 3.20 : Flow sheet of the water treatment plant, Haiderpur

3.3.3 Water treatment plant analytical data (Secondary)

The performance data for Haiderpur water treatment plant during July 2007 to June 2008 is collected for evaluation. The comparison of raw and treated water characteristics (pH and turbidity) is presented in **Figure 3.21** and the analytical results of pH, turbidity and bacteriology for raw and treated water is given in **Table 3.16**.



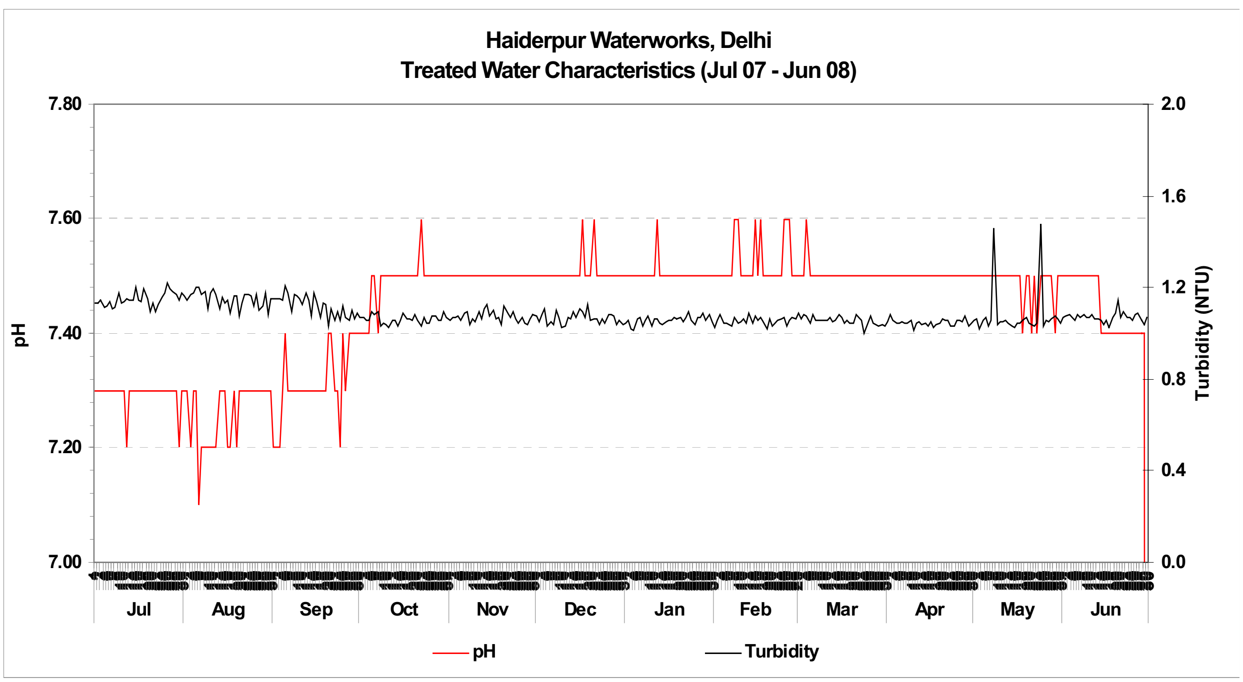


Figure 3.21 : Comparison of Raw and Treated Water Characteristics (pH and turbidity)

Table 3.16 : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	July 2007						August 2007						September 2007					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	7.9	447.3	2400	7.3	1.1	-	7.9	436.7	2400	7.3	1.2	-	7.9	710.0	2400	7.2	1.2	-
2	7.9	421.3	240	7.3	1.1	-	7.8	1158.8	460	7.3	1.1	-	7.9	634.6	240	7.2	1.2	-
3	7.9	371.9	240	7.3	1.1	-	7.9	1079.6	24	7.2	1.2	-	7.9	1020.6	2400	7.2	1.2	-
4	7.9	384.0	2400	7.3	1.1	-	7.9	1200.0	240	7.3	1.2	-	7.9	902.7	2400	7.3	1.1	-
5	7.8	1199.2	2400	7.3	1.1	-	7.9	1056.7	2400	7.3	1.2	-	7.8	878.8	2400	7.4	1.2	-
6	7.9	887.7	2400	7.3	1.1	-	7.8	3062.5	2400	7.1	1.2	-	7.8	783.8	2400	7.3	1.2	-
7	7.9	850.0	2400	7.3	1.1	-	7.8	3281.3	2400	7.2	1.2	-	7.8	789.6	2400	7.3	1.1	-
8	7.8	1035.8	2400	7.3	1.1	-	7.8	1888.3	2400	7.2	1.2	-	7.9	676.7	2400	7.3	1.2	-
9	7.9	1036.3	2400	7.3	1.2	-	7.8	1113.8	110	7.2	1.1	-	7.9	514.6	2400	7.3	1.2	-
10	7.9	872.1	2400	7.3	1.1	-	7.8	959.2	460	7.2	1.2	-	7.8	397.5	110	7.3	1.2	-
11	7.8	1319.6	2400	7.3	1.1	-	7.8	1037.5	2400	7.2	1.2	-	7.9	350.0	2400	7.3	1.1	-
12	7.8	1553.3	2400	7.2	1.2	-	7.9	819.2	2400	7.2	1.2	-	7.9	346.3	2400	7.3	1.2	-
13	7.8	977.5	240	7.3	1.1	-	7.9	807.5	2400	7.3	1.1	-	7.9	232.1	2400	7.3	1.1	-
14	7.9	819.0	110	7.3	1.1	-	7.8	704.2	2400	7.3	1.2	-	7.9	197.9	2400	7.3	1.1	-
15	7.9	670.4	2400	7.3	1.2	-	7.8	1880.6	2400	7.3	1.1	-	7.9	159.0	110	7.3	1.2	-
16	7.9	677.7	2400	7.3	1.1	-	8.0	4610.8	1100	7.2	1.1	-	7.9	137.9	110	7.3	1.1	-
17	7.9	570.4		7.3	1.1	-	8.0	3372.9	2400	7.2	1.1	-	8.0	118.5	110	7.3	1.1	-
18	7.9	477.9		7.3	1.2	-	8.0	2375.0	1100	7.3	1.2	-	8.0	115.4	110	7.3	1.1	-
19	8.0	391.5		7.3	1.2	-	7.8	1422.9	1100	7.2	1.2	-	8.0	105.6	110	7.3	1.1	-
20	8.0	311.7		7.3	1.1	-	7.9	817.3	240	7.3	1.1	-	8.0	92.3	110	7.4	1.0	-
21	7.9	310.0		7.3	1.1	-	7.9	1150.4	240	7.3	1.1	-	8.0	89.0	110	7.4	1.1	-
22	7.9	272.5		7.3	1.1	-	7.8	1150.4	2400	7.3	1.2	-	8.0	85.2	460	7.3	1.1	-
23	7.9	240.8		7.3	1.1	-	7.9	739.2	1100	7.3	1.2	-	8.1	90.4	110	7.3	1.1	-
24	7.9	199.2		7.3	1.2	-	7.9	824.6	110	7.3	1.2	-	8.1	295.6	110	7.2	1.1	-
25	7.9	660.6		7.3	1.2	-	7.8	717.5	1100	7.3	1.1	-	7.9	269.8	2400	7.4	1.1	-
26	7.9	982.1		7.3	1.2	-	7.8	555.0	150	7.3	1.2	-	8.0	199.8	110	7.3	1.1	-
27	7.9	1109.2		7.3	1.2	-	7.8	450.8	150	7.3	1.1	-	8.0	114.8	240	7.4	1.1	-
28	7.9	798.3		7.3	1.2	-	7.9	361.0	130	7.3	1.1	-	8.0	116.3	110	7.4	1.1	-
29	7.9	779.6		7.3	1.2	-	7.9	362.9	150	7.3	1.2	-	8.0	111.5	110	7.4	1.1	-
30	7.9	642.9		7.2	1.1	-	7.9	355.8	230	7.3	1.1	-	8.0	108.1	240	7.4	1.1	-
31	7.9	407.9		7.3	1.2	-	7.8	678.3	2400	7.3	1.2	-						

- No Count

Table 3.16 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	October 2007						November 2007						December 2007					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.0	103.8	110	7.4	1.1	-	7.9	81.7	110	7.5	1.1	-	8.1	62.3	110	7.5	1.1	-
2	8.0	102.8	110	7.4	1.1	-	8.0	81.9	110	7.5	1.1	-	8.1	125.2	24	7.5	1.1	-
3	8.0	98.5	110	7.4	1.1	-	8.0	81.5	460	7.5	1.1	-	8.0	183.5	110	7.5	1.1	-
4	8.1	89.8	110	7.4	1.1	-	8.0	80.6	460	7.5	1.1	-	8.0	83.8	110	7.5	1.1	-
5	8.0	76.9	240	7.5	1.1	-	8.0	82.7	110	7.5	1.1	-	8.0	80.6	110	7.5	1.0	-
6	8.0	72.9	110	7.5	1.1	-	7.9	79.8	46	7.5	1.1	-	8.0	80.8	110	7.5	1.1	-
7	8.1	67.3	110	7.4	1.1	-	7.9	79.6	460	7.5	1.1	-	8.1	81.3	46	7.5	1.0	-
8	8.1	68.1	460	7.5	1.0	-	7.9	81.5	110	7.5	1.0	-	8.0	73.5	110	7.5	1.1	-
9	8.0	68.5	110	7.5	1.0	-	7.9	80.4	110	7.5	1.1	-	8.0	70.2	46	7.5	1.1	-
10	8.0	66.9	110	7.5	1.0	-	8.0	79.0	24	7.5	1.1	-	8.0	62.3	46	7.5	1.0	-
11	8.0	73.1	110	7.5	1.0	-	8.0	82.1	46	7.5	1.1	-	8.1	71.9	46	7.5	1.0	-
12	8.0	68.7	110	7.5	1.1	-	8.0	82.1	24	7.5	1.1	-	8.0	67.5	110	7.5	1.1	-
13	8.1	68.1	110	7.5	1.1	-	8.0	72.5	24	7.5	1.1	-	8.1	62.5	46	7.5	1.1	-
14	8.1	73.1	110	7.5	1.0	-	8.0	80.6	110	7.5	1.1	-	8.0	62.2	110	7.5	1.1	-
15	8.1	71.3	110	7.5	1.1	-	8.0	72.5	110	7.5	1.1	-	8.0	60.6	46	7.5	1.1	-
16	8.0	72.1	460	7.5	1.1	-	8.0	71.9	460	7.5	1.1	-	8.1	58.5	24	7.5	1.1	-
17	8.0	68.5	110	7.5	1.1	-	8.0	78.5	240	7.5	1.1	-	8.1	53.1	46	7.6	1.1	-
18	8.0	69.8	110	7.5	1.1	-	8.0	76.5	110	7.5	1.1	-	8.0	51.9	24	7.5	1.1	-
19	8.0	71.3	460	7.5	1.1	-	8.0	67.1	110	7.5	1.0	-	8.1	52.7	2.4	7.5	1.1	-
20	8.0	97.3	110	7.5	1.1	-	8.1	71.7	460	7.5	1.1	-	8.1	52.1	2.4	7.5	1.1	-
21	8.1	131.7	110	7.5	1.1	-	8.0	64.2	110	7.5	1.1	-	8.1	51.0	110	7.6	1.1	-
22	8.1	104.2	110	7.6	1.0	-	8.1	61.5	240	7.5	1.1	-	8.1	47.5	110	7.5	1.1	-
23	8.1	96.3	46	7.5	1.1	-	8.0	61.3	110	7.5	1.1	-	8.1	45.6	46	7.5	1.0	-
24	8.1	97.1	46	7.5	1.0	-	8.1	59.8	110	7.5	1.1	-	8.1	42.3	24	7.5	1.1	-
25	8.0	97.1	110	7.5	1.0	-	7.9	64.0	110	7.5	1.0	-	8.1	41.7	24	7.5	1.0	-
26	8.0	95.8	110	7.5	1.1	-	8.0	64.2	240	7.5	1.1	-	8.1	42.3	110	7.5	1.1	-
27	8.0	92.9	460	7.5	1.1	-	8.0	61.7	110	7.5	1.0	-	8.1	47.1	110	7.5	1.1	-
28	8.0	91.9	110	7.5	1.1	-	8.1	62.7	110	7.5	1.0	-	8.1	49.2	110	7.5	1.1	-
29	8.1	90.4	110	7.5	1.1	-	8.1	58.8	240	7.5	1.1	-	8.1	47.3	110	7.5	1.0	-
30	8.0	90.2	460	7.5	1.1	-	8.1	61.5	110	7.5	1.1	-	8.1	45.2	110	7.5	1.1	-
31	8.0	84.0	110	7.5	1.1	-							8.1	43.5	110	7.5	1.0	-

- No Count

Table 3.16 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	January 2008						February 2008						March 2008					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.1	46.5	110	7.5	1.0	-	8.0	64.0	110	7.5	1.0	-	8.1	45.4	1100	7.5	1.1	-
2	8.0	117.9	110	7.5	1.1	-	8.0	63.8	11	7.5	1.1	-	8.0	45.8	11	7.5	1.1	-
3	8.0	86.0	46	7.5	1.0	-	8.0	62.5	11	7.5	1.1	-	8.0	47.1	11	7.5	1.1	-
4	8.0	92.5	46	7.5	1.0	-	8.0	58.1	11	7.5	1.0	-	8.0	49.0	46	7.6	1.1	-
5	8.0	104.2	110	7.5	1.1	-	8.0	54.4	46	7.5	1.0	-	8.0	55.2	11	7.5	1.0	-
6	8.0	134.2	110	7.5	1.1	-	8.0	56.0	110	7.5	1.0	-	8.0	57.3	110	7.5	1.1	-
7	8.0	125.4	110	7.5	1.0	-	8.0	49.6	11	7.5	1.0	-	8.0	53.0	11	7.5	1.1	-
8	8.1	93.3	46	7.5	1.1	-	8.1	41.7	11	7.6	1.1	-	8.0	47.9	11	7.5	1.1	-
9	8.0	86.0	46	7.5	1.1	-	8.0	49.6	11	7.6	1.0	-	8.0	47.9	11	7.5	1.1	-
10	8.0	82.1	46	7.5	1.0	-	8.0	59.0	46	7.5	1.1	-	8.0	47.5	11	7.5	1.1	-
11	8.0	73.3	24	7.5	1.1	-	8.0	56.3	46	7.5	1.1	-	8.0	47.5	46	7.5	1.1	-
12	8.1	78.1	110	7.6	1.1	-	8.1	57.7	11	7.5	1.0	-	8.0	49.0	11	7.5	1.1	-
13	8.0	78.8	110	7.5	1.0	-	8.1	60.5	11	7.5	1.1	-	8.0	50.4	110	7.5	1.1	-
14	8.0	76.7	110	7.5	1.0	-	8.0	60.4	240	7.5	1.0	-	8.0	55.0	460	7.5	1.1	-
15	8.0	71.9	110	7.5	1.1	-	8.0	57.9	11	7.6	1.1	-	8.0	53.9	11	7.5	1.1	-
16	8.0	78.3	110	7.5	1.1	-	8.1	59.4	11	7.5	1.1	-	8.0	52.9	46	7.5	1.1	-
17	8.0	124.6	110	7.5	1.1	-	8.1	55.6	11	7.6	1.1	-	8.0	57.3	24	7.5	1.0	-
18	8.1	146.3	110	7.5	1.1	-	8.1	60.6	11	7.5	1.1	-	8.0	54.4	11	7.5	1.1	-
19	8.1	82.1	110	7.5	1.1	-	8.1	56.5	11	7.5	1.0	-	8.0	56.5	24	7.5	1.0	-
20	8.0	101.6	46	7.5	1.1	-	8.1	57.7	11	7.5	1.1	-	8.0	58.5		7.5	1.0	-
21	8.0	76.7	46	7.5	1.1	-	8.0	61.9	11	7.5	1.0	-	8.0	58.8		7.5	1.1	-
22	8.1	76.5	110	7.5	1.1	-	8.0	56.5	11	7.5	1.0	-	8.0	57.5		7.5	1.1	-
23	8.0	74.6	110	7.5	1.1	-	8.1	56.7	11	7.5	1.1	-	8.0	56.9		7.5	1.1	-
24	8.0	74.2	110	7.5	1.1	-	8.1	56.9	11	7.5	1.1	-	8.0	56.5		7.5	1.0	-
25	8.0	74.0	46	7.5	1.0	-	8.1	54.0	11	7.6	1.1	-	8.0	56.0		7.5	1.0	-
26	8.0	71.7	46	7.5	1.1	-	8.1	48.3	46	7.6	1.0	-	8.0	57.5		7.5	1.1	-
27	8.1	71.5	11	7.5	1.1	-	8.1	47.7	11	7.6	1.1	-	8.1	59.6		7.5	1.0	-
28	8.1	71.7	24	7.5	1.1	-	8.1	45.8	11	7.5	1.1	-	8.1	57.5		7.5	1.0	-
29	8.1	67.7	11	7.5	1.1	-	8.1	44.0	46	7.5	1.1	-	8.1	60.2		7.5	1.0	-
30	8.0	66.0	110	7.5	1.1	-						-	8.0	57.9		7.5	1.0	-
31	8.1	66.3	11	7.5	1.1	-						-	8.0	58.1		7.5	1.0	-

- No Count

Table 3.16 (Contd..) : Analytical Results of pH, Turbidity and Bacteriology for Raw and Treated Water

Date	April 2008						May 2008						June 2008					
	Raw Water			Treated Water			Raw Water			Treated Water			Raw Water			Treated Water		
	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC	‘pH	Tur*	TC
1	8.0	57.9	46	7.5	1.1	-	8.0	111.0	110	7.5	1.1	-	8.0	257.9	110	7.5	1.1	-
2	8.0	57.2	110	7.5	1.1	-	7.9	112.3	110	7.5	1.1	-	8.0	218.1	240	7.5	1.1	-
3	8.0	56.5	110	7.5	1.1	-	8.0	111.5	11	7.5	1.0	-	8.0	185.0	110	7.5	1.1	-
4	8.0	61.5	110	7.5	1.0	-	7.9	112.3	11	7.5	1.1	-	8.0	179.6	110	7.5	1.1	-
5	8.0	69.0	46	7.5	1.0	-	7.9	112.5	11	7.5	1.1	-	8.0	175.0	240	7.5	1.1	-
6	8.0	69.8	46	7.5	1.1	-	7.9	114.6	110	7.5	1.0	-	8.0	173.8	110	7.5	1.1	-
7	8.0	76.3	46	7.5	1.0	-	7.9	108.1	1100	7.5	1.1	-	8.0	166.7	240	7.5	1.1	-
8	8.0	61.9	46	7.5	1.0	-	7.9	105.8	11	7.5	1.5	-	8.0	161.9	2400	7.5	1.1	-
9	8.0	60.8	110	7.5	1.1	-	8.0	106.7	46	7.5	1.0	-	8.0	159.8	110	7.5	1.1	-
10	8.0	61.0	110	7.5	1.0	-	8.0	109.2	110	7.5	1.1	-	8.0	150.6	110	7.5	1.1	-
11	8.0	60.8	110	7.5	1.0	-	7.9	132.1	110	7.5	1.1	-	8.0	151.3	110	7.5	1.1	-
12	8.0	61.7	110	7.5	1.1	-	7.9	163.3	11	7.5	1.1	-	7.9	187.9	240	7.5	1.1	-
13	8.0	61.9	46	7.5	1.0	-	7.9	133.5	110	7.5	1.0	-	7.8	792.5	110	7.5	1.1	-
14	8.0	65.6	46	7.5	1.0	-	7.9	115.2	110	7.5	1.0	-	7.9	729.6	240	7.4	1.1	-
15	8.0	95.6	46	7.5	1.0	-	7.9	115.1	110	7.5	1.0	-	7.9	772.1	240	7.4	1.0	-
16	8.0	129.0	240	7.5	1.1	-	7.9	112.6	110	7.5	1.0	-	7.9	1310.4	240	7.4	1.1	-
17	8.0	117.7	11	7.5	1.0	-	7.9	110.0	110	7.5	1.0	-	7.9	957.5	240	7.4	1.0	-
18	8.0	112.3	110	7.5	1.0	-	8.0	109.4	110	7.4	1.1	-	7.9	779.2	240	7.4	1.1	-
19	8.0	120.2	46	7.5	1.0	-	8.0	119.6	240	7.5	1.1	-	7.9	1015.4	240	7.4	1.1	-
20	8.0	122.5	240	7.5	1.1	-	8.0	118.8	110	7.5	1.0	-	7.9	889.6	240	7.4	1.1	-
21	8.0	122.3	110	7.5	1.1	-	8.0	193.1	240	7.4	1.0	-	7.9	717.1	240	7.4	1.1	-
22	8.0	113.3	110	7.5	1.1	-	7.9	357.9	46	7.5	1.0	-	7.9	571.7	240	7.4	1.1	-
23	8.0	113.5	460	7.5	1.0	-	8.0	265.2	110	7.4	1.0	-	8.0	1033.3	240	7.4	1.1	-
24	8.0	113.1	110	7.5	1.0	-	7.9	229.2	240	7.5	1.5	-	8.0	767.1	240	7.4	1.1	-
25	8.0	114.8	110	7.5	1.1	-	7.9	193.3	240	7.5	1.0	-	8.0	463.3	240	7.4	1.1	-
26	7.9	114.0	110	7.5	1.1	-	7.9	195.4	110	7.5	1.1	-	7.9	385.6	240	7.4	1.1	-
27	7.8	156.4	110	7.5	1.1	-	7.9	197.9	240	7.5	1.1	-	7.9	320.8	240	7.4	1.1	-
28	8.0	128.5	110	7.5	1.1	-	7.9	331.0	240	7.5	1.1	-	7.9	306.3	240	7.4	1.1	-
29	8.0	111.5	110	7.5	1.0	-	7.9	351.7	110	7.4	1.1	-	7.9	275.0	240	7.4	1.0	-
30	8.0	113.5	110	7.5	1.0	-	7.9	350.1	240	7.5	1.1	-	7.8	2101.0	240	1.3	1.1	-
31							8.0	272.1	240	7.5	1.0	-						

- No Count

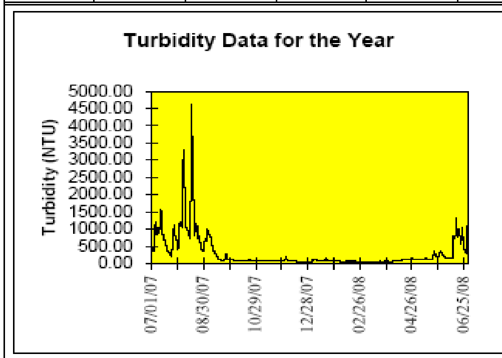
Observations

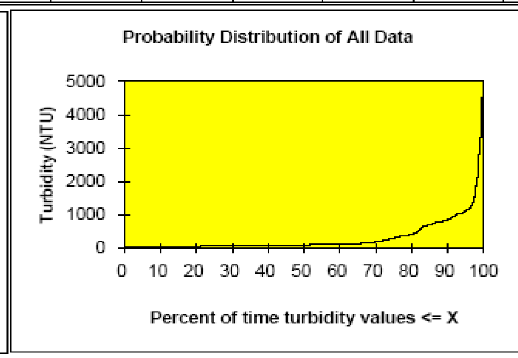
From the data it is observed that raw water is characterized by slightly alkaline pH, low turbidity and microbial count in the range of 80 to 1800+. Maximum turbidity of 100 NTU was recorded in July. Filtered water turbidity was in the range of 0.3-2.0 NTU in fare season. During monsoon the filtered water quality was poor with turbidity ranging from 1 to 25 NTU and Total Coliform count from 10 to 1000 MPN/100ml.Occasionally high TC values were also recorded indicating inadequate post chlorination.

3.3.4 Evaluation Based on PSW

The software was used to carry out performance evaluation of Haiderpur water treatment plant based on one-year raw water turbidity data. It is observed that 80% of the times turbidity was below 10 NTU. Comparison of raw and treated water turbidity is depicted in **Figure 3.22** respectively.

Percentile	Yearly	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
50	95.73	670.42	1037.50	215.94	83.96	74.48	58.54	78.13	56.67	55.21	103.54	118.75	344.02
75	303.59	932.60	1311.46	604.58	96.67	80.63	71.04	92.92	59.38	57.50	114.58	196.67	777.40
90	837.29	1109.17	3062.50	798.50	102.83	81.90	81.25	124.58	62.00	58.54	123.10	331.04	1017.21
95	1101.77	1259.39	3327.08	891.93	103.96	82.08	104.48	129.79	63.25	59.17	128.77	350.88	1185.73
96	1153.75	1295.49	3354.58	898.88	104.08	82.08	116.92	132.42	63.60	59.42	128.89	351.35	1266.08
97	1310.87	1342.94	3496.71	918.04	106.92	82.16	131.04	135.38	63.80	59.65	132.52	352.29	1413.20
98	1782.44	1413.07	3868.08	952.23	115.17	82.35	148.54	139.00	63.88	59.83	140.47	354.17	1642.48
99	2615.63	1483.20	4239.46	986.43	123.42	82.53	166.04	142.63	63.96	60.02	148.42	356.04	1871.76
Avg	300.31	699.27	1304.21	354.80	84.53	72.78	64.49	86.14	55.62	53.81	92.67	170.02	545.17
Min	41.67	199.17	355.83	85.17	66.88	58.75	41.67	46.52	41.71	45.42	56.50	105.83	150.63
Max	4610.83	1553.33	4610.83	1020.63	131.67	82.71	183.54	146.25	64.05	60.21	156.38	357.92	2101.04
RSD	168.3%	48.6%	77.3%	82.6%	18.5%	11.7%	43.0%	25.7%	10.4%	8.5%	31.7%	48.7%	81.0%



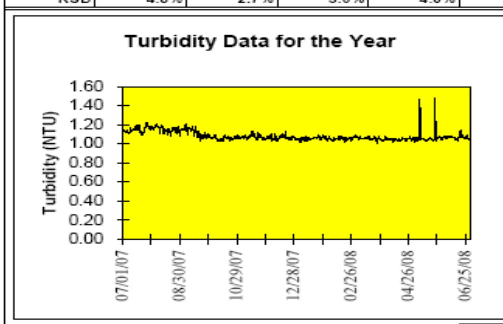


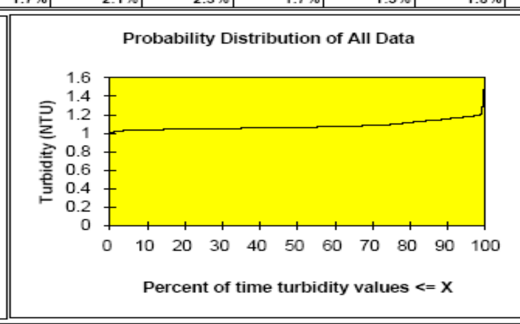
Haiderpur Water Works (Raw Water)

Start Year 2007 | 366 = Total Days
Month 7 | 12.00 = Total Months
Day 1

Utility Name	WTP
Plant Name	Haiderpur
Plant Street Address	Haiderpur
Plant City, State, Zip	Delhi
Plant Contact Name	GP Mittal
Plant Phone	011-
Plant E-mail Address	-

Percentile	Yearly	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08
50	1.07	1.14	1.16	1.13	1.06	1.07	1.06	1.06	1.05	1.06	1.05	1.05	1.07
75	1.09	1.17	1.17	1.15	1.07	1.09	1.08	1.07	1.06	1.07	1.05	1.06	1.08
90	1.15	1.19	1.18	1.18	1.09	1.10	1.10	1.08	1.07	1.08	1.06	1.07	1.09
95	1.18	1.20	1.20	1.18	1.09	1.11	1.11	1.08	1.08	1.08	1.07	1.27	1.09
96	1.18	1.20	1.20	1.18	1.09	1.12	1.11	1.09	1.08	1.08	1.07	1.38	1.09
97	1.18	1.20	1.20	1.18	1.09	1.12	1.11	1.09	1.08	1.08	1.08	1.46	1.10
98	1.20	1.21	1.20	1.19	1.09	1.12	1.12	1.09	1.08	1.09	1.08	1.47	1.12
99	1.21	1.21	1.20	1.20	1.09	1.12	1.12	1.09	1.08	1.09	1.08	1.47	1.13
Avg	1.08	1.15	1.15	1.12	1.06	1.07	1.07	1.06	1.05	1.06	1.05	1.08	1.07
Min	1.00	1.10	1.08	1.03	1.03	1.04	1.03	1.01	1.02	1.00	1.01	1.02	1.03
Max	1.48	1.22	1.20	1.21	1.09	1.13	1.13	1.10	1.09	1.09	1.08	1.48	1.15
RSD	4.8%	2.7%	3.0%	4.0%	1.7%	2.1%	2.3%	1.7%	1.5%	1.8%	1.3%	9.7%	1.9%





Haiderpur Water Works – (Treated Water)

Start Year 2007 | 366 = Total Days
Month 7 | 12.00 = Total Months
Day 1

Utility Name	WTP
Plant Name	Haiderpur
Plant Street Address	Haiderpur
Plant City, State, Zip	Delhi
Plant Contact Name	GP Mittal
Plant Phone	011-
Plant E-mail Address	-

Figure 3.22 : Turbidity data for treated water along with probability distribution for Haiderpur Water Works

3.3.5 Water treatment Plant Analytical Data

Continuous Monitoring – Turbidity of Filtered Water

In order to obtain a continuous profile of turbidity of filtered water, an automatic online turbidimeter was installed by M/s Hach, Delhi as a demonstration for two days. Due to logistic difficulties in installation and shifting problems associated with the online monitor, it was decided to monitor the output of final treated water from the filter house common outlet. The turbidity profile generated using the online Hatch turbidity monitor during September 21-22, 2008 is given in **Table 3.17** and presented graphically in **Figure 3.23**.

Table 3.17: Turbidity Profile of filtered water on 21-22.09.2008

Date	Time, Hr	Minutes					
		Hr+0	Hr+10	Hr+20	Hr+30	Hr+40	Hr+50
21/9/2008	1:PM	0.226	0.234	0.242	0.248	0.246	0.248
21/9/2008	2:PM	0.249	0.25	0.24	0.248	0.248	0.25
21/9/2008	3:PM	0.212	0.21	0.184	0.206	0.19	0.196
21/9/2008	4:PM	0.21	0.208	0.182	0.196	0.185	0.146
21/9/2008	5:PM	0.194	0.206	0.192	0.194	0.18	0.186
21/9/2008	6:PM	0.192	0.164	0.19	0.196	0.17	0.175
21/9/2008	7:PM	0.265	0.26	0.268	0.267	0.273	0.276
21/9/2008	8:PM	0.283	0.281	0.279	0.285	0.275	0.279
21/9/2008	9:PM	0.2	0.201	0.21	0.215	0.196	0.194
21/9/2008	10:PM	0.27	0.272	0.275	0.279	0.275	0.28
21/9/2008	11:PM	0.26	0.261	0.265	0.27	0.275	0.278
21/9/2008	12:PM	0.39	0.395	0.3	0.496	0.494	0.498
22/9/2008	1:AM	0.68	0.682	0.684	0.686	0.69	0.692
22/9/2008	2:AM	0.779	0.777	0.775	0.778	0.758	0.766
22/9/2008	3:AM	0.16	0.165	0.169	0.16	0.171	0.18
22/9/2008	4:AM	0.14	0.13	0.145	0.15	0.16	0.176
22/9/2008	5:AM	0.206	0.209	0.211	0.214	0.217	0.219
22/9/2008	6:AM	0.23	0.228	0.229	0.24	0.242	0.249
22/9/2008	7:AM	0.224	0.222	0.228	0.22	0.219	0.229
22/9/2008	8:AM	0.28	0.299	0.524	0.83	0.94	0.95
22/9/2008	9"AM	0.69	0.575	0.468	0.645	0.745	0.765
22/9/2008	10:AM	0.662	0.61	0.632	0.83	0.81	0.63
22/9/2008	11:AM	0.568	0.56	0.55	0.48	0.492	0.519
22/9/2008	12:AM	0.549	0.551	0.559			

Observations

It was observed that generally the turbidity remained around 0.3 NTU except during short time period between 1:00AM to 3:00AM and 8:30AM to 11:00AM when the filtered water turbidity increased to about 1 NTU. This could be attributed to some local disturbances and/or backwash operation, etc.

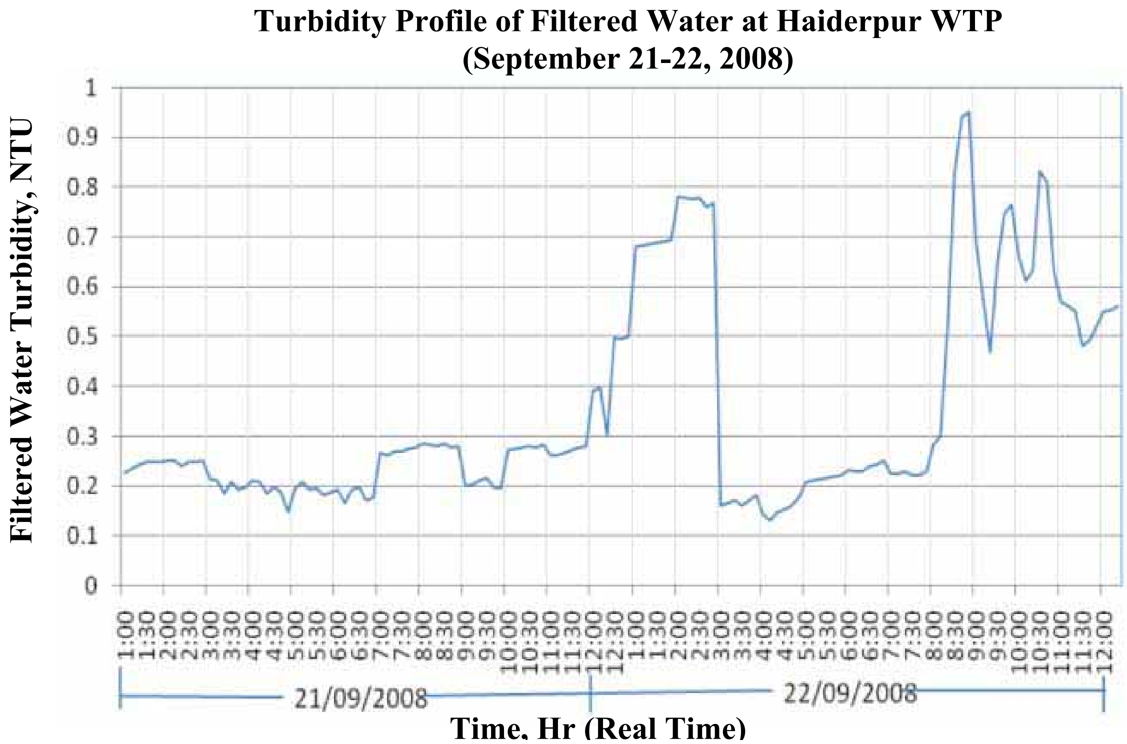


Figure 3.23 : Turbidity profile of Filtered water

During the visit to the plant the team of auditors decided to analyse the filtered water samples taken from the outlet of various filter houses on September 23, 2008. The results of analysis of these samples are given in the table below.

S. No.	Sampling Location	pH	Conductivity mS/cm	Turbidity NTU
1	Haiderpur I Filter House (South)	7.9	238	0.81
2	Haiderpur I Filter House (North)	7.8	251	0.98
3	Haiderpur II Filter House (South)	7.9	247	0.312
4	Haiderpur II Filter House (North)	7.8	232	0.83

It can be observed that the performance of both the plants is satisfactory as evidence from the turbidity of <1 NTU which is the desired level, although Haiderpur II was performing little better than the Haiderpur I plant.

The laboratory turbidity record also shows that turbidity is not usually reported below 1 NTU. However, for the purpose of optimization of the operation better measuring instruments and continuous online monitors are required to be installed at a No. of locations in the WTP.

3.3.6 Comprehensive Performance Evaluation (CPE) from Auditors :

The summary of auditors comments on comprehensive performance evaluation limiting factors and its rating is presented in **Table 3.18 and 3.19** respectively. The detailed perform in **Annexure 3.1(C)**.

Auditors Special Comments

1. **Er. N. Ramesh, Asif Nagar Water Treatment Plant, Hyderabad**
   - No routine calibration of raw water inflow and clear water outflow.
   - No process control testing conducted for calrifer.
   - Provide additional plant coverage and support minor plant equipment needs.
   - The promotion to be given on cadre to next higher cadar with in a span of 12 to 14 years to avoid unhappiness of staff.
2. **Er. C.Raja, Asif Nagar Water Treatment Plant, Hyderabad**
   - There appears to be stagnation of promotion of working staff in filtration. Person's work is same category for more than 10 to 15 years without any promotion. Promotion to be given for motivation of staff.
3. **Er. Sunil Kumar, Asif Nagar Water Treatment Plant, Hyderabad**
   - The monitoring staff is observed to be less and still there is a proper norm of sample collection is maintained.
   - Proper audit of the water is being maintained by the WTP.
   - The process control measurement has to be improved.
   - The administration of the WTP is well maintained by the chemists.
4. **Mrs. S.S.Dhage, NEERI, Mumbai**
   - Conduct Water and Energy Audit.
5. **Er. J.K.Bassin, NEERI, Delhi**
   - Promotional avenues need to be established to remove discontentment in junior staff and lack of interest
   - Transmission main and sub mains are used for even direct supply ion addition to supply to booster station.
6. **Mr. S.P.Andey, NEERI, Nagpur**
   - Dimensions of water treatments units not available, which may create difficulty in assessing the performance of different treatment unit in case of deterioration of treated water quality.
   - Improve floc formation during low turbidity of raw water
   - Staff is working on same post/ grade for more than 15-20 years.
   - Formulate suitable promotion policy for the staff working efficiently for longer duration.
   - Implement some award/ reward scheme for the staff who improve their qualification and who do some additional things, which will have positive impacts on plant performance in
   - addition to their routine jobs.
7. **Mr. R.K.Gupta, NEERI, Delhi**
   - Design data & dimensions of different treatments units are not available. Hence performance of different units cannot be matched or compared based on actual design criteria.
   - Operators and technicians are not provided adequate chances for promotions / up gradations.
   - They should be motivated based on some suitable promotion policies
   - Laboratory personnel should also be promoted after a suitable period of service
   - It is observed that staff are working in the same post for 20 years without any promotions
8. **Mr. R.D.Sharma, Delhi Jal Board**
   - Record maintained of very major and minor work
   - Separate maintenance teams are at the plant
   - Jar test used in every shift
   - All the pollution indicating test conduct in every shift regularly.
   - Supervisors are very effective
   - Quality controllers are in every shifts
   - Co-ordinations are very good with the administration and staff.

Table 3.18 : Comprehensive Performance Evaluation – Performance limiting factors

Issue	P.S. Nirbhavne	S.P. Bhange	V.S. Rokade	N. Ramesh	C. Raja	Sunil Kumar
A) Source protection and conveyance to plant	-	-	-	• Being open channel there is every possible pollution to avoid these, coverage with wall and roof protection to be done.	• Raw water canal is open and is not protected. • Contamination of raw water is possible as there is no monitoring facility available along the raw water canal.	• Raw water is drawn through open channel & prone to contamination • Periodical checking of COD, BOD, toxic metals, and trace elements is required to know the pollutants in the raw water.
B) Raw water quality	• Raw water turbidity was very high	• Automatic Screens should be installed for removing the floating material coming through canal.	• Floating material coming along the canal at intake gate should be removed by installing automatic screen.	-	• People are found to be bathing and washing in the raw water canal. • Plenty of water hyacinth is found to be coming in raw water. • Proper barricading should be provided for the protection all along the side of the canal. • Proper raw water quality monitoring is to be done to check the presence of toxic metals. • No. of samples drawn should be increased.	-
C) Measurement of raw and treated water flow	-	-	-	• Flow meters are essential to measure quantities and also percentage of the wastage.	• No device to measure the inflow of raw water. • Quantity received is noted as per the issue of the irrigation department, which some times lead to overloading of clarifloculator. • Digital flow measuring devices are functioning on the pumping outlets of the clear water.	• Proper measurement of the inflow and outflow are being recorded.

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	P.S. Nirbhavne	S.P. Bhange	V.S. Rokade	N. Ramesh	C. Raja	Sunil Kumar
D) Chemical storage for alum, chlorine and PAC	-	-	-	• Chlorine cylinders found to be stacked properly. • The empty cylinders are kept open to sunlight. • Measures to be taken for keeping them in shade.	• Chlorine cylinders are found to be stacked in proper order. • Empty cylinders are kept open to sunlight. • Measures to be taken for keeping them in shade.	• Chlorine cylinders are exposed to the open air in certain areas.
E) Consumption of chemicals eg. Alum, chlorine and PAC	-	-	-	• Alum and chlorine dosage are given in appropriate quantity.	• Alum and Chlorine dosage appears to be adequate.	• Proper dosage of Alum/PAC and chlorine is maintained.
F) Flocculation, coagulation and sedimentation	• Floating material should be removed • Speed of flocculator is more • Steel V-notch should be replaced	• Primary conditions is not good, floating material should be removed. • Speed of the flocculator is more. • "V" notch should be replaced.	• Floating material needs removal. • Steel V-Notch is rusted due to pre-chlorination and hence should be replaced by fiber material 'V' notch.	• 'V' notches to be changed from M.S.T plastic to avoid rust.	• Flocculator rotation appears faster than what is required, which results in breaking of flocs.	• There is no overloading of the clarifier and the clarified water quality is good.
G) Filter O & M and Back washing	• Cleaning of filter bed is required. • Atomization should work properly • Back wash should be more effective	• Cleaning of filter bed should be done. Floating material is more on filter bed. • Atomization should be in running condition. Backwash system should do one side at time.	• Cleaning of filter beds should be done periodically. • Back wash at a time one side only.	-	-	• Lot of algae and vegetation is observed on the filter beds.

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	P.S. Nirbhavne	S.P. Bhange	V.S. Rokade	N. Ramesh	C. Raja	Sunil Kumar
H) Disinfection	• Satisfactorily	• Satisfactorily	• Standby chlorinators is essential	• Satisfactorily	• Disinfections of clear water are done as desired. • The clear water contains 1.5ppm of residual chlorine • Samples should also be checked from tail end of the supply point to ensure adequate presence of chlorine as the transmission lines travel more than 25 km from the filtration point.	• Proper disinfection of the clear water is maintained by keeping 1.5 ppm of residual chlorine.
I) Balancing reservoir	-	-	-	• Accumulated sludge to be removed periodically and rooftops of reservoirs should be maintained very neatly.	• The clear water reservoir roof is covered with thick tiger grass and small trees. It may become breeding place for reptiles.	• Clear water reservoir is observed to be in a bad condition. Lot of grass is grown on the reservoirs.
J) Safety devices or measures	-	-	-	-	• Safety equipments should be kept near to the plant and caution boards to be kept near the chlorine plants.	-
k) Training Programme	-	-	-	• Training must be given to all staff periodically to the lower, middle staff, which results more efficiency and quality in the work.	• The water quality staff requires additional training in collection and checking of quality. • Advance training also should be given.	

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	P.S. Nirbhavne	S.P. Bhange	V.S. Rokade	N. Ramesh	C. Raja	Sunil Kumar
L) Laboratory	-	-	-	-	-	• The laboratory is well maintained with all the testing equipments and necessary tests are being conducted.
M) Pumping	• Power factor maintained unity. • Scada & Wireless communication should be installed. • Rising main & header connection should be proper	• Power factor should be maintained unity. • Cascade system for pump wireless communication should be installed. • Pump Maintenance should be done by authorized people only. • The smooth carved connection should be provided for rising main to header.	• Installation of Scada and wireless communication systems is essential for pump sets. • Unity power factor should be maintained	-	-	-
N) Housekeeping	• House keeping should be improved.	• House keeping should be improved.	• House keeping should be improved.	• House keeping should be improved for neatness.	• In general plant area and filtration is clean. • The filtration campus has scrub jungle all around and can be breeding place for reptiles. Hence may be kept clear.	• House keeping has to be improved as certain electrical parts are not properly covered with boxes in post chlorination room of filter plant I.

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	Ms. S.S. Dahge	J.K. Bassin	S.P. Andey	R.D. Sharma	R.K. Gupta	Ms. S.S. Dahge
A) Source protection and conveyance to plant	• Inadequate. • Open canal susceptible to Human Pollution. • Close conduct is under construction. • Floating matter removed manually.	• Bacterial contamination is unchecked by an open channel and accessible to people and cattle. • New covered channel is being provided.	• Unlined canal and human activities in the canal. • New canal under construction will reduce turbidity fluctuation and thereby reduction in expenditure on chemicals. • Human activities near source may increase pollution load (Chemical and bacteriological) in water thereby increase in chlorine dose and alum consumption.	• Maintained the Raw water from floating material and maintained the security point of view.	• Raw water feeding canal is open and hence affected by human activities. • Causes turbidity variation • This will lead to an increase in chemicals requirements to treat the water adequately • Closed channel is being provided to carry water	
B) Raw water quality	• Fluctuating Turbidity. • Possibility of contamination due to distillery, leather & tannery industries.	-	-	-	• Floating material observed on the surface of raw water which may cause foul smell to the treated water	
C) Measurement of raw and treated water flow	• No flow meter for raw water. • Flow calculated from the weir reading & charts.	• Flow measuring needs to be improved.	• Raw water flow is estimated from inlet door opening and depth of water in the inlet channel. • Suitable automatic flow measuring device should install for accurate flow measurement of alum and chlorine, extent of overloading and under-loading of plant and total plant output.	-	• Raw water flow estimated from depth of water and dimensions of inlet channel. • F Flow measuring system is essential to control proper chemical dosing.	

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	Ms. S.S. Dahge	J.K. Bassin	S.P. Andey	R.D. Sharma	R.K. Gupta	Ms. S.S. Dahge
D) Chemical storage for alum, chlorine and PAC	• 10 tanks for PAC • Solid alum is used & stored. • A stock for about three months is available. • Non-availability of chemicals decides the type of coagulant.	• Storage tanks are in good condition. • Six alum and PAC preparation tank for each plant, Overall arrangement is acceptable.	• Ice formation on chlorine cylinder may decrease the flow rate due to cooling effect.	• Maintained Alum and PAC stock.	-	
E) Consumption of chemicals eg. Alum, chlorine and PAC	• Varies as per turbidity Monthly Av. dose data for year 2003-2008 available.	• PAC and Alum are used conjunctively. Cost of PAC is less than alum and better level. • Control is possible with PAC being in liquid state. • Better particle removal is possible with PAC.	-	-	-	
F) Flocculation, coagulation and sedimentation	• Good performance. • One of the bridges moving at faster rate. • No overloading of clarifier significantly.	-	• Provide fine screens in channel to clariflocculators. • Clarifier outlet weir was submerged in the water which may decrease the filter runs due to carry over of flocs in the filter.	• Sedimentation doing very well, reduce turbidity from 4000 to 0.6 NTU.	• Outer weir of clarifloculator was submerged in the water, which will affect the filter run period	

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	Ms. S.S. Dahge	J.K. Bassin	S.P. Andey	R.D. Sharma	R.K. Gupta	Ms. S.S. Dahge
G) Filter O & M and Back washing	• Automated process. • No Head loss gauges. • Back wash after 48 hours or input is reduced. • Filter water recycle plant is under construction.	• <2% water used. • Overall operation is acceptable. • Backwashing twice between two cycles is 48 hrs.	• No head loss indicator and rate setter. • Filters are backwashed once in 48 hours on routine basis. • Can save water if backwashed based on head loss development. • Floating matter observed on filter, which may impart fouling smell to filtered water. • No arrangement for recycling of filter backwash.	-	• There is no provision for recycling of filter backwash water. Recycling will reduce water requirement as well as improve floc formation during low turbidity water. • **Head loss indicators & rate settlers are non-functional. Hence back wash period cannot be decided as per requirement.**	
H) Disinfection	• On line chlorination in filtered water channel. • Ice formation observed at cylinder bottom indicating excess withdrawal of chlorine gas may lead to inadequate residual chlorine at furthest end. • Safety for leakage of chlorine gas available. No booster chlorination.	• Chlorine gas is used. Chlorinators are in good condition.	-	• Chlorination plants are well maintained and running properly.	-	

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	Ms. S.S. Dahge	J.K. Bassin	S.P. Andey	R.D. Sharma	R.K. Gupta	Ms. S.S. Dahge
I) Balancing reservoir	• On CWR, a soil topping provided to grow lawn. • But wild grass grown which may contaminate the treated water due to development of cracks and seepage • Needs immediate attention.	-	-	-	-	
J) Safety devices or measures	• Available for chlorine gas. • The necessary precautionary & safety measures are displayed for all unit processes.	• Mock drills are organized. • Protective gear available but not in routine use.	-	• Loading and unloading shift is very good. • Absorption system is running very well. • Alarming system is running very well. • Mock drill conducted in every year with safety officers and other departments such as fire, police etc.	-	

Table 3.18 (Contd..) : Comprehensive Performance Evaluation – Performance limiting factors

Issue	Ms. S.S. Dahge	J.K. Bassin	S.P. Andey	R.D. Sharma	R.K. Gupta	Ms. S.S. Dahge
k) Training Programme	• Essential particularly to upgrade the lab practices. • Quality control & assessment of recorded data is essential.	• Operator training is desirable. • Training and upgradation of Manpower is essential.	-	-	• Plant operating and laboratory staff should be given training to improve their knowledge and performance efficiencies. • They should be given wide exposure and visits to other good laboratories / plants to enhance their capabilities.	
L) Laboratory	• Out of 5 mains three are provided with flow meters form Siemens, which are the replacement of original ones. • Two flow meters are under process.	-	-	-	-	
M) Pumping	• Except CWR good house keeping.	-	-	• Maintained greenness of the plant with lot of plants and flowers. • Excellent, neat and clean environment. • No air pollution.		
N) Housekeeping	-	-	-	-	-	

Table 3.19 : Comprehensive Performance Evaluation – Performance limiting factors – Rating

Issues	Auditor Name and Assigned Rating											
	PSN	SPB	VSR	KSN	NR	CR	SK	SSD	JKB	SPA	RDS	RKG
A) Source protection & conveyance to plant	-	-	-	A	-	A	A	-	-	A	-	B
B) Raw water quality	-	A	A	C	A	A	C	A	B	B	-	B
C) Measurement of raw & treated water flow	A	-	-	-	A	A	B	A	-	C	-	C
D) Chemical storage: alum/chlorine/PAC	-	-	-	B	B	C	B	-	C	-	A	-
E) Consumption of chemicals: Alum/chlorine/PAC	-	-	-	-	B	B	C	A	B	C	A	-
F) Flocculation, coagulation & sedimentation	A	-	-	-	B	A	C	C	-	B	A	B
G) Filter O&M & Back washing	A	A	B	B	-	-	-	-	C	A/C	-	A/C
H) Disinfection	C	-	-	C	C	B	C	-	-	-	-	-
I) Balancing reservoir	-	-	-	-	A	-	A	-	-	-	-	-
J) Safety devices or measures	-	-	-	B	-	-	-	-	C	-	-	-
K) Training Programme	-	-	-	-	-	-	-	-	B	-	-	-
L) Laboratory Staff adequacy /Equipment/ SOP/Testing & calibration	-	-	-	C	-	-	C	-	-	-	A	-
M) Pumping		A	A	-	-	-	-	-	-	-	-	-
N) Housekeeping	B			A	A	C	B	B			A	
O) Policies and Planning	-	-	-	-	-	-	-	-	-	-	A	
P) Validation of water quality	-	-	-	-	-	-	-	C	-	-	-	-
Q) Operation and Maintenance	A	-	-	C	-	-	-	-	-	-	-	-
R) Process control	-	-	-	-	B	-	A	-	-	-	A	-
S) Administration	-	-	-	A	A	B	C	C		A	A	A
T) Plant coverage	-	B	-	-	A	-	-	-	-	B	-	-
U) Lack of formalized preventive maintenance programme	-	-	-	-	-	-	-	-	-	-	A	-
V) Connection from Rising Main	-	A	-	-	-	-	-	-	B	-	-	-

LEGEND: *(Abbreviations used for Name of Auditors)*

PSN → P.S. Nirbhavane; SPB → S.P. Bhanage; VSR → V.S. Rokade
KSN → K.S. Narsappa; NR → N. Ramesh; CR → C. Raja
SK → Sunil Kumar; SSD → Shivani Dhage; JKB → J.K.Bassin
SPA → S.P. Andey; RDS → R.D.Sharma; RKG – R.K.Gupta

A- Major effect on long-term repetitive basis, B-Moderate effect on a routine basis or major effect on periodic basis, C-Minor effect

3.3.7 Interviews with the Plant personnel

The staff of various levels was interviews to know their opinion and understanding about the plant performance, their contribution to run the plant effectively. The staff interviewed includes the Plant Incharge (SE), Ex.En., AEN, Plant Supervisors, Plant operators (pump operator, chlorine operators & filter operators), the laboratory personnel like CWA, Chemist, Asstt. Chemist. The following points emerged out of the discussions during the interviews.

- The Plant Incharge is well qualified and experienced to handle the day to day operations. He is also entrusted with the electrical and construction work for other plants also.
- The staffs deputed at the Haiderpur Treatment Plant know their duties well and are responsibly discharging their duties. There has not been any major break-down / accidents are owing to experienced staff, a regular preventive maintenance etc.
- Automatic chlorinators have been installed and automatic sensors are present for detection of gas leakages. Gas masks are also available but are not routinely used. The chlorine operators have faced some problem with the changing of chlorine cylinders which is attributed by them to manufacturing defects. Mock drills for handling the emergency conditions are also organized from time to time.
- The manpower deployed at the treatment plant is adequate, however it was felt that regular training is lacking in general.
- There is a general discontentment amongst the staff regarding promotional avenues and opportunities for growth, particularly so at the junior / middle level.
- The analytical facilities available at the plant are adequate and a well-equipped laboratory is working round the clock. The chemical (Alum & PAC) doses are decided based on the tests conducted in each shift and the operators are accordingly guided.
- Chlorine dose is informed to chlorine operator based on hourly testing at CWR.

3.3.8 Conclusion and Recommendations

After the visit to Sonia Vihar WTP, the team of auditors and officials of DJB re-assembled at the Haiderpur water treatment plant for the concluding session. The session was chaired by Mr. K.S. Narsappa and other members included Ms. Adrian Stephnie, P.S. Nirbhavne and Ms. Shivani Dhage. The Group representatives of the three groups, viz. Mr. S.P. Bhanage – Group I, Mr. C. Raja – Group II and Mr. N. Ramesh – Group III presented the summary of interviews of the plant personnel. Gist of discussions is given below :-

- Overall the performance of the plant was adjudged as ‘Good’. However, it was observed that there is large variation in the turbidity in raw water and is also very high. In addition, Ammonia is also equally important in the raw water.

- Raw water source and flow measurement: There is inadequate source protection and the 103 km long open canal is susceptible to environment pollution. The records indicate high bacterial contamination in the raw water. A new closed conduit is under construction which is expected to remove these problems.
- The raw water turbidity is also very high and it fluctuates, the raw water turbidity measured on 23/09/2008 was 3000 NTU.
- Raw water flow measuring devices should be installed.
- Conjunctive use of alum and PAC effectively reduces the cost of chemicals, better level control is possible with PAC as also better particle removal. A stock of about three months is available.
- Coagulation and Flocculation are observed to be good. However, one of the bridges is moving at a faster rate, which might be breaking the flocs thereby affecting the removal efficiency.
- There is floating matter in the clarifier section. The steel V-notches were found to be rusted due to pre-chlorination suggesting that it may be replaced with fiber.
- Filter House: Filter house was observed to be well kept. However, the filter appurtenances such as head loss meter, rate setter, etc. were not functioning and the backwash of filters is taken up on the basis of service time. Each filter bed is backwashed in 48 hrs. and total water used for backwashing is about 2% of water production. The backwash water is to be recycled.
- The clear water reservoirs are underground and soil topping is provided to grow lawns. But the wild grass growing there may contaminate the treated water due to development of cracks and seepage.
- Adequate level of chlorination was found at the storage reservoirs Empty chlorine tonners (cylinders) are to be kept in shade.
- The general housekeeping was found to be satisfactory.
- An energy audit had been conducted by TERI, which should be made a regular practice.
- The power factor needs to be improved and brought to near 1.0.
- Since the employees feel that there are less promotional avenues, there is a general dissatisfaction among them, which affects the efficiency. An Award / Reward scheme is recommended.
- The auditors also felt that water audit of the plant should also be undertaken.
- The activity related to Comprehensive Technical Assistance (CTA) should be there so that CPE will be fruitful.

Chapter 4

Final Workshop to disseminate the findings of CCP activities

4.1 Relevance of CCP- WSP Approach for Management of Safe Water Supply

Access to safe drinking water is a basic human right. To protect the human health community water supply must be reliable, sufficient in quantity, of assured quality and readily accessible to all segments of the consumers. We have not achieved the expected level of progress in providing one of the most basic services to the people: safe and affordable drinking water and of course sanitation. The current practices of water purification are seldom adequate to produce secured water supply in rural and urban areas. It is essential to develop various tools to improve water purification and distribution system to provide safe drinking water.

CCP is a water treatment-optimization program that improves water treatment operation with limited capital investment by optimizing particle removal from water treatment plants. It has been reported that many microbial pathogens are recalcitrant to disinfection due to, their resistance to chlorine or their small size. With the application of achieving proper particle removal by improving water treatment processes, these pathogens can be removed to ensure safe drinking water for citizens.

The activity on CCP was initiated in April 2007 with the financial support from USEPA. This activity was implemented at three cities viz. Hyderabad, Pune and Delhi and post project workshops were successfully completed.

Another activity on WSP was also taken up in Hyderabad city. Conceptually, WSP emphasizes risk assessment and management of a water supply from catchments to consumer. WSPs are based upon preventive risk management as applied through “Hazard Analysis and Critical Control Points (HACCP) technique” utilized by the food manufacturing industry to effectively monitor and manage potential contamination of water and prevent public health burdens before they occur.

The main objective of this project is preparation of Water Safety Plan for Water Distribution System using Integrated Risk Assessment – Water Distribution System (IRA-WDS) software to predict the leakages in the under ground distribution system. Appropriate remedial measures can be undertaken with minimum efforts through WSP. The study covers identification of safety measures to protect the health of the user community. A complicated modeling and risk assessment is carried out.

During the workshops conducted at Hyderabad, Pune and Delhi valuable inputs were provided by respective Water Works authorities. External third party audit conducted by the engineers and other participants have resulted in fruitful suggestions for improvement in the performance of water treatment facilities with slight alterations in the operational procedure.

To disseminate the outcome of CCP activities conducted at three cities and share the applicability of the CCP concept in other cities, , the final workshop was organized on 16th June 2009 at New Delhi with all stakeholders and decision making authorities concerned with water supply.

During workshop, key note address and invited lectures were delivers by eminent personalities like Dr. P.K. Seth CEO, Biotech Park, Lacknow, Dr. V.K. Chaurasia, Asst.Advisor, CPHEEO, New Delhi, Dr. Bipin Behari, Secretary Delhi Jal Board, New Delhi, Mr. A.K. Sengupta, National Professor Officer WHO Country Office, Dr. Paramsivam Director Grade Scientist, NEERI (Retd). The topics like "Hyderabad water supply - issues and way forward", Application of CCP for optimization of water treatment, Integrated Risk Assessment of Water Distribution System (IRA-WDS) and Chemical contamination with reference to fluoride, Arsenic and Water related disease burden were presented by eminent scientist and experts in the respective field.

The panel discussion was organized in session three to delineate the hot spots and prioritize specific treatment schemes to address the emerging contamination problems. The session was jointly chaired by Dr. Bipin Behari, Secretary Delhi Jal Board, Delhi, Er S.V. Dahasahastra, Member Secretary, MJP, Mumbai and Dr. Paramsivam Director Grade Scientist, NEERI (Retd).

Various issues regarding the availability of water resources and their optimal use**,** improvement in efficiency of water treatment processes, necessity of training and awareness programmes for the utility group financial constrains, need for proper sanitation to avoid contamination etc were highlighted. The following suggestions have been offered for implementation:

- Wide circulation of the observations of CCP study to large number of people for the application
- Organize training programme for engineers to get acquainted with the mode of operation of the said programme.
- Public awareness campaign should be organized to indicate the necessity for improvement.
- Cost –Benefit analysis of Intermittent and continuous water supply
- Sanitation should be improved to protect the water resources from contamination, which are depleting at a very fast rate.
- Display the detailed conclusions of CCP activity on official websites of WHO and NEERI.
- Alignments of distribution networks should be above the sewer lines to minimize contamination ingress.

The keynote address delivered by Dr. V.K. Chaurasia on behalf of Mr. Sankaranarayanan DA (PHE), CPHEEO, New Delhi and few relevant presentations are submitted below:

A) Key Note Address

Dr. V.K. Chaurasia on behalf of Mr. Sankaranarayanan DA (PHE), CPHEEO, New Delhi

Dear delegates,

I am glad to be with you in this important event and I am privileged to share a few thoughts on the importance of water supply & sanitation its bearing on the gamut of urban development. Originally, Mr. M. Sankarnarayan, D.A (PHE) was to deliver this inaugural speech, but because of his engagement with standing Parliamentary committee on UD, the responsibility has fallen on me.

As you all know, Water is a State subject in India and the responsibility for planning, designing, implementation, operation and maintenance of water supply systems lies with the concerned ULBs and State Governments. The Government of India, M/o Urban Development is the Nodal Ministry for urban water supply and sanitation sector and facilities in policy formulation, planning, strategies and arrangement of external funding for implementation of the projects wherever needed.

You are aware that rapid urbanization and industrialization in India has resulted in over-stressing of urban infrastructure services including drinking water supply and sanitation. In the context of the International Drinking Water Supply and Sanitation Decade Programme (IDWSSD), it was targeted to cover 100% of the urban population with safe and adequate drinking water supply by the end of the decade 1981-90. But due to various constraints, such as lack of financial resources, inadequate manpower and institutional capacity, the coverage achieved was about 80%. Since then nearly two decades have passed; but the coverage target of 100% still remains a distant dream.

The assessment made by CPHEEO based on the information received from the States/UTs reveals that accessibility of the urban population to drinking water supply at present is about 91%. But the coverage figure is no guide whether the quantity and quality of the water supply is upto the national norms or not.

India had an urban population of 286.12 million as per 2001 census living in 5161 towns and cities constituting about 27.82% of the total population. Based on the trend of urbanization it is expected that the urban population may be around 366 million by 2012 and 433 million (32%) by 2021. The pressure of urbanization is more in class-I cities. The 35 million plus cities and the balance 388 class-I cities with population from 0.10 to 1 million constituted 67% of the total urban population as per 2001 census. By 2012 the proportion of population in these cities will increase to more than 70%.

Due to rapid urbanization and industrialization the demand for safe drinking water is ever on the increase, whereas the available resources – fresh water is static and finance is limited. Simultaneously the waste water disposal becomes critical. The 11th Five Year Plan document has indicated that the fund required to achieve 100% population coverage in urban areas with drinking water supply and sewerage & treatment would be about Rs.53,666 crore and Rs.53,168 crore respectively. Against this, the financial outlay made by the Planning Commission for the urban sector as a whole under the JNNURM is Rs.50,000 crore only up to 2012.

Apart from inadequate funds, the urban water supply service is having several inherent problems, like intermittent supply, inadequacy, inequity, inadequate quality etc.

The Benchmarking and Water Utilities Data Book developed by the ADB and this Ministry covers 15 Municipal Corporations, 2 City Boards, a Municipal Council, a local autonomous body and private operator. The data book analyses efficiencies of the service provider across several parameters like coverage, water availability, UFW etc. The analysis reveals that on an average piped water supply per day is available for 5 hours in Chennai, 12 hours in Chandigarh, 8.3 hours in Kolkata, 7 hours in Varanasi, 2.5 hours in Surat, 4.5 hours in Bangalore, 4.0 hours in Mumbai and one hour in Visakhapatnam. The poor, particularly those living in slums and squatter settlements, is generally deprived of safe potable water.

Several pilot studies conducted in the country have shown water losses due to leakage, pilferage etc, to be about 14% to 60% of the total flow in the systems. It has been noticed that maximum leakage occurs in the distribution network and 80% of this loss occurs in house connections. Since water supply is by and large intermittent, during non-supply hours when the system is not pressure, quite often external pollution gets sucked into the system through the points of leak, causing health hazards.

Therefore, I would like to emphasize that a systematic approach for identification and reduction of leakage and preventive maintenance has to be an in integral part of operation & maintenance of the water supple system on a regular basis, to save precious quality of treated water and to increase revenue to make the systems self-sustaining. If such measures are taken up, there may not be any immediate need for an augmentation scheme for the city.

In the wake of decreasing fresh water availability and increasing water demand, conservation of water is a sine qua non in the present day context. Conservation of water can be accomplished in many a way, of which metering is an important one in urban water supply. Metering will act as an incentive for those who wish to conserve water and a disincentive to those who waste water. It enables reduction of wastage and increases efficiency and sustainability of the water supply system.

In order to ensure universal access to safe drinking water to all the citizens in urban areas, it is necessary to introduce operational, financial and institutional reforms, besides improved resource management. Reduction of UfW would lead to water conservation and wastage of water can be minimized by installation of meters at all consumer connections.

The Initiatives taken by the GOI for water quality:

The Ministry of Urban Development has brought out a Manual on Water supply and treatment, in which the "Chapter on Laboratory Tests and Procedures" included the following for the benefit of field engineers

- Sampling for physical, chemical and bacteriological analysis
- Frequency of sampling, standard tests
- Method of examination
- Recommended minimum testes and equipment for different categories of water works
- Recommended minimum staff required for water works laboratories

CPHEEO has also formulated Drinking Water Quality Guidelines based on the Guidelines of World Health Organization (WHO) which have been incorporated in a separate chapter in the Manual on Water Supply and Treatment.

Moreover, the Manual on Operation and Maintenance of Water Supply Systems consists of a separate Chapter entitled "Drinking Water Quality Monitoring and Surveillance" which delineates the following important aspects:

- Importance of Water Quality
- Planning and Implementation of Water Quality
- Monitoring and Surveillance including Strategies
- Legal and Institutional aspect
- Surveillance programme
- Information management surveillance action
- Sanitary survey
- Water sampling and analysis
- Data analysis
- Data Interpretation and reporting in terms of Quality, Quantity, Coverage, Cost, Continuity etc.

The following aspects are provided as Annexure in the said manual:

- Functions and responsibilities of agencies for Water Quality Monitoring & Surveillance.
- Water Quality Management Laboratory network and their activities.
- Suggested lad service infrastructure of monitoring water quality.
- Suggested W.Q. Surveillance team
- Suggested minimum annual frequency of sanitary inspection, minimum sampling frequency for Water Quality Management & Surveillance
- Remedial & preventive measures for protection of water supplies.

PRESENT STATUS OF WATER QUALITY IN URBAN AREAS:

- Only the bigger Municipal Corporations, Municipalities have their own laboratory facilities for analysis of raw and treated water
- In smaller municipalities either the laboratory facilities are absent or inadequate.
- The availability of trained manpower is far from satisfactory, particularly in smaller municipalities.
- There is a need for proper training of the personnel deployed in the water treatment plants in operation and maintenance of the plant and machinery.
- In the PHE training courses sponsored by CPHEEO training on water and waste water analysis are impaired to the engineers and others covering detailed aspects on water quality and laboratory techniques etc.
- The training courses needed for technicians are far more than the number of personnel involved in the water supply sector.

Research Study on Water Quality:

The Ministry of UD has sponsored a Research Study entitled "Surveillance of Drinking Water Quality in 25 Cities/Towns in India" conducted by NEERI, Nagpur.

NEERI has forwarded a draft report I respect of 23 cities, which indicated the following:

- About 62% cities have Central laboratory and Water Treatment Plant (WTP) level laboratory, 17% cities have only WTP laboratories, 17% cities have only Central laboratories and 4% cities do not have any laboratory facility in the city.
- SDWQ Programme is in existence in 26% cities and in the remaining 74% cities, no SDWQ Programme is available.
- On an average, duration of supply of water vary from one hour daily to 10-12 hours daily and there are 3 cities where water is supplied on alternative days.

Laboratory facilities available at Central level and WTP level in 23 cities are as under:

	Adequate	Inadequate	Not Available/ Not Applicable
Central Level	**13**	**5**	**5**
WTP	**11**	**7**	**5**

IMPORTANT FINDINGS OF NEERI STUDY ON WATER QUALITY

- The physico-chemical water quality of the raw and treated water source, both surface and ground, has shown that all the quality parameters are well within the range of cause for rejection values as per CPHEEO Guidelines.
- The bacteriological quality of water in clear water reservoirs, service reservoirs, overhead tanks and consumer ends in the 23 cities have tested and the following have been observed:

- Excess iron content found in some samples of raw and treated water in 2 cities.
- Bacterial contamination of treated water in distribution system was observed in some of the cities.
- In some of the cities, the consumers' end samples were contaminated even though the CWR, SR and OHT serving the distribution zones had no contamination. It indicates in-line contamination and may be attributed to defective pipe lines.
- Some consumers' end samples were not showing contamination even though water samples of CWR/SR/OHT indicated presence of TC & FC counts. This may be due to inadequate contact time after chlorination of reservoir water and contact time was available in the course of flow of water to the distribution/ consumers end.

Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

- The Ministry of Urban Development has launched two National Programmes viz. JNNURM and UIDSSMT in December, 2005. These programmes are meant for Urban Governance and Infrastructure development including provision of water supply sewerage, sanitation and solid waste management facilities in 63+3 cities under JNNURM and in the remaining 5098-3 cities of the country under UIDSSMT Programme.
- The ULBs are being provided grants-in-aid (as per approved norms) for development/augmentation of water supply, sewerage, drainage and SWM projects on whole town/city basis.
- The ULBs are also eligible to get grants for development of Laboratory in case the same is not available or don't have any facility.

  Funds under JNNURM shall be released as Additional Central Assistance (ACA – 100% Central Grant) to the State Level Nodal Agency (SLNA) for implementation of the approved projects subject to signing of Memorandum of Agreement (MOA), after ascertaining availability of State share. To access funds, the ULBs / States have to implement identified mandatory and optional reforms, which will ensure improvement in urban governance and service delivery so that the ULBs become financially sound and sustainable to undertake new programmes.

The Outcomes for Urban Water Supply under JNNURM will be:

- Financially self-sustainable cities
- Universal Access to Basic Services
- City wide framework for Planning and Governance
- Modern Financial Management Systems
- Transparent & Accountable Governance and Service Delivery

Till March 2009, 461 infrastructure projects [140 water supply schemes (Rs.18324.61 crore), 99 Sewerage projects (Rs.12114.91 crore)] have been sanctioned by the CSMC at a total cost of Rs.49, 430.64 crore for 61 cities in various states and ACA to the tune of Rs.7, 212.36 crore has been released for the sanctioned schemes.

Out of above it is concluded:

- Fresh water availability is becoming scarce due to competing demands.
- The quality of water, both surface and ground, is subjected to contamination by man made and natural actions.
- Therefore, water conservation by way reduction of UFW, recycle and reuse of wastewater is necessary, not only to increase the water availability, but also to reduce pollution.
- Lot of efforts is still needed in maintaining the water quality and the responsibility for supplying good quality water lies with the Urban Local Bodies.
- To ensure good quality water, the Urban Local Bodies have to monitor its quality by way of periodical analysis through reputed laboratories and proper treatment.
- Analysis of raw as well as treated water has to be carried out by adequately trained laboratory personnel.
- Wherever, necessary laboratories have to be set up and the existing laboratories have to be suitably equipped.
- Emphasis is needed for creating separate laboratories in all Class I cities in the country to start with.

I hope this workshop will pave a way to move forward and work in tandem with Ministry to fulfill the target of universal coverage of urban population with continuous, reliable and quality drinking water supply.

Thank you,

Mr. Sankaranarayanan
DA (PHE), CPHEEO

Concept of Water Safety Plan and Composite Correction Programme

Workshop on Management Tools for
Safe Water Supply
New Delhi

A.K. Sengupta
National Professional Officer
Sustainable Development & Healthy Environment
WHO, India Country Office, New Delhi
16 June 2009

World Health Organization

Water and Health: Background

- About 21% communicable diseases are water borne
- 50 million suffer from intestinal diseases, like diarrhoea, cholera, dysentery, typhoid etc.
- 5 million people die, of which 1.5 million are children below 5.

INDIA	
Total WSH-related diseases	782, 000
% of total deaths	7.5%
Total WSH-related DALYs	28. 2 million
% of total DALYs	9.4%

World Health Organization

Why we need to review our approach ?

- In India like many other countries waterborne illness still occurs
- Outbreaks show us that we cannot solely rely on water treatment indicators
- End-point testing is too-little-too-late

World Health Organization

Start Up Activities

- Initial meetings/workshops with Ministry of Urban Development, CPHEEO, BWS&SB, HMWS&SB and other partners in 2004 : jointly by USEPA and WHO.
- September 2004: Workshop for strengthening Drinking Water Quality Surveillance programme involving five Ministries, ten research agencies and ten selected water boards/ PHEDs.
- March 2005: Workshop to introduce the concept of WSP, Development of Directory of DWQ Labs., Development of Manuals for Lab. Practitioners.

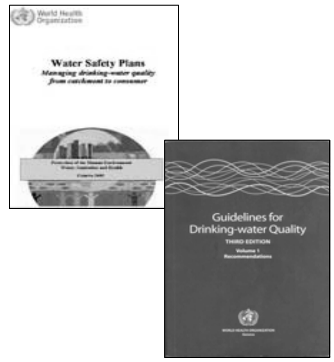
World Health Organization

What made Water Safety Plan Acceptable?

Since WSPs are a risk management tool to prevent the contamination of drinking water before it occurs, WS Managers accepted the concept.

Some basic questions to build a WSP

1. What are the hazards to safe drinking water?
2. How will these hazards be controlled?
3. How will the control for the hazard be monitored?
4. What actions must be taken to restore control?
5. How can the effectiveness of the system be verified?



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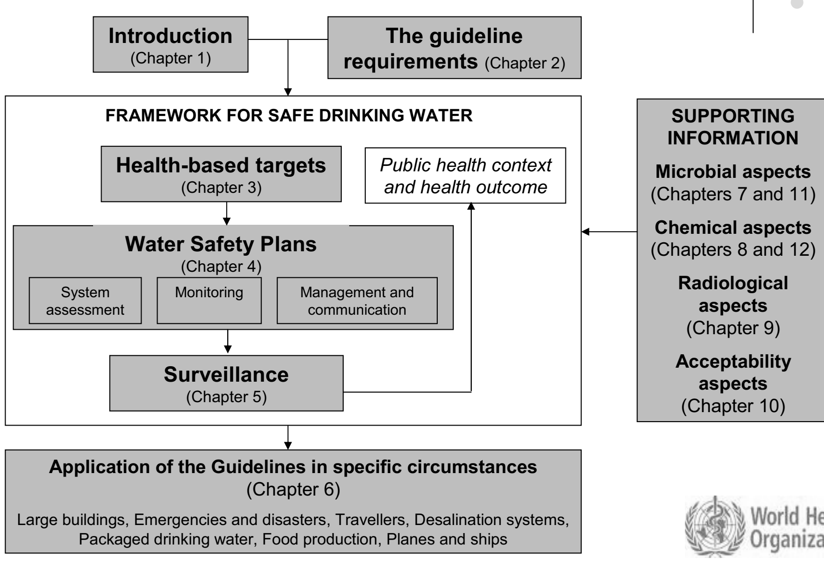
Interrelation of the chapters of the Guidelines for Drinking water Quality in ensuring drinking water safety



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The WHO's Framework for Drinking-water Safety

Component		Requirements
1: Setting Health-based Targets	➲	Targets based on an evaluation of health concerns and need to be set at a tolerable level for the community (e.g. are risk-based and can be coordinated with national guidelines, standards or WHO guidelines)
2: System Assessment	➲	An assessment is conducted to characterize the water supply system, assess risks and to determine whether the drinking-water supply (from source through treatment to the point of consumption) as a whole can deliver water that needs the health-based targets)
3: Operational Monitoring	➲	Monitoring of the control measures in the drinking-water supply that are of particular importance in securing drinking-water safety. Monitoring at multiple points within the system, rather than relying on end-product monitoring, provides the supplier with assurance that unsafe product does not end up with the consumer.
4: Management Plans	➲	Management Plans are set up and encompass: • Documentation of the system assessment • Monitoring plans including normal and incident operations, upgrades, improvements and communication
5: Surveillance	➲	A system of independent surveillance verifies that the above components are operating properly and effectively.

World Health Organization

WHO's Response

- Moving away from reliance on output monitoring- i.e. measuring parameters in final water
- More input monitoring- i.e. measuring parameters showing that the system is working
- Priority focus on microbial hazards
- Short- term chemical changes and exposures
- Catchment-to-consumer ("farm-to-fork")
- Multiple barrier approach – "HACCP"
- Reality check on today's water supply situations

World Health Organization

Water Safety Plan

A WSP comprises, as a minimum, the three essential actions that are the responsibility of the drinking water supplier in order to ensure that drinking water is safe. These are:

- a system assessment;
- effective operational monitoring; and
- management

World Health Organization

Foundations of WSP Implementation

Roles and responsibilities	➲	Identify the organization leading the WSP process
	➲	Gain commitment from other key organizations
Resource Commitment	➲	Commit to WSP implementation and maintenance
	➲	Identify and allocate the resources required
WSPs for Multiple Systems'	➲	Precisely identify distinct 'water supply systems'
	➲	Decide how systems will be grouped for WSP(s)
Preliminary assessment of system capability to meet targets	➲	Describe health-based targets in relevant terms
	➲	Assess system capability to meet health-based targets

World Health Organization

What are the benefits of doing a Water Safety Plan?

- ***Significant cost savings:*** allows more effective, targeted investments in infrastructure for maximum benefit
- ***Health benefits:*** improved water quality and reduced incidence of illness and disease
- ***Cutting edge approach and best practice for securing water safety***

World Health Organization

Aspects of collaboration

- Partnerships amongst GOI, State Water Boards, WHO, USEPA and NEERI
- Objective of collaboration is to demonstrate risk-based management of urban water supply systems, including following 3 activities:
  - Laboratory strengthening
  - Water safety plan demonstration
  - Water treatment plant optimization

World Health Organization

Laboratory Strengthening

- Collaboration between NEERI, NICD, WHO, and Ministry of Health and Family Welfare to develop laboratory manual
- Manual peer reviewed and published in 2007.
- Training offered to participants from Hyderabad and Pune based on manual
- Development of Directory of Water Quality Testing Laboratories.

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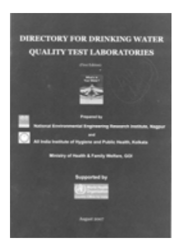
Development of Support Documents for DWQ Laboratories

1. Directory of Drinking Water Quality Test Laboratories.



2. Guidance Manual for Drinking Water Quality Monitoring and Assessment.

www.whoindia.org/sde/water_snitation/water/water_quality/

World Health Organization

WSP Demonstration Projects in Hyderabad

Three Locations

- Adikmet area – 24X7 water supply maintained by HMWS&SB. Comparatively new system.
- Serilingampally area- Bulk supply by HMWS&SB augmented by ground water sources. Maintained by Local Body.
- Moin Bagh area – Old city, narrow lanes, intermittent water supply maintained by MHWS&SB. Old system.

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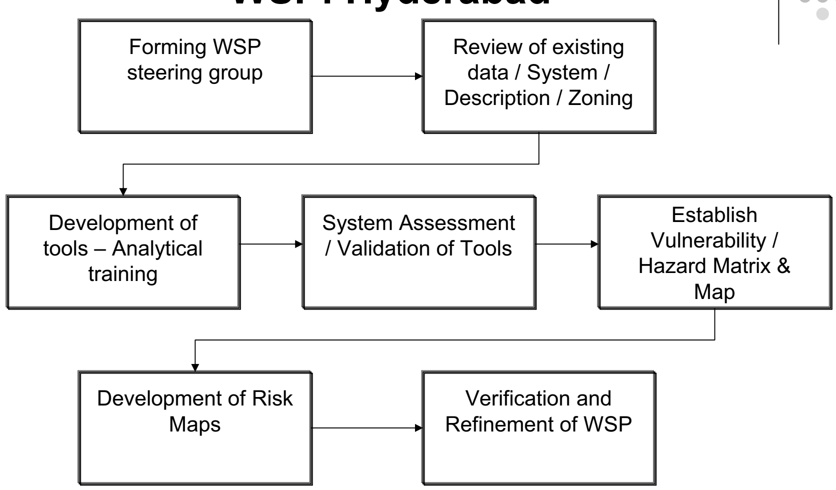
Steps adapted for the Development of WSP: Hyderabad



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Inspection Point Selection Criteria

Hazard	Proximity to physical hazard (sewer, low lying area)
	Proximity to area of high faecal loading (population density)
	Historical record of microbial contamination
Vulnerability	Proximity to primary/secondary infrastructure
	Pipe Attribute (age/material/length)
	Pressure/supply zone
	Proximity to identified vulnerable area
	Historical record of intermittence in supply
	Historical record of leakage
	Evidence of perpetually low residual chlorine levels
Susceptibility	Potential scale of health impact
	Number of people effected

World Health Organization

Health-Based Targets for DWS Objectives

- The overall objective of the study is to conduct a risk assessment in each of the three project sites that would provide baseline data for establishing health based targets to guide and evaluate the implementation of the WSPs in these sites. Specifically, in each of the project areas, the study aims to:
  - Estimate incidence of acute gastroenteritis (GE)
  - Estimate intra-household and distribution point prevalence of drinking water contamination
  - Assess relative risk relationship between exposure factors (drinking water and hygiene practices and water quality) and health outcomes
  - Assess socioeconomic determinants influencing exposure to risks and disease burden

World Health Organization

Incidence of Acute Gastroenteritis

Area	Slum	Non Slum	Total
GE Cases (Last Seven Days)			
Adikmet	5	5	10
Moinbagh	45	32	77
Serilingampally	27	23	50
Total	77	60	137
Population Covered			
Adikmet	896	1511	2407
Moinbagh	1320	1343	2663
Serilingampally	796	1493	2289
Total	3012	4347	7359
Incidence Rate of GE Per 1000			
Adikmet	5.58	3.31	4.15
Moinbagh	34.09	23.83	28.91
Serilingampally	33.92	15.41	21.84
Overall	25.56	13.80	18.62

World Health Organization

IRA - WDS

- **IRA : Integrated Risk Assessment**
- **WDS : Water Distribution System**

IRA-WDS is based on a risk-based modeling approach that assesses the risk associated with contaminant intrusion into water distribution system during non-supply hours. This is a GIS based decision support system that predicts the risk associated with contaminated water entering WDS from surrounding surface foul water bodies, sewer pipes, drains and ditches

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Components of IRA - WDS

- Contaminant Ingress System
- Pipe condition Assessment Model
- Risk Assessment Model
- GIS integration

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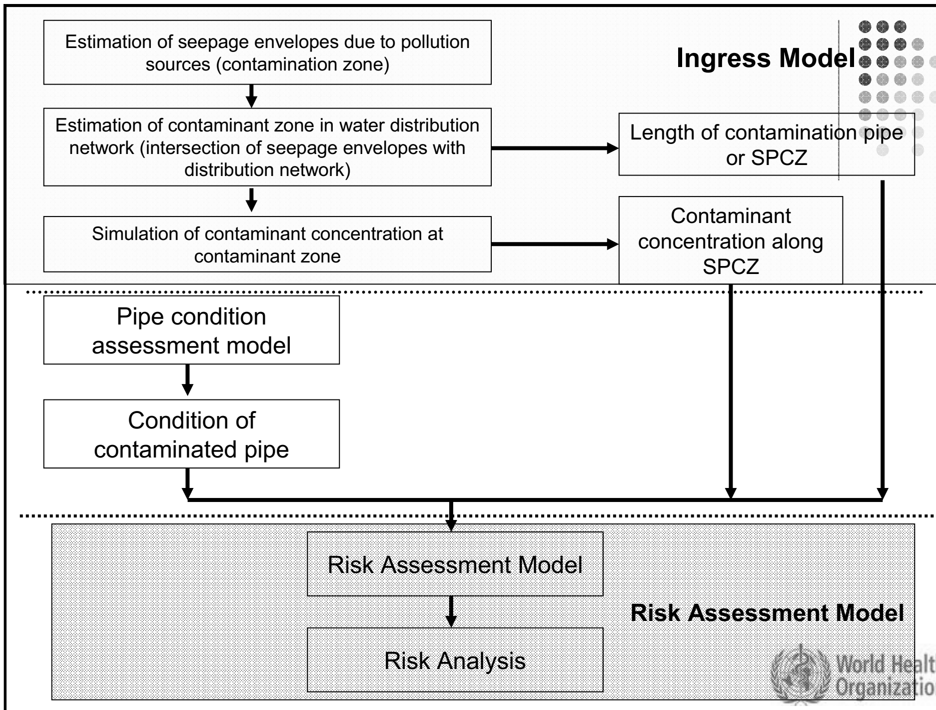

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Data Requirement for IRA-WDS

1. Properties of water distribution network
   - Underground water distribution network
   - Properties of different pipe materials
2. Properties of pollution source
   - Underground sewer pipe
   - Lined or unlined open ditch/drain
   - Open surface foul water bodies
3. Soil properties
4. Contaminant properties
5. Groundwater table
6. Pressure in the distribution system
7. Land Use Plan
8. Traffic Load

World Health Organization

Attribute Data Requirement for WS.Shape File

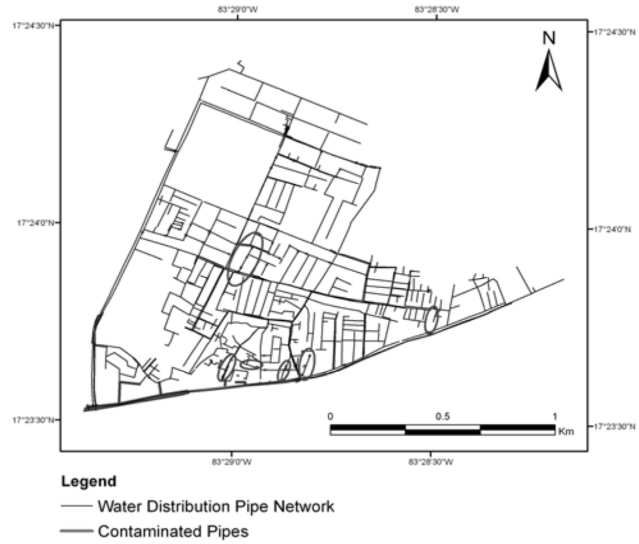
For Each Pipe :

1. **Length of pipe (m)**
2. **Bury depth (m)**
3. **Joint Method (Linguistic [rubber , leadite])**
4. **Material type (Linguistic [CI, DI, RCC, PVC…])**
5. **Traffic load (Linguistic [busy, medium, quiet…])**
6. **Surface type (Linguistic [hard, grassed, water body…])**
7. **Internal protection (Linguistic [good, medium, bad…])**
8. **External protection (Linguistic [good, medium, bad…])**
9. **Bedding condition (Linguistic [good, medium, bad…])**
10. **Workmanship (Linguistic [good, medium, bad…])**
11. **Diameter of pipe (mm)**
12. **Installation year (year)**
13. **Bury depth of start node (m)**
14. **Bury depth of end node (m)**
15. **No. of connections**
16. **No. of breaks per year**
17. **Leakage rate (lps)**
18. **No. of valves**
19. **Duration of water supply per day (hrs)**
20. **No. of times water supplied per day**

20 Attributes
To be defined
For each pipe in
Network

World Health Organization

Contaminated Zones in WDS of Adikmet



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Risk Mapping of WS Network in Adikmet

Legend
RISKRANK
2
3
4
5

Risk Rank	Risk Classification	Risk Index	No. of Pipes	Percentage(%)
2	Very High	0.3	3	0.32
3	High	0.45- 0.54	17	1.83
4	Medium	0.63- 0.82	490	52.8
5	Low	0.86- 1.0	418	45.04

World Health Organization

Findings

Risk Assessment

Very High Risk : 3 Pipes (1975)

High Risk : 17 Pipes (1975 and 1996)

Medium : 490 Pipes (1975, 1978 & 1996)

Low : 418 Pipes (1975, 1996 & 2005)

Condition of Pipes

Very Bad : 3 Pipes (1975)

Bad : 15 Pipes (1975)

Medium : 293 (1975, 1978, 1996)

Good : 327 (1975, 1996)

Very Good : 290 (1996 and 2005)

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Verification point 1

Back side of Batkama Kunta Sewer Crossing

Sewer Line Water Supply

Water Sample Collected on Feb 13, 08

No Contamination detected

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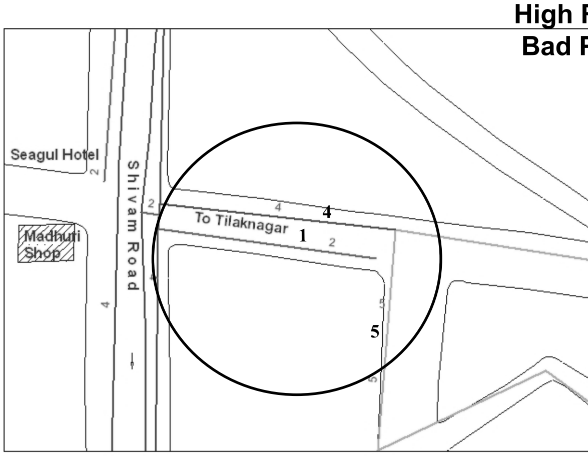
High Risk due to Bad Pipe Condition



Legend
RISKRANK
2
3
4
5
Road

Risk Rank	*Risk Class*	*PCA Rank*	*PCA Class*	*Installation Year*	*Material*	*Pressure Kg/cm²)*	*Leakage (lps)*	*Bedding Condition*	*Workm -anship*	*Traffic*	*Contaminant Conc*
2	High	1	V.Bad	1975	RCC	Low	1.2	Poor	Poor	Busy	0
4	Medium	4	Good	1996	CI	Low	0.3	Good	Good	Medium	0
5	Low	5	V.Good	1996	CI	Low	0.1	Good	Good	Quiet	0

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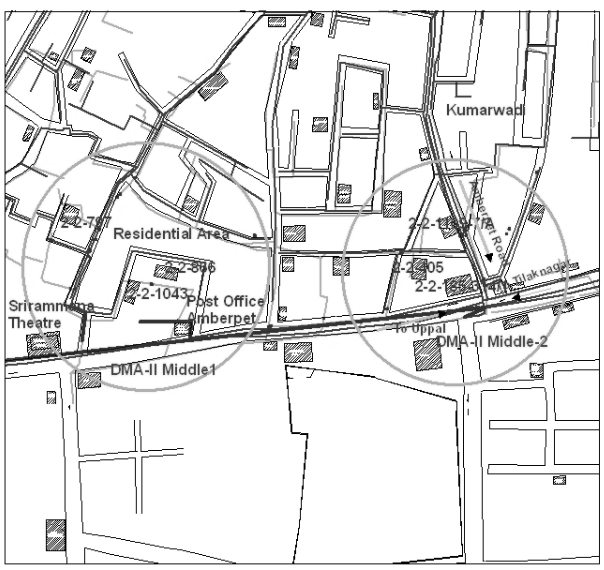
Contaminated Pipe at DMA-II

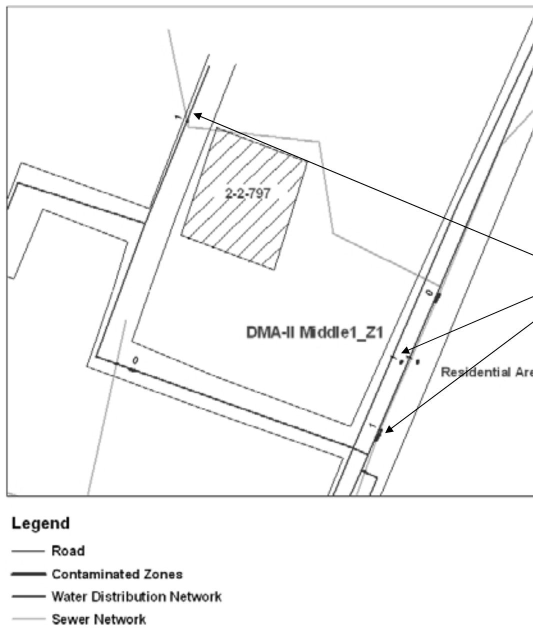
Sewer Crossing WS line



Legend
Road
Contaminated Zones
Water Distribution Network
Sewer Network

Physical verification required for contamination due to sewer

World Health Organization



Sewer Crossing WS Line

Contaminant Ingress
1 : Contaminant Concentration

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Composite Correction Programme

Aim: CCP is a water treatment optimizing program that improves water treatment operation looking for Particle removal (Turbidity) and Pathogen removal (Microbial Contamination)

Workplan of CCP:

a) Based on past data as well as current turbidity measurements, a plant audit (also called Comprehensive Performance Evaluation (CPE) is carried and analyze the plant's administrative, operational, and maintenance practice.

b) After deriving various factors causing suboptimal performance identified during the CPE, The Comprehensive Technical Assistance (CTA) is carried out to systematically address problem to improve performance.

World Health Organization

Benefits of Treatment Plant Optimization using CCP

- Minimization of microbial health risks to public.
- Effective with high risk water systems.
- Improved control and operation of treatment works.
- Improved WQ achieved with minimal capital outlay and minor changes to existing facility.
- Cost effective performance improvements are possible.

World Health Organization

Conducting a Comprehensive Performance Evaluation (CPE)

- Complete a performance assessment.
- Evaluate major unit processes.
- Conduct interviews/ Tour plant.
- Identify and prioritize performance limiting factors.
- Prepare and present CPE report.

World Health Organization

Conduct Performance Assessment

- Assess actual to established performance goals or standards.
- Develop historical (12 month) turbidity charts from existing data, if available.
- Develop turbidity profiles for individual filters, if possible.
- Conduct on-site special studies to measure performance (follow up).

World Health Organization

Steps completed in Hyderabad

- Regional workshop introducing participants to WSPs completed – May 2006
- Workshop brought together participants from Sri Lanka, Bangladesh, Nepal, in addition to the Chennai, Delhi, and Pune to build a network of regional water safety professionals
- Formation of Steering Committee and three task forces for three zones.
- Engagement of NEERI for documentation and provide technical support for Risk assessment.
- Study for "Assessing acute Gastroenteritis risks associated with water quality and sanitation facilities" in the three zones.
- Field level data collection for the water systems, sanitation, drainage, soil, groundwater, contour maps, land use plan etc. in three zones.
- GIS mapping
- Completed model treatment plant audit, to be expanded to two additional cities and additional water treatment plants.

World Health Organization

Other Uses of WSP

- WSP may be used as a tool for better management of water supply systems. This not only helps in identifying the risk areas, it could also be used for:

1. Identifying losses in the system including unaccounted for water/ revenue loss.
2. Investment planning by pinpointing very high risk and moderate risk areas.
3. Focusing the WQ monitoring locations and taking up corrective measures

World Health Organization

Agencies Involved in the development of Training Module

- Engineering Staff College of India, Hyderabad
- Hyderabad Metro Water Supply and Sewerage Board (HMWS&SB)
- NEERI- Nagpur, Mumbai and Hyderabad
- Department of Health, Government of Andhra Pradesh
- Institute of Health System, Hyderabad
- WHO India Country Office

World Health Organization

Training Material for Water Safety Plan in Urban Areas – Target Group

Participants

- Water Supply Managers, Public Health Engineers, Scientist involved in Water Supply Maintenance, Water Supply Policy Makers

Duration

- 4 Days

Location (present)

- Engineering Staff College of India, Gachi Bowli, Hyderabad – 500 032

World Health Organization

Partners signed on to the Collaborative Effort

Federal Agencies

- MoH&FW/ NICD
- MoUD/ CPHEEO
- RGNDWM
- MoWR/ CGWB
- MoE&F/ CPCB
- CSIR/ NEERI

AGENCIES

- USEPA/ USAID
- UNICEF
- World Bank –WSP
- WHO

State Agencies

- HMWS&SB
- DoH, GoAP
- IPM, GoAP
- EPTRI, GoAP
- Institute of Health System
- Hyderabad Mun. Corp.
- Serillingampally Mun.
- Delhi Jal Board
- Pune Municipal Corp.
- ASCI
- NGOs

World Health Organization

Opportunities to share lessons

- NEERI, as coordinator, will be documenting entire process
- Opportunity to share lessons learned in other urban systems (expanding risk assessment tools to assist water utilities with management).
- Opportunity to share guidance documents generated as a result of activity with interested cities.
- Training Programme for WSP.

World Health Organization

Future WSP in the Urban Areas

- Pune
- Delhi
- Nagpur
- Kolkata
- Surat

Funding for initiating this programme are expected from Ministry of Urban Development, GOI under JNURRM.

World Health Organization

Conclusion

- WSPs protect from contamination from catchments to consumer
- WSPs are comprehensive management strategies to prevent outbreak of disease
- WSPs assist water boards with making targeted investments for maximum benefit

*picture courtesy HMWS & SB

World Health Organization

CONTAMINATION ISSUES OF WATER IN INDIA

A person can live weeks without food, but only days without water

Dr. P. K. SETH
CEO, Biotech Park, Lucknow &
Former Director, IITR, Lucknow

There is a surprising connection between the quality of our water and healthful longevity.

In the early 1900s, before chlorine, pesticides, herbicides and the tens of thousands of other chemicals, to which we are exposed every day, the average person had a 1 in 50 chance of getting cancer.

Today 1 in 3 can expect to get cancer in their lifetime, 1 in every 2 males.

Water Quality - A Concern

- Limited Utilizable Water Resources
- Uneven Geographical Distribution
- Increasing Water Demand
- Deteriorating Water Quality & Impact

Global & Indian Scenario on Water

- Globally,1200 million people lack access to safe water. In India, 125 million people lack access to safe water.
- At global level about 2600 million people defecate in the open. In India, 700 million people lack access to sanitation facilities - defecate in open.
- Diarrhoea claims lives of 2 million children around the world every year. While one million children in India die of diarrhoeal diseases each year directly as a result of drinking unsafe water and living in unhygienic conditions.
- According to a UNICEF Report in 2006, 2.1 million under five years died in India, ie., one-fifth of the world's total. Whereas in China it was 0.42 million. Diarrhoea, pneumonia, malnutrition and poor neonatal care are among the major causes of child deaths in the region.

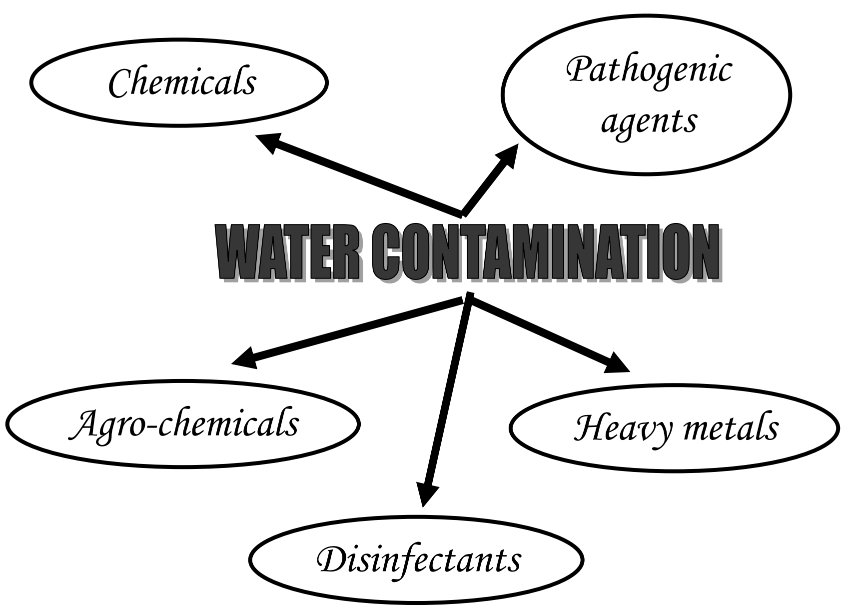
Source: Centre for Community Health Research (CCHR), Kerala, India

Water Resources in India

1. Surface Water Resources
2. Groundwater Resources

20 River Basins

Major Chemical Contaminants in Water



Major Water Quality Issues

Common issues of Surface and Ground water

- Pathogenic (Bacteriological) Pollution
- Salinity
- Toxicity (micro-pollutants and other industrial pollutants)

Surface Water

- Eutrophication
- Oxygen depletion
- Ecological health

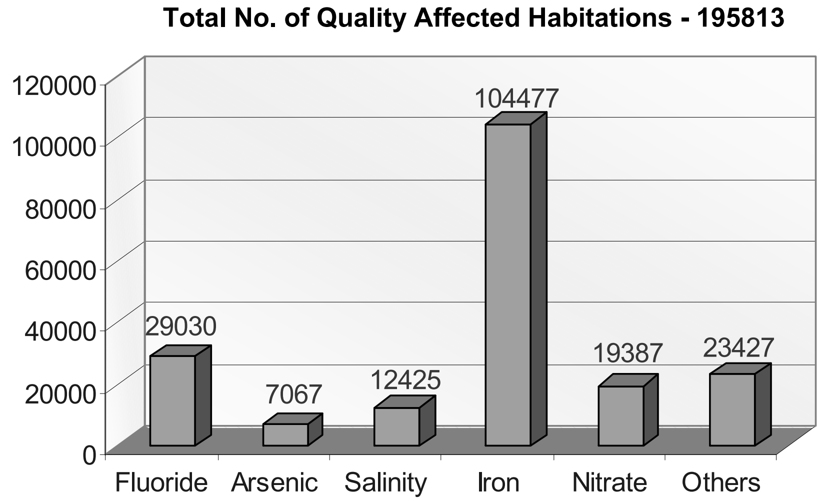
Ground Water

- Fluoride
- Nitrate
- Arsenic
- Iron
- Sea water intrusion

Major Factors Responsible for WQ Degradation

- Domestic: 423 class I cities and 499 class II towns harboring population of 20 Crore generate about 26254 mld of wastewater of which only 6955 mld is treated.
- Industrial: About 57,000 polluting industries in India generate about 13,468 mld of wastewater out of which nearly 60% (generated from large & medium industries) is treated.
- Non-point sources also contribute significant pollution loads mainly in rainy season. Pesticides consumption is about 1,00,000 tonnes/year of which AP, Haryana, Punjab, TN, WB, Gujarat, UP and Maharashtra are principal consumers.
- Domestic sewage is the major source of pollution in India in surface water which contribute pathogens, the main source of water borne diseases along with depletion of oxygen in water bodies.
- Sewage alongwith agricultural run-off and industrial effluents also contributes large amount of nutrients in surface water causing eutrophication

Water quality affected habitations



Source: Department of Drinking Water Supply, New Delhi

NATIONAL WATER QUALITY MONITORING PROGRAMME

- Network Comprising of 1019 stations.
- Extended to 27 states & 6 Union Territories
- Monitoring done on monthly or quarterly basis in surface waters and on half yearly basis in ground water
- Covers 200 Rivers, 60 Lakes, 5 Tanks, 3 Ponds, 3 Creeks, 13 Canals, 17 Drains and 321 Wells.
- Among the 1019 stations, 592 are on rivers, 65 on lakes, 17 on drains, 13 on canals, 5 on tanks, 3 on creeks, 3 on ponds and 321 are groundwater stations.

Source: http://www.cpcbenvis.nic.in/waterpollution/network.htm

Parameters for National Water Quality Monitoring

Core Parameters (9)

pH
Temperature
Conductivity
Dissolved Oxygen
Biochemical Oxygen
Nitrate-N
Nitrite-N
Faecal Coliform
Total Coliform

General Parameters (19)

COD	Chloride
TKN	Sulphate
Ammonia	Total Alkalinity
Total Dissolved Solids	P-Alkalinity
Total Fixed Solids	Phosphate
Total Suspended Solids	Sodium
Turbidity	Potassium
Hardness	Calcium
Fluoride	Magnesium
Boron	

Field Observations (7)

Weather
Approximate depth of main stream/depth of water table
Colour and instensity
Odor
Visible efluent discharge
Human activities around station
Station detail

Bio-Monitoring Parameters (3)

Saprobity Index
Diversity Index
P/R Ratio

Trace Metals (9)

Arsenic	Nickel	Copper	Mercury	Chromium Total
Cadmium	Zinc	Lead	Iron Total	

Pesticide (7)

BHC(Total)	Dieldrin	Carbamate	2.4 D
DDT(Total)	Aldrin	Endosulphan	

WATER-RELATED INFECTIONS PRIMARY PUBLIC CONCERN

- **Water borne diseases**
  - Cholera
  - Poliomyelitis
  - Diarrhoeal diseases
  - Roundworm
  - Enteric fevers: typhoid
  - Whipworm
  - Hepatitis A
  - Cryptosporidium
  - Giardia
- **Water-washed diseases**
  - Scabies
  - Typhus
  - Trachoma
  - Louse infestation
- **Water based diseases**
  - Schistosomiasis
  - Dracunculiasis (guinea-worm)
- **Diseases transmitted by water-related insect vectors**
  - Malaria
  - Onchocerciasis
  - Yellow fever
  - Dengue
  - Filariasis
  - African trypanosomiasis
  - Leishmaniasis

Survey for metals in water carried out in following districts

- Jammu & Kashmir
- Himachal Pradesh
- Uttar Pradesh
- Sikkim
- Tripura
- Meghalaya
- West Bengal
- Orissa
- Maharashtra
- Rajasthan

Indian Institute of Toxicology Research (IITR), Lucknow

Metals : Some Toxic Effects

As	**Dermal & Nervous System Toxicity, Cancer**
Cd	**Kidney effects, itai-itai (bone disease), Hypertension**
Cr	**Liver/Kidney effects, Cancer**
Pb	**Central/Peripheral Nervous System damage; Kidney effects; highly toxic to infants & pregnant women.**
Hg	**CNS disorders; Neurological and Renal disturbances**
Ni	**Dermatitis and Renal problems**
Fe	**Gastro-problems, Coloration**

Conclusions – Heavy Metals

Total about 4650 river water samples collected / analyzed

1. **As was insignificantly detected only in few samples.**
2. **Cu and Zn, although detected in majority of samples, their levels were within their permissible values.**
3. **Cd and Hg although detected in considerable number of water samples, their levels exceeded in about 5% of total samples.**
4. **Pb and Cr present in majority of samples, their level exceeded in about 10 and 15% of total samples.**
5. **Mn and Fe present almost in all the samples, their level exceeded their respective permissible values in more than 40 and 80% of total samples.**

Arsenic Chemistry

Two primary valence states

- **As (III)**
- **As (V)**

- **As (III):** **More Toxic, a hard acid and make complexes with oxides and nitrogen.**
- **As (V):** **Relatively Less Toxic, behaves like a soft acid and make complexes with sulfides.**

Arsenic Occurrence

As(III) :

$H_3AsO_3^0$

$H_2AsO_3^{-1}$

$HAsO_3^{-2}$

Predominates in Ground Waters

Arsenic Occurrence

As(V) :

$H_3AsO_4^0$

$H_2AsO_4^{-1}$

$HAsO_4^{-2}$

AsO_4^{-3}

Predominates in Surface Waters

Arsenic Today

- In West Bengal – 5,408 habitations in 79 blocks
- Others States viz. Bihar, Jharkhand, Chhattisgarh, Assam, Tripura – 1,659 habitations
- 16 million people at risk
- A serious problem

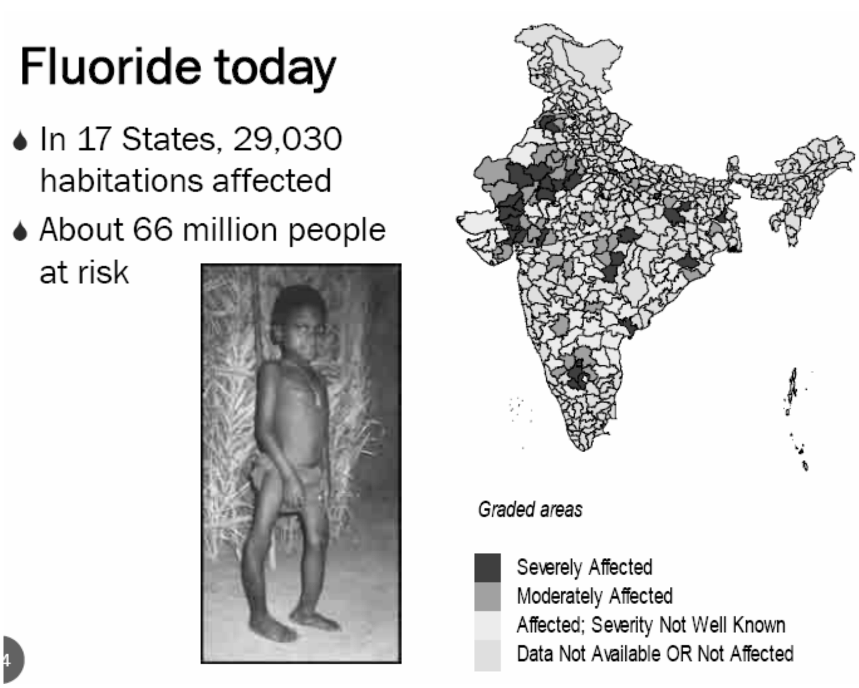



As affected areas in West Bengal (India)

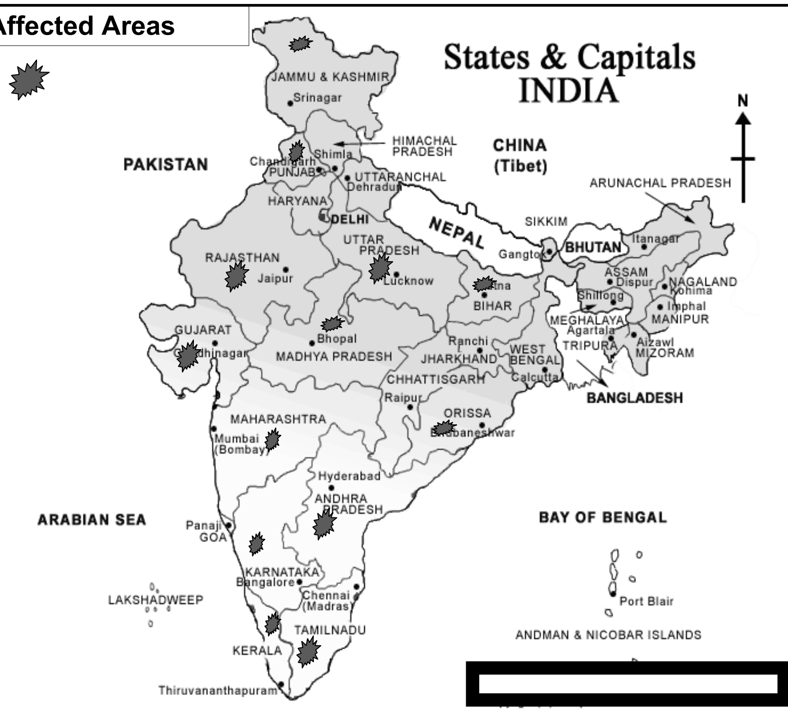
S. No.	District	No. of Blocks	Total Villages	Total population	Max As (mg/L)
1	Maldah	5	1803	2637000	1.43
2	Murshidabad	15	226	4740000	1.85
3	Nadia	13/1	1352	3852000	1.15
4	North 24 Parganas	19/7	3812	7282000	1.40
5	South 24 Parganas	10	---	5715000	3.20
6	Bardaman	2	2579	6051000	0.28
7	Howrah	3/1	763	3730000	0.09
8	Hooghly	1	1928	4355000	0.60
	Total	68	14563	38362000	
Population at Risk				~12%	

Fluoride

- A Non-Metal
- Belongs to the Halogen family in periodic table
- Very reactive in nature
- Natural constituent of earth crust
- Permissible level in drinking water up to 1.0 mg/l
- Exposure to higher levels may cause fluorosis (dental carries, skeletal deformities)
- Some 18 States in India are affected (0.5-50 mg/l)



Fluoride Affected Areas



Pesticides as Persistent Organic Pollutants

Organic Chemicals which are

1. Persistent in environment
2. Bio-accumulative
3. Long-Range Transport Potential (LRTP)
4. Toxic in nature
5. Can result in adverse environmental and human health effects at locations near and far from their sources

Pesticide Residues in Water

Pesticide	EPA Guideline (ug/l)	River Water		Drinking Water	
		Detection	Violation	Detection	Violation
DDT	0.001	90%	40%	85%	20%
r-HCH	0.01	90%	21%	95%	15%
Endosulfan	0.003	48%	12%	60%	8%

Pesticides
Chronic Health Effects

- Respiratory (asthma)
- Neurological
- Reproductive and Developmental
- Carcinogenic

Chronic Neurologic Effects of Pesticides

Organophosphates	Increased vibration sense; Motor, sensor neuropathy; Cognitive, affective deficits
Methyl bromide, sulfuryl fluoride	Olfactory, cognitive, behavioral deficits
Paraquat, others	Parkinson's Disease?

Emerging Chemicals

What is an Emerging Chemical

Emerging chemicals include not only those in active production or use in the domestic market, but also those that are a byproduct of production and manufacturing, a combustion byproduct, or a metabolite (i.e., a breakdown product) of a parent compound, as well as classes or categories of chemicals.

Emerging Substances of Concern

- **Persistent, Bioaccumulative and Toxic**
- **Global Organic Contaminants**
- **Pharmaceuticals and Personal Care Products (PPCP)**
- **Endocrine Disrupting Chemicals**
- **Nanoparticles**

Global Organic Contaminants

Flame Retardants and their impurities

- polybromonated diphenyl ethers (PBDEs)
  - polybromonated biphenyls (PBBs)
  - polybromonated dibenzo-p-dioxins (PBDDs)
  - polybromonated dibenzofurans (PBDFs)
- Hexabromocyclododecanes (HBCDs)

Perfluoronated Compounds

- Perfluororoctane sulfonates (PFOS)
- Perfluoroctanoic Acid (PFOA)

Pharmaceuticals and Personal Care Products (PPCPs)

- Basically all prescription and over-the counter drugs
- Diagnostic agents
- Dietary Supplements
- Fragrances, soaps, conditioners, sunscreens, cosmetics…
- http://www.cosmeticsdatabase.com/

PPCPs

- Most diverse "category" of Emerging Substances of Concern; Many are water soluble;
- Most common route into the environment is through wastewater (municipal and septic drainage) and land application of sewage sludge and manure, and landfill leachate
- To state the obvious, the most common route to humans is through ingestion and topically application (although the dose is often unintended – drinking water, breast milk)
- WWTP treatment may or may not be effective at removing the compounds from the effluent depending upon the treatment and chemical

Endocrine Disrupting Chemicals

- Natural and synthetic hormones
- Surfactants
- Pesticides

Nanoparticles

- Fullerenes (a.k.a. buckyballs)
- Nanotubes
- Quantum dots
- Nanopowders (metal oxides)
- Natural particles (e.g., soot)

Nanoparticles

- Natural and manmade structures in the 1 to 100 nm size range
- Used in nanotherapeutic pharmaceuticals, drug delivery, cosmetics, energy storage products, fabrics, lubricants, even golf balls
- Potential use in contaminated site clean up
- Environmental impacts largely unknown

Environmental Effects of EMCs

- **Difficult to quantify due to low concentrations and chemical mixtures**
- **Can be confounded in field and laboratory experiments by parasites in the test subjects that can alter endocrine pathways (daphnids and amphipods)**
- **Widely varying sensitivities amongst wildlife receptors**
- **Effects can be reversible**

Bigger Cities Have Big Problems

A fact of life!
No matter you are in any Indian city, there is shortage of potable water.

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Thank you

DEVELOPMENT OF WATER SAFETY PLAN THROUGH COMPOSITE CORRECTION PROGRAMME APPROACH

COLLECTION OF DATA RELATED TO EVALUATION OF WATER TREATMENT PLANTS

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22.10.2009

Water Safety Plan (WSP) in Urban areas – ESCI, Campus Hyderabad

Presentation Outline

- Water Cycle
- Water contamination
- Benefits of Water Purification
- Background of WSP and CCP
- CCP Technical Approach
- Water purification Steps and Effective O&M
- Data requirement for Treatment Plant Evaluation
- CCP Implementation Experience : Case Studies

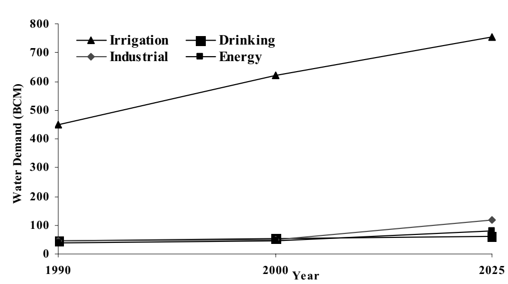
Water : 'A Vital Element of Life'

- A balanced and sustainable approach to water resource development is mandatory to avoid adverse impacts of impending water crisis
- By 2025, one third of World's population is projected to be in water stress or scarcity
- Water stress occurs when less than 1700 m^3 of renewable water per person per year is available
- Water scarcity is defined as less than 1000 m^3 per person per year

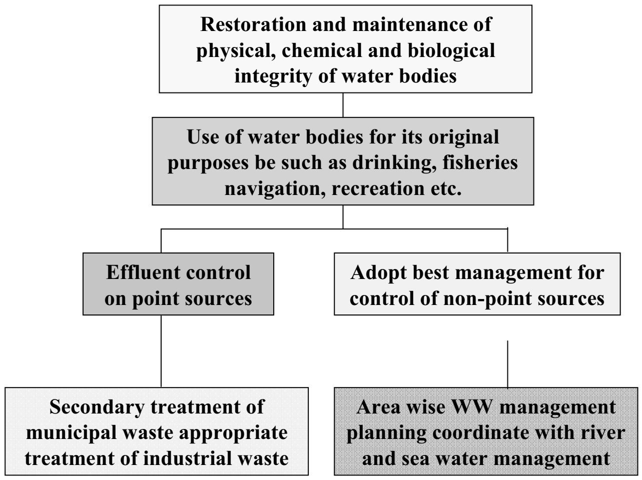
Water Availability and Demand

- India, has 16 %of world's population, but only 4 % of global water resources.
- Characterized by uneven distribution of water resources and rainfall (annual average of >10,000 mm in parts of Meghalaya, >200 mm in Rajasthan.
- Rain water in rain intensive monsoon months can not be used as store for developmental activity and ultimately join sea.
- The per capita availability of fresh water has dropped from 5177 cubic meter in 1951 to 1869 cubic meter in 2001
- As a result, India faces scarcity of water in several regions during critical period

Water Demand in Different Sectors in India



Water Quality Goals, Objectives and Strategies



The significance of any organized water supply is to provide, in the most convenient manner, an adequate supply of water of good physico-chemical quality, free from unpleasant taste or odour, and containing nothing, which might be detrimental to health

Classification of Inland Surface Water

Fresh water, a resource for drinking purposes is available through natural sources like lakes, streams, rivers and ground water. The Indian classification of surface water is as under :

Class	Designated Best Use
A	Drinking water source without conventional treatment but after disinfections
B	Outdoor bathing (organized)
C	Drinking water source with conventional treatment including disinfections
D	Propagation of wild life, fisheries
E	Irrigation, industrial, cooling controlled waste disposal

(CPCB Standards)

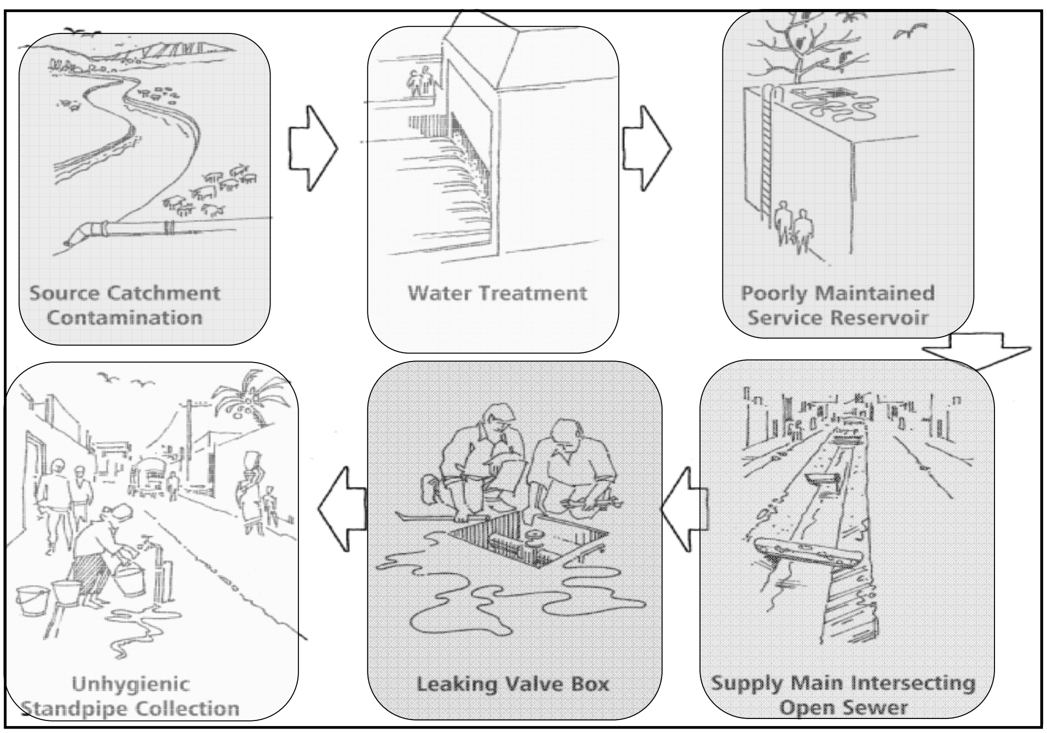
Characteristics (Max permissible)	A	B	C	D	E
Dissolved Oxygen, mg/l, Min	6	5	4	4	--
Biochemical Oxygen Demand, mg/l	2	3	3	--	--
Total Coliform Organisms* MPN/100 ml	50	500	5000	--	--
Sodium absorption ratio	--	--	--	--	26
Boron (as B), mg/l	--	--	--	--	2
Free Ammonia (as N), mg/l	--	--	--	1.2	--
Conductivity at 25°C μS/cm	--	--	--	--	2250

* If the coliform count is found to be > than prescribed limits, the criteria for coliforms shall be satisfied if not > 20 % of samples show > than limits specified, and not > 5 % of sample show values > 4 times the limits. Fecal coliform should not be > 20 % of the coliform

Water Pollution

Water May Contain

Physical	Chemical	Metals	Organics	Bacteriological	Biological	Radioactive
Clay	Calcium	Iron	Phenols	Total Coliforms	Zooplankton	Alpha emitters
Silt	Magnesium	Manganese	Oil & Grease	Faecal Coliforms	Phytoplankton	Beta emitters
Humus	Sodium	Copper	Pesticides			
Peat Materials	Potassium	Chromium				
Weeds	Chloride	Cadmium				
	Sulphate	Zinc				
	Fluoride	Lead				
	Carbonates	Mercury				
	Nitrate	Nickel				
	Phosphate	Selenium				
		Boron				



Causes for Water Pollution

- Intermittent Water Supply
- Individual connections crossing Strom water and Sewer Drains
- Water supply pipeline leakages
- Pit taps
- Corrosion of GI pipes
- Overflowing sewage
- In sanitary conditions near dwelling place
- Improper storage conditions
- Unhygienic habits
- Dumping of domestic wastes/sewage into sluice valve chambers

Water realated diseases:
- **Arsenicosis**
- **Fluorosis**
- **Lead poisoning**
- **Miamata**
- **Itai Itai**
- **Methaemoglobinemia**
- **Trihalomethane- cancer, POP**
- **Alzimer's – Aluminum**

Water borne diseases
- **Ascariasis**
- **Cholera**
- **Cryptosporiodiosis**
- **Gastro enteritis**
- **Diarrhoea**
- **Giardiasis**
- **Hepatitis - A**
- **Hookworm infection**
- **Leptospirosis**
- **Typhoid**
- **Unidentified acute gastro intestinal infections (E.Coli / Virus)**

Necessity For Water Treatment

- Water is never found pure in nature
- Rainwater is the nearest approach to chemically pure water which Contains
  - Small amounts of organic matter
  - Dissolved gases, principally oxygen and carbon dioxide
- The composition of the ground over which and through which it flows after falling to the earth is determined by the additional impurities that it absorbs
- Water of specific quality is required for drinking, for use in industry, agriculture, etc. and therefore treatment of water is required
- Evidence of man's desire to improve the quality of water is found in the earliest recording of knowledge. This is illustrated by a quotation from a body of medical lore in Sanskrit said to date 2000 B.C.
- "Impure water should be purified by being boiled over a fire or being heated in the sun, or by dipping hot iron into it, or it may be purified by filtration through sand and coarse gravel and then allowed to cool"

Water Purification Processes

Based on the contaminants, various treatment technologies are applied to get product water of acceptable quality.

Suspended Matter
- -Coagulation -Sedimentation
- -Filtration -Disinfections

Microbial Organisms
- -Disinfections
  - -Chlorine -Ozone
  - -Radiation -UV Lights

Dissolved Salts
- - Reverse Osmosis -Electro Dialysis

Specific Contaminant Removal like
- -Defluridation -Iron Removal
- -Arsenic Removal -Toxic Metal Elimination
- -Trace Organics

Specific Performance Goals for Unit Processes in Water Treatment

Process	Effluent Turbidity (NTU)	Inactivation of microbial population	Remarks
Sedimentation	<2.0 (95 percent of the time)*	-	
Filtration	<0.1 (95 percent of the time)	-	0.3NTU post backwash upto 15 min.
Disinfection	-	Giardia, Crystosporidium and viruses	#

• Settled water turbidity <1 NTU 95 % of the time when annual average raw water turbidity is < or equal to 10 NTU.
Settled water turbidity < 2 NTU 95 % of the time when annual average raw turbidity is greater than 10 NTU
Concentration and Time (CT) values to achieve required log inactivation of Giardia and viruses.

Water Safety Plan (WSP)

Water safety plan (WSP) is another modern tool which attempts to address the overall issue of complete programme, wherein a source to delivery of water to the consumers is mapped through different means to assess the risk of contamination at various levels.

A WSP as an improved risk management tool designed to ensure the delivery of safe drinking water. It identifies:

- **The hazards that the water supply is exposed to & the level of risk associated**
- **How each hazard will be controlled;**
- **How the means of control will be monitored;**
- **How the operator can tell if control has been lost;**
- **What actions are required to restore control; and**
- **How the effectiveness of the whole system can be verified.**

By developing a WSP, the system managers and operators will gain a thorough understanding of their system and the risks that must be managed. This knowledge can then be used to develop operational plans and identify key priorities for action. The development of a WSP will also identify what additional training and capacity-building initiatives are required to support and improve the performance of the water supplier in meeting the water safety targets.

WSP Plans & Components

- Health-based outcomes: improving water quality based upon the health impacts of current levels of contamination. Utilizing health-based outcomes will assist in identifying the how best to verify and analyze changes to the water supply.
- System assessment: the system assessment will analyze the current risks for contamination in water supply beginning from the catchments, to the treatment and storage facilities, the distribution system, and finally at the level of the household itself. The system assessment will also identify the potential controls for each identified risk.
- Operational monitoring: Once risks have been identified, the controls must be operationalized to understand how the control should be implemented. Operational limits for factors such as residual chlorine, dissolved oxygen, or pH should be determined as a part of the performance measures.
- Management plans: Management plans will formalize the corrective action necessary in case the operational limit is surpassed.

Composite Correction Program (CCP)

Composite Correction Program (CCP), is a water treatment optimization program that improves water treatment operations with limited capital investment by optimizing particle removal from water treatment plants to minimize turbidity of finished water.

Many microbial pathogens, particularly *cryptosporidium*, are difficult to handle due to their resistance to chlorine or their small size. By ensuring proper particle removal by improving water treatment processes, these pathogens can be removed to ensure safe drinking water.

Background on CCP

- Developed to improve wastewater plant compliance
- State of Montana adapted to drinking water
- U.S. EPA Involvement
  - Further develop and demonstrate after Montana
  - CCP Handbook development
  - Development/demonstration phase with states
- EPA conducted pilot programs to assist in skills development
  - Technical skills alone are not sufficient for success
  - Institutional barriers prevent use of skills
- EPA conducted area-wide optimization programs
  - Addressed institutional barriers
  - Developed program and technical skills
  - Initially - Twenty-one states, EPA Region 4

Methodology

- **CCP not only improves water treatment performance, but also builds local capacity to carry out audits of water treatment plants and strengthen a regional network of water safety professionals.**
- **CCP involves a round-robin, whereby engineers from two outside cities visit the water treatment facility of the third city to carry out an audit. These engineers rotate to all 3 cities to carry out audits on all 3 plants.**
- **By the end, each treatment plant has been audited by an outside entity, and the engineers of each plant now have the capacity to carry out audits in the future. Each facility would also have a technical assistance plan to improve their operations.**
- **The Composite Correction Program is carried out in two phases. First, an audit, or a Comprehensive Performance Evaluation (CPE) is carried out to review and analyze the plant's administrative, operational, and maintenance practices.**
- **Based on the factors causing suboptimal performance identified during the CPE, the Comprehensive Technical Assistance (CTA) is carried out to systematically address problems to improve performance.**

Composite Correction Program (CCP) Two-Part Approach

Step 1 -
Comprehensive Performance Evaluation (CPE) - Determine root cause(s) of performance problems

Step 2 -
Comprehensive Technical Assistance (CTA) – Correction phase to address root causes identified in CPE

Conducting a Comprehensive Performance Evaluation (CPE) Five-step Approach

- Complete a performance assessment
- Evaluate major unit processes
- Conduct interviews / Tour Plant
- Identify and prioritize performance limiting factors
- Prepare and present CPE report

1. Conduct Performance Assessment

- Assess actual to established performance goals or standards
- Develop historical (12 month) turbidity charts from existing plant data
- Develop turbidity profiles for individual filters, if possible
- Conduct on-site special studies to measure performance

2. Evaluate Major Unit Processes

- Major unit processes include flocculation, sedimentation, filtration, and disinfection
- Calculate unit process rated capacity
- Determine peak instantaneous flows
- Develop performance potential graph and assess if unit process is Type 1, 2, or 3

3. Interactions with Personnel

- Include administration, operations, support, and maintenance personnel
- Initiate after field activities to provide basis for questions
- Interaction should be private, confidential and non-threatening

4. Identify & Prioritize Performance Limiting Factors

- Base on information and perceptions from CPE activities
- Each plant unique
- Relate factors to achieving established performance goals
- Rate factors and prioritize

5. Prepare and Present CPE Report

- CCP proven to be effective tool for treatment plant optimization
- Promise of significant improvements with minimal capital investment
- Each treatment plant is unique and performance limiting factors will vary
- Structure of CCP oversight and participants may vary – team approach is essential
- Capacity building (transfer of responsibility) is important

CCP Benefits

- ❖ Minimization of microbial health risks to public
- ❖ Effective with high risk water systems
- ❖ Improved control and operation of treatment works
- ❖ Improved water quality achieved with minimal capital outlay and minor changes to existing facility
- ❖ Cost effective performance improvements are possible

Steps for a Comprehensive Performance Evaluation

- **Assessment of plant performance: Utilize the data listed above**
  - **Assess performance goals/standards**
  - **Develop historical turbidity charts and turbidity profiles for individual filters**
  - **Measure performance on-site**
- **Evaluation of major unit processes and conducting interviews**
  - **Evaluate performance measures for flocculation, sedimentation, filtration and disinfection**
  - **Calculate unit process rated capacity**
  - **Determine peak instantaneous flows**
  - **Conduct interviews with administration, operations, support, and maintenance personnel**

- ❖ **The maximum filtrate turbidity should be 0.3 NTU with optimum targeted value of 0.1 NTU for best performance of filters**
- ❖ **The back wash recovery period should be 15 minutes thereafter the filtrate turbidity should be 0.1 NTU**
- ❖ **If accurate particle size analysis is performed there should be < 10 particles in the range of 3-18 µm range/ml**

Steps for a Comprehensive Performance Evaluation (Contd..)

- Identification and prioritization of performance limiting factors
  - Based on interviews and performance assessment, determine limiting factors
  - Rate factors to determine which impact performance the most
- Reporting results of the evaluation
  - Present findings to plant and administrative personnel and prepare and distribute CPE report
  - Follow-up with a Comprehensive Technical Assistance (CTA) to achieve performance improvement

CPE Performance Limiting Factors

CPE Performance Limiting Factors	
Plant Name/Location:	
CPE Performed By:	
CPE Date:	
Plant Type:	
Source Water:	
Performance Summary:	
Issues	
A) Source protection and conveyance to plant	L) Laboratory, Staff adequacy, Equipment, SOP, Testing & calibration
B) Raw water quality	M) Pumping
C) Measurement of raw and treated water flow	N) Housekeeping
D) Chemical storage for alum, chlorine and PAC	O) Policies and Planning
E) Consumption of chemicals eg. Alum, chlorine and PAC	P) Validation of water quality
F) Flocculation, coagulation and sedimentation	Q) Supervision
G) Filter O & M and Back washing	R) Operation and Maintenance
H) Disinfection	S) Process control
I) Balancing reservoir	T) Administration
J) Safety devices or measures	U) Plant coverage
k) Training programme	V) Lack of formalized preventive maintenance Programme

Rating Description

A – Major effect on long-term repetitive basis.

B – Moderate effect on routine basis or major effect on periodic basis.

C – Minor effect.

Performance Potential through PSW

Partnership for Safe Water

American Water Works Association
U.S. Environmental Protection Agency
Association of Metropolitan Water Agencies
National Association of Water Companies
Association of State Drinking Water Administrators
American Water Works Association Research Foundation

Major Unit Process Performance Potential Spreadsheet v. 2.1-SI (Metric Units)

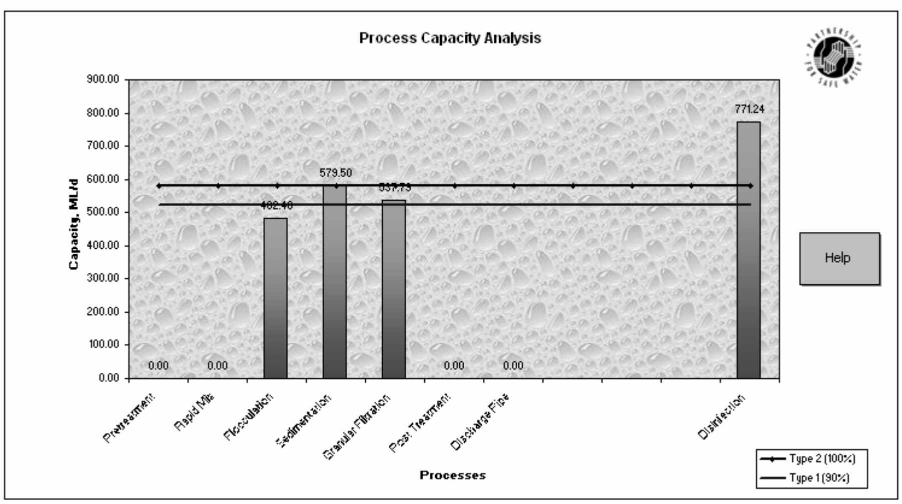
Please provide a general description of your water plant:

- Click Here to Update Plant Address & Flow Information
- Click Here to Update Process Sequence Information
- Click Here to Update Pretreatment Information
- Click Here to Update Rapid Mix Information
- Click Here to Update Flocculation Basin Information
- Click Here to Update Sedimentation Information
- Dissolved Air Flotation Not Used
- Click Here to Update Granular Filtration Information
- Membrane Filtration Not Used
- Click Here to Update Post Treatment Information
- Click Here to Update Discharge Pipe Information
- Click Here to Print Graphs and Treatment Summary

The calculations provided with this software are NOT suitable for compliance with regulatory requirements. They are only to be used for assessing the relative/theoretical capacity of unit treatment processes as part of the Partnership for Safe Water program.

Parvati Water Works
Singhgad Road
0.00
Pune, Maharashtra

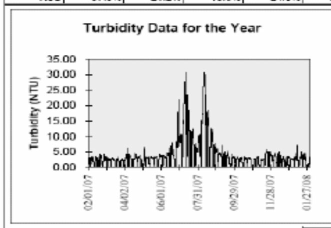
11-13 Feb 2008

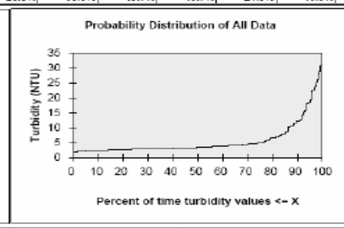


Turbidity Data for Raw Water and Probability Distribution for Pune Water Treatment Plant

PMC

Percentile	Yearly	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08
50	3.50	3.30	2.70	3.10	3.20	4.60	12.20	12.20	4.08	2.90	2.90	3.40	2.89
75	4.91	3.68	2.90	3.88	3.55	6.81	18.45	18.45	4.86	3.01	4.30	3.70	3.89
90	12.10	3.96	3.13	4.19	4.08	7.89	24.86	24.86	5.38	3.28	4.80	4.01	4.30
95	18.42	4.12	3.41	4.49	5.54	8.66	27.81	27.81	6.19	3.40	5.52	4.35	4.78
96	21.16	4.13	3.42	4.79	5.80	10.74	28.41	28.41	6.39	3.43	5.62	4.44	5.15
97	22.89	4.15	3.44	5.17	5.97	13.66	28.98	28.98	6.60	3.47	5.67	4.54	6.61
98	25.00	4.17	3.46	5.54	6.15	16.37	29.56	29.56	6.80	3.52	5.71	4.64	6.08
99	28.10	4.18	3.48	5.92	6.32	19.18	30.13	30.13	7.00	3.56	5.76	4.73	6.64
Avg	5.56	3.18	2.71	3.41	3.49	5.90	14.53	14.53	4.30	2.90	3.47	3.28	3.34
Min	1.80	1.80	2.10	2.50	2.70	3.00	4.91	4.91	3.00	2.18	2.20	1.80	2.10
Max	30.70	4.20	3.50	6.30	6.50	22.00	30.70	30.70	7.20	3.60	5.80	4.83	7.00
RSD	97.3%	21.2%	13.6%	24.6%	26.5%	65.9%	49.7%	49.7%	24.5%	10.8%	30.3%	22.4%	32.9%





Start Year 2007 — 365 = Total Days
Month 2 — 12.00 = Total Months
Day 1

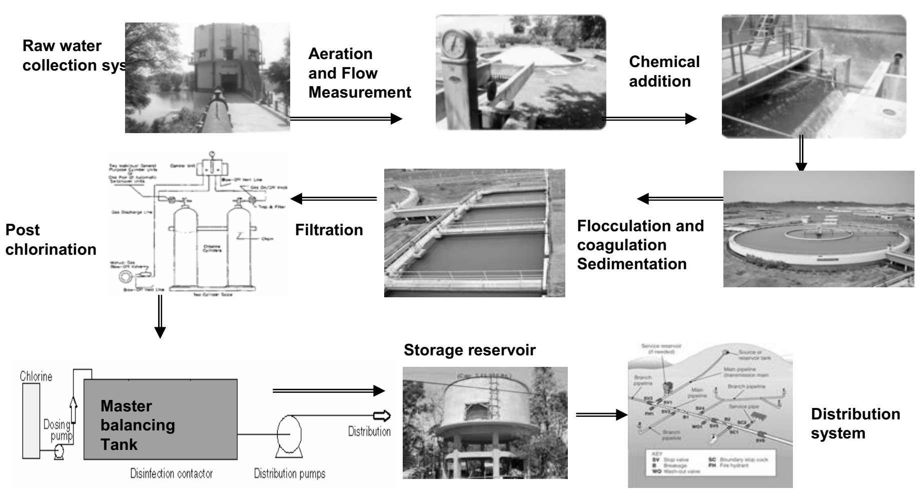
Utility Name	WTP
Plant Name	Parvati
Plant Street Address	Parvati
Plant City, State, Zip	Pune
Plant Contact Name	Nirbhavne
Plant Phone	020-
Plant E-mail Address	-

1Entry_Per_Day PMC Raw

Statistical Results
5/20/2009

Conventional Unit Processes of Water Purification System

The treatment of water for drinking and domestic use includes a combination of different physical, chemical and biological processes to remove unwanted and harmful impurities. The unit operations in water treatment broadly include aeration, flocculation, coagulation, sedimentation, filtration and disinfection.



Effective Operation and Maintenance Practices

Process	Current Practices	Shortfalls	Improved Methods	Approach	Expected Impacts
Source Protection	Confined to prevent contamination	Uncontrolled and domestic wastewater discharges	Implementation of stringent rules by PCB's	Penalty to polluting organization	Preservation of water resources
Intake	Upkeep of screens, silt removal	Poor maintenance, pollution in the vicinity	Ease of access for maintenance and repairs	Change in design parameters	Adequate water flow
Flow Measurement and control	Reckoned with the rated capacity of the pumps	Improper dosing of chemicals, under-loading/ over loading	Modern flow measuring devices with recorders	Adequate financial provision and proper data handling	Adjusted chemical feed rates, detention time
Pre-treatment	Pre chlorination	Improper dose results in corrosion, formation of trihalomethanes	Frequent chlorine demand test	Decide appropriate dose as per seasonal variations	Reduction in THM formation and protection against corrosion and improved life of units

Effective Operation and Maintenance Practices (Contd..)

Process	Current Practices	Shortfalls	Improved Methods	Approach	Expected Impacts
Chemical dosing and control	Alum slabs sometimes added if alum solution is not ready. Application as point addition of alum	Jar test not conducted daily resulting in improper alum dose, poor quality of product water	Decide alum dose daily based on turbidity, Distribute alum solution through perforated pipes across the entire width	Effective mixing of coagulant	Formation of good flocs. Effective settling, minimizing residual alum which is harmful to health
Flocculation and coagulation	Points of excessively high or low velocity in the flocculation chambers, avoiding alum addition during low turbidity	Flash mixers and flocculators not working effectively and bad short-circuiting	Proper O&M of mixers and checking floc formation and flock settle ability	Nominal dose of alum also helps in better removal of other suspended impurities during filtration	Proper utilization of chemical added, resulting in minimization of wastage
Sedimentation	Conventional gravity settling	Overloading / under loading, improper sludge removal arrangements, carryover of flocs	Overflow rate and weir loading should be checked frequently, recycle and reuse from spent waterworks waste	Proper design norms for functional efficiency. Check sludge scraping and sludge removal facilities	Improve settle water quality
Filtration	Rapid gravity single media, down flow filters	Filter gadgets, non functional, pre-decided backwash frequency, inadequate time of water wash	Electronically control rate setters. Proper backwashing schedule	Online turbidity measurement for influent and effluent as reliable index , sand bed for presence of cracks and undulations	Confirms possibility of removal of microbial population

Effective Operation and Maintenance Practices (Contd..)

Process	Current Practices	Shortfalls	Improved Methods	Approach	Expected Impacts
Disinfection	Chlorination with chlorine gas	Safety measures for chlorine cylinders, does not imply complete destruction of living organisms	Adequate chlorination, use of alternate disinfector for waters with identified specific organisms	Frequent testing for proto zones, virus and pathogenic micros	Safe water satisfaction health based standards
Storage	Combined master balancing tank	Improper mixing and inadequate contact time for disinfection	Frequent /online monitoring of residual chlorine and microbial quality of outgoing treated water	Strengthening laboratory facilities for biological parameters	Improvement in product water quality
Distribution system	Frequent leakages resulting to 25 to 35 % wastage of precious treated water and contamination	Apathy of management to timely replace the distribution network	Separation of water distribution and wastewater pipelines,	Effective leak detection programme	Improvement and health and reduction of water born diseases

Data Requirement for Treatment Plant Evaluation

While generating and collecting data, following aspects of Water purification System need to be addressed to

- **Catchments**
  Source of Raw water , | Abstraction of water
  Source Protection, | Flow measurement,
  Control and Pumping | Water quality assessment and Chances of Pollution
- **Conveyance system**
  Distance from treatment work | Raw water intake and pumping
  Enroute possible contamination | Safe guards
- **Treatment - Unit Processes**
  Prechlorination, | Chemical mixing and Coagulation
  Flocculation and sedimentation | Filtration
  Disinfection
- **Water Storage and Distribution**
  Treated water reservoir | Clear water pumping
- **Infrastructure**
  Laboratory facilities | Staff
  Safety measures | Record Keeping
  Quality control | Financial

Information Required

- Plant performance charts
- Raw water turbidity: daily and maximum value
- Sedimentation basin effluent turbidity: daily and maximum value
- Filter effluent turbidity: daily and maximum for each filter
- Water system monthly reports
- Sanitary Surveys
- Evaluation of laboratory quality control (particularly calibration of instruments)

The unit operations in water treatment broadly include aeration, coagulation, flocculation, sedimentation, filtration and disinfection.

- **Raw water collection system** generally consists of in filtration gallery/ intake well when river is the source and canal or closed conduit for reservoirs.
- **Aeration** is provided to oxygenate water and remove odour causing impurities
- **Prechlorination** helps is minimizing the organic pollutants and reduce the load on subsequent units.
- **Chemical addition** involves addition of coagulant like alum, polyaluminum chloride or coagulant aid. Lime is required for pH correction and adequacy of alkinity
- **Flocculation and coagulation** involves formation of flocs of aluminum hydroxide which helps to destabilized collided suspended impurities and agglomeration of the flocs for better settling.
- **Sedimentation** – Essentially removes the coagulated suspended material with the product water quality suitable for conventional sand filtration
- **Filtration** – Removes fine suspended impurities which had escaped previous unit processes to produce aesthetically acceptable, clear water.
- **Post chlorination** – Tackle the problem of microbial contamination and makes the water safe for human consumption.
- **Storage reservoir** – to provide adequate contact time for disinfection and balancing capacity for supply.
- **Distribution system** – Allotment of safe potable water to the door steps of the consumer via elevated service reservoir or individual storage in societies.

Check List of Information

GENERAL
- Name and Location
- Year of Construction
- Design Capacity
- O & M Agency
- Raw Water source

ENGINEERING
- Raw water pumping
- Raising main diameter
- Raw water inflow measurement

PRE-CHLORINATION
- Chemical
- Dosage

COAGULATION
- Chemicals used
- Type of mixing
- Sizes of Flash mixer chamber
- Detention Time

FLOCCULATION
- Method / Type of unit
- No. & Dimensions

SEDIMENTATION
- Type of units
- Surface overflow rate
- Detention time

FILTRATION
- Type of units
- No. & size of units
- Rate of filtration
- Filter media (Depth of sand)
- Backwash arrangements
- Method
- Duration
- Backwash tank capacity

DISINFECTION
- Method
- Chlorinator details
- Type, No, & Capacity

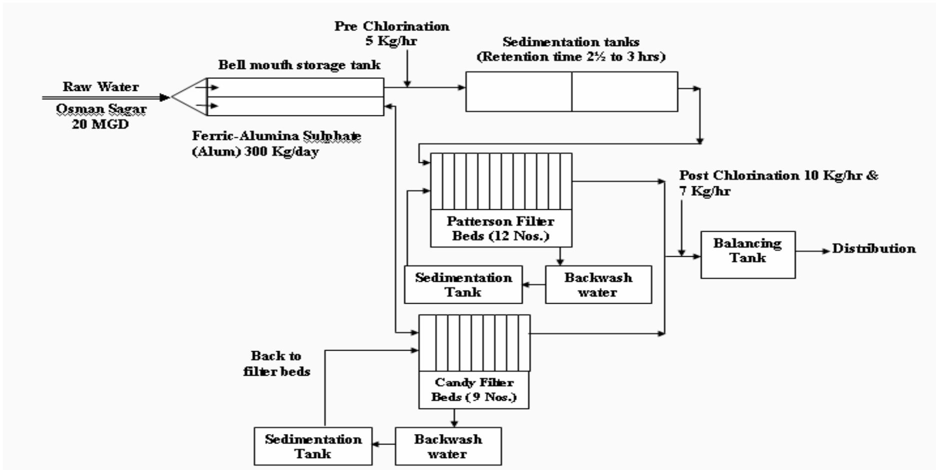
Evaluation Parameters

- **Aeration** - DO, Odour
- **Prechlorination** – Proper mixing ,Residual chlorine, trihalomethane formation potential
- **Chemical addition** – Jar test, pH, alkalinity, resultant turbidity
- **Flocculation** – Floc size, particle size analysis
- **Coagulation –** Settling efficiency of flocs
- **Sedimentation** – Residual turbidity, SOR, weir loading
- **Filtration** – Rate of filtration, head loss, turbidity, frequency and efficiency for backwash,
- **Post chlorination** – Residual chlorine, confirmation for absence of coliform, pathogenic organisms expected from the reported water borne diseases.
- **Storage reservoir** - Residual chlorine, absence of any floating or foam forming material
- **Distribution system** – Leak detection programme, microbial quality, evaluation at consumer end.

Need for improvement – awareness of operators, frequent training to upgrade the knowledge of recent development, third party audit of a water treatment plant

CCP Implementation Experience : Case Studies (I)

Asifnagar Water Treatment Plant (118 MLD)

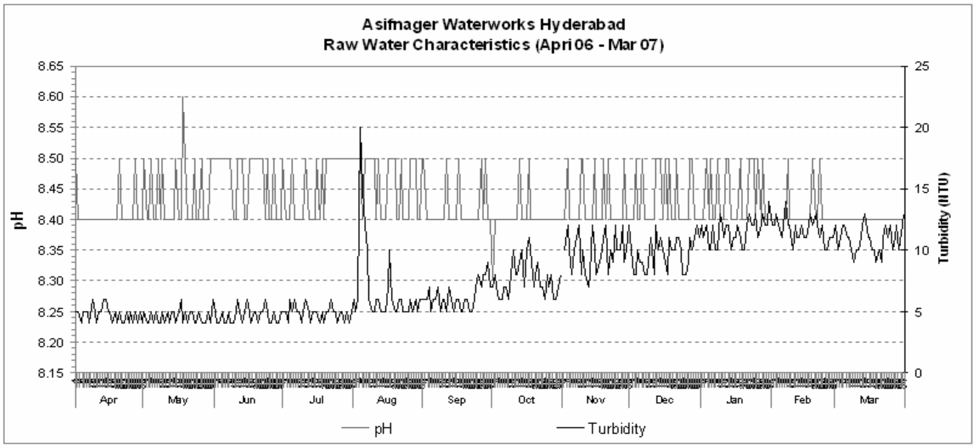


Schematic Flow Chart of Asif Nagar Water Treatment Plant

Sedimentation and Filtration at Asifnagar

Laboratory Facilities

Raw Water Characteristics at Asifnagar Water Treatment Plant



Comprehensive Performance Evaluation – Limiting Factor – Rating Asifnagar Water Treatment Plant, Hyderabad

Issues	Rating				
	Dr. Somdutt	Mr. R.D.Sharma	Mr. D.R. Arya	Mr. Debabrata Mandal	Mr. S. Bhange
A) Source protection and conveyance to plant	A	-	B	-	A
B) Raw water quality	C	-	-	-	-
C) Measurement of raw and treated water flow	B	-	B	-	A
D) Chemical storage for alum, chlorine and PAC	B	-	-	-	B
E) Consumption of chemicals eg. Alum, chlorine and PAC	C	-	B	-	B
F) Flocculation,, coagulation and sedimentation	A	B	B	B	A
G) Filter O & M and Back washing	B	A	-	B	-
H) Disinfection	A	B	A	-	A
I) Process Control	A	B	-	A	-
J) Validation of water quality	B	-	-	-	-
K) Operational staff/Financial/Planning	B	A	A	A	A
L) Supervision	C	A	B	-	B
M) Operation and Maintenance	-	A	B	-	B
N) Housekeeping	-	B	B	A	B

Summary of CPE, Hyderabad

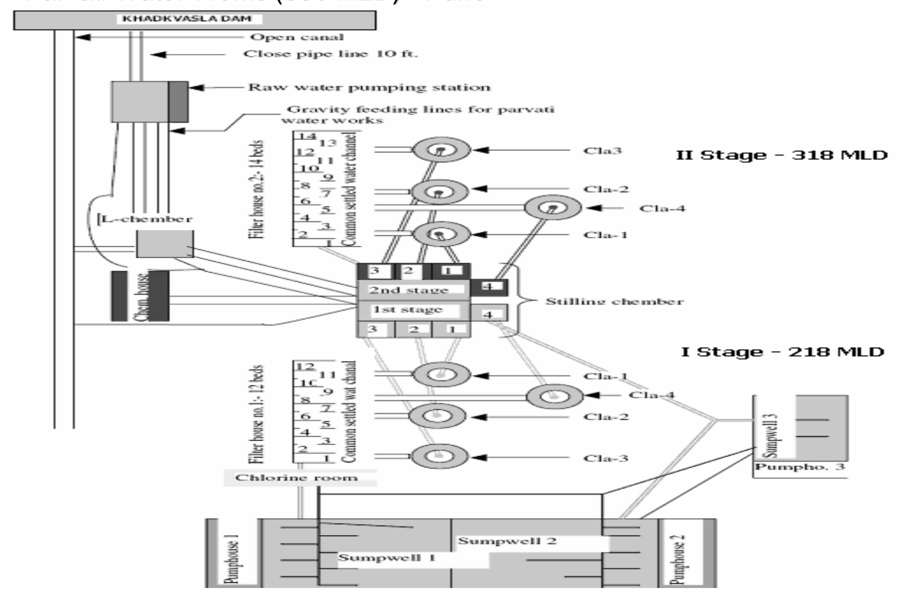
- Source protection and conveyance to plant:
  - Possibility of contamination in Open canal
- Measurement of Raw and Treated water flow:
  - Implant flow measurement system for allowing proper chemical dosing and treatment
- Chemical Application:
  - Jar test, chlorine demand and complete physico-chemical analysis frequency to be increased
- Flocculation, Coagulation and Sedimentation:
  - Equal flow distribution
  - Continuous de-sludging of sedimentation tanks
- Filter O & M and Back Washing:
  - Back washing should be with chlorinated water
  - O & M of filter should be improved and renovate filters

Summary of CPE, Hyderabad (Contd..)

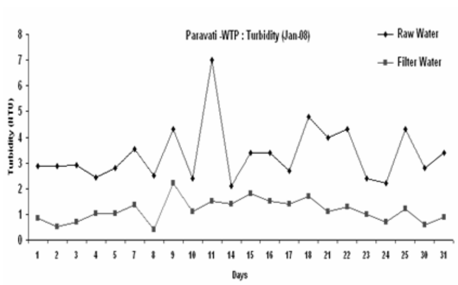
- Disinfection:
  - Maintain residual chlorine up to 1.0 mg/L
- Safety measures:
  - Safety and disaster management plan should be prepared
- Laboratory and Staff:
  - Data generated should be stored in computers for checking the performance
  - Microbiological analysis to be outsourced
  - Blending of experienced and fresh recruited staff is essential
  - Improvement in communication between O & M staff and laboratory staff may be explored
- Housekeeping:
  - Require more attention

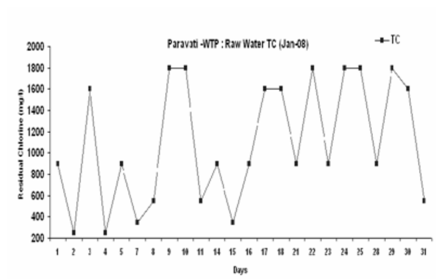
CCP Implementation Experience : Case Studies (II)

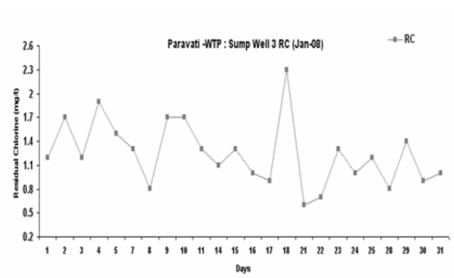
Parvati Water Works (536 MLD) - Pune

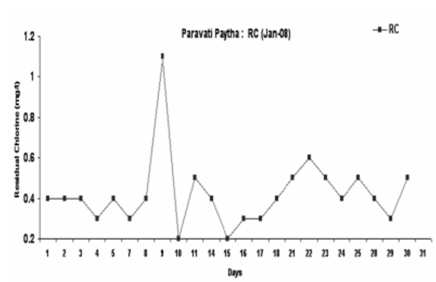


Raw and Treated Water Quality









Storage of Chlorine Cylinders

Improper Storage

Proper Storage

Summary of CPE - Pune

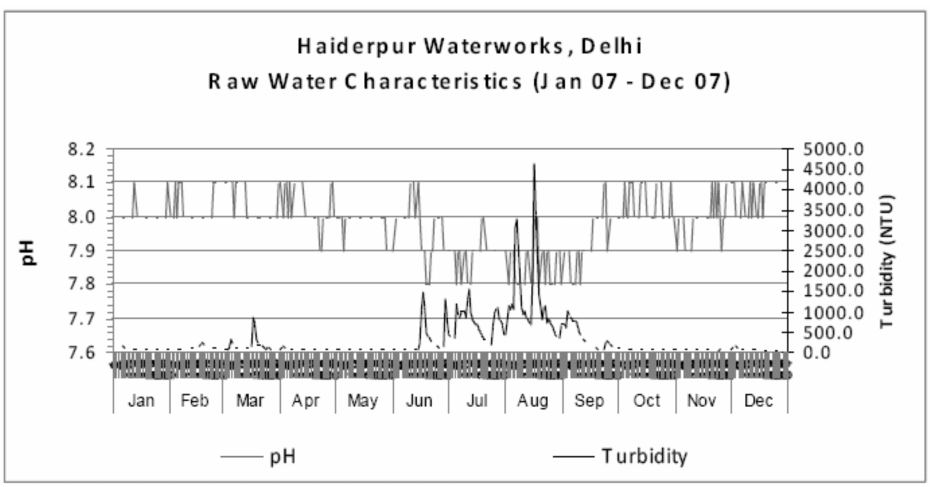
- Closed pipeline for raw water conveyance with the flow meter is planned
- Immediate action taken on improper storage of chlorine cylinders
- Appointment of additional staff – In process
- Modification of existing clarifiers in to tube settlers
- Replacement of filter media – Tender quotations in progress
- Recycling and reuse of backwash water will be operational within 2 years
- The repair works of balancing reservoirs is already taken up. Limitations of direct pumping and capacity of the elevated service reservoirs
- The suggestions for improved efficiency through proper training, safety practices, SOPs, modernization of laboratory and good house keeping

CCP Implementation Experience : Case Studies (III)

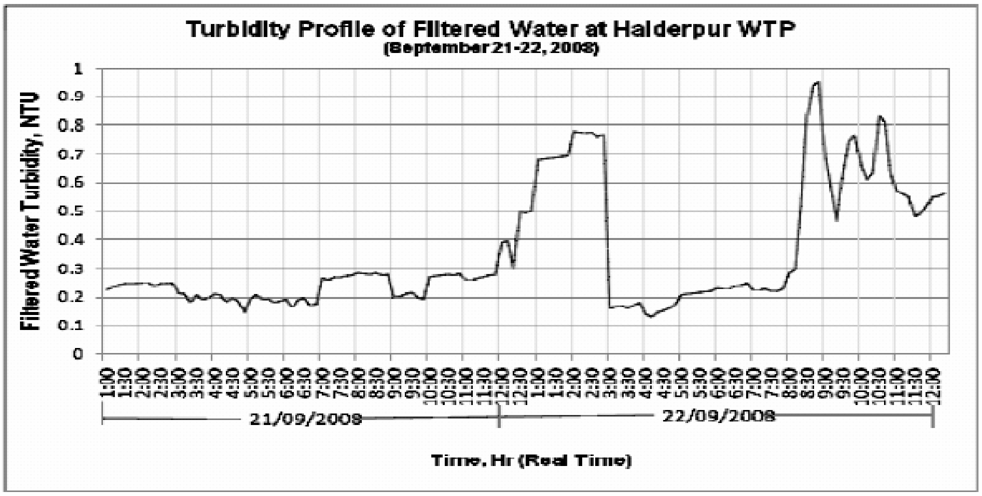
Haiderpur Water Treatment Plant -900 MLD : Delhi

- The Raw water source: Western Jamuna Canal
- It provides treated water to about 43 lacks persons at the rate 150-200 lpcd

Raw Water Characteristics of Haiderpur Water Works During Jan 2007-Dec 2007



Turbidity Profile of Filtered Water at Haiderpur WTP



Summary – (Delhi)

- The auditors also felt that water audit of the plant should also be undertaken.
- Barricading along the raw water channel is suggested.
- V notch may be replaced with fiber.
- CWR is covered by jungles, it should be maintained.
- Empty chlorine toners (cylinders) are to be kept in shade.
- The general housekeeping was found to be satisfactory.

Summary (Contd..) : Delhi

- An energy audit had been conducted by TERI, which should be made a regular practice. The power factor needs to be improved and brought to near 1.0.
- A new closed conduit is under construction, which is expected to remove these problems.
- Since the employees feel that there are less promotional avenues, there is a general dissatisfaction among them, which affects the efficiency. An Award / Reward scheme is recommended.

Conclusions on CCP Application

- CCP proven to be effective tool for treatment plant optimization
- Promise of significant improvements with minimal capital investment
- Each treatment plant is unique and performance limiting factors will vary
- Structure of CCP oversight and participants may vary – team approach is essential
- Capacity building (transfer of responsibility) is important

Conclusions on Evaluation of Water Treatment plants

- Protection of source from contamination
- Necessity of raw water flow measurement and recording devices
- Implementation of Quality assessment and Quality control programme
- Essential tests like Jar Test and Chlorine demand should be performed daily for proper chemical dosing
- Improvement in desludging methodology by enhancing frequency. Recycle and reuse water works waste to conserve the resources.
- Renovations of filters for head loss measurements, troughs, inspection box cover etc.
- Safety measurement plan for chlorine storage.
- Capacity enhancement for balancing tank.
- Online measurement of important quality parameters.
- Routine quality surveillance at consumers end in high, medium & low income groups
- Strengthening manpower with fresh technicians and appropriate training.
- Distribution system evaluation for leak detection and preventive measures.
- Attending and shifting Improper locations of sewage discharges
- Necessity for replacement of old pipelines
- Increase the pressure to provide adequate water at tail enders
- Adopt CCP and WSP concept.
- Minimize political interventions

Evaluation of Engineering, Economic, Health and Social Aspects of Intermittent vis-à-vis Continuous Water Supply Systems in Urban Areas

Prakash S. Kelkar

NEERI, Scientist & Head, GEM Division, Nagpur

OBJECTIVES

- **A critical appraisal of engineering design and operational aspects of intermittent water supply systems commonly in vogue with focus on pressure and flow patterns, per-capita water consumption, delivered water quality and waste levels in the distribution system.**
- **Comparative study of the said parameters when switched over to continuous water supply.**
- **Economic evaluation of the two systems consistent with functionality and with due consideration to the investment by consumers on household water storage.**
- **Assessment of intangibles such as risk to public health and agency consumer relation as influenced by the two modes of water supply.**
- **Arising out of the above, delineate practical recommendations for engineering design of urban water supply systems consistent with functionality, economy and public health safety.**

Selection of Study Area : Criteria

- The study area should be typical and representative of the city
- Number of house connections should be in the range of 100-500 or population size should be 1000-4000
- The area should have completely metered water supply
- The area normally receives intermittent water supply but should be amenable to switch over to 24 hours supply when desired
- The area should be capable of being hydraulically isolated from the rest of the distribution system

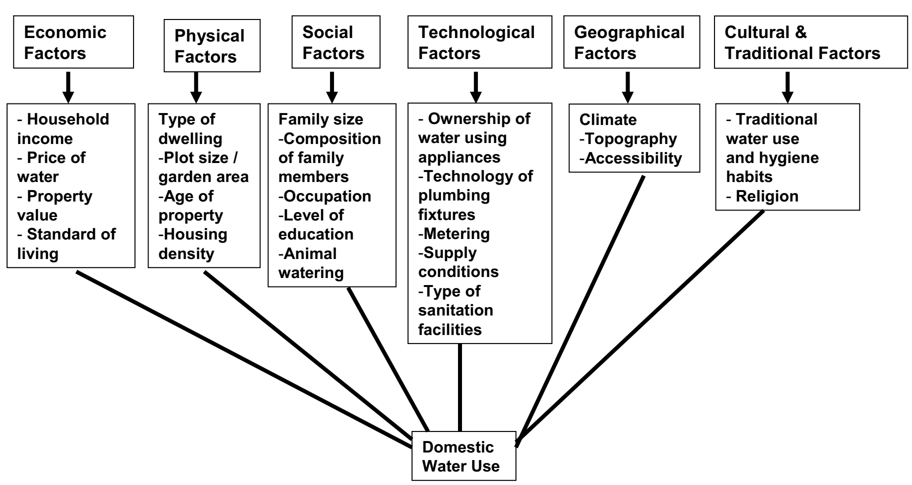
Plan of Work

- Preparatory work including updating of plans showing the pipeline alignment, location of valves, etc.
- Physical verification of distribution network for valves, fire hydrants, bulk meter positions and working condition of valves etc.
- Replacement / repair of defective valves, meters and checking for hydraulic isolation of the zone.
- Population / connection / meter survey
- Installation of bulk meter for flow measurement / waste assessment under intermittent / continuous mode of supply

Plan of Work

- Reading water meter to assess per capita consumption during intermittent as well as continuous water supply
- Assessment of unaccounted for water (UFW) in the project area under intermittent / continuous water supply
- Selection of representative locations for flow and pressure measurements under both modes of water supply
- Selection of sampling points for water quality
- Questionnaire survey for health and socio-economic data

An idealized model showing factors influencing domestic water use



Water Quality :Bacteriological Analysis

- Cracks or openings in the joints etc.
- During repairs or laying new mains in contaminated soil or use of dirty tools in repair work
- Entry of wastewater into the distribution system through leaky service pipes due to back syphonage especially with intermittent water supply
- Cross connections between water distribution system and wastewater collection system

Field Studies

- Water consumption
- Pressure survey
- Flow pattern
- Unaccounted for water
- Water quality
- Socio-economic survey

Per Capita Water Consumption – Lohia Nagar, Ghaziabad Intermittent Water Supply

Sample No.	Period of observation (1992)	Duration (days)	No. of meters read	Per Capita Water Consumption (lpcd)			
				Average	Median	SD	Mode
S1	Apr. 30- July 20	82	31	175	165	79	148
S2	May 27-July 20	55	29	193	177	94	140
S3	June 28 - July 20	23	31	180	177	52	153
S4	Apr. 30- June 28	6	32	171	168	75	170
S5	May 27-June 28	31	30	171	185	66	208
S6	Apr. 30 - May 27	28	31	175	184	67	196

SD – Standard Deviation

Summary Data on Per Capita Water Consumption – Lohia Nagar, Ghaziabad Continuous Water Supply

Sample No.	Period Covered	Duration (days)	No. of meter s read	Per Capita Water Consumption (lpcd)			
				Average	Median	SD	Mode
S1	December 8-29	21	5	256	275	101	270
S2	December 25-29	4	12	249	253	83	253
S3	December 28-29	1	15	246	256	125	255
S4	December 8-28	20	11	240	230	93	225
S5	December 25-28	3	16	168	100	113	88
S6	December 8-25	17	10	174	120	126	70

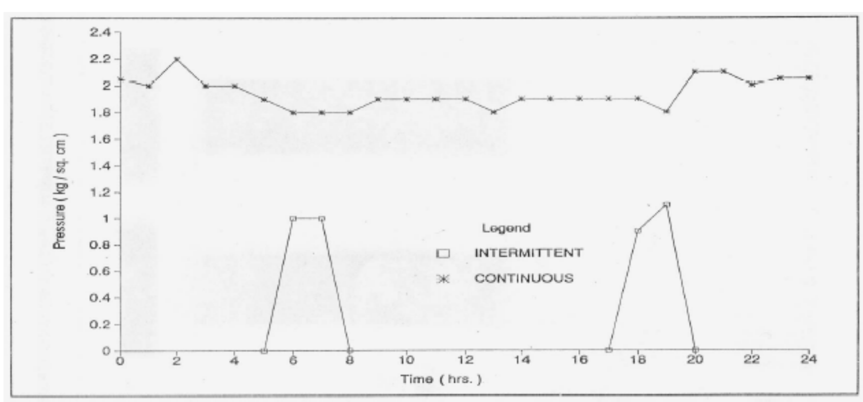
SD – Standard Deviation

Summary Data on Per Capita Water Consumption in Study Zones

Name of the City	Intermittent water Supply				Continuous Water Supply			
	Mean	Median	Mode	SD	Mean	Median	Mode	SD
Ghaziabad	175	165	148	79	249	253	253	82
Jaipur	174	149	133	90	193	186	189	87
Nagpur	209	188	146	119	232	235	130	108
Panji	120	102	70	74	158	134	125	92

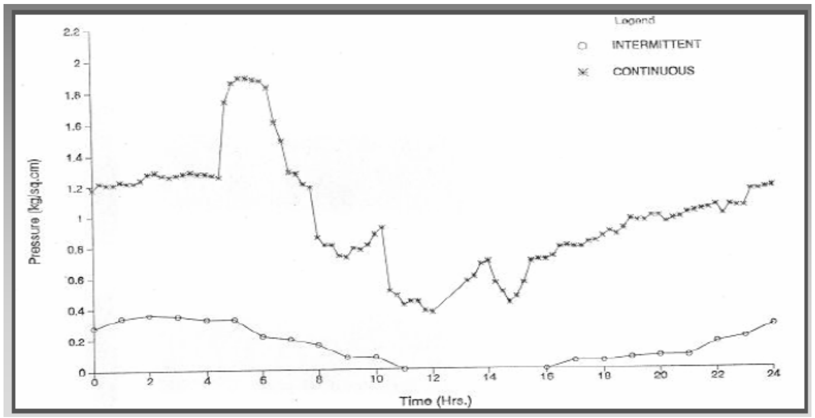
SD – Standard Deviation

Field Pressure

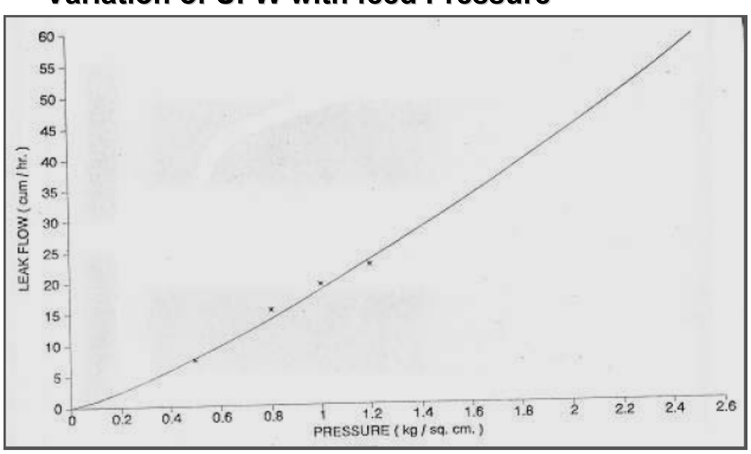


Comparison of field pressure variation at location II

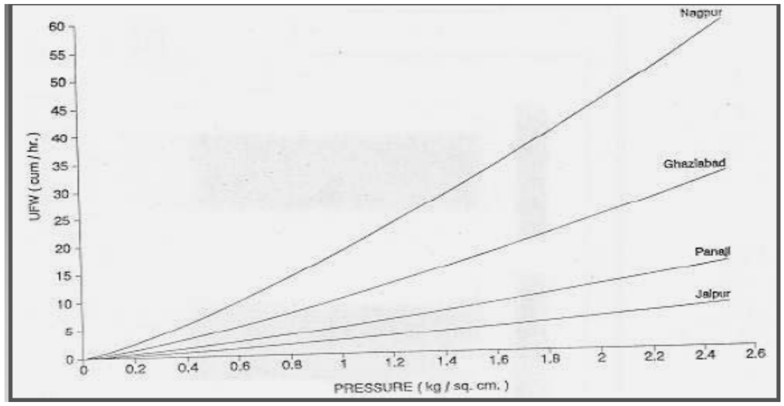
Comparison of field pressure variation at Location V



Variation of UFW with feed Pressure

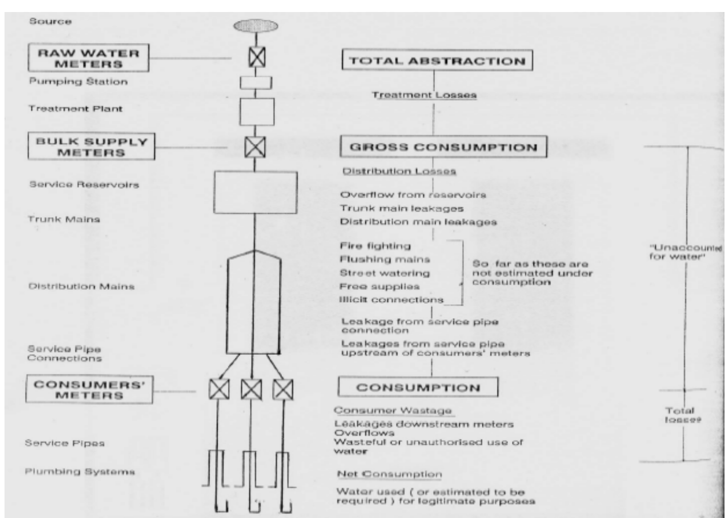


Unaccounted for Water

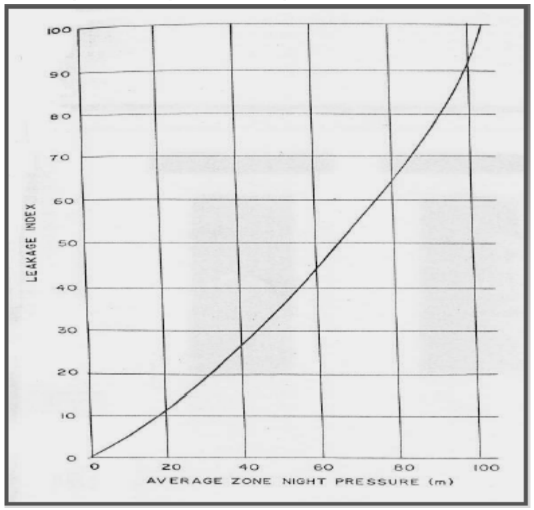


Variation of UFW with feed pressure in study areas

Water Balance Scenario – Abstraction to consumption in a water supply system



Relationship between leakage (Net Night Flow) and pressure



Salient Findings

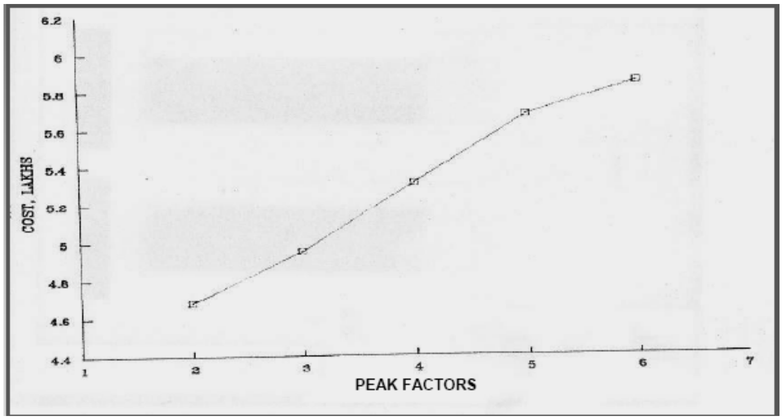
INTERMITTENT VIS-A-VIS CONTINUOUS WATER SUPPLY SYSTEMS

SALIENT FINDINGS

Particulars	Intermittent Water Supply (IWS)				Continuous Water Supply (CWS)			
	Ghaziabad	Jaipur	Nagpur	Panaji	Ghaziabad	Jaipur	Nagpur	Panaji
Duration of supply (Hours)	10	3	16	5	24	24	24	24
Per capita consumption (LPCD)	175	174	209	120	249	193	232	158
Pressure (meters of water column)	Nil-25	8.2-19	1.2-10	1-21	1.5-12.5	18-25	1.4-24	2-24
Total supply (Cum/day)	482.6	197.0	924.6	185.2	770.7	299.5	1093.0	298.1
Average flow (Cum/hr)	48.3	65.7	57.8	37.0	32.1	12.5	45.5	12.4
Peak factor	6.15	4.38	2.03	6.40	3.06	1.66	2.02	1.98
UFW as % of total supply based on								
a) Average consumption	27.0	19.5	32.0	35.8	34.1	31.0	35.0	47.8
b) Field Study	21.0	11.0	28.0	32.6	12.0	62.0	44.0	56.8
Percent samples negative for faecal coliforms	24.5	73.5	37.4	60	48.5	91.2	93.5	100

UFW : Unaccounted For Water

Costs for different peak factors



Socio-economic Survey

- Consumers satisfaction
- Degree of Service
- Storage requirements
- Tariff structure

Annexure 2.1

CPE Proforma for Auditors to Record the Assessment of Plant Performance

CPE Performance Limiting Factors Summary		
Plant Name/Location:		
CPE Performed By:		
CPE Date:		
Plant Type:		
Source Water:		
Performance Summary:		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**

Rating Description

A — Major effect on long-term repetitive basis.
B — Moderate effect on a routine basis or major effect on a periodic basis.
C — Minor effect.

Performance Limiting Factors Notes		
Factor	**Notes**	
	•	
	•	

CPE Factor Summary Sheet Terms

Plant Type	:	Brief but specific description of plant type (e.g., conventional with flash mix, flocculation, sedimentation, filtration and chlorine disinfection; or direct filtration with flash mix, flocculation and chlorine disinfection).
Source Water	:	Brief description of source water (e.g., surface water including name of water body).
Performance Summary	:	Brief description of plant performance based on performance assessment component of the CPE (i.e., ability of plant to meet optimized performance goals).
Ranking Table	:	A listing of identified performance limiting factors that directly impact plant performance and reliability.
Rank	:	Relative ranking of factor based on prioritization of all “A” and “B” rated factors identified during the CPE.
Rating	:	Rating of factor based on impact on plant performance and reliability: A — Major effect on a long-term repetitive basis B — Moderate effect on a routine basis or major effect on a periodic basis C — Minor effect
Performance Limiting Factor (Category)	:	Factor identified from Checklist of Performance Limiting Factors, including factor category (e.g., administration, design, operation, and maintenance).
Notes: Brief listing of reasons each factor was identified (e.g., lack of process control testing, no defined performance goals).		

Guidelines

Definitions for assessing performance limiting factors

Note: The following list of defined factors is provided to assist the evaluator with identifying performance limitations associated with protection against microbial contaminatants in water treatment system. Performance limiting factors are described below using the following former.

A. Category

1. Subcategory
   a. Factor name
      - ♦ Factor description
        - ➢ Example of factor applied to specific plant or utility.

B. Administration

1. Plant administrators
   a. Policies
      - ♦ Do existing policies or lack of polices discourage staff members from making required operation, maintenance, and management decision to support plant performance and reliability?
        - ➢ Utility administration has not communicated a clear policy to optimize plant performance for public health protection.
        - ➢ Multiple management levels within a utility contribute to unclear communication and lack of responsibility for plant operation and performance.
        - ➢ Cost saving is emphasized by management at the expense of plant performance.
        - ➢ Utility managers do not support reasonable training and Certification requests by plant staff.
        - ➢ Administration continues to allow connections to the distribution system consideration for the capacity of the plant.

   b. Familiarity with plant needs
      - ♦ Do administrators lack first hand knowledge of plant needs?
        - ➢ The utility administrators do not make plant visits or otherwise communicate with plant staff.
        - ➢ Utility administrators do not request input from plant staff during budget development.

   c. Supervision
      - ♦ Do management styles, organizational capabilities, budgeting skills, or communication practices at any management levels adversely impact the plant to the extent that performance is affected?
        - ➢ A controlling supervision style does not allow the staff to contribute to operational decisions.
        - ➢ A plant supervisor's inability to set priorities for staff in sufficient time allocated for process control.

   d. Planning
      - ♦ Does the lack of long range planning for facility replacement or alternative source water quantity or quality adversely impact performance?
        - ➢ A utility has approved the connection of new customers to the water system demand impacts on the plant capacity.
        - ➢ An inadequate capital replacement program results in utilization of updated equipment that can support optimization goals.

e. Complacency
- ♦ Does the presence of consistent, high quality source water results in within the water utility?
  - ➢ Due to the existence of consistent, high quality source water, plant staff is not prepared to address unusual water quality conditions.
  - ➢ A utility does not have an emergency response plan in place to respond to unusual water quality conditions or events.

f. Reliability
- ♦ Do inadequate facilities or equipment, or depth of staff capability, present a potential weak link within the water utility to achieve and sustain optimized performance?
  - ➢ Outdated filter control valves result in turbidity spikes in the filtered water entering the plant clears well.
  - ➢ Plant staff capability to respond to unusual water quality conditions exists with only the laboratory supervision.

g. Source water protection
- ♦ Does the water quality lack an active source water protection program?
  - ➢ The absence of source water protection program has resulted in the failure to identify and eliminate the discharge of failed septic tanks into utility's source water lake.
  - ➢ Utility management has not evaluated the impact of potential contamination sources on water quality within their existing watershed.

2. Plant Staff

a. Number
- ♦ Does a limited number of people employed have a detrimental effect on plant operations or maintenance?
  - ➢ Plant staff are responsible for operation and maintenance of plant as well as distribution system and meter reading, limiting the time available for process control testing and process adjustment.

b. Plant coverage
- ♦ Does the lack of plant coverage result inadequate time to complete necessary operational activities? (Note: This factor could have significant impact if no alarm/shutdown capability exists- see design factors).
  - ➢ Staffs are not present at the plant during evening, weekends, or holidays to make appropriate plant and process control adjustments.
  - ➢ Staff is not available to respond to changing source water quality characteristics.

c. Personnel turnover
- ♦ Does high personnel turnover cause operation and maintenance problems that affect process performance or reability?
  - ➢ The lack of support for plant needs results in high operator turnover and, subsequently, in consistent operating procedures and low staff morale.

d. Compensation
- ♦ Does a low pay scale or benefit package discourage more highly qualified persons from applying for operator positions or cause operators to leave after they are trained?
  - ➢ The current pay scale does not attract personnel with sufficient qualifications to support plant process control and testing needs.

e. Work environment
- ♦ Does a poor work environment create a condition for " sloppy work habits" and lower operator morel
  - ➢ A small, noisy workspace is not conductive for recording and development of plant data.

f. Certification
- Does the lack of certificate personnel result in poor O&M decision?
  - The lack of certification hinders the staff's ability to make proper process control adjustments.

3. Financial

a. Operating ratio
- Does the utility have inadequate revenues to cover operation, maintenance, and replacement of necessary equipment (i.e., operating ratio less than 1.0)
  - The current utility rate structure does not provide adequate funding and limits expenditures necessary to pursue optimized performance (e.g., equipment replacement, chemical purchases, and spare parts).

b. Coverage ratio
- Does the utility inadequate net operating profit to cover debt service requirements (i.e., coverage ratio less than 1.25)
  - The magnitude of a utility debt service has severely impacted expenditures on necessary plant equipment and supplies.

c. Reserves
- Does the utility have inadequate reserves to cover unexpected expenses or future facility replacement?
  - A utility has a 40 year-old water treatment plant requiring significant modifications; however, no reserve account has been established to fund these needed capital expenditure.

C. Design

1. Source water quality

a. Microbial contamination
- Does the presence of microbial contamination sources in close proximity to the water treatment plant intake impact the plant's ability to provide an adequate treatment barrier?
  - A water treatment plant intake is located downstream of a major wastewater treatment plant discharge and is subject to high percentage of this flow during drought periods.

2. Unit process adequacy

a. Intake structure
- Does the design of the intake structure result in excessive clogging of screens, build- up of slit, or passage of material that affects plant equipment ?
  - The location of an intake structure on the outside bank of the river causes excessive collection of debris, resulting in plugging of the plant flow meter and static mixer.
  - The design of a reservoir intake structure does not include flexibility to draw water at varying levels to minimize algae concentration.

b. Pre-sedimentation basin
- Does the design of an existing pre-sedimentation basin or the lack of a pre-sedimentation basin contribute to degraded plant performance?
  - The lack of flexibility with a pre-sedimentation basin (i.e., number of basins, size, and bypass) causes excessive algae growth, impacting plant performance.
  - A conventional plant treating water directly from a "flashy" stream experiences performance problem during high turbidity events.

c. Raw water pumping
- Does the use of constant sped pumps cause undesirable hydraulic loading on downstream unit processes?
  - The on- off cycle associated with raw water pump operation at plant results in turbidity spikes in the sedimentation basin and filters.

d. Flow measurement

- Does the lack of flow measurement devices or their accuracy limit plant control or impact process control adjustments?
  - The flow measurement device in a plant is not accurate, resulting in inconsistent flow measurement records and the ability to pace chemical feed rates according to flow.

e. Chemical storage and feed facilities

- Do in adequate chemical storages and feed facilities limit process needs in a plant?
  - Inadequate chemical storage facilities exist at a plant, resulting in excessive chemical handling and deliveries.
  - Capability does not exist to measure and adjust the coagulant and flocculants feed rates.

f. Flash mix

- Does inadequate mixing result in excessive chemical use or insufficient coagulation to the extent that it impacts plant performance?
  - Static mixer does not provide effective chemical mixing throughout the entire operating flow range of the plant.
  - Absence of a flash mixer results in less than optimal chemical addition and insufficient coagulation.

g. Flocculation

- Does a lack of flocculation time, inadequate equipment, or lack of multiple flocculation stages result in poor floc formation and degrade plant performance?
  - A direct filtration plant, treating cold water and utilizing a flocculation basin with short detention time and hydraulic mixing, does not create adequate floc for filtration.

h. Sedimentation

- Does the sedimentation basin configuration or equipment cause inadequate solids removals that negatively impacts filter performance?
  - The inlet and outlet configuration of the sedimentation basin cause short-circuiting, resulting in poor settling and floc carryover to the filters.
  - The outlet configuration causes floc break-up resulting in poor filter performance
  - The surface area of the available sedimentation basins is adequate, resulting in solids loss and inability to meet optimized performance criteria for the process.

i. Filtration

- Does filter or filter media characteristics limit the filtration process performance?
  - The filter loading rate in a plant is excessive, resulting in poor filter performance.
  - Either the filter under drain or support gravel have been damaged to the extent that filter performance is impacted.
- Do filter rate-of –flow control valves provide a consistent, controlled filtration rate?
  - The rate –of –flow control valves produce erratic, in consistent flow rates that result in turbidity and/or particle spikes.
- Do in adequate surface wash or backwash facilities limit the ability to clean the filter beds?
  - The backwash pumps for a filtration system do not have sufficient capacity to adequately clean the filters during backwash.
  - The surface wash units are inadequate to properly clean the filter media.
  - Backwash rate is not sufficient to provide proper bed expansion to properly clean the filter.

j. Disinfection

- Do the disinfection facilities have limitations, such as adequate detention time, improper mixing, feed rates, proportional feeds, or baffling, that contribute to poor disinfection?
  - An snaffled clear well does not provide the necessary detention time to meet the giardia inactivation requirements of the SWTR

k. Sludge / Backwash water treatment and disposal

- ♦ Do inadequate sludge or backwash decent water without adequate treatment.
  - ➢ The plant is recycling backwash decent water without adequate treatment.
  - ➢ The plant is recycling backwash water intermittently with high volume pumps.
  - ➢ The effluent discharged from sludge/ backwash water storage lagoon does not applicable receiving stream permits.
  - ➢ Inadequate long-term sludge disposal exists at a plant, resulting in reduced cleaning of settling basin and recycle of solids back to the plant.

3. Plant operability

a. Process flexibility

- ♦ Does the lack of flexibility to feed chemicals at desired process locations or the lack of flexibility to operate equipment or processes in an optimized mode limit the plant's ability to achieve desired performance goals?
  - ➢ A plant does not have the flexibility to feed either a flocculants aid to enhance floc development and strength or a filter aid to improve filter performance.
  - ➢ A plant includes two sedimentation basins that can be operated in series.

b. Process controllability

- ♦ Do existing process controls or lack of specific controls limit the adjustment and control of a process over the desired operating range?
  - ➢ Filter backwash control does not allow for the ramping up and down of the flow rate during a backwash event.
  - ➢ During filter backwash, the lack of flow control through the plant causes hydraulic surging valves to overcompensates during flow rate changes in a plant
  - ➢ Flow between parallel treatment units are not equal and cannot be controlled.
  - ➢ The plant influent pumps cannot be easily controlled or adjusted, necessitating automatic start-up/shutdown of raw water pumps.
  - ➢ Plant flow rate measurement is not adequate to allow accurate control or chemical fed rates.
  - ➢ Chemical feed rates are not easily changed or are not automatically changed to account for changes in plant flow rates.

c. Process instrumentation /automation

- ♦ Does the lack of process instrumentation or automation causes excessive operator time for process control and monitoring?
  - ➢ A plant does not have continuous recording turbidimerters on each filter, resulting in extensive operator time for sampling.
  - ➢ The indication of plant flow rate is only located in the pipe gallery, which causes difficulty in coordinating plant operation and control.
  - ➢ Automatic shutdown/start- up of the plant results in poor unit process performance.

d. Standby units for key equipment

- ♦ Does the lack of standby unit for key equipment cause degraded process performance during breakdown or during necessary preventive maintenance activities?
  - ➢ Only one backwash pump is available to pump water to backwash supply tank, and the combination of limited supply tank volume and an unreliable pump has caused staff to limit backwashing of filter during peak production periods.

e. Flow proportioning

- ♦ Does inadequate flow splitting to parallel process units causes individual unit overloads that degree process performance?
  - ➢ Influent flow to a plant is hydraulically split to multiple treatment trains, and uneven flow distribution causes overloading of one flocculation/sedimentation train over the other.

f. Filter systems
- ♦ Does the absence or inadequacy of an alarm system for critical equipment or process cause that degraded process performance?
  - ➢ A plant that is not staffed full-time does not have alarm and plant shut-down capability for critical finished water quality parameter (i.e., turbidity, chlorine residual).

g. Alternate power source
- ♦ Does the absence of an alternate power source cause reability problem leading to degraded plant performance?
  - ➢ A plant has frequent power outages, and resulting plant shutdowns and start-ups cause turbidity spikes in the filtered water.

h. Laboratory space and equipment
- ♦ Does the absence of an adequately equipped laboratory limit plant performance?
  - ➢ A plant does not have an adequate process control laboratory for operators to perform key tests (i.e., turbidity, jar testing)

i. Sample taps
- ♦ Does the lack of sample taps on process flow streams prevent needed in formation from being obtained to optimized performance?
  - ➢ Filter –to- waste piping following plant filters does not include sample taps to measure the turbidity spike following backwash
  - ➢ Sludge sample taps are not available on sedimentation basins to allow process control of the sludge draw-off from these units.

D. Operation

1. Testing

a. Process control testing
- ♦ Does the absence or wrong type of process control testing Cause operational control decisions to be made?
  - ➢ Plant staffs do not measure and record raw water ph, alkalinity, and turbidity on routine basis; consequently, the impact of raw water quality on plant performance cannot be assessed.
  - ➢ Sedimentation basin effluent turbidity is not measured routinely in a plant.

b. Representative sampling
- ♦ Do monitoring results inaccurately represent plant Performance or are samples collected improperly
  - ➢ Plant staffs do not record the maximum turbidity spikes that occur during filter operation and following filter backwash events.
  - ➢ Turbidity sampling is not performed during periods when reclaim backwash water pump is in operation.

2. Process control

a. Time on job
- ♦ Does staff's short time on the job and associated unfamiliarity with process control and plant needs result in inadequate or improper control adjustment
  - ➢ Utility staff, unfamiliar with surface water treatment, were given responsibility to start anew plant; and lack of experience training contributed to improper coagulation control and poor performance.

b. Water treatment understand
- ♦ Does the operator's lack of basic water treatment understanding contribute to improper operational decision and poor plant performance or reliability?
  - ➢ Plant staffs do not have sufficient understanding of water treatment processes to make proper equipment or process adjustments.
  - ➢ Plant staffs have limited exposure to water treatment terminology, limiting their ability to interpret information presented in training events or in published information.

c. Application of concepts and testing to process control

- ♦ Is the staff deficient in the application of their knowledge of water treatment interpretation of process control testing such that improper process control adjustments are made?
  - ➢ Plant staffs do not perform jar testing to determine appropriate coagulant dosages for different water quality conditions.
  - ➢ Plants filters are placed back in service following backwash without consideration for effluent turbidity levels.
  - ➢ Filter to waste valves are available but are not used following filters backwash.
  - ➢ Plant staffs do not calculate chemical dosages on routine basis.
  - ➢ Plant staffs do not change chemical feed system to respond to changes in raw water quality.
  - ➢ Filters are backwash based on time in service or head loss rather than on optimized performance goal for turbidity or practice removal.
  - ➢ Plant staff "bump" filter by increasing the hydraulic loading to see if backwash is necessary.
  - ➢ Visual observation rather than process control testing controls sedimentation basin performance.

3. Operational resources

a. Training program

- ♦ Does inadequate training result in improper process control decisions by plant staff?
  - ➢ A training program does not exist for new operator at a plant, resulting in inconsistent operator capabilities.

b. Technical guidance

- ♦ Does inappropriate information received from a technical resource (i.e., design engineer, equipment representative, regulator, peer) cause improper decisions or priorities to be implemented?
  - ➢ A technical resource occasionally provides recommendations to the plant staff; however, recommendations are not based on plant-specific studies.

c. Operation guidelines/procedures

- ♦ Does the lack of plant-specific operation guidelines and procedures result in inconsistent operation decisions that impact performance?
  - ➢ The lack of operational procedures has caused inconsistent sampling between operator shift and has led to improper data interpretation and process control adjustment

A. Maintenance

1. Maintenance Program

a. Preventive

- ♦ Does the absence or lack of an effective preventive program cause unnecessary equipment failure or excessive downtime that results in plant performance or reliability problems?
  - ➢ Preventive maintenance is not performance on plant equipment as recommended by the manufacturer, resulting in premature equipment failure and degraded plant performance.
  - ➢ A work order system does not exist to identify and correct equipment that is functioning improperly.

b. Corrective

- ♦ Does the lack of corrective maintained procedures affect the Completion of emergency equipment maintenance?
  - ➢ A priority system does not exist on completion of corrective maintenance activities, resulting in critical sedimentation basin out of service for an extended period.
  - ➢ Inadequate critical spare parts are available at the plant, resulting in equipment downtime.

c. Housekeeping

- Does alack of good housekeeping procedure detract from the professional Image of the water treatment plant?
  - An unkempt, cluttered working environment in plant does not support the overall good performance of the facility.

2. Maintenance resources

a. Material and equipment

- Does the lack of necessary material and tools delay the response time to correct plant equipment problems?
  - Inadequate tool resources at a plant results in increased delays in repairing equipment.

b. Skill or contract services

- Do Plant maintenance staff have inadequate skill to correct equipment Problems or do maintenance staff have limited access to contract Maintenance service
  - Plant maintenance staff does not have instrumentation and control skills or access to contract service for these skills, resulting in the inability to correct malfunctioning filter rate control valves.

Plant Information

Checklist of Performance Limiting Factors

B. ADMINISTRATION

1. Plant Administrators
   - a. ☐ Policies ______
   - b. ☐ Familiarity With Plant Needs ______
   - c. ☐ Supervision ______
   - d. ☐ Planning ______
   - e. ☐ Complacency ______
   - f. ☐ Reliability ______
   - g. ☐ Source Water Protection ______
2. Plant Staff
   - a. ☐ Number ______
   - b. ☐ Plant Coverage ______
   - c. ☐ Personnel Turnover ______
   - d. ☐ Compensation ______
   - e. ☐ Work Environment ______
   - f. ☐ Certification ______
3. Financial
   - a. ☐ Operating Ratio ______
   - b. ☐ Coverage Ratio ______
   - c. ☐ Reserves ______

[

C. DESIGN

1. Source Water Quality
   - a. ☐ Microbial Contamination ______
2. Unit Process Adequacy
   - a. ☐ Intake Structure ______
   - b. ☐ Presedimentation Basin ______
   - c. ☐ Raw Water Pumping ______
   - d. ☐ Flow Measurement ______
   - e. ☐ Chemical Storage and Feed Facilities ______
   - f. ☐ Flash Mix ______
   - g. ☐ Flocculation ______
   - h. ☐ Sedimentation ______
   - i. ☐ Filtration ______
   - j. ☐ Disinfection ______
   - k. ☐ Sludge/Backwash Water Treatment and Disposal ______
3. Plant Operability
   - a. ☐ Process Flexibility ______
   - b. ☐ Process Controllability ______
   - c. ☐ Process Instrumentation/ Automation ______
   - d. ☐ Standby Units for Key Equipment ______
   - e. ☐ Flow Proportioning ______
   - f. ☐ Alarm Systems ______
   - g. ☐ Alternate Power Source ______
   - h. ☐ Laboratory Space and Equipment ______
   - i. ☐ Sample Taps ______

D. OPERATION

1. Testing
   a. ☐ Process Control Testing ______
   b. ☐ Representative Sampling ______
2. Process Control
   a. ☐ Time on the Job ______
   b. ☐ Water Treatment Understanding ______
   c. ☐ Application of Concepts and Testing to Process Control ______
3. Operational Resources
   a. ☐ Training Program ______
   b. ☐ Technical Guidance ______
   c. ☐ Operational Guidelines/Procedures ______

E. MAINTENANCE

1. Maintenance Program
   a. ☐ Preventive ______
   b. ☐ Corrective ______
   c. ☐ Housekeeping ______
2. Maintenance Resources
   a. ☐ Materials and Equipment ______
   b. ☐ Skills or Contract Services ______

Annexure 2.2

Determination of Rate Capacities of unit processes

A) Major unit process evaluations - Water treatment plant

A comprehensive performance Evaluation of model plant A is being conducted. Field data have been collected and design data forms have been completed.

The basic facility information, appropriate part of the design data forms, and criteria for major unit process evaluation are collected. The next step required is to develop performance potential graph is attached for your use.

Complete the following steps as a group:

1. Read the attached information.
2. Draft the performance potential graph.
3. Determine the major unit process types
4. Be prepared to report your findings.

The following can be used to prepare Performance potential graph and assess the major unit processes.

Flocculation

1. Select hydraulic detention time necessary to allow floc formation **(Table A1**)
2. Calculate flocculation basin volume in gallons.
3. Calculate rated capacity:

$$\text{Rated Capacity} = \frac{Basin\,Volume(gal)}{HydraulicDetentionTime(\min)} \times \frac{MGD}{694.4\,gpm}$$

$$\text{Rated Capacity} = \frac{Basin\,Volume(m3)}{HydraulicDetentionTime(\min)} \times \frac{MLD}{41.7\,M3/hr}$$

Sedimentation

1 Select surface overflow rate necessary to allow adequate settling.

2 Calculate sedimentation basin surface area.

3 Surface area = number of basin × length × width.

4 Calculated rated capacity:

Rated Capacity = Surface Area (ft^2) × Surface Overflow Rate (gpm/ft^2) × $\frac{MGD}{694.4\,gpm}$

Rate Capacity = Surface Area (m^2) × Surface Overflow Rate (m/hr) × $\frac{MLD}{41.7\,m3/hr}$

Filtration

1 Select filtration rate necessary to ensure adequate filtration
2 Calculate filter surface area.
3 Surface area = number of filters × length × width.
4 Calculate rated capacity:

$$\text{Rated Capacity} = \text{Surface Area } (m^2) \times \text{Filtration Rate } (m/hr) \times \frac{MLD}{41.7 m3/hr}$$

Disinfection

1. Utilized the information included on the Design Data from for disinfection to calculate the functional volume of the clear well.
2. Utilize the selected process parameter included on the Design Data form for disinfection and the CT Table to determine the required CT.

$$\text{Contact Time} = \frac{CT_{10(mg/L-\min)}}{Cl_{2\,\mathrm{Re}\,sidual\,(mg/L)}}$$

3. Determine rated capacity:

$$\text{Rated Capacity} = \frac{Funtionalvolume(gal)}{ContactTime(\min)} \times \frac{MGD}{694.4 gpm}$$

Criteria for Major Unit Process Evaluation

Table A1. Major Unit Process Evaluation Criteria

Flocculation	**Hydraulic Detention Time**
Base	20 minutes
Single-Stage	30 minutes
	25 minutes
Multiple-Stage	20 minutes
	15 minutes

Sedimentation				
Conventional (circular and rectangular) and solids contact units (Operating mode)				
Conventional Depth (ft)	Solids Contact Depth (ft)	Turbidity Removal (SOR) (gm/ft²)	Softening SOR (gm/ft²)	Colour Removal SOR (gm/ft²)
10	12-14	0.5	0.5	0.3
12-14	14-16	0.6	0.75	0.4
>14	>16	0.7	1.0	0.5

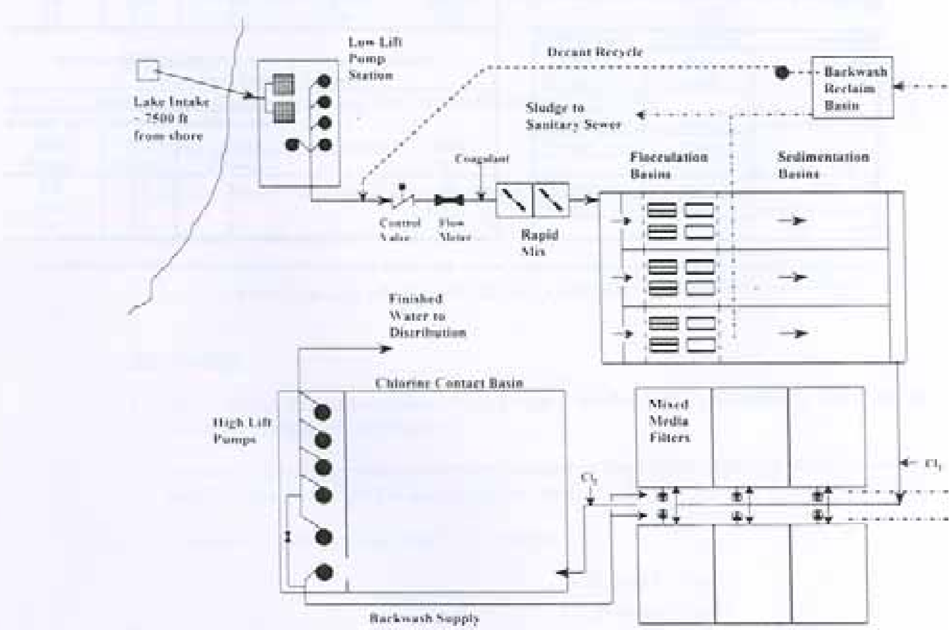
Conventional (circular and rectangular) and solids contact units with vertical tube settlers (Operating mode)			
Conventional Depth (ft)	Turbidity Removal (SOR) (gm/ft²)	Softening SOR (gm/ft²)	Colour Removal SOR (gm/ft²)
10	1.0	1.5	0.5
12-14	1.5	2.0	0.75
>14	2.0	2.5	1.0

Facility Formation

The example Water Treatment Plant A severs a suburban community of approximately 24,000 people. The plant was completed and is owned and operated by the community. The water use is all residential and commercial since there is no significant industry in the community.

The plant was originally designed to treat 9 MGD. Normally during the year the plant is operated 24 hours per day. The average flow through the plant for past year was about 6MGD and the peak daily flow rate was 12 MGD during the summer.

Plant treats water from a lake source, which provides an adequate supply of water. Raw water turbidity can be as high as 60 during the winter and spring. The water supply is generally of good quality and has not had any significant organics detected during annual spring.

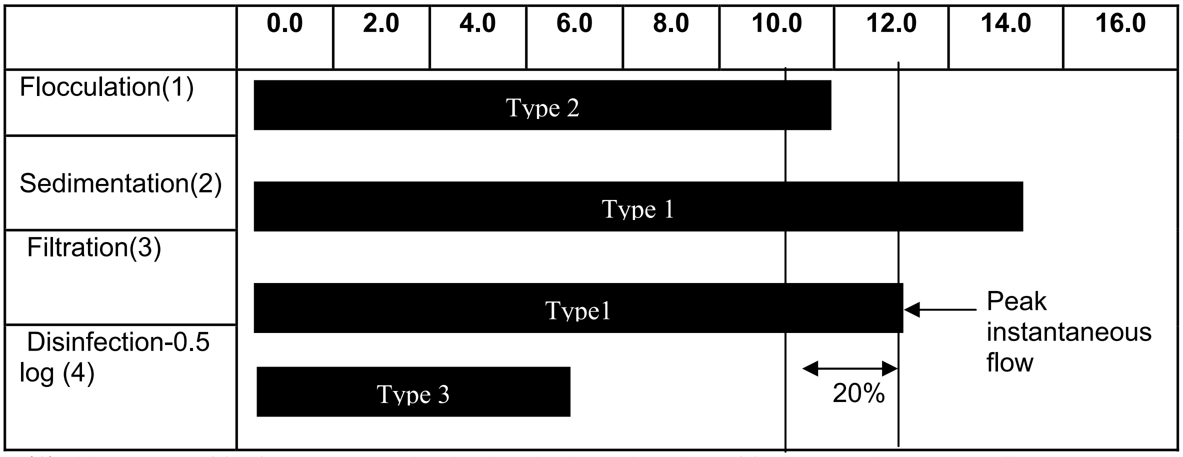


Typical water treatment plant

B) Suggested Responses

To determine whether the major unit processes are Types 1, 2 or 3, a performance potential graph (PPG) must be prepared. The PPG for Plants A is shown below. The calculation supporting the development of the graph is also presented.

Performance Potential Graph for Water Treatment Plant A



(1) Volume = 207.345 gal ; rated at hydraulic detention time=30minutes;single stage Flocculation.
(2) Surface area=13.440ft^2; rated at 0.7gpm/ft^2; swd=>14ft:-30% weir coverage
(3) Surface area= 2.110ft^2: rated at 4gpm/ft^2: mixed media: adequate backwash
(4) Volume= 1,050,000gal; total 3log giardia inactivation/removal
Required; assume2.5log removal allowed through conventional plant credit and
0.5 logs required by disinfection: pH=7.5.temp=0.5^{0}c;residualchlorine=1.8mg/L
T_{10}/T = 0.1; 12 ft minimum clear well depth

C) Flocculation Basin Evaluation

The flocculation basins were rated at a hydraulic detention time of 30 minutes because the flocculation system has limited flexibility (e.g., single stage).

Flocculation Basin Rated capacity

Basin Volume = 3 basin × 22 × 40 × 10.5 × 7.48 gal/ft^3
= 207, 345 gallons

Select 30-minutes detention time determine peak rated capacity.

Rated Capacity = $\frac{207{,}345 gal}{30 \min} \times \frac{MGD}{694.4 gpm}$ = 10.0 MGD

The 30- minute's detention time results in a rated capacity of 10MGD. Therefore, the flocculation system is rated Type 2 because the 10 MGD is within 80 percent of the peak instantaneous plant flow of 12.0 MGD.

D) Sedimentation Basin Evaluation

The sedimentation basins were rated at 0.7gpm/ft^2 surface overflow rate. This value was selected because of the depth of the basin (i.e., 14ft) and the weir coverage of about 30 percent.

Sedimentation Basin Rated Capacity

Basin Surface Area = 3 basins × 112 × 40
= 13,440 ft^2

Select 0.7 gpm/ft^2 surface overflow rate to determine peak rated capacity.

Rated Capacity = 13,440 ft^2 × 0.7gpm/ft^2 × $\frac{MGD}{694.4gpm}$ = 13.5 MGD

The 0.7gpm/ft^2 overflow rate results in a rated capacity of 13.5MGD.The sedimentation basins are rated Type 1 because the 13.5 MGD rating is greater than the peak instantaneous operating flow.

E) Filter Evaluation

The filters were rated at 4gpm/ft^2 filtration rate because they were mixed with adequate backwashing capability.

Filter Rated Capacity

Filter Area = 6filter × 22 × 16
= 2,112 ft^2

Selected 4gpm/ft^2 to determine peak rated capacity.

Rated Capacity = 2,112 ft^2 × 4 gpm/ft^2 × $\frac{MGD}{694.4gpm}$ = 12.2 MGD

The 4gpm/ft^2 rated results in a rated capacity of 12.2MGD. The filter rated Type 1
Because 12.2MGD exceeds the peak instantaneous operating flows.

F) Disinfection Process Evaluation

The disinfection system was evaluated based on post disinfection capability only since prechlorination was not practiced at Plant A.

Post Disinfection System Rated Capacity

1. Determine the functional volume of the clear well.

   Functional basin volume = 130 × 90 × 12 ×0.1 × 7.48 gal/ft^2
   = 105,000gallons

2. Determine CT based on process parameter and required inactivation

Giardia Inactivation by disinfection	0.5 log
Minimum water temperature	0.5log
Maximum PH	7.5log
Maximum chlorine residual	1.8 mg/L
Required CT from TableD-1	47mg/L- min

3. Determine required contact time based on maximum free chlorine Residual that can be maintained:

   Contact Time = $\frac{47mg/L-\min}{1.8mg/L}$ = 26.1 min

4 Determine rated capacity:

Rated Capacity = $\frac{105{,}00gal}{26.1\min} \times \frac{MGD}{694.4gpm}$ = 5.8MGD

The disinfection system was rated Type3 because 5.8MGD is less than 80 percent of the peak instantaneous plant flow. A modification to the clear well to add baffling could increase the effective volume and improve the rating of this major unit process.

G) Performance Assessment Workshop

Review plant operating data during CPE is an important step to establish if any performance problem exists. The purpose of this workshop is to interpret plant operating data from the perspective of a CPE evaluator.

Attached are typical example turbidity graphs that have been developed from plant operating data for the past year from three different CPE histories. Included are 12 month turbidity versus time plots for raw, settle, and filtered water. In two cases supplemental performance data on individual filters are also provided.

The audit group is to evaluate the performance data from these three plants. The team has to discuss plant performance trends and the ability of these plants to achieve the optimized performance goals.

H) Performance Assessment Workshop- Suggested Responses

<u>Plant A Summary (case study)</u>

Figure A.1 explains the raw turbidity was generally less than 20 NTU for plant A. However, raw water variability increased during January through march, and turbidity values as high as 70NTU occurred during this period.

Variability occurred in the settled water turbidity values, especially during the January through March event. Plant A was not able to consistently meet the settled water turbidity goal of 2NTU 95 percent of the time. It is evident from the data that raw water turbidity spikes are passing through the sedimentation basins to the filters.

Filtered water turbidity values for plant A were very good and the plant was able to meet the 0.1NTU turbidity goal. Minor variability occurred in filtered water turbidity during January through March.

Figure A.2 explains the particle counting profile for an individual filter in plant A shows significant variability on the attached **Figure A.2a**. These data show the impact that recycle streams and flow variations can have on filter performance. The particle count goal for filtered water of 10 particle/mL was not being achieved at Plant A during extended times of the filter run.

<u>Plant B summary (case study)</u>

Figure A.3 explains the raw water turbidity was generally less than 100NTU for plant B. However, on several occasions during the 12-month period, values over 200NTU occurred. Raw water turbidity generally higher during the winter.

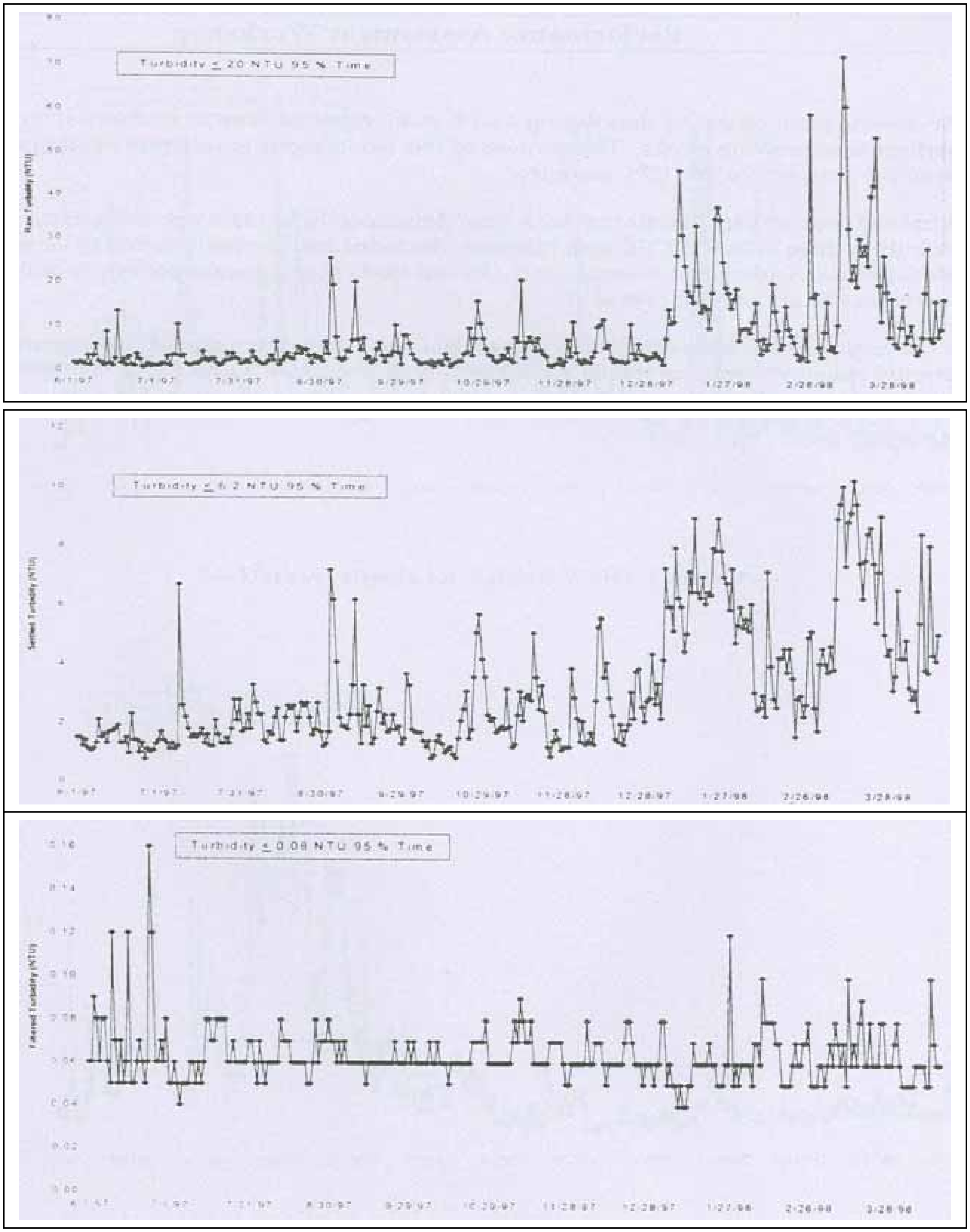


Figure A.1 : Plant A-Process Turbidity Profile

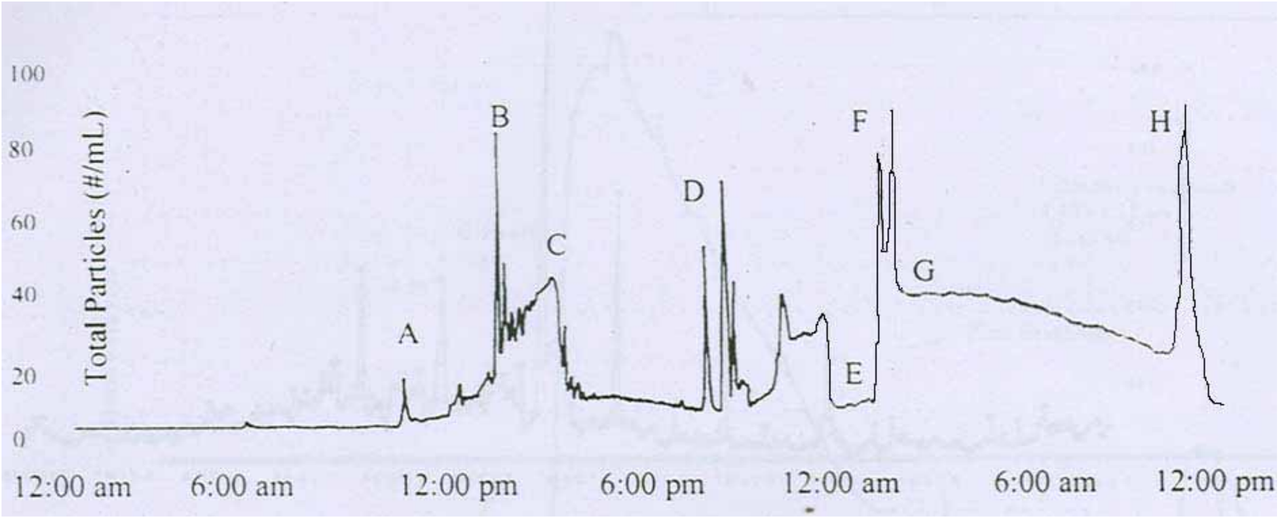


Figure A.2 : Plant A-Individual Filter Particle Count Profile

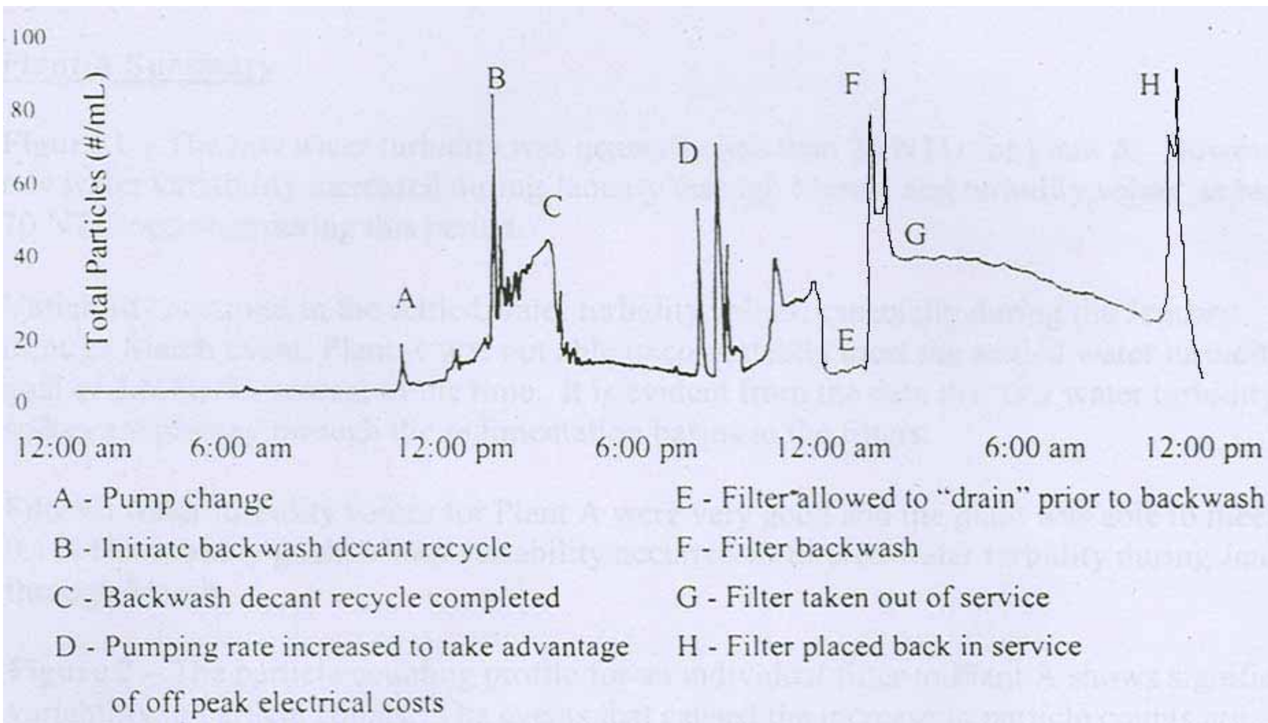


Figure A.2a : Events contributing to Individuals Filter particle spikes

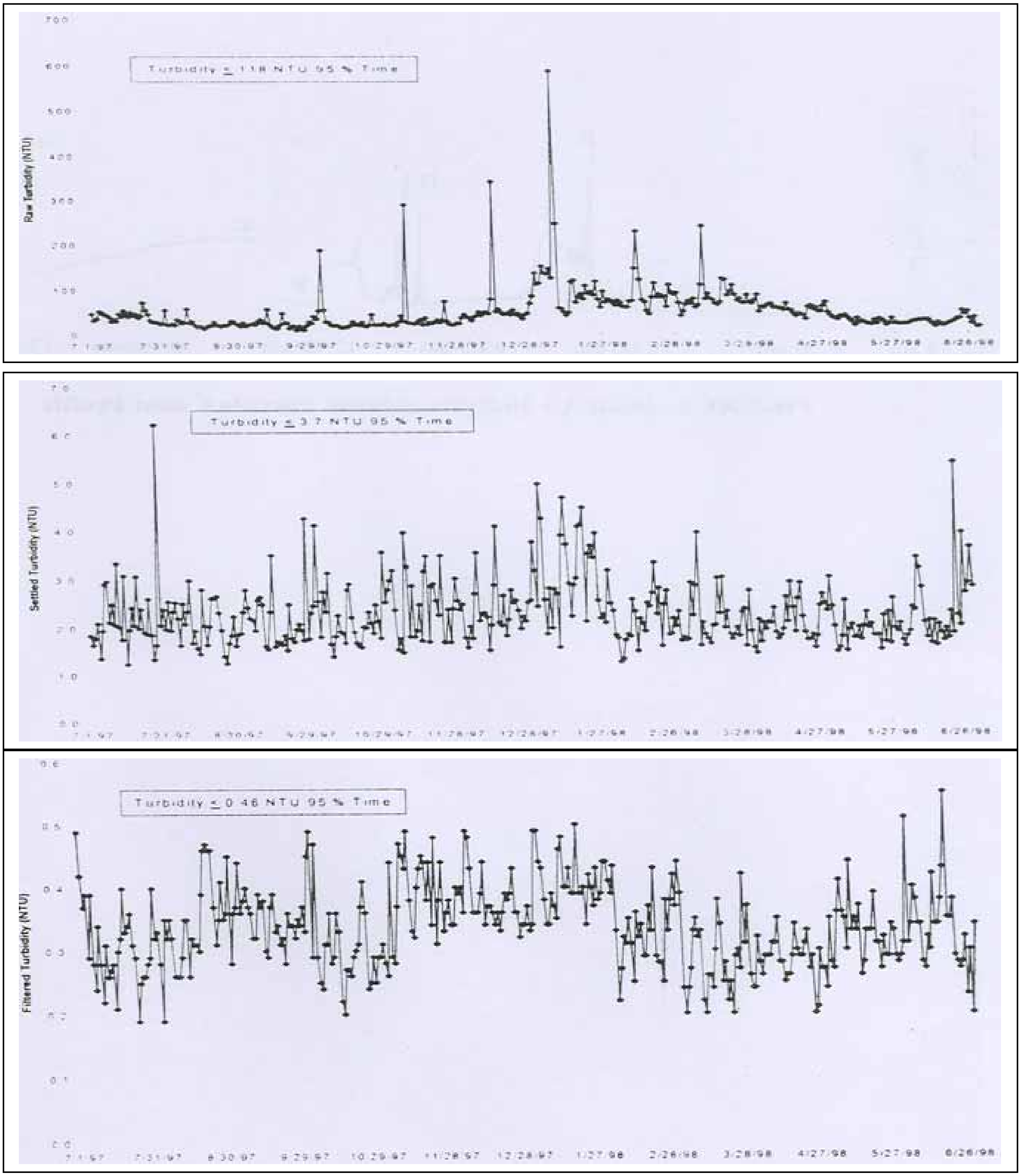


Figure A.3 Plant B -Process Turbidity Profile

Settled water turbidity values were less than 3.7 NTU 95 percent of the time; consequently, the plant was not able to achieve the sedimentation turbidity goal for this plant of 2NTU.

Plant B has been incompliance with the surface Water Treatment Rule with most filtered water turbidity values less than 0.5NTU (i.e., 0.46 NTU95 percent of the time);However, it has not been able to achieve the optimized performance goal of 0.1NTU.It also important to note that many of the filter effluent turbidity spikes are associated with turbidity spikes from the sedimentation.

Figure A.4 explains the turbidity profile for filter 3 in plant B that the effluent turbidity began to increase about 7a.m. The filter was backwashed when the turbidity reached about 0.45NTU. Optimization practices recommend that filters the backwashed when turbidity breakthrough occurs. Following the backwash of filters 3, the effluent turbidity increased to about 1.4 NTU and remained above 0.5NTU for about 5hours. Filter 3did not achieved the optimized performance goal for backwash recovery (i.e., maximum turbidity spike to 0.3NTU for less than 15 minutes).This significant backwash spike increased the plant's vulnerability for the passage of microbial contaminants into the finished water supply. The profile also confirmed the inability of the filter to achieve the optimized filtered water turbidity goal of 0.1NTU.

Although Plant B has been in compliance with the Surface Water Treatment Rule, it has not been able to achieve the optimized performance goals. Area for improvement includes increased sedimentation basin stability, achieving the filtered water turbidity goal of 0.1NTU, and optimizing the filter backwash spikes.

<u>Plant C Summary (case study)</u>

Figure A.5 explains the raw turbidity was less than 10NTU for Plant C. Turbidity values indicates a period of instability during March through May and in November through December.

The plant did not collect turbidity values from their sedimentation basins. Consequently, the effectiveness of this treatment barrier is not known. Based on the pass –through of turbidity through the filter, it appears that the sedimentation process has not been an effective barrier.

Plant C was in violation of Surface Water Treatment Rule for 5 month of the year. Performance improved significantly during the remainder of the year; however, the 0.1 NTU filtered water turbidity goal was not achieved during this period. The performance data for Plant C indicates that it is high risk facility (i.e., a high potential exists for the passage of microbial contaminants in to finished water).

I) Performance Limiting Factors Workshop

Attached is a presentation of selected information from a plant where a CPE is being conducted. The purpose of this workshop is to identify and prioritize the factors limiting performance at this plant. Read the facility information and use the attached Checklist of Performance Factors (Handbook Appendix B) to identify and classify the factors as "A", "B", or "C". Finally, rank the factors in order of priority on the attached CPE summary sheet for Ranking Performance Limiting Factors (NOTE: Rank only the "A" and "B" factors).

Facility Information

The water Treatment Plant is a 1350m^3 /day plant that serve as a small community and a surrounding rural Area. There are approximately 46 taps in the community and 62 in the rural area surrounding the community. The plants treat surface water from Morias River, which typically has a turbidity of about 10NTU during winter month and about 10during summer months. During run- off events turbidity values as high as 3, 0000 NTU have been recorded. These very high turbidity values occur about every three years and last for period of about 1or2days.

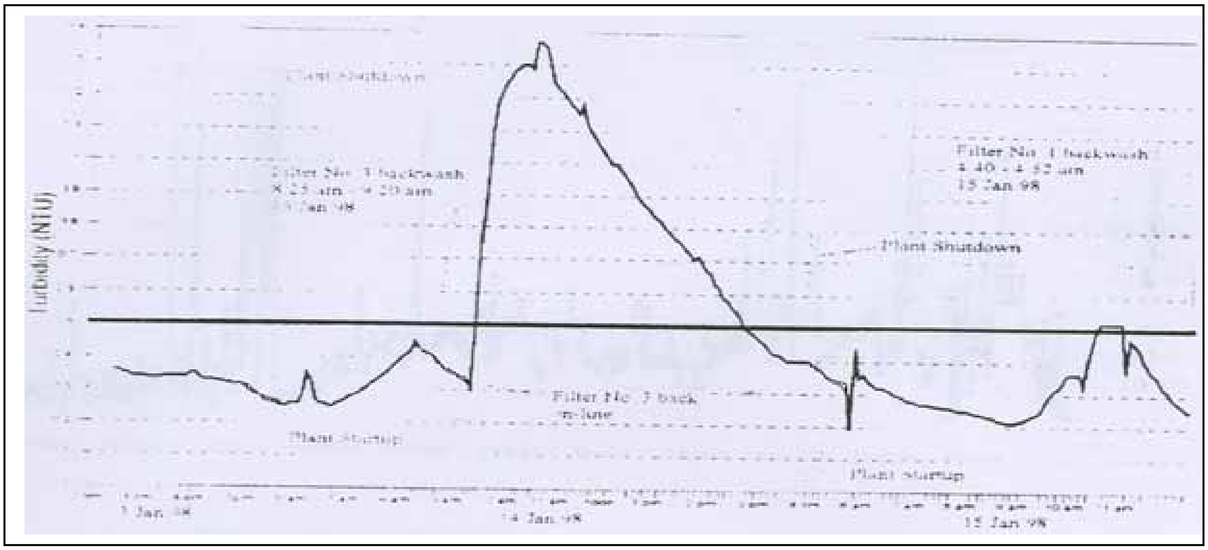


Figure A.4 Plant B - Individual Filter Turbidity Profile

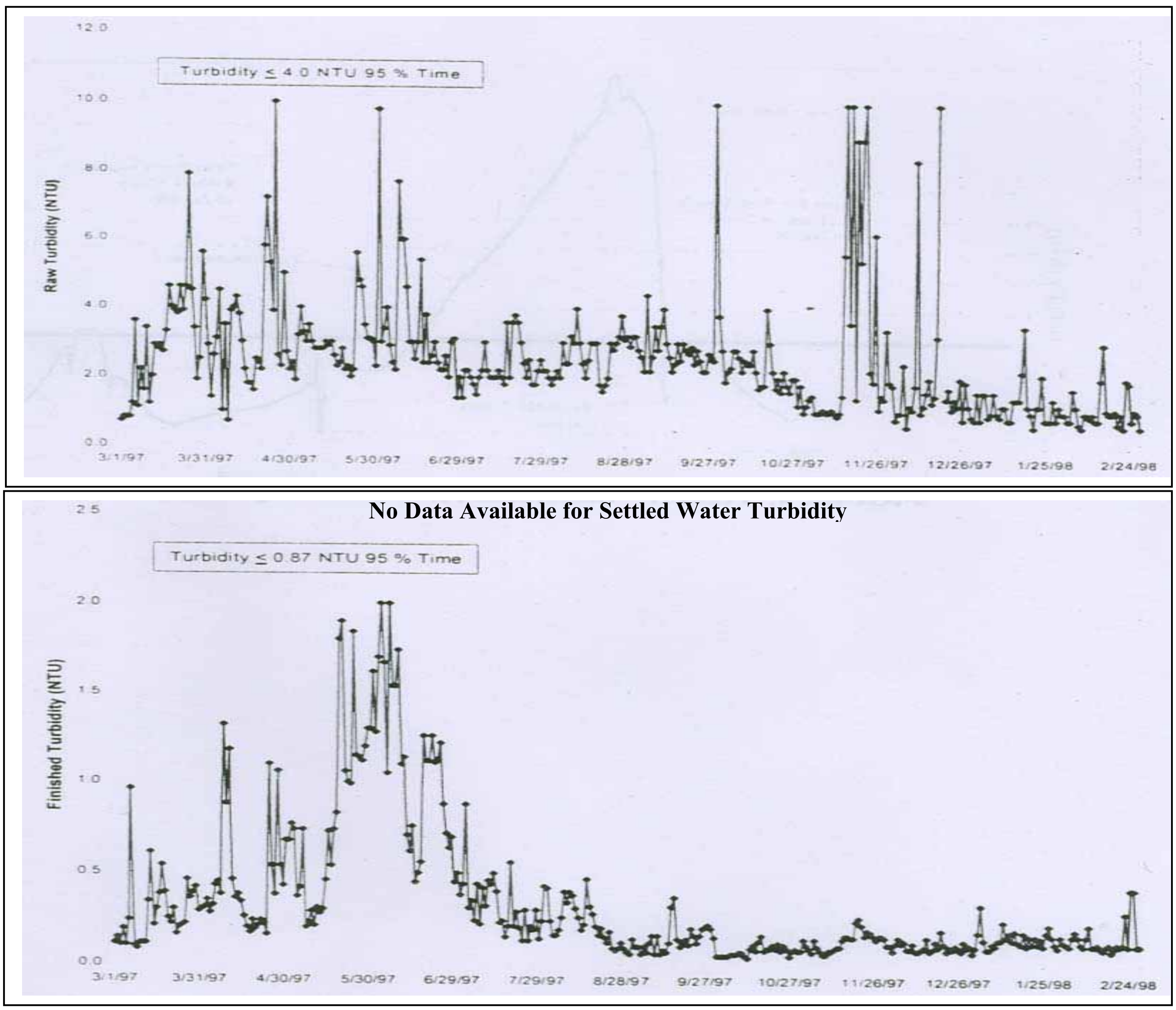


Figure A.5 Plant C – Process turbidity profile

Two pumps of capacity of 1350 m3/day pump water from the river approximately one –half mile to the plant. The plant consists of reactor clarifier (flocculation and sedimentation in one basin) and dual –media filter. After filtrations the water flow s to aclearwell and is then pumped to the distribution system by two 1350m3/day turbine pumps. Plants flow is measured in the influent line by propeller meter. In- line turbidimeter is used to measure raw water and finished water turbidity. Chemical feed facilities include a dry feeder for alum, pumps to feed cationic polymer. The plant also has the capability to feed fluorine and chlorine.

The plant has experienced performance problem and a CPE was conducted. The following observations were made.

- The plant operator indicated that the plant would not handle low turbidity (8-10NTU) during summer months. The operator indicated that there were times when the turbidity leaving the plant was not as low as he would like. He felt the problem was that the plant was undersized to handle the water quality. He said he could not hold a “blanket” in the reactor clarifier. University personnel had visited the plant, but the operator felt they were not at the plant long enough tap provide him help.
- The plant started and stopped automatically based on the water level in the distribution reservoir. The plant typically operated 6-12 hours per day. The plant always started on dirty filters. The plant operated said that it didn’t Seems to be problem.
- The operator was paid to spend two hours each day at the plant .He often spent some of his own time trying to improve plant performance. It appeared that to control the reactor clarifier an operator should be on duty during operation to respond to varying water qualities and performance. The operator provides plant coverage seven days week because there was no trained back-up operator. If the Operator left for vacation or training, a board member would “watch” the plant. Board members would come to the plant and provide assistance when a major project was undertaken such as replacing a raw water pump.
- The plant chemical feeders were not adjusted despite variations in raw water turbidity values of over 100NTU. The operator indicated that there was alarm on the raw water turbidity to notify him if water quality changed.
- A review of state monitoring reports indicated that the finished water turbidity was less than or equal to 0.85NTU 95 percent of the time for 12 –month period prior to the CPE. The peak turbidity values noted were 1.5 and 2.0 NTU, when were recorded for one day each in September and February.
- An interview with the secretary of the board revealed that the District had about $ 4,000 in the bank and sometimes was out of money at the end of the year. Water rates were $ 95/month for rural customers and $40/month for the community customers. The plant had been constructed in 1981 with loan, and bond payments represented over 70 percent of the operating budget. Board members indicated that they wanted to produce good quality finished water, but couldn’t afford to pay the operator for more plant coverage or to hire an additional plant operator because of their high monthly loan payment.
- The operator periodically checked the results from the finished water turbidimeter but did not calibrate the unit. On occasion (estimated annually),a jar test was conducted . Turbidity was not measured on the water leaving the reactor basin to the filter. Also testing was done to determine the concentration of the sludge in the center mixing area of the basin or to determine the depth of the blanket. Operator stated that he relied instincts (e.g., seat of the plant).
- The chemical feeders were calibrated when the plant was originally placed in operation. The operator indicated that 89mg/L alum was being fed at the time of the CPE. The operator reported that he was “feeding polymer at concentration of one percent,” which he said he prepared by adding 125grams of polymer to 378 gallons of water (actual 0.03%conc). He reported that the polymer dosage was 3mg/L.

- During an interview with the chairman indicated that he wasn't sure if the operator had the capability to operate the plant. The chairman had never been involved with water treatment before, but he felt more testing should be done at the plant. He was very sincere and dedicated they had just raised rates in order to build up their FHA bond reserve fund and might not be able to get another increase to have more operator time for additional testing.
- A special study of the filter conducted during the CPE indicated that filter effluent turbidity increased to about 5NTU after plant start- up. Filter effluent turbidity then decreased to about 1.2NTU and remained fairly steady. After the filter was backwashed, the turbidity increased to13NTU and gradually decreased to 0.5NTU one hour following the backwash. The operator indicated that he recorded the lowest turbidity measured since only one was required each day. He did indicate that he had numerous complaints on days when he produced "dirty" water.
- An evaluations of the filter by probing indicated level sub gravel and no mud balls.The filtration rate at design flows was 6.5m/hr.Filter rate control was adequate.
- The evaluations of the reactor clarifier indicated that the basin had a reasonable surface overflow rate depth of 3 meters. As a result, the basin was rated Type 2 when the performance potential graph was prepared. It was projected that the basin would perform adequately expect during periods when raw water turbidity exceeded 1,000NTU. There was nothing inherent in the basin design that would cause the poor performance noted during the CPE.
- The operator indicated that the wasted varied amounts of sludge. Observation of the sludge drying beds reveled very little sludge and what was there had completely dried up and cracked.
- The output from the alum feeder was collected for one minute and weighed. The analysis revealed that alum feed was set at 160mg/L rather than the 80mg/L reported dose. The output from the polymer pump was collected for one minute in volumetric cylinder. The results indicated an actual dose of 0.1mg/L rather than the 3mg/L reported dose. Water from the top of the reactor clarified looked like river water.
- A check of sample points on the side of the reactor clarifier indicated that the sludge at the bottom of the clarifier was very odorous and concentrated. All evidences indicated that no sludge has been removed for long time.
- A review of the laboratory capability indicated that the bench mode turbidity and continuous finished water turbidimeter could not be calibrated and would have to be sent to sludge and the sludge blanket in the clarifier, but was not used.
- The operator was certified at the second to the highest level in the state, and he annually attended the week –long "water school" put on by the state.
- While watching the operator backwash the filter, it was apparent that the filter did not become clean even after 20minutes of washing. The operator did not know how to check the backwash rate and did not realize that partially cleaning a filter could lead to, problem. Further investigation indicated that the backwash pump had adequate capacity, but had been "throttled".
- No documented preventive maintenance program existed at the plant. The operator said he didn't have much equipment and kept track of preventive maintenance needs in his head. There were no items of equipment out of operation during the evaluations or in the year prior to the evaluations.

Annexure 3.1

Performance Limiting Factors Summary

A) Asif Nagar Water Treatment Plant, Hyderabad

CPE Performance Limiting Factors Summary		
Plant Name/location : Asifnagar Filtrations Plant Hyderabad		
CPE Performed By: Mr. Shrikant Bhanage & Mr. Nitin Bagul Pune Municipal Corporation		
CPE Date: 14th & 15th May 2007		
Plant Type: Conventional with flask mix. sedimentation, filtrations& chlorination		
Source Water: Unmans agar dam's Raw Water. Hyderabad Metro. Water Supply & Sewerage Beds		
Performance Summary: 1. Overall plant performance is 'good' 2. Staff running plant smoothly in unfavorable conditions 3. Lack of qualified staff 4. Desire to get sufficient Budget for maintenance & development works. 5. Desire to rehabilitee the old plant		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	Administration (Source Water Protection)
2	A	Design (Flow Measurement)
3	B	Operation (Chemical Test of water)
4	B	Maintenance (Preventive Major)
5	A	Sedimentation Tank (Design)
6	A	Budget (Planning)
7	B	Supervision (Administration)
8	A	Chlorination plant (Design)
9	B	House Keeping (Maintenance)
10	B	Storage of material (Maintenance)

Rating Description

A- Major effect on long-term repetitive basis.

B- Moderate effect on routine basis or major effect on periodic basis.

C- Minor effect.

(Mr. Shrikant Bhanage & Mr. Nitin Bagul)

Performance Limiting Factors Notes	
Factor	**Notes**
1 Source Water Protection (Administration)	To Prevent ugly formation in Raw Water
2 Flow Measurement (Design)	• No Flow measurement for intake & outlets. • No Flow meters put up for outgoing reservoirs. • No venture meter for each beds to measure flow (Loss of head or Rate of flow measurement).
3. Chemical test of water	• Jar Test must take every day. • Model flocculators equipment must be in a lab. Settle water (sedimentation) turbidity must taken • PH value of Raw water is high • Modern technology should be adopted
4. Preventive and major maintenance (maintenance)	• History card/ record must be kept after each every maintenance for each bed/ valves/chlorinators etc. • Should have separate maintenance team.
5. Budget (Planning)	• Get only 4-5 lacs rupees for maintenance • Requires budget for development works. • High budget for major (outsourcing) repairs & replacement (Development)
6. Supervision (Administration)	• Require more effective supervision • Require chemist in each shift • More coordination required among departments
7. Sedimentation Tank (Design)	• Continuous sludge removal should be there
8.Chlorination plant (Design)	• Requires chlorine neutralization plant
9. House keeping (maintenance)	• Requires more attention
10. Storage of material (maintenance)	• Only minor material available • Alum storage capacity should be improved • Quality of supplied Alum should be also tested in government laboratory

CPE Performance Limiting Factors Summary

Plant Name/location : Asifnagar Filtrations Plant Hyderabad

CPE Performed By : Mr. R.D Sharma, Delhi Jal Board

CPE Date: 14-05-07 & 15-05-07

Plant Type: Conventional

Source Water: Osman Sagar Dam's Raw Water. Hyderabad Metro Water Supply & Sewerage Board

Performance Summary:

1. Overall plant performance is 'good'
2. Staff running plant smoothly with limited staff.
3. Lack of qualified staff need in every shift.
4. Desire to get sufficient Budget for maintenance & maintenance
5. Development works.

Ranking Table

Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	Administration (Operation & maintenance)
2	B	Process Control testing (Operation)
3	A	Plant Coverage Plant staffing (Administration)
4	B	Sedimentation (Design)
5	B	Budget (Planning)
6	B	Design (Flow meter)
7	A	Operation
8	A	Supervision (Administration)
9	B	Chlorination plant (Design)
10	B	House keeping (Maintenance)

Rating Description

A-Major effect on long-term repetitive basis.

B-Moderate effect on routine basis or major effect on periodic basis.

C-Minor effect.

(**Mr. R.D Sharma)**

Performance Limiting Factors Notes	
Factor	**Notes**
1 Source Water Protection (Administration)	• To Prevent ugly formation in raw water &maintain the pH of the raw water between 7.5-8.5
2 Flow Measurement (Design)	• Needs flow meter for intake filter water as well as outlet point
3. Chemical testing	• Alum dosing Jar test should be in every shift • Latest testing equipment should be in the lab as • Spectrophotometer. • Residue Alumina listing should be in two times in every shift (4hrs).
4. Bacteriologies Test	• To control the PH of filter water &maintain the flow rate of filter of filtered water or to reduce the bacteriologic load at filter beds.
5. Chlorination (pre & post)	• Pre chlorination should be applied as the R/cl_2 at filter bed up to .1ppm-.2ppm to neutralize the algae growth at filtered. • Post cl_2 gels should at plant up to 1.5ppm of reduced in city reservoir to maintain their upto1.5ppm to protect the system of the treatment. • To check the pollution in this distribution maintains upto0.5ppm at the consumer point.
6. Maintenance (Preventive major)	• History record must be kept after every maintained for each bed/valve should have separate maintenance team.
7. Safety Measures	• For loading & unloading the chlorine cylinders should be at the sites • Alarming systems should be provided • Chlorine Absorption system should be at the chlorine point.
8. Budget (Planning)	• Get only 4-5 lacs rupees for maintenance • Requires budget for development works. • High budget for major (outsourcing) repairs & replacement (Development)
9. Supervision (Administration)	• Require more effective supervision • Require chemist in each shift • More coordination required among departments
10. Communication Network	• Required local network to contact every staff immediately &put the information immediately for better result.

(Mr. R.D Sharma (Contd..))

Performance Limiting Factors Notes	
Factor	**Notes**
11. Sedimentation (Design)	• Detention time should be same throughout the every season to prepare the healthy flocks for better quality of filtered water • For higher turbidity season detention period increase in the system process.
12..House keeping (maintenance)	• Requires more attention
13. Canteen	• Canteen should be there running 24 hours to give the energy to the staff
14. Historical monument	• To maintain the historical plant for coming generation or to study the old process &the improvement.

CPE Performance Limiting Factors Summary

Plant Name/location : Asifnagar Filter Bed

CPE Performed By : Dr. Somdutt, Delhi Jal Board

CPE Date: 14, 15 ,16 May 2007

Plant Type: Conventional Treatment Plant

Source Water: Surface water, osmansagar pond

Performance Summary:

There is no variations in parameter in the season of the year expect turbidity in monsoon .the plant is very old, constructed in the year 1921; Rehabilitation of the plant can improve the performance at the plant. However the plant is capable to meet the prescribed standard and performance goals

Ranking Table

Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	Surface water protection
2	C	Water quality
3	B	Measurement of inflow and outflow
4	B	Chemical storage /feeding
5	C	Alum/chlorine consumption
6	A	Sedimentation and flocculation
7	A	Process control
8, 9	B	Sludge removal/ Backwashing
10	B	Validation of water quality
11	A	Disinfection
12,13,14,15	B	Balancing/ operational staff/financial/ planning/ supervision
16	C	Supervision

Rating Description

A-Major effect on long-term repetitive basis.

B-Moderate effect on routine basis or major effect on periodic basis.

C-Minor effect.

(Dr. Somdutt)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Source water protection	• Have adequate monitoring by outside agencies also; there are no social activities around the source. However the possibility of contamination cannot be ruled out.
2. Water quality	• There is problem of grove of algae in the Osman sagar reservoirs, which residues the filtration.
3. Measurement of raw water inflow /outflow	• Measurement devices for raw water entering into the system must. But there is not measurement of treated unit quantity leaving from its treatment plant.
4. Chemical storage and feeding system	• There is one chemical store having inadequate storage capacity. The feeding device is inadequate manually as per alum also.
5. Alum and chlorine consumption	• There is no regular reamentation of alum dose requirement by jar tester apparatus. Chlorine is added per chlorine demand examined in the laboratory in day shift.
6. Sedimentation and flocculation	• The plant is getting raw water more than the sedimentation capacity. The mixing of chemicals is by hydrate fall in the channel therefore, thus is for flocculation and sedimentation
7. Process control	• The treatment process is not related with the chemical parameter testing report only, laboratory staff available in day shift.
8. Sludge removal process	• Sedimentation tanks have a provision to remove the sludge by scoring but the rates do not operate due to common and very old. Therefore it is removed normally and annually i.e. after monsoon over year
9. Backwashing of filter beds	• Back washing is done with one minutes and scouring and backwash water by over head tanks. Surface washing is done with unchlorinated water
10. Validation of water quality	• There is no provision of out sourcing of water quality checks .
11. Disinfection	• Chlorine is used for disinfection of water. It is added in two stages I.e., prechlornation and post chlorination. Being the hazardous chemicals, no safety arrangement units
12. Balancing tank at water treatment plant	• This is only one balancing tank& inadequate capacities are not hold water if sudden break down occur in the plant operation.

(Dr. Somdutt (Contd..))

Performance Limiting Factors Notes	
Factor	**Notes**
13. Operation staff	• Adequate staff for operation of filter beds are available, but for laboratory inadequate to come in shifts.
14. Finance provision	• An usually budget is provided but inadequate to keep the units in order, Painting lubrication.
15. Planning	• It being submitted to the authority but no action has been takes and help in plenty for along time which hinders the performance of the plant
16. Supervision of the treatment process	• Adequate, staffs are required for operation of the plant.

CPE Performance Limiting Factors Summary

Plant Name/location : Asifnagar water Treatment Plant

CPE Performed By : Mr. D.R Araya " Delhi" Jal Board

CPE Date: 14-5-07 & 15-5-07

Plant Type: Conventional

Performance Summary:

1. Since water Treatment is quite old however overall performance is good.
2. Treatment /Purification of raw water &functioning of laboratory persons needs more alteration and requires more facility to work in three running shift.

Ranking Table

Rank	Rating	Performance Limiting Factor (Category)
1	B	Administration (Water protection)
2	B	Design (Measuring device)
3	B	Operation (Chemical testing)
4	B	Maintenance (Minor /major)
5	B	Sedimentation/Settling tanks
6	A	Budget (Planning)
7	B	Supervision (Administration)
8	A	Chlorination system
9	A	Staff (Administration)
10	B	Upkeep of plant/Laboratory

Rating Description

A- Major effect on long term repetitive basis

B- Moderate effect on a routine basis or major effect on periodic basis

C-Minor effect

(Mr. D.R Araya)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water source (Administration)	• Require prevention of un desired greenish color and growth of "Algae" & filter chocking cell
2. Raw water measurement devices	• Flow meters, not in existence Raw water quality in settling tank to, feed exact quality of Alum/chlorine
3. Feeding of Alum and chlorine and proper Log sheet	• Lack of proper dosing of Alum & Disinfection -chlorine. In each shift laboratory need for application
4. Maintenance Minor/Major	• Lack of consistent maintenance i.e. Day to day minor maintenance .which cause malfunctioning of system followed by adverse affect on result
5. Budget Provision	• To maintenance up keep of plant's Unit followed by efficient result that quality and quantity of potable water adequate budget is needed.
6. Settling/Sedimentation tank (Design)	• Requires regular sludge removal system i.e. "Scouring" unit to put in working order.
7. Chlorination system and safety arrangement	• Chlorine machines of M/s. Emitone make, already installed are ok but Racking" safety arrangement during any possible leakage of chlorine"
8. Laboratory testing operation	• Requirement full-fledged laboratory with sophisticated instrument. It should work round the clock (in three shift) to ensure treatment /purification process Alum and chlorine application and any possible pollution raw water source.
9.Monitoring of water quality	• Step must be taken to monitor quality of water right from raw water treatment plant up to consumer point
10. Maintenance of Log book	• Daily recording must exercised while application of quantity of Alum in raw water Chlorine at pre &post
11.Turbidity, Clarity Free residual Cl_2	• Required Lab instruments to determine turbidity of raw water, finished water, residual chlorine up to consumed end.
12.Supervision (Administration)	• Quality control/Laboratory person to be deployed to supervise entire process of treatment by purification in three shifts

(Mr. D.R Araya (Contd..))

Performance Limiting Factors Notes	
Factor	**Notes**
13.Cleaning of plant (Administration)	• Almost, all chamber, were filtered water is being collected are uncovered which is contrary to the safeguard of quality
14. Interaction with other agency	• It would be significant if plant persons are allowed to visit other metro city to exchange or no entire system
15.Ensurence of water quality in city (Administration)	• Effort should be made to make surveillance of water quality by enhancing daily sampling
16. Guide lines of BIS10500-193 regd quality of water	• At every stage guidelines of BIS1050-1993 for drinking water quality be strictly followed • .

CPE Performance Limiting Factors Summary

Plant Name/location : Asifnagar water Treatment Plant, Asifnagar, Hyderabad, AP

CPE Performed By : Mr. Debabrata Mandal, KMDA,Kolkata

CPE Date: 15 May ,2007

Plant Type: Conventional with flash mixing, sedimentation, Filtration, disinfection

Performance Summary:

Plant commenced 80years ago three sets of treatment system exist in the plant.

i. 10MGD with 12 hours rapid pond filter followed by settling tank.
ii. 10MGD with 9hours rapid pond filter followed by settling tank
iii. One independent 6MGD plant of rapid gravity sand filters followed by clarification, but presently starring for raw water after post chlorination 1&2 stored in

Ranking Table

Rank	Rating	Performance Limiting Factor (Category)
1	A	Application of concept and testing process control Operation
2	B	Process control testing operation
3	B	Plant coverage
4	B	Plant shifting pattern
5	A	Coverage Ratio
6	A	Budget (Planning)
7	A	Reserved fund
8	B	Sedimentation tank
9	B	Filtration
10	A	Store keeping

Rating Description

A- Major effect on long term repetitive basis
B- Moderate effect on a routine basis or major effect on periodic basis
C-Minor effect

(Mr. Debabrata Mandal)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Application concept and testing of process control	• Backwash is done in every 48hours, rating is not measured • Chemical feeding 's not calibrated properly
2. Process control testing	• Process control testing is done test not in regular basis. • Lab is equipped with chemicals but not with digital measuring devices.
3. Plant coverage	• Plant has good coverage of available water but very old required through over turbidity of filter bed, valves, building fresh with experienced one.
4. Plant stuffing pattern	• At the operating levels trained personnel with certification to be provided. • Second line of defiance in operating level should be created, blending fresh with experienced one.
5. Coverage Ratio	• Capital cost is realized but fund required for overtaking, renovation and establishment of existing plant, conveyance system. • Pond getting allocation required.
6. Reserved fund	• No reserve fund is created to copy with immediate/emergency requirement.
7. Sedimentation	• Some being imponding reservoir raw water does not content high turbidity do not require frequent cleaning but pre monsoon and after monsoon cleaning only
8. Filtration	• Filter bed through function well now but require resetting in near future to get stable rate of filtration. • Material system is to be introduced
9. Store keeping	• Cl_2, alum and other chemicals not stored properly. • Machine parts and effective equipment rare to protected properly to avoid accident.
10. Water after	• Care to be taken even before existing to sedimentation tank against contamination. • Weeds and other foreign water one to be removed absolutely
11. Microbial Testing	• Data not available • It seems during monsoon contamination and/or reduction microorganism are not done properly
12. Plant staff (Administration)	• Staffing does not allow for routine laboratory testing during shifts other than day shift. NOTE: Does not allow rapid detection of treatment and/or water quality problem.

(Mr. Debabrata Mandal)

Performance Limiting Factors Notes	
Factor	**Notes**
13. Unit process Adequacy (Design)	• Flocculation done has limited hydraulic mixing but apparent in adequate to get good floc formation.
14. Unit Process adequacy (Design)	• No continuous sludge removal capability exists in sedimentation basin .NOTE: This in conjunction with in frequently cleaning results in the builds of sludge deposits and increased filter loading
15. Laboratory Testing (operation)	• Outside, independent verification of test results such as with the center/lab; finished water turbidity data is rounded to nearest NTU and should be reported to nearest 0.1 NTU. Lack of periodic outside. Independent verification of data and testing accuracy, especially for turbidity, reduced the use ability and confidence of the data.
16. Operational Guidelines /Procedure (operational resources)	• Standardized operating procedures were not found for much major plant operation. NOTE: SOPs help provide greater consistency and uniformity of operation. Also are benefited for the training of new employed.
17. Backwash water (Design)	• Recycle backwash water (water treatment) to one could result in concentration of microbial pathogens at this point.
18. Coagulation (Design operation)	• Alum is used as a coagulants an append to be working. Some lab data indicated that PH raised over recent year to high be the coagulant best suited for the high PH treatment. Use of coagulant aids or other coagulants may prove move effect ion, reduce sludge volumes, or reduce costs, NOTE: some alum may go into solution at higher pH.
19. Evaluation following	• Facilitates the development of optimization performance goals by the water system • Conduct engineering evaluation/study or best approach to renovate or replace filters or work toward implement of prior study recommendation • Facilitates laboratory quality assurance measures with outside lab to validate and ensure reliability of data. • Facilitate the development of standardized operating procedure in order to improve overall (SOP) uniformity and consistency operations • Facilitate evaluation feasibility of seeding backwash recycle to the head of the plant and prior to rapid mix/Alum feed. Evaluate potential improvement during the flocculation /coagulation process due to "seeding" of turbidity. • Facilitate the evaluation of coagulant aids or alternate coagulant for possible cost redactors and performance improvements

Performance Limiting Factors Summary

B) Parvati Water Works – Pune

CPE Performance Limiting Factors Summary
Plant Name/Location: Parwati Water Works
CPE Performed By: Er. David Visintainer, USEPA
CPE Date: 11.02.08 to 13.02.08
Plant Type: Conventional treatment plant
Source Water: Khadakwasala Dam
Performance Summary: Overall, the plant appears to be producing good quality finished water, although comprehensive quality test data is lacking. Staff and management generally appear to be professional and committed to producing water of a quality conductive to the protection of public health.

Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	Flow Monitoring
2	A	Sump well roof conditions, Ventilation screens
3	A	Sedimentation Basin Hydraulic Overload
4	A	Water supply from canal
5	A	Laboratory test standardization and calibration
6	B	Lack of online turbidity data
7	B	Training/Standard Operating Procedures
8	B	Chemical feed improvements
9	B	Lack of formalized Preventative Maintenance Program
10	B	Chlorine handling safety
11	C	Laboratory Staffing Level
12	C	Filter operation and maintenance

Rating Description
A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Er. David Visintainer)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Laboratory Staffing Level	Heavy load of sampling/testing at laboratory may need to evaluate if additional personnel is needed, especially with respect to microbiological testing. Also limits ability for 24 hours, 7 days a week monitoring or emergency response.
2. Sedimentation Hydraulic Overload	Sedimentation basins are reportedly under designed hydraulically under certain production levels. Need to evaluate cost-benefits of additional sedimentation capacity.
3. Lack of formalized Preventive Maintenance Programme	No formalized Preventive Maintenance Programme currently exits, either on paper or computerized. Implementation of such programmes including scheduling, procedures, record keeping, assignment of responsibility and cost tracking should reduce costs for repairs and emergency response. It can also be used to justify capital expenditures through cost tracking. An example of such activity would be the recent infrared survey of electrical equipment which could be routinely done on 6 to 12 months basis .
4. Training and Standardize Operating Procedures (SOPs)	Plant and laboratory staff needs to be provided with sufficient and on going training. Some training exists but it needs to be expanded. SOPs would be of value during operational, maintenance, emergency response and laboratory assignments.
5. Chlorine Handling Safety	Existing 1-ton chlorine cylinders are stored in a stacked position, one on top of another. This practice makes emergency response to a potential chlorine leak difficult. The overall safety programme should be reviewed and strengthened as necessary.
6. Flow monitoring	Improved flow monitoring will allow for the control of chemical dosing and treatment, especially with respect to the usage of canal water.
7. Laboratory Test Standardization and Calibration	Presently, standard methods are used for analytical tests. However, staff reports that some standard solutions are on order but not yet delivered. Increased emphasis should be placed assurance of lab data quality.
8. Chemical feed improvements	Lime is added manually at present time, although this is done only a few days per year, a better system needs to be installed. Alum feed is difficult at low flows. Need to address this problem. Dosage control is difficult during low turbidity periods.

(Er. David Visintainer, Contd..)

Performance Limiting Factors Notes	
Factor	**Notes**
9. Lack of line turbidity measurement	On-line continuous turbidity monitoring provides insight to potential problems or short duration events which may not be detectable by manual sampling and testing.
10. Water supply	• Water Supply from the canal is not as high quality as from reservoir. • Pursue construction of second pipe from reservoir to minimize the potential of contamination entry into the open channel.
11. Filter operation and maintenance	Some filters are being reconstructed and media replaced. Overall, the filters operate well. However it appears that sand may be migrating to and plugging under drains. This probably relates to the location of the air scour. No corrective action may be justifiable economically. Therefore, continual monitoring of filters condition and reconstruction of the filters when needed may be most appropriate.
12. Sump well roof condition	Corrosion from chlorine has badly disintegrated the roof and column caps. Parts of one roof have collapsed and allow potential for entry of contaminated storm water. Screens on roof ventilation structures are badly corroded or missing and need to be replaced to prevent entry of birds etc.

CPE Performance Limiting Factors Summary

Plant Name/Location: Parwati Water Works

CPE Performed By: Dr. Som Dutt, New Delhi

CPE Date: 11.02.08 to 13.02.08

Plant Type: Conventional treatment process

Source Water: Khadakwasla Dam

Performance Summary: As stated, there is no variation in quality of raw water in the season of the year except turbidity in monsoon. The turbidity varies 4.0 NTU to 160 NTU in the season of the year. The plant is old and based on gravity flow except clear water pumping. Overall, the performance is satisfactory. The plant is meeting the described standard as well as demand of the drinking water.

Ranking Table

Rank	Rating	Performance Limiting Factor (Category)
1	A	Source protection
2	A	Water quality
3	B	Measurement of raw water and treated water
4	B	Chemical storage at plants for alum, PAC, chlorine
5	A	Consumption of chemicals
6	A	Flocculation and sedimentation
7	A	Process control
8	B	Back washing of filter
9	A	Validation of water quality
10	A	Disinfection
11	A	Balancing reservoir
12,13,14,15	B	Safety devices, supervision, training, conservation of water
16	A	Laboratory chemical, bacteriological tests
17	A,B,C	Other parameters

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Dr. Som Dutt)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Source protection	Khadakwasla dam is the source of raw water of Parwati Water works. There are tow separate carrying system of raw water from dam. Close conduct system is OK. There will be no contamination during transmission. Whereas, open irrigation canal can be contaminated by adding effluent in stream.
2. Water quality	Raw water is drawn from dam, having under protected areas. There is no magnificent variation in parameters except turbidity. However, regular monitoring of raw water source is recommended. The irrigation canal requires regular monitoring and patrolling upto dam.
3. Measurement of Row water and treated water	At present no flow meters are provided for measurement of raw water entering into the system and treated water leaving from treatment plant resulting in doses of chemicals cannot be applied as per requirement. Hence recommended for installment of flow meter.
4. Chemical storage at plants	There is inadequate storage capacity of chemical i.e. alum, PAC, and chlorine. Recommended to find out suitable place for storage of chemicals at plants. So that sufficient chemical is available all times at plant.
5. Consumption of Alum, PAC, chlorine	As reported these chemicals are fed as per jar test and determination of chlorine reagent in the laboratory. It requires further strengthening as no testing is done in two shifts i.e 2 PM to 10 PM and 10 PM to 6 AM.
6. Process control	Examination and evaluation of raw water quality in each shift has not been done except day shift. Resulting in the processed water cannot be judged whether application of chemicals as being done there is no determination of residual aluminum in treated water.
7. Back washing of filter	It is done properly and at an adequate pressure. The designed of filter beds is very old therefore, loss of water during back washing is on higher side. This is due to non provision of syphon in the filter bed i.e. surface cleaning of filter beds.
8. Validation of water quality	Provision of water quality checks by outside agencies must be explored for validation of water quality.

(Dr. Som Dutt, Contd..)

Performance Limiting Factors Notes	
Factor	**Notes**
9. Disinfection	Liquid chlorine is used for disinfection of water supply, chlorinated install are sufficient to meet the requirement. As informed bleaching powder is used for disinfection when chlorine is not available. But adding of these chemicals is not done as per norms. Disinfection at pre stage should be meeting that at least 0.2 to 0.5 mg/l. Free chlorine residue is available at top of the filter bed. Post chlorination should be done at place where treated water enters into the reservoir. At present it is added in the individual balancing reservoir which is not advisable. It corrodes the wall and roof of the reservoir.
10. Balancing reservoir	These are in bad condition. The roof where it damaged should be covered with plastic sheet and repaired should be taken on priority. There is a possibility of contamination in it.
11. Safety devices, supervision, training, conservation of water	No provision has been made for safety of the labour when there is heavy leakage in chlorine feeding devices or any accidents occur during process. It should be as per norms prescribed by explosive department or factory inspector.
12. Supervision of treatment process	Adequate staff is provided for operation of treatment units. But inadequate staff for controlling of treatment process. The laboratory personnel should be in each shift for evaluation of raw water quality for treatment and for conformation whether water leaving from treatment plant is as per prescribed norms.
13. Training programme of the staff	There are so many programme conducted by various organization viz. PHE Kolkata, Mumbai, Chennai etc for training the staff at various levels. The staff engaged should be sent there regularly
14. Conservation of water	There are about 10 % of water is used for treatment process and wasted. This should be collected and recycled so that huge amount can be save by construction of recycling water treatment plant.
15. Laboratory	It requires strengthening to determine various parameters as presented by BIS/CPHEEO guidelines. This methodology should be according to prescribed standards.
16. Chemical Parameters	More scenarios should be taken to test the maximum parameter and also get tested from outside agency. Proper record should also be maintained.
17. Microbiological	Microbiological parameters viz. Total coliform, faecal coliform, E.Coli, should be conducted in raw water, clarified water, filtered water and final water regularly to see whether treatment prices is functioning well.
18. Other Parameters	Other parameters by which the performance can be improved should also be taken.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Mr. R.D.Sharma, Delhi Jal Board		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Conventional treatment process		
Source Water: Khadakwasla Dam		
Performance Summary: 1. Raw water from Dam to the plant is in sufficient quantity 2. Contamination in row is nil, so chlorination is maintain properly 3. Management is sufficient but need more quality staff 4. Improved in leak detection 5. Maintenance are doing well		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	B	Administration (Operation & maintenance)
2	B	Process control testing (Operation)
3	A	Plant coverage. Plant installing(Administration)
4	B	Sedimentation (Design)
5	A	Budget (planning)
6	B	Design (Planning of flow meter)
7	A	Operation
8	C	Storage (filtered water) under maintenance
9	A	Supervision (Administration)
10	A	Chlorination Plant (Design)
11	B	House keeping (Maintenance)

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Mr. R. D. Sharma)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Source of Raw water	Sufficient quantity with best quality.
2. Flow measurement	Needs flow meters for the actual capacity of the plant in two phases as early as possible.
3. Chemical testing	• Quality testing staff should be in every shift • latest safety equipment should be in lab as spectrophotometer • Quality staff should be trained with other plants.
4. Chlorination	To check the pollution in the distribution to city & maintain the residual chlorine upto 0.5 ppm at the consumer point.
5. Maintenance (preventive major)	Maintenance should be before the break down of the system also civil work should be properly done before time to stop any accident in the plant.
6. Safety Measures	• Chlorine tonner should not be corrosive • Alarming system should be provided • Chlorine absorption system should be operational regularly and maintain the concentration of caustic
7. Supervision (Administration)	• Require more effective supervision • Require Alchemist in each shift • More coordination required among department
8. Communication network	Require local network to contact every staff immediately & put the information immediately for better results.
9. Sedimentation (Design)	Detention period should be same throughout the every season. To make the healthy flocks for better settlement during higher turbidity season detention period should be increased.
10. (House keeping maintenance)	Require more attention
11. Historical nature	To maintain the historical nature of the plant for the coming generation to see the initial stages of the treatment process.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Mr. Subhash Chandra, New Delhi		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Rapid Sand Filter		
Source Water: New Mutha Right bank and closed pipe (Khadakwasla Dam)		
Performance Summary: Overall satisfactory		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
Sub Engineer	A	Valve operation
Filter Inspector	B	Filter plant operations.
Chemical Operator	B	Chemical dose
	(NIL)	Distribution of water
Valve men		On the whole- Satisfactory

Rating Description:

- A – Major effect on long-term repetitive basis.
- B – Moderate effect on routine basis. Major effect on periodic basis.
- C – Minor effect.

(Mr. Subhash Chandra)

Performance Limiting Factors Notes	
Factor	**Notes**
Valve operation	All the valve operators are well conversant to their job and seems to laborious
Filter plant operation	All the staff found good at holding expertise in their job
Chemical Dose	Staff has adequate knowledge in regards to Chemical dose as per requirement
Distribution of water	Not pertains to staff working in filter house and allied jobs
Overall Observation	

Interview of following staff was taken
-Sub Engineer
-filter Inspector
-Chemical Operator
-Valve man – 2 nos

It has been observed that all the staff is well conversant in their hobs/duties. They have sufficient knowledge and experience for doing their jobs. I would like to emphasize that still more scope for imparting technical know-how such as size of filter not known by them, size of coarse sand is not known, I would also suggest that mock drill should be carried not n once a year but more over wind cocks should be installed. The entire sire should be freehand so as to alter in staff in case of failure of equipment or leakage or chlorine due to one or other reason. Further during the visit of pump house it has been notice that a portion of CC over the reservoirs has been broken and which can cause contamination to water. It should be cover to avoid enter of foreign items. The pump installed in pump house is very close to each other and have less working place. The installation should be as per good engineering practices. The standby motor are kept in the pump house, this should be kept in right manner. Painting to equipment is required to avoid corrosion and for been look. Flow meter require to be installed at inlet or well outlet plant

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Er. P S Kelkar, NEERI, Nagpur		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Conventional clarrifloculator, filtration, disinfection		
Source Water: Mutha river		
Performance Summary:		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	Raw water quantity and quality adequate
2	B	Chances of pollution in canal
3	B	No flow measurement at the plant
4	B	Insure proper mixing of alum/PAC
5	B	Performance of clarifiers is not qualified
6	A	Filter backwash automation done / maintenance facility available
7	B	Satisfactory back washing
8	A	Cleanliness required, No SOP available, colour coding for pipeline
9	B	Good, adequate control over the chemical dose
10	B	Immediate repairs are needed for balancing tank
11	C	Training needs to be identified for O&M staff, no guidelines available. Responsibility of each staff members has to be defined

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Er. P S Kelkar)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water sources	Reservoir (Khadakwasala) – Very clean, low turbidity except in monsoon
2. Raw water transmission by gravity	Through open channel and close pipe line upto treatment plant (12 km), pollution is expected in open channel.
3. Flow measurement	Near the outlet of reservoir, calibration (measurement) questionable, no measurement of flow or any device at the plant inlet flow configuration is old and new plant is approximate
4. Alum (Chemical dosing)	As directed by the chemist, Manually measured Single point application ,Mixing adequate (apparently)
5. Flocculators and clarifier	• Performance of individual clarifloculator is to be judge • No testing at the plant ,SOP is not available • Equal distribution all along the periphery
6. Filtration (back washing)	Filter under investigation had uniform back wash, aeration adequate, automation is done
7. Pumping machinery	Three pumping stations, very congested, standby pump available
8. Chlorination	• Chlorinate is in working conditions, Available chlorine is 1.5 mg/l • Cylinder outside with ventilation. Stack one over the other • Safety equipment available. No mock drilling for safety measures
9. Master balance reservoirs	• Three compartment • Roof in depleted conditions urgent need to repair for which shut down must be undertaken
10. Human Resource Development	• Interview with filter inspector, sub engineer, electrician, chemical doser and valve man • Guidelines for maintenance not available • SOP is not available for various equipment and machinery • Colour is not provided ,No mock drilling
11. Chemical doser	• Dose suggested by the chemist adjusted normally by the chemical doser • Take decision to change the dose looking at the efficiency of the flocculators. • Point wise staff is deployed.
12. Chlorination and laboratory facilities	• Point were decided traditionally • Adequate safety equipment available • Laboratory facility available • Adequate physico-chemical and bacteriological analysis • No training to filter inspector only on job training • Knowledge of about filtration available • No specific problem maintained by O&M staff

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Er. S.P.Andey		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Conventional with flash mixing, clariflucation, RSF and post chlorination		
Source Water: Khadakwasala dam on Mutha river		
Performance Summary: Being a reservoir source turbidity in less during lean period (<10 NTU), During monsoon period turbidity reaches to 200 -300 NTU for one or two monsoon. Liquid alum is used a coagulant and dose is controlled properly. So the plant performance is satisfactory.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	B	Policy (emergency expenditure)
2	A	Flow measuring device (raw water)
3	B	Back wash water recycling
4	B	Chlorination system
5	C	Staff
6	C	In-house training
7	B	Alum dose application

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Er. S.P.Andey)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Policies (emergency repair expenditure)	Increasing limit of expenditure without tender to avoid delay in repairs
2. Flow measurement devices	Absence of raw water flow measuring device, will have impact on chemical dose fixing
3. Back wash water recycling	• Can save the water • Can improve the coagulation and flocculation during low turbidity period
4. Chlorination system	• Proper method of feeding chlorine by bleaching powder application in absence of gas should be follow • (Preparing bleaching powder solution and feeding settled chlorine solution).
5. Staff	Employment of staff on the vacancy due to retirement as per requirement
6. In-house training	Organize in-house training programme for latest development in method equipment and instrumentation for water treatment.
7. Alum dose application	Provide suitable alum solution feeder for constant dose of alum for correct dose application

CPE Performance Limiting Factors Summary
Plant Name/Location: Parwati Water Works
CPE Performed By: Er. J.K.Bassin
CPE Date: 11.02.08 to 13.02.08
Plant Type: Conventional water treatment plant
Source Water: Khadakwasala Dam on Mutha River through pipeline and open cannel
Performance Summary: • Raw water source quality does not very much except for turbidity in season. • Product water of consistent quality is provided through operational of plant. • Filters have been provided through automatic activator which have made the overall back wash operation simpler and with less labour. • Overall performance of water treatment plant is good. • Clarifier design needs to be checked, as also the coagulation dose etc. seems to be low here.

Ranking Table

Rank	Rating	Performance Limiting Factor (Category)
1	B	Water quality monitoring of open cannel can very water to water treatment plant.
2	B	Flow measurement device and record
3	B	Use of bleaching powder in case chlorination have problem or gas supply is hampered. BC is directly put into CMR
4	A	Wasted back wash water recirculation is advocated
5	B	Storage of chemicals like alum, PAC, BC and chlorine gas
6	A	Safety aspects of use of chlorine gas. The staff of water treatment plant should be properly framed for the event of gas leakages. Safety drills should be assigned
7	B	Microbial quality assurance in distribution system through surveillance
8	B	Maintenance of day to day basis. Procedures are causing delay in treatment of spares, for in-house repair of pumping machinery

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Er. J.K.Bassin)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Water quality monitoring	Water is conveyed from dam upto water treatment plant through close conduit as well as open channel. An elaborate water quality monitoring programme may be taken up to ensure consistent quality of water carried through both channels. There is a quality difference as observed in the stilling chamber. Change in quality would require frequent adjustment in plant operating parameters.
2. Flow measurement	The flow is estimated base on the pump capacity and number of hours of operation. Measurement would be desirable along with a record so that proper adjustment of chemical dosing can be provided.
3. Chlorination	Chlorination is used for disinfection. In case of failure of chlorinator or disrupted gas supply, BC is used. Normally it should have a solution making tank of proper strength solution. Supernatant should be used for chlorination it is noted that BC is directly put into the MBR. Result may be higher turbidity water and or settling in MBR.
4. Filter back wash	2 to 3 % water is used for back washing filter it would be desirable to recirculate the water with adequate safety.
5. Storage of chemicals	Safety aspects should be looked into, since all this chemicals are to be stored properly. Particularly PAC should be handled properly. Chlorine cylinder storage should be appropriate needs attention.
6. Safety aspects	Chlorine gas is a toxic gas and lethal. All staff of the plant who would be exposed when leakage offer, will well acquainted with the precaution and doe's and don't.
7. Water quality & laboratory analysis	Water quality assurance must be performed through regular daily sampling in distribution system and laboratory analysis. Emergency lab staff should be available throughout the day and night. Lab is generally close at 6 pm and no chemist is available on 24 hrs. Their must be need of chemist during night time. Communication of contamination through distribution division and separate plant operator should be appointed, so that appropriate action be taken timely.
8. Repair & Maintenance	It was understood that, purchase procedures for petty items, like bearing etc., which are needed on day to day basis for repair and maintenance and causing delays. The process of tendering is to be adopted even for Rs. 3000/- purchase Thus, down time of machinery is prolonged.
9. General	The design capacity seems to be exceeded in daily operation. A complete analysis and design parameters needs to be evaluated. Since the settled water has high turbidity more attention needs to be paid to clarifier design including alum and pH dosing, flocculation and coagulation efficiency. These needs to be checked periodically in post monsoon when treatment meet the higher second stage season to be more critically in these respect. No leak detection programme is installed nor is any water audit planned. Manpower has reduced over a time due to contract, but part automation has been helpful in this respect.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Mr. J.Sunil Kumar		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Conventional treatment plant		
Source Water: Khadakwasala Dam		
Performance Summary: • In general the Paravti water works is working moderately and require being upgraded adequate staff and training impartation to them and providing SOP to the operator for effective maintenance of the plant.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	B	Valve operations
2	B	filtration plant operations
3	C	chemical dosing
4	B	General

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis. Major effect on periodic basis.
C – Minor effect.

(Mr. J.Sunil Kumar)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Valve operation	All the valve operators are well conversant with valve operations and experienced.
2. Filtration operation	Filter operator's needs to be trained with all the operational procedures as they do not have perfect knowledge of the same. The details of the bed size, media size and rate of filtration are not properly understood by the filter operators. No standard guidelines in operation of filtration plant are given the filter operators. No color coding of the operating valve and system is not marked clearly. Proper chlorine leakage arresting precautions such as siren which indicate leakage is not working and the operator are not knowing the handling of safety equipment like mask etc.
3. Chemical dosing	Chemical dosing operator is well experience and knows his job and acts accordingly to assist the chemist in fixing of the doses of alum or PAC in controlling turbidity.
4. Staff availability	The interview staff expressed that they are having shortage of staff in effective operation of filtration plant.
5. Filter bed premises	The surrounding of clarifier is having lot of vegetation which is giving ugly look.
6. Balancing reservoir	The balancing reservoir is having lot of hole on the top, which will reduce the residual chlorine in the treated water, as the residual chlorine will be evaporated from the reservoir.
7. Chlorine dosages	The residual chlorine was observed to be 1 mg/l in the reservoir and has to be enhanced to 2 mg/l to have efficient chlorine at the tail end point.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Mr. Raja Cherukuri, Hyderabad		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Rapid gravity sand filters conventional treatment		
Source Water: Khadakwasala reservoir through open channel and pipe line		
Performance Summary: • The overall plant performance is satisfactory. The clarifloculator are found to be overloaded. The chlorine toners have found to be stack one over the other, could be hazardous, if the toner in the bottom row leak. The roof stack of the clear water reservoir is found to broken and it is exposed to open sky, enhancing the chances of evaporation of chlorine and may change quality of water.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	Raw water protection
2	B	Water quality monitoring
3	B	In flow and outflow measurement
4	B	Alum and chlorine consumption
5	B	Over loading of clarifloculator
6	B	Disinfection of clear water
7	A	Condition of clear water reservoir
8	A	Stacking of chlorine toner
9	B	House keeping

Rating Description

A – Major effect on long-term repetitive basis.

B – Moderate effect on routine basis or major effect on periodic basis.

C – Minor effect.

(Mr. Raja Cherukuri)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water protection	Part of the raw water is drawn through open channel. There is a possibility of contamination as there are number of slums on the bank of the channel
2. Water quality monitoring	The raw water drawn through the open channel and is essential to monitor the quality of raw water.
3. In flow and out flow measurement	Measuring devices for raw water and clear water are not available and are unable to specify the actual quantity of water drawn.
4. Alum and chlorine consumption	The alum and chlorine demand of raw water and clear water is approximately calculated as there are not flow measuring device, finding it to difficult to dose uniform doses of alum during low turbidity.
5. Over loading of clarifloculator	It is found that flocculators are being over loading resulting in less retention period. The plant being over loaded and the quality of filter may very.
6. Disinfection of clear water	Chlorine is added in two stages for disinfection for raw and clear water. The clear water reservoir is open to sky at places and chances of evaporation of chlorine is more.
7. Condition of clear water reservoir	The roof slab of clear water reservoir is broken and damage due to the effect of chlorine and exposed as many places.
8. Sacking of chlorine toner	The chlorine toners are sacked in two rows one over the other and drawler of chlorine is being done through bottom row. It will be difficult to arrest leakage if occurred in bottom row of toner and its dangerous.
9. House keeping	There is a growth of scrub all around the clarifloculator. The clarifloculator side wall is leaking at several places. At pump houses are stored with old motor in the pathway giving little place for movement.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Parwati Water Works		
CPE Performed By: Er. N. Ramesh, Hyderabad		
CPE Date: 11.02.08 to 13.02.08		
Plant Type: Conventional treatment plant		
Source Water: Mutha river by gravity from Khadakwasala		
Performance Summary: • There is no variation in parameters in the season of the year except in the monsoon and it is goes turbidity upto 160 NTU. But plant is old and constructed in the year 1969 and 1972 the performance of the plant is satisfactory the plant is need limited demand, however, source require regular monitoring and patrolling of open channel		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	B	Surface water protection
2	C	Water quality
3	A	Measurement of inflow and outflow
4	A	Chemical storage
5	B	Alum and chlorine consumption
6	B	Sedimentation and flocculation
7	B	Process control
8 - 9	B	Sludge removal and backwashing
10	B	Validation water quality
11	B	Disinfection
12-15	B	Balancing operational staff /financial /planning supervision
16	C	Suggestions

Rating Description

A – Major effect on long-term repetitive basis.
B – Moderate effect on routine basis or major effect on periodic basis.
C – Minor effect.

(Er. N. Ramesh)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Source water protection	The raw water cannel is open to sky, avoid floating material cover it.
2. Water quality	Water quality is good, but however periodically check is required during monsoon period
3. Measurement of inflow or outflow	Measurement devices for raw water entering into the system, but there is no measurement of treated unit quantity having its treatment plant, except pumping discharge.
4. Chemical storage and feeding system	Feeding system to be strengthen for good results
5. Alum and chlorine consumption	Chlorine is added as per chlorine demand examine in the lab during day shift.
6. Process control	Satisfactorily
7. Validation of water quality	There is no provision for water quality checks
8. Disinfection	Chlorine is used for disinfection of water.
9. Balancing tank	There are two balancing tanks, Roof of one was damage which results chlorine of treated water evaporated, hence tank roof immediately protected by reproofing or by other alternative.
10. Operating Staff	Adequate staff for operation of filter bed. Pumping, electric problems. They are well cooperative and coordinating with each other. The necessary training to be given for better performance.
11. Finance Provision	Increase amount upto Rs. 50000/- for attending a electrical repairs day to day and prolong.
12. Supervision of the treatment process	Satisfactory working
13. Planning	Repairs of balancing tank is very essential planning to be made

Performance Limiting Factors Summary

C) Haiderpur Water Works, Delhi

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Mr. J. Sunil Kumar**,** HMWS & S. Board, Hyderabad		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: Performance of the WTP is good, due to effective reduction of turbidity of 1000 NTU to 0.6 NTU. The quality of the water is good with proper chlorination with a residual chlorine of 1.5 ppm and all the parameter of the water is adhering to the drinking water standards.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor(Category)**
1	A	The raw water protection.
2	C	Water quality monitoring.
3	B	In flow and out flow measurement.
4	C	Alum and chlorine consumption.
5	C	Over loading of clari-flocculators.
6	C	Disinfection of clear water.
7	A	Condition of clear water reservoir.
8	B	Stacking of chlorine tonner.
9	B	House-keeping.
10	C	Administration.
11	A	Process control
12	C	Laboratory/SOP/testing/calibration

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Mr. J. Sunil Kumar)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water protection	• The raw water is drawn through open channel and prone from contaminates from sewage, industrial effluent contaminates, periodical checking of BOD and COD is required to know the contamination or pollutants in the raw water. • Periodical analysis of toxic metals, trace elements are to be checked to know the exact pollutants in raw water.
2. Water quality monitoring	• The system of water quality monitoring observed to be good as the tail end points are checked for residual chlorine and the observation of 0.5 ppm. • At the end point is good. The monitoring staff is observed to be less and is still there is proper a norm of sample collection is maintained.
3. Inflow and outflow measurement	Proper measurement of the inflow and outflow are being recorded and proper audit of the water is being maintained by the WTP.
4. Alum and chlorine consumption	Alum and chlorine consumption is observed to be maintained properly by proper doses of alum/PAC and chlorine resulting in the quality of clear water obtained from the WTP.
5. Overloading of clari flocculators	There is no overloading of the clarifiers and the clarified water quality is good.
6. Disinfection of clear water	Proper disinfection of the clear water is maintained by keeping 1.5 ppm of residual chlorine in the clear water.
7. Condition of clear water reservoir	• Condition of the clear water reservoir is observed to be in a bad condition. • Lot of grass is observed to be grown on the reservoirs.
8. Stacking of chlorine cylinders	The chlorine cylinders are observed to be exposed to the open air in certain areas.
9. House-keeping	House-keeping has to be improved as lot of algae and vegetation is observed on the filter beds and certain electrical points are not properly covered with boxes in post chlorination room of filter plant-1.
10. Administration process control	• The administration of the WTP is well maintained by the chemists. • The process control measurement has to be improved.
11. Laboratory/SOPs/ Testing/Calibration	The laboratory is well maintained with all the testing equipments and necessary tests are being conducted.
12. Training	• Essential Particularly to upgrade the lab practices. • Quality control & assessment of recorded data is essential.
13. CW Pumping	Out of 5 mains three are provided with flow meters from Siemens which are the replacement of the original ones. Two flow meters are under process.
14. House keeping	Except CWR good house keeping The plant is under construction
15. Filter Water Recycle	Water audit & energy

CPE Performance Limiting Factors Summary

Plant Name/Location: Haiderpur Water treatment Plant, Delhi.

CPE Performed By: Er. J. K. Bassin

CPE Date: 22.09.08 to 24.09.08

Plant Type: Conventional Treatment Plant

Source Water: Western Yamuna Canal

Performance Summary:

- Raw water source quality varies with season and even day to day basis.
- Treated water quality was acceptable :turbidity was usually <1NTU
- Filters have automatic panel for back-washing. Backwashing operation was seen for one filter bed. The beds were seen to be washed properly. However, parameters may be identified to check the state of backwash filters. Filters beds were found to be dirty or emptying for backwash (gutters & under rains).
- Floculators design parameters need to checked. The bridge movement of max was a bit high, the flock shearing might be occurring G & T values needs to be verified.

Ranking Table

Rank	Rating	Performance Limiting Factor(Category)
1	B	Raw water canal- water qualities issue. Used for bathing, etc. New covered channel is under construction and should resolve many issues related to raw water quality and variations in bacterial quality. Record shows high bacterial count but treated water is free from it. Flow measurement and metering may also be done for proper records.
2	B	Use of PAC in conjunction with alum
3	C	Recirculate backwash water(<2% water used)
4	C	Chlorination, mock drills organized once a year. Protective gear not used on a routine basis.
5	C	Chemical storage: alum, PAC etc.
6	B	Training and upgradation of man-power.
7	B	Transmission and sub-mains used for direct supply even.

Rating Description

A-Major effect on long-term repetitive base
B-Moderate effect on a routine basis or major effect on a periodic basis
C-Minor effect

(Er. J. K. Bassin)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw Water Canal	• Bacterial contamination is unchecked by an open channel & accessible to people & cattle. • New covered channel is being provided. • Flow measuring needs to be improved and recorded as also the metering may be done. • If bacterial quality is improved, load on plant and risk of treated water contamination may be reduced.
2. Coagulant	• PAC and alum are used conjunctively effect on design parameters of flocculators and efficiency. • Cost of PAC is less than alum and better level control is possible, with PAC being in liquid state. • Better particle removal is possible with PAC.
3. Back-wash Water	• <2 % water used. Overall operation is acceptable. • Back-washing time between two cycles is 48 hrs
4. Chlorination	• The chlorine gas used. Chlorinators are in good condition. • Operator training is desirable. • Emergency condition handling is working. • Mock drills are organized. • Protective gear available but not in routine use.
5. Chemical storage	• Storage tanks are in good condition. Six alum & PAC preparation tanks for each plant. • Overall arrangement is acceptable.
6. Training	• Training and up gradation of man- power is essential. • Promotional avenues need to be established to remove discontent ion in junior staff and lack of interest.
7. Supply-lines	Transmission man and sub- man are used for even direct supply in addition to supply to booster station.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Er. C. Raja, Dy GM (Eng), HMWS & SB, Hyderabad		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: • The plant receives raw water with high turbidity with plenty of floating particle. • The plant appears to be over loaded. • The clear water turbidity is within the permissible limits • The plant managing operators have adequate knowledge about day to day operations of the plant • The clear water contains 1.5 ppm of residual chlorine before letting out for supply. • The clear water is adhering to the prescribed standards.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor (Category)**
1	A	The Raw water protection
2	B	Water quality monitoring
3	A	Inflow and out flow measurement.
4	B	Alum and Chlorine consumption
5	A	Over-loading of clariflocculation
6	B	Disinfection of clear water reservoir
7		Condition of clear water reservoir
8	C	Stacking of chlorine tonners
9	C	House keeping
10	B	Motivation to the staff of filtration plant.

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Er. C. Raja)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water protection	• The raw water canal is open to sky and is not protected. People are found to be bathing and washing in the raw water canal. Plenty of water hyacinth is found to be coming with raw water contamination of raw. • Water is possible as there as no monitoring facility available along the raw canal. Proper barricading could be provided for protection all along the side of the canal.
2. Water quality monitoring	The raw water color appears to contain pollutants. proper raw water quality monitoring to be done to check the presence of toxic metal and nitrite. The clear water quality monitoring appears to be adequate .the no of sample drawn could be increased. The Water quality staff require admitted training in collection and checking of quality
3. Inflow and Outflow Measurement	There is no device for measuring the inflow of raw water the quantity received in is noted as per the issues of the irrigation department due to lack of measurement on raw water inflow the quantity received could be move resulting in over loading of clarifloculator and filters. Digital flow measuring devices are functioning on the pumping outlet of the clear water .
4. Alum and Chlorine Consumption	The Alum & Chlorine doses appear to be adequate as the results of the clear water appear to be in permissible limits.
5. Over loading of Clarifloculators	There is no overloading of Clarifloculator. The floculators rotation appears faster then what is requiring could result in breaking of flocks.
6. Disinfection of clear water	Disinfection of clear water is done as deserved the clear water contains 1.5ppm of residual chlorine. sample should also be check from the tail end of the supply point the ensure adequate presence of chlorine is the transmission lines. Move than 25 Km from The filtration point.
7. Stalking of chlorine toners	Chlorine cylinders as found to be stalker in proper order. The empty cylinders are kept open sunlight. Measures to be taken for keeping them in shade. The chlorine operators are very good in operation and maintenance of chlorine plants and have good knowledge in handling of chlorine toners. Safety equipment should be kept near to the plant and caution boards to be kept near the chlorine plant.
8. House Keeping	In general the plant area and the filtration are clean. The filtration campus has serubjungla all round and can be breeding place for reptiles. Hence may be kept clear.
9. Motivation to the staff of filtration plant	There appears to be stagnation of promotion of working staff in filtration person work in same category for more than 10 -15 years without any promotion. Promotion….to be created for motivation of the staff. Advanced training also to be given as there are no periodical training imparted to them

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Mr. S.P. Bhanage		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: • Overall performance at plant is good. Due to large space available plant lay out is well planned. The raw water quality is bad. No measurement device for raw water flow. Housekeeping of pump flow (raw) is very good.100% stand by pumps are available. Chlorination is good. Power sector should be maintained unity. • Flocculators speed is more than required.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor(Category)**
1	A	Raw water quality will be improved.
2	A	Pump maintenance will reduce.
3	A	Filter bed will be clean. Flock formation will be improved.
4	B	Automization should be running condition
5	A	Power factor should maintain unity
6	A	Rising main connection to header, losses will reduce

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Mr. S.P. Bhanage)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water	Automatic screen should install for removing the floating material coming through canal.
2. Raw water pump house	Power factor should be maintained unity. SCADA systems for pump should install &wireless communication system should be installed.
3. Pre chlorination	Satisfactorily
4. Clari-flocculaters	• Prima fancy Condition is not good. • Floating material should be removed • Speed of Flocculators is more. Steel “V” notch should be replaced.
5. Filter house	• Housekeeping should improve. • Cleaning of filter bed should be done. • Scraping of algae and filter bed wall. • Stating material is more than filter bed. • Atomization should be in running condition backwash system should have one side at time.
6. Post chlorination	Satisfactory
7. Pure water pump house	• SCADA and wireless communication system should be installed. • Power factor should maintained unity.
8. Pump House	• Pump maintenance should be done by authorized people only. • Rising main to header connection should not be in right angle the smooth curved connection should provide.
9. Training	• Essential Particularly to upgrade the lab practices. • Quality control & assessment of recorded data is essential.
10. CW Pumping	• Out of 5 mains three are provided with flow meters from Siemens which are the replacement of the original ones. Two flow meters are under process.
11. House keeping	• Except CWR good house keeping • The plant is under construction
12. Filter Water Recycle	Water audit & energy

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Er. S. P. Andey, NEERI Nagpur		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: Source of raw water is open canal. Due to human activities turn is wide fluctuation in raw water turbidity. Though turbidity of raw water ranges from 30-5000 NTU, turbidity of felted water is 0.5-2 NTU indication satisfactory performance of the plant.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor(Category)**
1	B	Wide fluctuation in raw water turbidity
2	A	Filter appertances
3	C	Screens for arresting floating matter
4	B	Over loading of clarifloculators
5	B	Availability of plant design data
6	C	Overdraw of chlorine
7	A	Source protection
8	C	Recycling of filter backwash water
9	C	Raw water flow measuring device
10	A	Motivation of plant operating staff

Rating Description

A-Major effect on long-term repetitive base
B-Moderate effect on a routine basis or major effect on a periodic basis
C-Minor effect

(Er. S. P. Andey)

Performance Limiting Factors Notes		
Factor		**Notes**
1.	Fluctuation in raw water turbidity	• Unlined canal & human activities in the canal. • New canal under construction will reduce turbidity fluctuation & there by reduction in expenditure on chemicals.
2.	Filter appertances	• No head loss indicator & rate setter. • Filter are backwashed once in 48 hrs on routine basis. • Can save water if backwashed based on head loss development.
3.	Screens for arrestation of floating matter in raw water	• Floating matter absorbed on filter. • Provide fine screens in channel to clarifloculators. • May impart foul smell to filtered water due to decay of plant material in the floating matter.
4.	Overloading of clarifloculators	• Clarifier outlet weir was submerged in the water. • May decrease the filter run due to carry over of flocks in the filter.
5.	Availability of plant design data	• Dimensions of water treatment units are not available. • May create difficulty in accessing the performance of different treatment unit in case of deterioration of treated water quality.
6.	Over drawl of chlorine from cylinder	Ice formation of cylinder may decrease the flow rate due to cooling effect.
7.	Source protection	Human activities near source may increase pollution load (chemical & bacteriological) in water thereby increase in chlorine dose & alum consumption.
8.	Recycling of filter backwash water	• No arrangement for recycling of filter backwash. • Recycling will conserve water. • Improves the flocks' formation during low turbidity of raw water.
9.	Raw water flow measurement	• Raw water flow is essential from the chart based on inlet door opening and depth of water in the inlet channel. • Suitable automatic flow measuring device should install to measure plant inlet flow to estimate accurate flow rate of alum and chlorine extent of overloading/under loading of plant and total plant output.
10.	Motivation of plant operating staff	• Staff is working on same post/grade for more than 15-20 yrs. • Formulation of suitable promotion policy for the staff working efficiently for longer duration. • Some award/reward scheme for the staff who improve their qualification and who do some additional things which will have positive impacts on plant performance in addition to their routine job.

CPE Performance Limiting Factors Summary

Plant Name/Location: Haiderpur Water treatment Plant, Delhi.

CPE Performed By: Mr. R.D.Sharma

CPE Date: 22.09.08 to 24.09.08

Plant Type: Conventional Treatment Plant

Source Water: Western Yamuna Canal

Performance Summary:

- Over all performance is excellent.
- Staff running plant with limited staff.
- plant maintained 0.6 NTU Turbidity
- Plant controlled above 4000 NTU turbidity
- 200 MGD plant with pre & post chlorination at both the plant but zero Cl2 in the atmosphere maintained proper pre & post chlorination
- Qualified staff is at the W.T.P.N.P.

Ranking Table

Rank	Rating	Performance Limiting Factor(Category)
1	A	Administration cooperation and maintenance
2	A	Process control testing (operation)
3	B	Plant staffing
4	A	Sedimentation (design)
5	A	Quality control
6	A	Maintenance (preventive major)
7	A	Budget (Planning)
8	A	Housekeeping (Maintenance)
9	A	Storage of PAC & alum cakes
10	A	Chlorination plant

Rating Description

A-Major effect on long-term repetitive base
B-Moderate effect on a routine basis or major effect on a periodic basis
C-Minor effect

(Mr. R.D.Sharma)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Source water protection (administration)	Maintained the raw water from floating material and maintain the security point of view
2. Flow measurement (Design)	Flow meters are working in raw water main lines & clear water raising mains
3. Chemical test	• Jar test used in every shift. • All the pollution indicating test conduct in every shift regularly.
4. Preventive & major maintenance	• Record maintained of every major and minor work. • Separate maintenance teams are at the plant.
5. Supervision (Administration)	• Supervisors are very effective. • Quality controllers are in every shift. • Co ordinations are very good with the administration & staff.
6. Sedimentation(Design)	Sedimentation doing very well. Reduced turbidity from 4000 NTU to 0.6 NTU
7. Chlorination Plant(Design)	Chlorination plant are very well maintained and running properly
8. Safety Measures	• Loading and unloading safety is very good. • Absorption system is running very well. • Alarming system is running very well. • Mock drill conducted in every year with safety offices and other department as fire police etc.
9. Storage of coagulant material	Maintained alum stock and PAC stock
10. Green-ness	Maintained greenness of the plant with lot of plants and flowers.
11. Environment(Plant)	Excellent neat and clean. No air pollution.

CPE Performance Limiting Factors Summary

Plant Name/Location: Haiderpur Water treatment Plant, Delhi.

CPE Performed By: Er. N. Ramesh, Dy.GM(E) HMWS & SB

CPE Date: 23.09.08

Plant Type: Conventional Treatment Plant

Source Water: Western Yamuna Canal

Performance Summary:

- Haiderpur Water Treatment plant in Delhi
- The raw water draws from open channel of Yamuna river canal having high turbidity and floating materials.
- Maintains good standard for treated water.
- The staff having adequate knowledge.
- Extra staff required in rainy seasons.
- Most of the staff not promoted even 25 years service due to they are unhappy.

Ranking Table

Rank	Rating	Performance Limiting Factor(Category)
1	A	Raw water protection
2	A	Water Quality monitoring
3	A	Inflow and outflow measurement
4	B	Alum and chlorine consumption
5	B	Overloading clarifloculators
6	C	Disinfection of clear water
7	A	Condition of clear water reservoir
8	B	Stocking of chlorine tonners
9	A	House-keeping
10	B	Application of concepts and testing to process control(operation)
11	B	Process control testing(operation)
12	A	Coverage ratio or reserves (Administration)
13	A	Promotion of the staff

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Er. N. Ramesh)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw Water Protection	Its open channel there is every possible pollution to be avoid the coverage with wall and roof protection to be done.
2. Water Quality Monitoring	The staff stated only whenever consumer complaint against quality of water then only analysis the water. It should be periodically checked wherever such pollution areas.
3. In-flow and out-flow Measurement	The repair/replacement of water bodies, out-flow meters were essential to measure quantity and also percentage of wastage and quantity as there are working 8 no. flow meters out of 10 no.
4. Alum and chlorine consumption	For alum and chlorine dosage measurement of raw water quantity and clear water quantity measured present they were giving doses or appropriate quantity. The flow meters to be installed.
5. Over loading-clari-floculators	“V” notches to be changed from M.S.T. plastic to avoid rust
6. Disinfection of clear water	Presently satisfactorily doing
7. Condition of clear water reservoir	Accumulated sludge to be removed periodically and remove the grass of roof-top and roofs of reservoirs should be maintained very neatly
8. Stacking of chlorine towers	Satisfactorily stacking and shed needs repair to avoid empty cylinders kept in open place
9. House-keeping	To be improved for neatness
10. Application of concepts and testing to process control	In this rages the staff is doing satisfactorily for better results training must be given
11. Process control testing	No routine calibration of raw water inflow and clear water outflow. No process control testing conducted for clarifiers
12. Coverage ratio or reservoirs (Administration)	Provide additional plant coverage and support minor plant equipment needs/improvement
13. Promotion to the staff	The promotion to be given one cadre to reset higher cadre within a span of 12 to 14 years to avoid unhappiness in staff
14. General	A general training to be given periodically to the lower, middle staff which results more efficiency and quality in the work

CPE Performance Limiting Factors Summary

Plant Name/Location: Haiderpur Water treatment Plant, Delhi.

CPE Performed By: Mrs Shivani Dhage

CPE Date: 23.09.08

Plant Type: Conventional Treatment Plant

Source Water: Western Yamuna Canal

Performance Summary:

- The plant receives fluctuating raw water turbidities which necessitates every day variation in coagulant dose. Unit processes of working efficiently. Modernization of instrument for turbidity with online measurement is recommended. Data recording can be made in computers to retrieve the information.
- Source protection & flow measurement essential.

Ranking Table

Rank	Rating	Performance Limiting Factor(Category)
1	A	Raw water quality & flow measurement
2	A	Use of PAC if effective & economical to be maximized.
3	B	Coagulant dose monitoring records.
4	B	Recycle backwash to conserve water
5	C	Over load of clarifiers
6	C	Motivation of staff to achieve better product quality &not to restrict to meeting standards
7	B	Housekeeping on CWR for weeds
8	C	Water quality monitoring

Rating Description

A-Major effect on long-term repetitive base
B-Moderate effect on a routine basis or major effect on a periodic basis
C-Minor effect

(Mrs Shivani Dhage)

Performance Limiting Factors Notes	
Factor	**Notes**
Source Protection	• "Inadequate". 103 KM long open canal susceptible to human pollution. • By gravity , Bar screening 3" • Close conduit is under construction. • Flooding matter removed manually.
Raw water Quality	Fluctuating turbidity Possibility & contamination due to distillery, leather & tannery industries.
Measurement of flow	No flow meter for raw water Flow calculated from the weir reading & charts
Chemical storage Consumption	• 10 Tanks for PAC • Solid alum used & stored • A stock for about 3 months available • Non availability of chemicals decide the type of coagulant • Varies as per turbidity monthly Avg. data for 2003-2008 available
Flocculation , Coagulation & sedimentation	• Good performance • One of the bridges moving at the faster rate. • No overloading of clarifiers significantly
Filter O & M & Back wash	• Automated process • No head loss gages. • Back wash offer 48 hours or input is reduced.
Disinfection	• On line chlorination in filtered water channel. • Ice formation observed at cylinder indicating excess drawl of Cl_2 gas may lead to inadequate Res.Cl_2 at farthest end.
Balancing Reservoir	On CWR, a soil topping provided to grow lawn. But wild grass grown which may contaminate the treated water due to development of cracks & seepage needs immediate attention.
Safety Device	• Available for Cl_2 • The necessary precautionary & safety measures are displayed for all unit processes.
Training	• Essential Particularly to upgrade the lab practices. • Quality control & assessment of recorded data is essential.
CW Pumping	Out of 5 mains three are provided with flow meters from Siemens which are the replacement of the original ones. Two flow meters are under process.
House keeping	• Except CWR good house keeping • The plant is under construction
Filter Water Recycle	Water audit & energy

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Er. R.K. Gupta		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: Water treatment is found to be satisfactory in spite of a wide range of raw water turbidity and coliform, treated water of turbidity around 0.5 to 2.0 NTU is produced. Microbial contamination is also removed satisfactorily.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor(Category)**
1	B	Fluctuation in raw water turbidity
2	C	Screen for removed of flooding material
	B	Overloading of clarifloculators
3	A	Lack of filter apparatus
4	B	Non availability of plant units design data.
5	B	Unprotected raw water source
	C	Recycling of filter back wash water
	C	Flow measuring devices for raw water
6	A	Motivation to plant operating staff
	A	Motivation to laboratory staff

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Er. R.K. Gupta)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Turbidity of raw water fluctuates	Western Jamuna canal feeding raw water to plant is open and hence affected by human activities, causes turbidity variation. Closed channel is being provided to carry water.
2. Screens for removal of floating material from raw water	Floating material observed on the surface of water being filtered. This may cause foul smell & organic matter in the treated water.
3. Overloading of clarifloculators	Outer weir of clarifloculators was flow to be submerged in water This will attach the filter run period. Due to carrying of flocks to the sand filters.
4. Filter Appertences	Head loss indicator and rate settlers are non functional, hence backwash period cannot be decided as per requirement it is practiced at all most regular periods.
5. Plant Design 6. Data-Availability.	Design data and dimension of different treatment units are not available hence performance of different unit cannot be matched or compared.
7. Protection of raw water source &flow measurement through flow rate meters	• Based on the actual design criteria: Raw water channel being open may cause pollution load to increase due to cleaning and open defecation. This will lead to an increase in chemicals requirements to treat the waste adequate. • Raw water flow rates estimated from depth of water and dimensions of inlet channel. Flow measuring system is essential to control the proper chemical dosing.
8. Filter backwash 9. Water recycling	There is no provision for recycling of filter backwash water this recycling will reduce the water requirement as well as improve the flocks' formation during low turbidity water.
10. Training to plant operating staff and laboratory personals	Staff engaged in plant operation and laboratory analysts/Chemists should be given training to improve their knowledge and performances efficiencies. They should be given wide exposure and visits to often good laboratories /Plants to enhance their capabilities.
11. Motivation/Incentives for Operating and laboratory staff.	Operators and technicians are not provided adequate channels for further promotions/up gradations; they should be motivated based on some suitable promotions and policies. Laboratory personals should also be promoted often a suitable period of service. It is observed that staffs are working in some post / grade as long as 20 years Without any promotions.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Er. P.S Nirbhvane (Dev. Eng.) PMC		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: • Overall performance of plant is good. • Due to availability of ample land the layout is nicely arranged. Partly plant is very well maintained Engineers, Chemist &all other technical persons had a good knowledge. • Power factor is not maintained. Hence some modifications are required for that purpose. Water coming from canal have a high turbidity. But effluent characteristics are good.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor(Category)**
1	A	Floating material should be removed
2	A	Maintenance cost will reduced
3	A	Effective filtration will obtained
4	C	Dosing should maintained
5	B	Cleaning is necessary.
6	A	Proper flow will flow through rising main
		All plant should be atomized

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Er. P.S Nirbhvane)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water	Raw water turbidity is very high i.e. 150 NTU on 22 sept 08 Today raw water turbidity is -3000 NTU 23.9.08
2. Raw water pump house & pure water pump house	Power factor maintained unity SCADA & wireless communication should be installed.
3. Clarifloculators	Floating material should be removed speed of floculators are more Steel V notch should be replaced.
4. Pre & Post chlorination	Satisfactory.
5. Filter House	Housekeeping should be improved cleaning of filter bed is required. Atomization should work properly. Back wash should be more effectively.
6. Pure Water Pumping	Rising main & heater connection should be proper.

CPE Performance Limiting Factors Summary		
Plant Name/Location: Haiderpur Water treatment Plant, Delhi.		
CPE Performed By: Mr. Rokade Vikas Shankar (Asst .Eng.) PMC		
CPE Date: 23.09.08		
Plant Type: Conventional Treatment Plant		
Source Water: Western Yamuna Canal		
Performance Summary: • Overall performance of plant is good. • There is ample land available for future development. Canal raw water is highly turbid. Intake water measurement should be done by installing measuring device. Filter beds should be cleaned periodically unity power factor is essential.		
Ranking Table		
Rank	**Rating**	**Performance Limiting Factor(Category)**
1	A	Improvement in raw water quantity.
2	A	Reduction in Pump maintenance
3	A	Formation of flock will improve.
4	B	Discharge from filter beds will improve

Rating Description

A-Major effect on long-term repetitive base

B-Moderate effect on a routine basis or major effect on a periodic basis

C-Minor effect

(Mr. Rokade Vikas Shankar)

Performance Limiting Factors Notes	
Factor	**Notes**
1. Raw water Intake	Floating material and other material coming along the canal at intake gate should be removed by installing automatic screen.
2. Raw Water and pure water Pump house	Installation of SCADA and wireless communication system is essential for pump sets .Unity power factor should be maintained.
3. Pre & post chlorination	Maintained properly and chlorinators are working conditions .stand by chlorinators is essential.
4. Clari-floculators	Floating material needs removal. Steel “V” notch is rusted due to pcb-Chlorination and hence could be replaced by fiber material “V” notch.
5. Filter houses	Houses keeping should be improved. Cleaning of filter beds should be done periodically. Back wash at a time one side only.

CPE Performance Limiting Factors Summary

Plant Name/Location: Haiderpur Water treatment Plant, Delhi.

CPE Performed By: K.S.Narsappa

CPE Date: 23.09.08

Plant Type: Conventional Treatment Plant

Source Water: Western Yamuna Canal

Performance Summary:
Water Drawn through open channel requires frequent analysis at different points for detailed analysis before it enters the plant. The change of send under in both the 1973 and 1993 commission plan is quality to be done. The plant commission in 1973 required repair for loss of head and control values. Third party checking required for QA/QC.

Ranking Table

Rank	Rating	Performance Limiting Factor(Category)
1	A	Source Protection
2	C	Water quality
3	B	Man Power Shortage felt during rainy season
4	B	Filter back wash
5	C	Overall operating process
6	B	Chemical Storage
7	B	Safety equipment at Chlorine plant
8	A	Working Condition and job promotion.
9	C	Disinfection
10	A	Maintenance at the inlet point.
11	C	Laboratory analysis
12	A	Major decision on over all maintenance required for allocation of funds requirement.

Rating Description

A-Major effect on long-term repetitive base
B-Moderate effect on a routine basis or major effect on a periodic basis
C-Minor effect

Annexure 3.2

Interview Guidelines

The following interview guidelines are provided to assist CPE providers with the interview process.

1. **Conduct interview with one staff person at a time in private location.**
   - It is important to create a comfortable environment for the interview process to take place. Confidentiality of the interview should be explained.

2. **keep the interview team size small**
   - The number of people included on each interview team should be kept to a minimum (e.g., 1 to 3) to avoid overwhelming the person being interviewed. If more than one person is included on the team, one person should be assigned as the lead interviewer

3. **Allow 30 to 45 minutes for each interview.**
   - It is important for people being interviewed and the number and type of issues involved. It is the responsibility of the interviewer to maintain the focus on performance – related issues. Interviews can easily be detracted by individual who find an "open ear" for presenting grievance.

4. **Explain the purpose of the interview and use of the information.**
   - It is important for the people being interviewed to understand that any information obtained from this process is only used to support identification of factors limiting performance (i.e., areas impacting performance). The interview information is not used to place blame on specific individuals or departments.

5. **Conduct interview after sufficient information has been gathered from CPE Interview**
   - Utilize results and observation gained from plant tour, performance assessment, major unit process evaluations, and data collection activities to identify areas of emphasis during the interviews.

6. **Progress through the interview in logical order**
   - For example, if an administrator is being interviewed, focus questions on administrative support, then on design issues, followed by operation and maintenance capabilities.

7. **Ask relevant questions with respect to staff area of involvement**
   - For example, when interviewing maintenance personnel, ask question related to relevant topics such as maintenance responsibilities, communication with supervisors, and administrative support for equipment.

8. **Ask open-ended questions**
   - For example, a question such as "Are you aware of any design deficiencies with current plant? "Would provide better information that questions like "Do you think that the flocculation basin provides sufficient detention time for flocculation?"

9. **Ask the question; don't give the answer**
    - The purpose of the interview is to gain the perspective of the person being interviewed. Ask the question and wait for the response (i.e., don't answer your own question based on information you may have received from pervious activities). Re phrasing the question may sometimes be necessary to provide clarity.

10. **Repeat a response to a question for clarification or confirmation**
    - For example, the interview can confirm a response by starting, "If I understand you correctly you believe that the reason for poor plant performance during April was due to excessive algae growth in the source water."

11. **Avoid accusatory statement**
    - Accusatory statement will likely lead to defensiveness by the person being interviewed. Rather, if an area of concern is suspected, ask questions that can confirm or clarify the situation.

12. **Use the interviewed to clarify that support factor information.**
    - For example, if performance problem occurred during one month of the past year, ask questions to clarify the perceived reasons for these problems.

13. **Note specific response that supports factor identification**.
    - During or following the interview, the interviewer may want to note or underline specific responses that support the identification of possible factors limiting performance. This summary can then be used during team debriefing and factor identification meeting.

Appendix – 1

A) Programme Copy for Hyderabad Workshop

Workshop on Composite Correction Programme (CCP), May 14 -17, 2007

Organizers : NEERI, Hyderabad, USEPA & HMWSSB
Venue: Hotel NKM's Grand, Hyderabad

Programme

May 14, 2007 – Day 1

Inaugural Programme

10:00 – 11:00 hrs

Welcome of Guests	Dr. Rakesh Kumar Scientist & Head, NEERI, Mumbai
Initiative on the CCP	Ms. Lisa Patel & Mr. David Visintainer South Asia Programme, USEPA
Special Address	Er. A.K. Sengupta, National Professional Officer WHO, India Dr. Jawahar Reddy (IAS), Managing Director, HMWSSB
Vote of Thanks	Dr. B. Chakradhar Scientist, NEERI, Hyderabad
Health Break	

Technical Session

Initiate Comprehensive Performance Evaluation (CPE) Course

11:15 – 13:15 hrs
- Background and short review of CPE and description of proposed activities

13:15 – 14:00 hrs - Lunch
14:00 – 17:30 hrs
- Visit to Asifnagar treatment plant
- Interaction with plant manager and operating staff
- Acquaintance with plant operations
- Set up testing equipment (turbidimeters)
- Performance assessment data collection and review
- Major unit operations and processes evaluation
- Discussion on initial observations

May 15, 2007 - Day 2

Field exercise continues
10:00 – 13:15 hrs
- Continue Performance assessment data collection & review
- Major unit operations and processes evaluation

13:15 – 14:00 hrs- Lunch
14:00 – 17:30 hrs
- Operator interviews
- Review status of CPE components (performance assessment data and develop performance potential graphs, major unit process evaluation, results of operator interviews, historical laboratory data)
- Discuss impressions and issues for interviews

May 16, 2007 - Day 3

Field exercise continues
10:00 – 13:15 hrs

- Continue review status of CPE components: Overall team reviews on-line turbidimeter data, performance potential graphs, major unit process evaluations
- Develop list of factors projected as limiting performance at the water treatment plant

13:15 – 14:00 hrs - Lunch
14:00 – 17:30 hrs

- Summarize results of CPE: Discuss results of initial interviews and direction subsequent interviews. Sub-teams complete interviews and compare observations.

May 17, 2007 - Day 4

10:00 – 13:15 hrs

- Presentation of CPE Results: Team members review on-line turbidimeter data.

13:15 – 14:00 hrs- Lunch
14:00 – 17:30 hrs

- Standard operating procedure (SOP) development course :
- Team members compare observations, develop list of performance limiting factors, prioritize any recommendations, develop preliminary report
- Describe need and approach - about SOPs
- Provide initial SOP
    - Power and pumping
    - Supply and purifying
    - Laboratory
    - Emergency response
- Select presenter for exit meeting
- Exit meeting, including presentation of findings, answer questions, team meets to discuss process and any way to modify in future.

Concluding Remarks

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LIST OF PARTICIPANTS FOR HYDERABAD WORKSHOP

Hyderabad Water Works (HM&WSSB)

- ***Er. K.S. Narasappa , General Manager (QAT) -*** Cell 9948080711
- ***Er. N. Ramesh , Deputy General Manager***
- ***Mrs. B. Meera Bai DGM (QAT), Asst. Engineer***

  Quality Assurance and Testing Wing
  Asif nagar, Filter Beds Premises
  Mehdipatnam, Hyderabad – 500028
  Phone : 23442830

Pune Water Works

- **Mr. S. Bhange, Suburban Additional Engineer -** Cell. 9823073652
- **Mr. N.S.Bagul, Assistant Engineer -** Cell. 9823172851

  Paravati Water Treatment Plant, Paravati Water Supply Centre,
  Sinhgadh Road, Pune -411037

Delhi Jal Board

- **Dr. Somdutt , Director (T&QC)**
- **Dr. Dhaniram Arya, Chief Water Analyst**
- **Mr. R. D. Sharma, Asst. Engineer**

Haiderpur Water Treatment Plant, Varunalaya, Phase-I, Karol Bagh, New Delhi

Kolkata Water works

- **Dr. Devabrata Mandal**

NEERI Zonal Laboratory, Delhi (DZL)

- **Er. J.K. Bassin, Scientist & Head**

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NEERI Zonal Laboratory, Mumbai (MuZL)

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- **Mrs. S. S. Dhage, Dy. Director**

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NEERI Zonal Laboratory, Hyderabad (HZL)

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- **Er. Ravindar Rao, Scientist**
- **Ms. Morami Kalita, Scientist**
- **Mr. I. Ram Mohan Rao, Scientist**
- **Mr. K.G. Rama Rao, Technical Officer**
- **Mrs. M. Sumathi, Technical Officer**

  NEERI Zonal Laboratory, Hyderabad
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  Phone No. 27160639

NEERI, Nagpur (HQ)

- **Dr. (Mrs.) Abha Sargaonkar, Scientist**

B) Programme Copy for Pune Workshop

Workshop on Composite Correction Programme (CCP), February 11-13, 2008

Organizers : NEERI, USEPA & Pune water works authority, PMC

**Venue : Hotel Raviraj, 790, Deccan Gymkhana,
Bhandarkar Road, Pune – 411 004, Ph – 9520-25679581/82/83/84**

Programme

February 11, 2008 – Day 1

Inaugural Programme
10.00 – 11.00 hrs

Inaugural Programme

10:00 – 11:00 hrs

Welcome Address	Dr. Tapan Chakraborty, Director, NEERI
Initiative on the CCP	Ms. Stephanie Adrian, International Water Supply Manager, USEPA
Inauguration & Inaugural Speech	Mr. P.P. Pardeshi, IAS Municipal Commissioner, Pune
Special Address	Dr. Suresh Gajendragadkar Retired Professor VJTI, Mumbai
Vote of Thanks	Ms Shivani S. Dhage, Scientist, NEERI,Mumbai

Health Break

Technical Session

Initiate Comprehensive Performance Evaluation (CPE) Course
11:15 – 13:15 hrs
- Background and short review of CPE and description of proposed activities.
  Mr. David Visintainer, Ex. South Asia Programme Officer, USEPA
- Status of Pune water supply: Er. V. G. Kulkarni
- Hydrabad Water Works CCP workshop: Dr. B. C. Chakradhar

13:15 – 14:00 hrs - Lunch

14:00 – 17:30 hrs
- Visit to Parvati water treatment plant – guided by Er. S. P. Bhanage
- Interaction with plant manager and operating staff
- Acquaintance with plant operations
- Performance assessment data collection and review – Turbidity data:
- Ms. Shivani Dhage, Mr. David Visintainer
- Major unit operations and processes evaluation - Methodology: Er. Andey
- Discussion on initial observations: Group activity

February 12, 2008 – Day 2

Field exercise continues

09:30 – 13:15 hrs

- Visit to raw water source - Khadakwasala Dam
- WSP- A tool to minimize health risk: Mr. A.K Sengupta, National Professional Officer, WHO, India Country Office, New Delhi
- WSP initiative in Hyderabad – Background: Er. K. S. Narsappa, General Manager QAT

13:15 – 14:00 hrs : Lunch

14:00 – 17:30 hrs

- Operator's interviews
- Review status of CPE components (performance assessment data and develop performance potential graphs, major unit process evaluation, results of operator interviews, historical laboratory data)
- Discuss impressions and issues from interviews by auditors
- Continue review status of CPE components: Overall team reviews turbidity data, performance potential graphs, major unit process evaluations

February 13, 2008 – Day 3

Field exercise continues

10:00 – 13:15 hrs

- Lecture on water treatment plant processes: Dr. A. D. Patwardhan, Consultant
- Develop list of factors projected as limiting performance at the water treatment plant
- Summarize results of CPE: Discuss results of initial interviews and direction subsequent interviews. Sub-teams complete interviews and compare observations

13:15 – 14:00 hrs : Lunch

14:00 – 17:30 hrs

- Presentation of CPE Results: Team members compare observations, develop list of performance limiting factors, prioritize any recommendations, and develop preliminary report
- Standard operating procedure (SOP) development course
- Describe need and approach - about SOPs
- Provide initial SOP
  - Power and pumping
  - Supply and purifying
  - Laboratory
  - Emergency response
- Select presenter for exit meeting
- Exit meeting, including presentation of findings, answer questions, team meets to discuss process and any way to modify in future.

Concluding Remarks

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LIST OF PARTICIPANTS FOR PUNE WORKSHOP

Name	Contact No.
Dr. Tapan Chakrabarti, Director, NEERI	--
Mr. A. K. Sengupta, National Professional Officer (SDE), WHO Country Office for India, New Delhi	09810178436
Ms. Adrian Stephanie, International Water Supply Manager, USEPA	--
Mr. David Visintainer, Ex. South Asia Programme Officer, USEPA	--
Er. K. S. Narsappa, General Manager, Hyderabad	09948080711
Er. N. Ramesh, Dy. General Manager, Hyderabad	09948080035
Er. C. Raja, Manager (Engg.),Hyderabad	09948080246
Mr. Sunil Kumar, Technical Officer (QAT), Hyderabad	09948080722
Dr. Somdatta, Director, Delhi Jal Board	09810852193
Mr. R. D. Sharma, Chemist, Delhi Jal Board	09971347099
Dr. D. Arya, Delhi Jal Board	--
Mr. Subhash Chandra, Astt. Engineer, Dehli Jal Board	09871794141
Dr. B. C. Chakradhar, HZL	09963100696
Er. R.R. Rao HZL	09849794240
Er. J. K. Basin, DZL	09873038089
Dr. Rakesh Kumar, MuZL	09820839821
Er. P. S. Kelkar, Nagpur	09423681552
Er. S. P. Andey, Nagpur	09423681551
Ms. S. S. Dhage, MuZL	09821266800
Ms. Amita Dalvi, MuZL	---
Mr. Vijay Chaudhary, MuZL	09869802755
Dr. A. D. Patwardhan, Consultant	09881209063
Dr. Suresh Gajendragadkar, Ex. Prof.VJTI	9520-25390371
Mr. P. Pardeshi, Municipal Commissioner, PMC, Pune	--
Mr. Eknath Khobragade, Additional Commissioner (Special)	--
Mr. Sudhir Khanapur, Additional Commissioner (General)	--
Er. Prashant Waghmare, City Engineer, Pune	--
Er. Narendra Salunkhe, Dy. City Engineer, Cantonment	--
Er. Uday Biniwale, Dy. City Engineer, Pune	09823073650
Er. V.G. Kulkarni, Development Engineer, Pune	09823269291
Er. S. P. Bhange, Assistant Engineer, Parvti Water Works, Pune	09823073652
Er. V. S. Rokade, Assistant Engineer, Cantonment	09923750610
Dr. Ajay Ojha, Pune AQMC	09823011520
Mr. Utkarsh, Pune AQMC	09822077507
Ms. Bhavana Zope, Pune AQMC	09922121890
Ms. Manisha Ghule, Pune AQMC	09960980702

C) Programme Copy for Delhi Workshop

Workshop on Composite Correction Programme (CCP), September 22-24, 2008

Organizers : NEERI, USEPA & Delhi Jal Board, Haiderpur Water Treatment Plant

Venue: Haiderpur Water Treatment Plant, Delhi Jal Board
Haiderpur, New Delhi – 110 088

Programme

September 22, 2008 – Day 1

Inaugural Session

10:00 – 11:00

Welcome	: Dr. Tapan Chakrabarti, Director, NEERI
CCP Initiative	: Ms. Adrian Stephanie, USEPA
Special Address	: Er. A. K. Sengupta, India Country Office, WHO
Guest of Honour	: Er. R. K. Garg, Member (WS), Delhi Jal Board
Chief Guest	: Mr. X. K. Mahato, Member (A), Delhi Jal Board
Vote of Thanks	: Er. Jagdish K. Bassin, NEERI Delhi

11:00 – 11:15 Tea Break
11:15 – 13:00 Technical Session
Initiate Comprehensive Performance Evaluation Course

- Background and short review of CPE and description of proposed activities, Mr. David Visintainer, USEPA.
- Evaluation of Water Treatment Plant - **:** Er. S. P. Andey, NEERI Nagpur
- Water Safety Plan -**:** Mr. A. K. SenGupta, WHO India
- Latest technologies in Water Treatment – Sonia Vihar Water Treatment Plant -**:** Er. G. P. Mittal, SE, DJB
- Treatment / Purification of Water & Surveillance -**:** Mr. D. R. Arya, CWA, DJB
- Surveillance of Water Quality – Bacteriological -**:** Mr. Y. Sanwal, Bacteriologist, DJB

13:00 – 13:45 Lunch
13:45 – 14:30

- Application of CPE for optimization & Upgradation of Water Works at Hyderabad & Pune, Ms. Shivani S. Dhage, Deputy Director, NEERI Mumbai
- Application of GIS & Risk Assessment - Er. J.K. Bassin, NEERI Delhi

14:30 – 17:30 Field Exercise

- Evaluation of WTP - Staff of Haiderpur WTP
- Visit to Haiderpur water treatment plant (coordinated by Er. J.K. Bassin)
- Interaction with plant manager and operating staff
- Acquaintance with plant operations
- Performance assessment of data collection and review
- Evaluation of major unit operations and processes
- Summarization of observations

September 23, 2008 - Day 2

10:00 – 13:15 Field exercise continues

- Discussion on Initial observation on plant performance

Tea Break

Group I: Operators Interview Coordinated by Mrs. Shivani Dhage, Mr. C. Raja, Mr. S. Bhanage, and Er. P. S. Kelkar

- Group I: Review of SOPs of Important processes Coordinated by Mr. David Visintainer, Er. S.P. Andey, Er. V.S. Rokade, Er. J.K. Bassin and Er. K.S. Narsappa
  - Flow measurement
  - Chemical addition
  - Filter backwash
  - Lab. Analysis

13:15 – 14:00 Lunch

14:00 – 17:30 Field exercise continues

- Review status of CPE components (performance assessment data and develop performance potential graphs, major unit process evaluation, results of operator interviews, historical laboratory data) All Auditors to fill the Proforma and rank the Performance (Coordinated by Ms. Adrian Stephanie, Mrs. Shivani Dhage, Mr. Bill Freeman)
- **Tea Break**
- Discuss impressions and issues for interviews
- Develop list of factors projected as limiting performance at the water treatment plant
- Presentation of CPE results (Coordinated by Er. P.S. Kelkar, Ms. Shivani Dhage, Mr.David Visintainer)

September 24, 2008 – Day 3

8:00 – 12:00

- Visit to Sonia Vihar Water Works (Coordinated by Delhi Jal Board Authorities)

12:00 – 13:30 Lunch at Haiderpur WTP

13:30 – 16:00

- Summarize results of CPE: Discuss results of initial interview and direction subsequent interviews (Coordinated by Mr.David Visintainer, Ms. Adrian Stephanie, Er.P.S. Kelkar, Ms. Shivani Dhage)
- Compare observations, develop list of performance limiting factors, prioritize recommendations, develop preliminary report

Tea Break

- Discussion on Salient Findings Er. J.K.Bassin : Team to discuss the process and suggestions for modification in future

Concluding Remarks

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LIST OF PARTICIPANTS FOR DELHI WORKSHOP

Special Invitees

1. Dr. Tapan Chakrabarti, Director NEERI, Nehru Marg, Nagpur
2. Mr. X.K. Mahato, Member (Admn.), Delhi Jal Board, Varunalaya, Phase-I, Karol Bagh, New Delhi
3. Er. R.K. Garg, Member (WS), Delhi Jal Board, Varunalaya, Phase-I, Karol Bagh, New Delhi
4. Er. Lalit Mohan, Chief Engineer, (C)-IV, Delhi Jal Board, Varunalaya, Karol Bagh, New Delhi
5. Mr. A.K. Jain, Chief Engineer (WW), Delhi Jal Board, Chandrawal Water Works No. 1, Delhi
6. Mr. A.K. Sengupta, WHO Country Office India, Room No. 536, Nirman Bhawan, New Delhi

USEPA Representatives

7. Ms. Adrian Stephanie, International Water Supply Manager, USEPA, USA
8. Mr. David Visintainer, Ex. South Asia Programme Officer, USEPA, USA
9. Mr. Bill Freeman, India Programme Manager, USEPA
10. Ms. Pam Teel, Central America Programme Manager, USEPA

Participants of CCP Workshop

11. Er. K.S. Narasappa, GM(QAT), QA&T Wing, Asifnagar, Filter Beds Premises,Mehdipatnam, Hyderabad
12. Er. N. Ramesh, Deputy General Manager, Asifnagar, Filter Beds Premises,Mehdipatnam, Hyderabad
13. Mr. C. Raja, Asifnagar, Filter Beds Premises, Mehdipatnam, Hyderabad
14. Mr. Sunil Kumar, Technical Officer (QAT), Asifnagar, Filter Beds Premises,Mehdipatnam, Hyderabad
15. Mr. S. Bhanage, Suburban Addl.Engineer, Parvati Water Treatment Plant, Centre, Sinhgadh Road, Pune
16. Mr. P.S. Nirbhavane, Development Engineer, Parvati Water Supply Centre, Sinhgadh Road, Pune
17. Er. V.S. Rokade, Assistant Engineer, Cantonment, Army Water Supply Centre, Pune
18. Mr. D.K. Mittal, SE, Delhi Jal Board, Haiderpur Water Treatment Plant, Delhi
19. Mr. D.K. Arora, Ex. En, DJB, Haiderpur Water Treatment Plant, Delhi
20. Mr. S.N. Sharma, Asst. Engineer, DJB, Haiderpur Water Treatment Plant, Delhi
21. Mr. R.D. Sharma, Asst Engineer, DJB, Haiderpur Water Treatment Plant, Delhi
22. Mr. Dhani Ram Arya, Chief Water Analyst, DJB, Haiderpur Water Treatment Plant, Delhi
23. Mr. Yugal Sanwal, Bacteriologist, DJB, Haiderpur Water Treatment Plant, Delhi
24. Mr. R.P. Sharma, DJB, Sonia Vihar WTP
25. Er. P.S. Kelkar, Deputy Director & Head, GEM Division, NEERI, Nehru Marg, Nagpur
26. Er. S.P. Andey, Scientist, GEM Division, NEERI, Nehru Marg, Nagpur
27. Ms. Shivani S. Dhage, Deputy Director, NEERI Zonal Laboratory, Mumbai
28. Er. J.K. Bassin, Deputy Director & Head, NEERI Zonal Laboratory, Delhi
29. Mr. R.K. Gupta, Senior Scientist, NEERI Zonal Laboratory, Delhi
30. Ms. Bhavana Sharma, Tech. Asst,, NEERI Zonal Laboratory, Delhi
31. Ms. Amita Dalvi, Project Asst., NEERI Zonal Laboratory, Mumbai
32. Ms. Kavita Shukla, Project Asst., NEERI Zonal Laboratory, Mumbai
33. Ms. Kanchan Wakdikar, Project Asst., NEERI Zonal Laboratory, Mumbai
34. Mr. Ajay Sharma, Project Asst, NEERI Zonal Laboratory, Delhi
35. Mr. Kush, Project Asst. NEERI Zonal Laboratory, Delhi
36. Dr. Rakesh Kumar, Deputy Director & Head, NEERI Zonal Laboratory, Mumbai
37. Er. R. Ravindar Rao, Senior Scientist, NEERI Zonal Laboratory, Hyderabad
38. Dr. (Mrs.) Abha Sargaonkar, Scientist, ESDM Division, NEERI, Nehru Marg, Nagpur

D) Programme Copy for Workshop On Management Of Safe Water Supply

Workshop on Management Tools for Safe Water Supply (CCP & WSP), June 16, 2009

Organizers: NEERI, USEPA & WHO

Venue: CSIR Science Centre (Vigyan Kendra), Lodi Gardens Gate No. 2 Lane, Opp India International Center Annex, Opp World Bank, New Delhi-110 003

Programme

June, 16, 2009 – Day 1

Inaugural Programme

10.00-11.00

Welcome of Guests	Ms Shivani S. Dhage, Dy. Director, NEERI, Mumbai
Purpose of the Seminar	Dr. Rakesh Kumar, Dy. Director, NEERI, Mumbai
Address	Er. M. Sankaranarayanan, Deputy Adviser (PHE), CPHEEO
	Dr. S.C. Saxsena, Director, IIT, Roorkee
Invited lecture	Dr. P.K. Seth, Chief Executive Officer, Biotech Park, Lucknow
Vote of Thanks	Mr. J.K. Bassin, Dy. Director, NEERI, Delhi

11.00-11.30 hrs : Teak Break

SESSION – I : 11.30-1.30 hrs

Chairman	Dr. Bipin Behari, Secretary Delhi Jal Board
CCP and WSP concepts	Mr. A.K. Sengupta, National Professional Officer, WHO India Country Office
Application of CCP for Optimization of Water Treatment	Ms. Shivani Dhage, Dy. Director, NEERI, Mumbai
Case Study- WSP Hyderabad	Er. K.S. Narsappa, General Manager, Asif Nagar Water Treatment Plant, Hyderabad
WSP IRDA	Dr. (Mrs) Abha Sargoankar Scientist, NEERI, Nagpur
Discussions	

1:30-2:30 hrs :Lunch

SESSION – II : 2.30-3.45 hrs

Chairman	Er. S.V. Dahasahastra, Member Secretary, MJP, Mumbai
Improvements in water treatment- A case study	Dr. R. Paramsivam, Director Grade Scientist, NEERI (Retd), Coimbatore
Chemical Contamination- Defluoridation	Er. S.P. Andey, Scientist, NEERI, Nagpur
Water related disease burden	Dr. Uma Chawla, Joint director, NICD, New Delhi
Discussions	

SESSION – III : 3.45-4.45 hrs

Chairmen	Dr. P.K. Seth, CEO, Biotech Park, Lucknow
Co-Chairmen	Dr. R. Paramsivam, Director Grade Scientist, NEERI (Retd), Coimbatore
Panel Discussion	• Dr. A.C. Gupta • Prof. B. Singh • Dr. T. Chakrabarti • Mr. Suresh Babu • Dr. Bipin Behari • Er. P.S. Kelkar • Mr. A.K. Sengupta • Mr. R.M. Deshpande

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LIST OF INVITEEES FOR WORKSHOP ON MANAGEMENT OF SAFE WATER SUPPLY

1 **Er. K.S.Narsappa**
General Manager (QAT)
Quality Assuring and Testing Wing
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2 ***Mr. R. M. Deshpande***
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3 **Mr. Ramesh Negi**
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