CHAPTER 9

PRELIMINARY DESIGN
OF
AUGMENTATION/ REHABILITATION
OF
EXSITING JAJMAU SEWAGE TREATMENT PLANT

CHAPTER 9 PRELIMINARY DESIGN OF AUGMENTATION/ REHABILITATION OF EXSITING JAJMAU SEWAGE TREATMENT PLANT

9.1 EXISTING CAPACITY AND CONDITION OF EQUIPMENT

Sewage from District - I is conveyed to Jajmau STP. At Jajmau, domestic wastewater is pumped to the existing 130 mld STP, which is based on activated sludge technology and also to a 5 mld pilot STP based on UASB. In addition, a separate network of open drains and pumping stations collects about 13 mld of tannery wastewater in Jajmau area and pumps it to the 36 mld UASB based STP.

130 mld STP was commissioned in January 1999, 5 mld was commissioned in 1989 and 36 mld was commissioned in1993. The plant of capacity 130 mld was designed with three parallel streams for a total capacity of 130 mld. Also, a provision was made for adding another 43 mld stream.

9.2 MASTER PLAN PROVISIONS

Mater Plan has analysed the average monthly data for existing 130 mld STP for the period of Nov 2002 to Oct 2003 and has given following recommendations:

Complete segregation of tannery wastewater from domestic wastewater
Improvement of domestic wastewater collection system in District – I
Provision of roughing filter to protect the activated sludge process
Disinfections of treated wastewater either by chlorination or by maturation pond

Moreover, the total wastewater generated in District-I exceeds the carrying capacity of existing 90 inch sewer i.e. 168 mld approximately. The existing treatment capacity for domestic wastewater in this district amounts to 135 mld. Therefore, capacity of 130 mld STP needs to be upgraded to 173 mld with the addition of another 43 mld stream.

9.3 SURVEY WORKS EXECUTED

MWH carried out a reconnaissance survey for 130 mld STP with JICA Study Team and UP Jal Nigam officials which was followed by detailed survey.

Topographical Survey

Topographical and contour survey was conducted and all the existing facilities have been marked on the drawing.

Geo Technical Survey

Two bore holes, each of 20 m depth, were bored to assess the soil profile at the proposed site. The results of this report are used while finalizing the design of STP units.
Soil assessment report: -

The soil strata are predominantly plastic in nature consisting of clayey silt of low plasticity (CL group) and sandy silt of very low plasticity (ML, CL groups) up to 14.5 m. The N values in plastic strata are 5 to 17 indicating medium to stiff consistency. Non plastic silty sand (SM group) is met from 4 to 5.5m and below 14.5 m to full exploration depth of 20m. The corrected N in non plastic strata ranges from 13 to 18 indicating medium relative density. The water table has been met at 13.25 m below ground level in the bore holes.

The net safe bearing capacities on shear consideration and allowable bearing pressures on settlement

consideration are computed for 6 and 12m depths in Table 21 of separately delivered report on Soil investigation.

9.4 SEWAGE STRENGTH AND QUANTITIES

The tannery wastewater is getting mixed with domestic wastewater and the mixed wastewater is reaching to 130 mld STP which is provided to handle only domestic wastewater. This plant is not equipped to handle the tannery wastewater, which contains leather flushings, hair, chromium and sulphides, etc.

Average monthly data is presented in Table 9.1.

Table 9.1 Average Monthly Data for 130 mld Jajmau STP

	Influent			Effluent		
	Jan-04	**Mar-04**	**Jun-04**	**Jan-04**	**Mar-04**	**Jun-04**
BOD	323	317	296	60.3	77.1	32
Filtered BOD	136	119	138	31.4	22.1	23
COD	1,165	1,201	1,018	143	262	150
DO	-	-	-	1.2	0.7	2.4
pH	8.2	8.3	8.3	7.9	7.9	8.2
Temperature	19	27.2	31.5	11.3	24	29
TSS	1,213	980	1,033	151	142	101
VSS	473	275	425	100	92	75
TDS	3,145	2,240	2,880	1,530	1,765	1,045
TFS	2,945	2,145	2,670	1,280	1,620	960

Source : UPJN

9.5 PERFORMANCE OF EXISTING TREATMENT PROCESS

It can be seen from Table 9.1, that actual strength of incoming wastewater exceeds the design parameters, which is mainly due to mixing of industrial wastewater. Treated wastewater does not meet the NRCD standards for discharge into river or for irrigation. The table also shows lower BOD removal efficiency as considered for activated sludge process. Therefore, complete segregation of Domestic and Tannery wastewater becomes necessary in order to get the desired plant performance.

The centrifuge system provided for de watering of sludge has become defunct due to presence of leather flushings, hair, chromium etc. UP Jal Nigam has added 18 nos. of sludge drying beds subsequently which cater to only one-third plant capacity.

Also, the plant does not meet the criteria for faecal coliform content in treated wastewater.

9.6 EQUIPMENT REPLACEMENT NEEDS

MWH conducted a detailed inventory survey of the plant and observations made are presented hereunder. The plant was not in operation at the time of survey (dt.13-10-04). Following equipments need to be replaced

a) Existing bar screens of 20 mm clear spacing needs to be replaced with 6 mm clear opening screen in order to stop the flow of plastic pouches, etc.
b) Primary settling tank No.1 is damaged which requires heavy repairs such as bridge, drive mechanism, tie rods, bearing, etc. All the other tanks require complete

overhauling and replacement of worn out parts.

c) Existing aerators require replacement of gear boxes and cones
d) One spare return sludge pump is required
e) In treated effluent pump house, pumps require spare parts such as shaft sleeve, SS impellers, D joint and suction pipes. Also, sluice valve and reflux valves of all pumps need to be repaired. 5 nos. of D.O.L (direct on line) starters to be replaced by ATS (auto transformer starters), with control panel. Provision has to be made for new dewatering pumps also (2 nos.).
f) In grit chamber, complete overhauling, replacement of reduction gearboxes and bearings, etc. is required
g) Gas compressor requires complete overhauling
h) Gas scrubber requires complete overhauling
i) Gas engine requires complete overhauling including changing of oils, filters, changing of all batteries, repairing of all control valves, control panels and synchronizing panel.

9.7 PROPOSED PROCESS MODIFICATIONS: LIQUID AND SOLID STREAM

The capacity of 130 mld STP needs to be augmented with additional treatment capacity of 43 mld. It is proposed to adopt the same technology (activated sludge process) as the operators of 130 mld plant shall be able to look after the augmented capacity of 43 mld also. If the plant is fitted in the available space at the site there shall be ease in the operation and there will not be a separate requirement of the whole set up.

In the existing 130 mld STP, mechanical dewatering of the digested sludge was provided but these equipments are presently not in working condition and appear to be irreparable. Hence, it has been proposed to provide sludge drying beds in place of existing mechanical units.

Existing plant does not meet the discharge guidelines for faecal coliforms. Hence, disinfecting facility of chlorination has been proposed for total capacity of (130+43) mld of plant.

9.8 DESIGN ENGINEERING WORKS- 43 MLD ADDITIONAL STREAM

9.8.1 Design Flow

Table 9.2 Design Flow at Jajmau STP

Sr.	Parameter	2015
1	Average flow (mld)	43
2	Average flow (m^3/hr)	1,805
3	Peak flow (m^3/hr)	3,610

9.8.2 Raw Sewage Characteristics

The following wastewater characteristics are used for design of sewage treatment plant.

Table 9.3 Raw Sewage Characteristics Considered for Design Purpose

Sr.	Parameter	Average Value
1	Minimum Temperature, ^{o}C	20
2	pH	6.0 - 8.5
3	Biochemical Oxygen Demand (BOD_5), mg/l	230
4	Total Suspended Solids, mg/l	500
5	Faecal Coliform Count, MPN/100ml	2×10^7

9.8.3 Discharge Standards

NRCD have conveyed the recommendations of the Expert Committee through their DO letter No. A-33013/1/99-NRCD dated 5th October 1999, suggesting that the desired level for faecal coliform in treated water should not exceed 1,000 MPN per 100 ml sample irrespective of its mode of disposal in river or its use for irrigation to grow either restricted or unrestricted crops. It is also mentioned in NRCD guidelines that BOD and TSS concentration shall be less than 30 mg/l and 50 mg/l respectively.
The STP has been therefore designed so as to achieve treated wastewater of equal or better quality as mention in the Table 9.4 hereunder.

Table 9.4 Treated Wastewater Quality

Sr.	Parameter	Value (Irrigation Field/River)
1	pH	5.5 – 9.0
2	Biochemical Oxygen Demand, mg/l	$\leq$ 30
3	Total Suspended Solids (BOD_5), mg/l	$\leq$ 50
4	Faecal Coliform Count, MPN/100ml	Permissible < 10,000 and Desirable < 1,000

9.8.4 Treatment Scheme

The additional stream is designed for a capacity of 43 mld based on activated sludge process in accordance with the existing STP. A detailed schematic flow diagram for the proposed STP is presented in drawing no. KAN-STP-JAJMAU-3.

Preliminary treatment will consist of inlet chamber, screen channel, grit chamber and primary clarifier. After primary treatment, the wastewater will be passed on to the secondary treatment consisting of aeration tank and secondary clarifier. After secondary treatment, the wastewater will be taken for disinfection using chlorine for removal of faecal coliform. The excess sludge produced in the primary clarifier and secondary clarifier will be combined together and will be taken for digestion using two stage digester system after passing through gravity thickener. The biogas produced in the digesters will be supplied to the existing gas utilisation system.

The treatment process at the Jajmau STP consists of the following treatment units:

A. Preliminary Treatment

- Main pumping station
- Inlet chamber,
- Screen channel,
- Grit chamber and

- Primary clarifier

B. Secondary Treatment

- Aeration tank
- Secondary clarifier / Secondary settling tank
- Sludge recirculation system

C. Tertiary Treatment

- Chlorine house,
- Chlorine mixing tank,
- Chlorine contact tank

D. Sludge Treatment

- Gravity thickener
- Primary sludge digester
- Secondary sludge digester
- Filtrate/supernatant pumping station,
- Sludge drying beds

The inlet chamber will receive the raw sewage to pass it further to screen channel and subsequently to the grit chamber. In screen channel floating matters are trapped and removed and grit is removed in grit chamber. Thereafter the sewage will be conveyed to primary clarifier.

The sewage having been treated for screening and grit removal and primary settling, will then be treated biologically in activated sludge process. The activated sludge process consists of an aeration tank wherein aerobic biological reaction takes place in the presence of active bio-mass. The wastewater from aeration tank is then sent to secondary clarifier where the settleable solids are settled. A part of the settled solids are then recirculated back in to the aeration tank and a part is removed from the system as excess sludge.

The treated sewage from activated sludge process is then passed on to the tertiary treatment process for disinfection consisting of chlorine mixing tank and chlorine contact tank. The effluent of chlorine contact tank meets the requirements of final discharge standards.

The excess sludge from secondary clarifier and the sludge produced in primary clarifier are mixed together and then thickened in a gravity thickener to improve the consistency of the sludge. Gravity thickener also helps in reducing the cost by lowering the sizes of the sludge digesters. A two stage digestion system is proposed for mineralising the sludge.

The biogas produced during digestion of sludge will be supplied to the existing gas utilisation system.

9.8.5 Unit Description

(1) Inlet Chamber

An inlet chamber is provided ahead of screen channel to receive the sewage from the main pumping station via rising main.

(2) Screen Channel

Screening is an essential step in sewage treatment to remove large size floating materials like rags,

wooden pieces, plastics, tobacco pouches, etc. which otherwise would damage pumps and interfere with the satisfactory operation of various treatment units. Screen channel consists of bars placed across the channel to trap the floating materials. The spacing of bars is kept depending on the degree of treatment required. The bars arrest the floating materials, which have to be removed periodically.
Mechanical screens are provided with three units working and two manual screen unit as standby unit. The screening process is undertaken by screen consisting of 50 mm x 10 mm thick flats with 12 mm clear openings to trap the floating materials.

The mechanically operated screens will be equipped with a mechanism, which will automatically rake at a pre-set timer/differential level control. The screenings will be collected in a hopper located above the water level such that the screenings can be easily collected in a collection cart.

Each of the standby screen channels will have manually cleaned bars screens with bar clearance of 12 mm. Removable square mesh of 25 mm x 25 mm is provided after 12 mm opening screen to trap the escaped floating matters. Aluminium gates are provided with RCC platforms and access staircase. Hand railing is provided on all platforms.

(3) Grit Chamber

The screened sewage flows through a grit removal system consisting of mechanical grit removal mechanism in a grit chamber. Grit in sewage consists of coarse particles of sand, ash and clinkers, egg shells and many inert materials inorganic in nature. Grit is a non-putrescible and possesses a higher hydraulic subsidence value than organic solids. Hence, it is possible to separate the gritty material from organic solids by differential sedimentation in a grit channel.

Grit removal is necessary to protect the moving mechanical equipment and pumps from abrasion and accompanying abnormal wear and tear. It is separated in a Grit chamber with designed detention period. The grit washing and removal mechanism is fully automatic. Also a manually cleaned grit channel of the full flow capacity has been considered keeping in view the maintenance of mechanical grit removal.

(4) Primary Clarifier

A primary settling tank is provided before wastewater is feed to activated sludge process. The clarifier considered is central feed and collection on the periphery of the circular settling tank. Mechanical scraper is provided in the clarifier for collection of settled matter (sludge) at the centre. The sludge produced in the clarifier is not mineralised and needs to be digested before its disposal.

(5) Activated Sludge Process

Activated sludge process (ASP) considered for the sewage treatment is an aerobic suspended growth process. ASP consists of the (1) aeration tank containing microorganisms in suspension in which the reaction takes place, (2) activated sludge recirculation system, (3) excess sludge wasting and disposal facilities, (4) aeration system to transfer oxygen and (5) secondary sedimentation tank to separate and thicken activated sludge. Fixed type surface aerators are provided in the aeration tank for effective oxygen transfer and 50% recirculation ration is provided for return sludge.

(6) Sludge Treatment:

Excess sludge from secondary clarifier and from the primary clarifier is mixed together. The sludge treatment scheme consists of

- Sludge pumping station
- Gravity sludge thickener

- Primary sludge digester
- Secondary sludge digester
- Sludge drying beds

The sludge produced in the sewage treatment plant is first mixed together and then after it is fed to gravity sludge thickener. The consistency of sludge in terms of solids content will improve in sludge thickener and which will also economise the sizes of digesters system. Mechanical sludge scrapping system is provided at the bottom of the sludge thickener. The thickened sludge is then fed to the primary sludge digester in which mixing arrangements are provided. From 1st stage digester the sludge is conveyed to the secondary sludge digester, where the sludge will get completely mineralised which can be fed to the sludge drying beds.

A 250 micron size LDPE (low density polyethylene) sheet is spread over the floor of the sludge drying beds to prevent the seepage of the filtrate into the ground as ground water table is found at higher level in this area. A 150 mm thick layer of gravel having a size of 30 - 50 mm is spread over the brick lining, which is followed by a 150 mm thick layer of gravel having a size of 12 - 30 mm. On top of this layer of gravel, a 225 mm thick layer of sand having 0.30 - 0.75 mm size is laid. When wet sludge is spread on the top of bed major portion of liquid drains off in few hours after which drying of sludge commences by evaporation. The dried sludge is transported in trucks for disposal to sanitary landfills for use as manure on agricultural land.

The supernatant produced in the thickener and the digesters will be recirculated back in to the system.

(7) Chlorination System

Chlorination system is given to meet the faecal coliform standards. Chlorination system includes mainly of three units namely chlorine house, chlorine mixing tank and chlorine contact tank.

Chlorine House

Chlorine house will incorporate vacuum type gaseous chlorinator along with all accessories and required number of chlorine toner.

Chlorine Mix Tank

Chlorine mix tank is provided with slow speed mechanical mixer to mix the chlorine solution with treated effluent from ASP. From chlorine mix tank water will flow to chlorine contact tank.

9.8.6 Sludge Utilisation

The various alternatives available for the disposal of sludge are:

(1) Land Filling

Sludge can be finally disposed off for the purpose of landfill, which is the most common method of solid waste disposal in India. Sludge disposal in this manner requires additional yearly operation & maintenance cost in terms of staff & vehicle for loading, unloading, transportation & disposal of sludge.

(2) Sludge as a Manure

Digested sludge from STP is now acceptable to local farmers to be used as manure in the field. By selling sludge at a nominal rate, department can generate yearly revenue which will help in the operation & maintenance of the plant.

Keeping in view the above two available options, use of sludge as manure is found most techno-economical alternative.

9.9 DESIGN CRITERIA

The design parameters for 43mld STP at Jajmau have been adopted from Manual on Sewerage and Sewage Treatment of CPHEEO and the latest NRCD guidelines. The parameters adopted for design are presented in following table.

Table 9.5 Design Parameters for 43 mld STP at Jajmau

Sr.	Parameter	Value	Unit
Average Flow		0.502	Cum/sec
Peak Factor		2.0	
Peak flow		1.003	Cum/sec
Sewage Treatment Plant:			
1.	Inlet Chamber		
	Min Hydraulic retention time	30	Sec
2.	Screen Channel		
	Clear opening through screen	6	mm
	Minimum approach velocity at average flow	0.3	m/sec
	Minimum velocity through screen at peak flow	0.6	m/sec
	Maximum velocity through screen at peak flow	1.2	m/sec
3.	Grit Chamber		
	Particle size	0.15	Mm
	Specific gravity of grit at 20^{o} C	2.65	
	Settling velocity	0.0168	m/sec
	Efficiency	75	%
4.	Primary Clarifier		
	Overflow rate	35	Cum/sqm.day
	Max Weir loading	125	Cum/m.day
	Sludge solid concentration	3	%
5.	Aeration Tank		
	F/M ratio	0.4	
	MLSS	3000	Mg/l
	MLVSS/MLSS	0.8	
	Oxygen requirement	1.0	Kg O_2/Kg BOD removed
	Aerator supply rate (min at field condition)	1.2	Kg O_2/ KWH
	Sludge Volume Index (SVI)	100	ml/mg
	Sludge retention time	6	Days
6. Secondary Clarifier			
	Overflow rate	25	cum/ sqm.day
	Maximum Solid loading rate at peak flow	210	kg/ sqm.day
	Max Weir loading	185	cum/m.day
	Sludge solid concentration	1	%
7. Chlorine Mix Tank			
	Detention time	5	Min
8. Chlorine Contact Tank			
	Detention time	30	Min
9.	Sludge Thickener		
	Solid surface loading of thickener	50	Kg/day/sqm
	Sludge solid concentration	5	%
10.	Sludge Digester – Primary & Secondary		
	Volatile matters in thickened sludge	70	%
	SRT in primary digester	15	Days
	SRT in secondary digester	10	days
	Ration of diameter to depth	1.5 to 4.0	
	Digested sludge solid concentration	6	%
11.	Gasholder		
	Detention time	l4.0	Hr
	Pressure	0.02	kg/sq.cm

9.10 UTILITIES

9.10.1 Water Supply

The STP will be provided with water from the existing water source. Also, water requirement for the gardening, fire hydrant and other miscellaneous uses will be connected from the existing water source. The water distribution will be done by means of 100 mm AC pipes. Hydrants with valves are provided for cleaning and flushing of the units. Sufficient residual pressure will be available for cleaning purposes.

9.10.2 Waste Collection and Disposal

Liquid Wastes

Liquid waste, generated at within the STP premises, is storm water as well as the sewage from the utility of the STP. Open drains of 230 mm x 300 mm depth are provided to take care of the water logging at STP. Sanitation facilities are provided for the proposed administrative building and the staff quarters. The sewage from the administrative block and staff quarters will be discharged into the sump well of main pumping station within the STP premises.

Solid Wastes

The solid waste generated within the treatment plant will be from the following units:

Screen Chamber

Large amount of floating materials and other inert material like cloth, plastic, wood etc will be there in the raw sewage. Screens are used to stop these materials into the treatment plant units. Two screens, one of 12 mm clear opening along with 25 x 25 mm aluminium wire mesh is provided. The screenings collected will be transferred to the conveyor belt and thus into a chute. The screenings will be transported to the disposal site by means of trucks/trailers.

Grit Chamber

Grit will be removed from the grit chamber means. The grit removed from the tank will be taken to the near by landfill sites by means of wheelbarrows.

Staff Quarters and Office Building

The domestic solid waste from the administrative building and the staff quarters will be collected in the dustbins. Staff quarters will be provided with masonry dustbins of 1.5 x 1.5 x 1.25m depth, at the place of transporting points. The waste, which arises by street sweepings, will be transferred to the transporting points. The solid waste from the transporting points will be transferred to the disposal site by means of trucks or trailers.

9.10.3 Internal Roads

4.0 metre wide asphalt road are provided for access to the new treatment plant units and its access to the existing STP for comfortable movement of men and material within the plant premises. At places where vehicular traffic is not expected, particularly above underground/surface pipes or insufficient space for laying of roads, brick pavement having a width of 1.0 metre are proposed so that there is access from the 4.0 metre road to the destination.

9.10.4 Plant Lighting

Sodium vapour lamps mounted on 9 m height steel/aluminium tubular pole are provided at every 30.0 m interval on the road for sufficient illumination and provide the treatment plant personnel with a smooth, glare and accident free environment due to bad illumination.

9.10.5 Green Belt

There will be a green belt zone all around the treatment plant. The green belt will have various trees at every 20 meter interval, as they act as air purifiers. This will help in circumventing to some extent the odour problem in the eventuality of an improper operation of the treatment plant. Besides, a green belt will act as natural screen against the outside populace.

9.10.6 Bypass Arrangement

A bypass arrangement has been considered for the STP in case of breakdowns. This is provided from downstream of grit chamber of treated effluent pump house.

9.11 UNITS SIZES

9.11.1 Civil Works

The treatment scheme adopted for Jajmau STP consists of the following units. A detailed process design has been carried out and the required sizes are also presented in the following table.

Table 9.6 List of Plant Units

Sr.	Units	No.	Size (meter)
1	Inlet chamber	1	1.9 x 3.2 x 5.0 LD + 0.5 FB
2	Screen channel	2	5.0 x 1.5 x 1.0 LD + 0.5 FB
3	Grit chamber	1	10.8 x 10.8 x 0.7 LD + 0.6 FB
4	Primary clarifier	1	39.7 dia x 3.0 LD + 0.5 FB
5	Aeration tank	1	66.8 x 33.4 x 3.5 LD + 0.5 FB
6	Secondary clarifier	1	47.0 dia x 3.2 LD + 0.5 FB
7	Chlorine mixing tank	1	5.0 x 5.0 x 2.5 LD + 0.5 FB
8	Chlorine contact tank	1	26.9 x 13.5 x 2.5 LD + 0.5 FB
9	Sludge thickener	1	23.8 dia x 3.5 LD + 0.6 FB
10	Primary sludge digester	1	26.1 dia x 5.5 TD
11	Secondary sludge digester	1	26.1 dia x 5.5 TD
12	Sludge drying beds	30	19.3 x 11.4
13	Thickened sludge pump house	1	7.6 x 3.8
14	Primary digester feed pump house	1	7.6 x 3.8
15	Secondary sludge pump house	1	5.0 x 3.0
16	Filtrate pump house	2	4.5 x 3.0
17	Gas holder	1	8.0 dia x 5.1 TD
18	MEP room	1	25.0 x 6.5
19	Transformer Yard	1	20.0 x 12.0

A general layout showing the proposed units at Jajmau STP is presented in drawing no. KAN-STP-JAJMAU-1. The hydraulic flow diagram for this treatment plant is presented in drawing no. KAN-STP-JAJMAU-2.

9.11.2 Mechanical Works

Proposed augmentation of Jajmau STP consists of the following mechanical equipment.

Table 9.7 List of Mechanical Works

Sr.	Units	No.	Rating (HP)
1	Mechanical screen	2	3.0
2	Conveyor belt	1	5.0
3	Detractor mechanism	1	5.0
4	Clarifier mechanism with scum removal arrangement	1	2.0
5	Aerators	8	50.0
6	Clarifier mechanism	1	3.0
7	Chlorinators	1	5.0
8	Sludge thickener arrangement	1	3
9	Sludge mixers	2	30.0
10	Sludge pumps	6	10.0
11	Filtrate pumps	4	5.0
12	Gas holder accessories	1	-
13	Gas flaring system	1	-
14	Chlorinators	1	5.0
15	Gates	4	-
16	EOT and chain pulley	2	5.0

9.11.3 Electrical & Instrumentation Works

Following components have been considered for electrical and instrumentation works for Jajmau STP.

Table 9.8 List of Electrical & Instrumentation Works

Sr.	Units	No.
1	11kV Overhead transmission line	1.6 km
2	24V DC Sealed maintenance free battery & battery charger	1
3	11kV Vacuum circuit breaker panel	1
4	Gas engine synchronization and AMF panel	1
5	11/0.433kV Dyn11, ONAN cooled transformer with off circuit tap changer	2
6	Main electrical panel	1
7	Screen & grit removal mechanism panel	1
8	Aerator panel	1
9	Thickened feed pump panel	1
10	Sec sludge pump panel	1
11	Thickener panel	1
12	Digested sludge panel	1
13	Filtrate pump panel	1
14	Gas digester acc panel	1
15	Main lighting panel	1
16	Chlorinator panel	1
17	125 kVAr capacitor control panel	2
14	11kV & 1.1kV cables, cable terminations & cable carrier system	Lot
15	Indoor & outdoor lighting	Lot
16	Earthing & safety equipment	Lot
17	Instrumentation system	Lot

9.12 CAPITAL COST

9.12.1 Civil Cost

Table 9.9 Cost of Civil Works

Sr.	Units	Amount (Rs.)
1	Inlet Chamber	251,000
2	Screen Channels	169,000
3	Grit Chamber	493,000
4	Primary Clarifier	6,500,000
5	Aeration Tank	15,618,000
6	Secondary Clarifier	8,988,000
7	Chlorine Mixing Tank	542,000
8	Chlorine Contact Tank	6,500,000
9	Sludge Thickener	3,010,000
10	Primary Sludge digester	5,886,000
11	Secondary Sludge digester	5,150,000
12	Gas Holder	449,000
13	Gasholder Structural Steel (MT)	900,000
14	Primary sludge pump house	715,000
15	Secondary sludge pump house	24,000
17	Sludge Drying Beds	5,594,000
18	MEP Room	894,000
19	Generator Room	0
20	Transformer Yard	360,000
21	Chlorine house	504,000
22	Interconnecting Piping	1,200,000
23	Roads	480,000
24	Pathways	50,000
25	Treated Water Disposal Channel	160,000
	Total	64,437,000

9.12.2 Mechanical Cost

Table 9.10 Cost of Mechanical Works

Sr.	Equipment	Amount (Rs.)
1	Mechanical screen	3,796,000
2	Conveyor belt	400,000
3	Grit removal mechanism	1,700,000
4	Aerators	6,800,000
5	Clarifier mechanism –PCLF	1,560,000
6	Clarifier mechanism –SCLF	1,625,000
7	Sludge return pumps-SCLF	400,000
8	Sludge pumps- PCLF	150,000
9	Digested sludge pumps	1,200,000
10	Filtrate pumps	200,000
11	Sludge thickener mechanism	920,000
12	Sludge digester mixers	1,400,000
13	Sludge digester mixers	1,200,000
14	Chlorinator	2,500,000
15	Gas holder accessories	350,000
16	Gas flaring system	300,000
17	Gas digester accessories	229,000
18	Aluminium gates	400,000
19	EOT, chain pulley	1,000,000
	Total	26,130,000

9.12.3 Electrical & Instrumentation Cost

Table 9.11 Cost of Electrical & Instrumentation Works

Sr.	Units	Electrical & Instrumentation Cost (Rs.)
1	Power equipment	14,062,000
2	Cables	4,066,000
3	Lighting	192,000
4	Earthing and safety equipment	983,000
5	Instrumentation	765,000
6	Miscellaneous	198,000
	Total	20,266,000000

9.12.4 Utilities

The utility items required for operation of STP and its costs are presented in the following table.

Table 9.12 Cost of Utility Items

Sr.	Units	Utility Cost (Rs.)
1	Site drainage	150,000
2	Wheel barrow and trolley mounted pump	150,000
3	Fire fighting arrangement	30,000
4	Roads and pavements	720,000
5	Site development	180,000
6	Bypass arrangement	1,600,000
7	Miscellaneous	500,000
	Total	3,330,000

9.13 OPERATION & MAINTENANCE

9.13.1 General

The detailed operation and maintenance manual of the STP will be submitted at the time of Start-Up and monitoring phase of the plant. Operation and Maintenance of the treatment plant is very much required for sustainability of the treatment plant and to achieve discharge standards. The operational aspects include regular checking of the units (which include the electrical and mechanical equipment), to identify any non-functionality of the units and to evolve the strategic measures to be taken, so as to run the plant.

All the activities of the treatment plant are scheduled and coordinated by the Plant Manager. The Plant Manager will also be responsible for taking steps like shutting down the plant or to bypass the wastewater in case of emergencies, after having proper deliberations with the management and the operational staff.

9.13.2 Screens

Screens are provided to remove the large floating material in the raw wastewater. Each of the working screen channels will have one mechanically cleaned bars screen with bar clearance of 6 mm opening at STP site and one manually cleaned mesh screen with opening of 25 mm x 25 mm, located on the downstream of fine screen.

The standby screen channel will have one manually cleaned bars screen with bar clearance of 12 mm opening at STP and one manually cleaned mesh screen with opening of 25 mm x 25 mm, located downstream of the manually cleaned 12 mm opening bars screen.

Table 9.13 Operation and Maintenance - Screen

Sr.	Equipment	Operational	Maintenance
1	Mechanical Screens	• Hourly Incoming amount of the screenings should be clearly recorded in the data sheet. The type of the screenings should also be recorded in the data sheet • A timer should control the mechanism for removal of the screenings • Frequent checks of the mechanical raking mechanism are required for every 2 to 3 hours	• Regular checks should be done for proper working of the rake mechanism • The screens should be painted for every 3 to 4 months
2	Manual Screens	• Hourly incoming amount of the screenings are to be clearly recorded in the data sheet, which should also give details of the type of the screenings screened • The screens should be cleaned after every one hours, so that there will not be any clog at the screens, and thus leading to the over flow of the wastewater • The labourer cleaning the screens should wear safety equipment such as gloves and shoes	• The screens should be cleaned every hour. • The screens should be painted for every 3 months

A coarse mesh screen is placed after the fine screen. The main function of the mesh screen is to remove the plastic materials and other small items, which pass through the bar screens. The operational staff should clean the wire mesh for every hour in order to avoid choking of the mesh. The staff should wear gloves and boots when they are in operation of cleaning the screens.

9.13.3 Grit Chamber

The grit chamber consists of circular tank, which consists of moving scrapper mechanism. An airlift pipe is provided in the tank along with a bypass line. The following are the operational and maintenance aspects of the grit chamber.

Table 9.14 Operation and Maintenance – Grit Chamber

Operational	Maintenance
• The time & amount of grit cleaned from each channel should be recorded in a daily record sheet.	• All the Gates/Valves should be cleaned periodically • The grit channel should be cleaned properly.

9.13.4 Sludge Drying Beds

Sludge characteristics should be known at the time of the start up of the plant, as it determines the

average sludge drying time. The sludge applied in shallow depths dewaters at a much rapid rate, but more frequent discharge from the beds is required. So the optimum sludge height should be evaluated depending upon the sludge characteristics. The following table shows the operational and maintenance aspect of the sludge drying beds.

Table 9.15 Operation and Maintenance – Sludge Drying Beds

Operational	Maintenance
• The sludge should be applied after the dewatered sludge cakes are removed • The sludge drying beds should be free from vegetation before the application of the sludge • The sludge cakes should be removed at regular interval of time, which depends upon the sludge characteristics • The position of the splash gates and trays should be checked before applying the sludge on the bed	• Drainpipes should be checked frequently so that no clogging takes place • The sludge piping should be washed, after application of the sludge • All the metallic elements such as chequered plates etc. should be painted once in a year

9.13.5 Chlorination System

Chlorination equipment should be properly housed and reserve supply of cylinders, valves, gaskets etc. should always be available. Valves and piping should be regularly checked for leaks. Leaks should be attended to as per the instruction in the manufacturer's catalogues. Chlorine cylinders should be kept on scales and the weight read each day as a check for the amount of chlorine used. Gas mask must be used while attending to chlorine leaks. Operation record should show the volume of sewage chlorinated, rate of application of chlorine, residual chlorine in the plant effluent and the amount of chlorine consumed per day.

9.13.6 Sludge Pumps

Water level in the sludge sump should not be lower than the minimum designed level. Also the water level in the sump should not reach beyond maximum designed level. Floats and sequence switches controlling the pumping cycle should be examined at the beginning of each shift. All bearings, water seal, motors, guide rail and electrical wire & control equipment should be inspected periodically. The manufacturer's directions for operation & lubrication should strictly be followed. The time interval between start & stop of any pump should not be less than 5 minutes. All pumps including standby pumps should be operated in rotation so that the wear and tear is distributed evenly.

9.13.7 Manpower Requirement

The manpower requirement for operation and maintenance for 43.33 mld capacity STP has been not considered as the manpower being utilised for existing 130 mld capacity plant will be utilised for operation and maintenance of the augmentation plant as well.

9.13.8 Operation and Maintenance Cost Estimates

(1) Operation Cost

Table 9.16 Operation Cost

Sr.	Particulars	Costs per annum (Rs.)
1	Power	9,585,000
2	Manpower	911,000
3	Chemical	645,000
	Total	11,141,000

(2) Maintenance Cost

Table 9.17 Maintenance Cost

Sr.	Particulars	Costs per annum (Rs.)
1	Civil @ 1.5% per year	967,000
2	Mechanical, electrical and instrumentation @3% per year	1,392,000
	Total	2,359,000

(3) Total Operation & Maintenance Cost

Table 9.18 Total O&M Cost

Sr.	Particulars	Costs per annum (Rs.)
1	Operation & Maintenance Cost	13,500,000

9.14 ABSTRACT OF COST ESTIMATE FOR 43MLD ADDITIONAL STREAM

Table 9.19 Abstract of Cost Estimate

Sr.	Particulars	Amount (Rs.)
1	Civil	64,437,000
2	Mechanical	26,130,000
3	Electrical and instrumentation	20,266,000
	Sub total	110,833,000
4	Utilities	3,330,000
	Total	114,163,000

9.15 REHABILITATION OF 5 MLD UASB AND130 MLD STP

9.15.1 Proposal for Improvement Works in the above Mentioned STPs: -

To improve the quality of the effluent at 5 mld UASB domestic sewage treatment plant and to improve the efficiency of the present 130 mld sewage treatment plant to its designed capacity the following works are proposed for existing sewage treatment plants.

9.15.2 5 mld UASB Sewage Treatment Plant

To utilize the treated effluent for land application, a pump house along with pumping arrangement has been proposed. To reduce the sulphide contents for improving the quality of treated effluent floating aerators in the polishing ponds have been proposed along with LDPE lining of polishing ponds.

Table 9.20 Cost Estimate for Improvement Works for Existing 5 mld STP at Jajmau

Sr.	Description	Quantity	Unit	Rates	Amount (Rs.)	Remarks
A)	CIVIL WORKS					
1	Construction of sump cum pump house for 5 mld sewage after maturation pond	1	No.	660,000	660,000	For pumping the sewage after maturation pond to irrigation channel.
2	Excavation for pipeline in ordinary soil lift upto 1.50 m and disposal of surplus earth upto 50 m. also refilling in layers with proper compaction after laying the pipe complete	585	cum	44	25,740	For pumping the sewage after maturation pond to irrigation channel.
3	Supply of 350 mm dia. PSC pipe as per IS:784-1978 with rubber rings including all taxes, excise duties etc. complete to site of works.	500	m	1,300	650,000	For pumping the sewage after maturation pond to irrigation channel.
4	Supply of specials as per IS code - 7322-1985 for 300 mm dia. PSC pipes complete.	10% of cost of pipe			65,000	For pumping the sewage after maturation pond to irrigation channel.
5	Laying and jointing of 300 mm dia. PSC pipe true in alignment in trenches complete.	500	m	120	60,000	For pumping the sewage after maturation pond to irrigation channel.
6	PCC in 1:2:4 (cement: coarse sand: 20 mm size grit) in thrust blocks complete.	1.5	cum	2,800	4,200	
7	Construction of chamber for disposal of sewage for irrigation channel	1	No.	5,500	5,500	For pumping the sewage after maturation pond to irrigation channel.
8	Construction of chamber for disposal of sewage for irrigation channel	60	m	3,300	198,000	For pumping the sewage after maturation pond to irrigation channel.
9	Construction of a generator room.	34	sq.m	6,000	204,000	For pumping the sewage after maturation pond to irrigation channel.
10	Construction of civil works for installation of floating aerator i.e. weir wall etc.		Job	LS	110,000	For reducing of sulphide contents
11	Supply of all labour T & P material etc. for laying of 200 micron, LDPE shed, over 50 mm thick fine sand, 75 mm thick P.C.C. 1:24 in cement and course land and lining finished with 10 m. thick cement plaster of 1:6 incl. Cement & sand water including dewatering of polishing pond, excavation of anaerobic bonds and disposal of sewage upto 3.0 m and dewatering of pump	5420.8	sqm	385	2,087,008	For installation of aerators to reduce sulphide contents

Sr.	Description	Quantity	Unit	Rates	Amount (Rs.)	Remarks
12	Provision for installation of floating aerator for reducing the sulphide in effluent of 5 mld treatment plant.	3	Nos.	700,000	2,100,000	For reducing of sulphide contents
	Sub total				6,169,448	
B)	E/M Works					
13	Supply, erection, testing & commissioning of sewage pump for 3,500 lpm at 20 m head with motor complete.	2	Nos.	660,000	1,320,000	For pumping the sewage after maturation pond to irrigation channel.
14	Provision for power transmission line complete.	1	No.	550,000	550,000	For pumping the sewage after maturation pond to irrigation channel.
15	Supply, erection, testing and commissioning of 45 kVA diesel generating set complete.	1	No.	700,000	700,000	For pumping the sewage after maturation pond to irrigation channel.
	Sub total				2,570,000	
	Grand total				8,739,448	

9.15.3 130 mld Domestic Sewage Treatment Plant

Tannery wastewater is mixing with domestic waste reaching to 130 mld sewage treatment plant. The tannery wastewater contains leather flushings, hair, chromium and sulphides and other toxic material for which plant is not designed. Centrifuge system installed at 130 mld plant is defunct and it is analysed that centrifuge cannot be used. Provision of sludge drying beds is made for dewatering of the excess sludge produced in the plant.

To increase the capacity of the treatment plant from present capacity to its full capacity, sludge dewatering arrangement will have to be improved and some renovation of existing electrical / mechanical equipments are to be taken up. For these works a sum of Rs.2.79 cores has been released by U.P. State Govt. under revolving fund. Under revolving fund renovation and replacement of some E&M equipments and construction of 16 nos. sludge-drying beds (total required 78 nos.) have been done. Provision for construction of remaining 62 nos. sludge drying beds including digested sludge pump house along with the filtrate pump house has been made in this estimate.

Table 9.21 Estimate for Improvement Works for 130 mld STP at Jajmau

(1) Civil

Sr.	Description	Quantity	Unit	Rate	Amount
1	Construction of 62 nos. sludge drying beds each of 400 sqm (25.3m x 15.8) area, as alternate arrangement for dewatering of digested sludge as per unit estimate	62	nos.	600,000	37,200,000
2	Supply and laying of gravity main of RCC pipe from digested sludge pump house to sludge drying beds	1	LS	1,000,000	1,000,000
3	Construction of filtrate pump house	1	LS	1,000,000	1,000,000
4	Supply and installation of filtrate pumping plants including supply of cables etc.	1	LS	2,200,000	2,200,000
5	Supply and laying of PSC rising main from filtrate pump house to the sump of the existing centrate pump house	1	LS	1,700,000	1,700,000
6	Supply and laying of RCC pipe from the sludge drying beds to the filtrate pump house and from the existing digested sludge pipe to digested sludge pump house	1	LS	1,200,000	1,200,000
7	Approach (brick on edge) road	1	LS	1,200,000	1,200,000
8	Levelling and dressing of undulated ground by cutting and filling of earth average one metre deep	72,100	cum	43	3,100,000
	Sub Total				48,600,000

(2) Mechanical and Electrical

Sr.	Description	Quantity		Unit	Rate (Rs.)	Amount (Rs.)
		New	Repairs			
1	Mat type mechanical bar screen having 6 mm					
	spacing between bars	2		Nos.	4,500,000	9,000,000
2	Primary settling tank		2	Nos.	50,000	100,000
3	Aerators (37 kW each)		10	Nos.	400,000	4,000,000
4	Return sludge pumps (90 kW each)		3	Nos.	40,000	120,000
5	Starters 90 kW auto transformers	4		Nos.	50,000	200,000
6	Treated effluent pumping plants (90 kW each)		7	Nos.	40,000	280,000
7	Filtrate pumps (45 kW) 540 m3/hr. 17 m head	2		Nos.	250,000	500,000
	11 kW/0.4 kV 2000 kVA 3 phase 50 C/s step down transformers	2		Nos.	1,000,000	2,000,000
	Sub Total					16,200,000
	Total					64,800,000

9.15.4 CSPS at Jajmau

Two pumping stations were constructed at Jajmau under the Ganga Action Plan (GAP-I) to pump the sewage to the STPs.

9.15.5 Results of Inspection, Equipment (Inventory) Survey

Table 9.22 Specifications of the Jajmau Pumping Stations

CSPS at Jajmau 1 (130mld)	
Dimensions	14.30 m dia 6.0 m depth
Installed capacity	4,200 lps
Installed pumps	7 x 225 HP – 3,600 lpm @ 20m head
Rising main	1500 mm dia PSC
CSPS at Jajmau 2 (25 mld)	
Dimensions	12.5 m dia (wet well cum dry well) 10 m depth
Installed capacity	580 lps
Installed pumps	4 x 75 HP – 8,700 lpm @ 20m head
Rising main	700 mm dia PSC

9.15.6 Observation of CSPS Pumping Stations at Jajmau:

As per survey of CSPS pumping stations at Jajmau the following salient points are given below: -

- 3 pumps of 225 HP are out of order and required urgent repair
- The sump is common for both pump houses i.e. for 130mld and 25 mld
- Civil structure of pumping station is OK.
- Alternative power supply (DF Generator) is installed in Jajmau treatment plant that feeds alternative power supply to CSPS.
- The capacitor panel to improve the power factor of pumping stations is not properly working.
- There is not a single instrument to measure level, flow, pressure, temperature etc for proper operation.
- There is no telecommunication provided at pumping station

9.15.7 Proposed Rehabilitation Programme for CSPS at Jajmau

1) The main existing 11kV HT panel is provided with three transformer feeders to feed 3 Nos. transformers of 630kVA. All the 11kV breaker panels are provided with Oil circuit breakers, which are outdated today and also the availability of the spares to maintain these OCBs is very poor. Moreover there is no protection to any of the 11kV breaker panel. The DC battery and battery charger panel is lying in rusted condition and no part of the panel is in usable condition. All the protections of HT panels are bypassed and panel is working without any protection to the HT breakers. This outdated OCB panel with 1: incomer and 3: outgoing transformer feeders is proposed to be replaced by new 11kV Vacuum Circuit Breaker Panel.
2) One 48V sealed maintenance free DC battery and battery charger set is proposed for the protection of the HT breaker panel.
3) Presently, in case of failure of grid power from the 33kV switchyard, the pumping station has to be dependent on the DFG Engines at 130mld STP site near to the pumping station. Running of these DFG sets is solely dependent on the availability of the gas at the STP site. This DFG power then is stepped up to 11kV and then transmitted through the overhead transmission line to the CSPS site. After receiving this 11kV DFG power at the CSPS, it is again stepped down to 0.433kV by a 1600 kVA transformer. To remove this dependency of standby power, 2 new DG sets of capacity 1250kVA (1 working and 1 standby) are proposed for the CSPS. One DG power distribution panel with Air Circuit Breakers is also proposed for distribution of DG

power to LT panels in the pump house.

4) The existing LT panels having Minimum Oil Circuit Breakers are outdated and spares are also not easily available to maintain these breakers. Hence all the 3 LT panels with MOCB are proposed to be replaced by Air Circuit Breakers panels. The configuration of the panel is retained so that the existing cable can be used from panel to pump starter panel.
5) Presently the capacitors are connected directly across motor terminals. The capacitors connected directly across motor terminals are not adequate to maintain the power factor to the desired value i.e. 0.99 lagging. Hence one capacitor control panel for each LT panel, with automatic power factor correction relay is proposed.
6) The lighting system (indoor as well as outdoor) is no more working and hence entire new lighting system is proposed.
7) Continuity of the existing earthing system could not be traced at site and the sizes of the earthing conductor used for panel as well as motor earthing are very inadequate. Hence the entire new earthing system with adequate size of earthing conductor is proposed.
8) New cabling and cable carrier system is proposed for new panels only and existing cables from LT panels to the pump motors will be retained as it is.
9) There is no provision of exhaust fans for heat dissipation in the HT panel room. Hence new exhaust fans are proposed in this panel room and proposed new DG room.
10) 2 nos. mechanical bar screens are proposed
11) New rising main from sump for a length of 800 m of dia 800mm (plan and profile of this rising main is presented in drawing KAN-PC—CT-1)

Table 9.23 Estimate for Improvement Works for CSPS at Jajmau

Sr.	Description	Quantity		Unit	Rate (Rs.)	Amount (Rs.)
		New	Repairs			
1	Mechanical bar screens complete in all respects	2		Nos.	1,500,000	3,000,000
2	36,000 lpm 20 m head 170 kW (225H.P.) 735 RPM vertical non-clog sewage pumping plant complete in all respects.	4		Nos.	1,600,000	6,400,000
3	11 KV/0.4KV 630 kVA 3 phase step down transformer complete in all respects	1		Nos.	350,000	350,000
	Total					9,750,000

CHAPTER 10

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 10 ENVIRONMENTAL IMPACT ASSESSMENT

10.1 INTRODUCTION

10.1.1 Justification of the Project

Kanpur city's population is projected to double from 2.8 million in 2003 to 5.6 million by 2030. At present the total domestic wastewater load is about 395 mld vs. an installed treatment capacity of 171 mld. The amount of wastewater collected and diverted to treatment is on average 79 mld, and represents less than 20% of the total amount generated. Remaining wastewater is discharged to Ganga and Pandu rivers through open drains. The Pandu river is a tributary of the Ganga with its confluence at approximately 25 km downstream of Kanpur.

Water supply and sanitation services are inadequate for Kanpur's present population. The sewer infrastructure is old, and poorly maintained. Many of the existing trunk sewers do not have sufficient hydraulic capacity for projected wastewater loads.

In the absence of a sewerage Master Plan, urban development continues without adequate infrastructure for public health and sanitation. New sources of pollution crop up as the population grows and new areas develop. To address the growing demands of sanitation and to prevent further pollution of the river, it is important to implement a sewerage Master Plan in the city.

10.1.2 Objective and Need for the Environmental Impact Assessment (EIA) Study

The purpose of the EIA study is to ensure that development options under consideration are environmentally sound and sustainable and that the environmental consequences of the project are recognized early and taken into account in the project design.

The Ministry of Environment and Forests does not make it mandatory to prepare an EIA for sewerage projects. The sewerage projects are not listed Schedule I projects under the EIA Notification that makes it mandatory for them to get an environmental clearance. As such, these projects do not require an environmental clearance from the Ministry. The report, however, follows the guidelines laid out by the Ministry for industrial projects. It also takes into account the JBIC guidelines for preparation of an EIA.

The major objective of this study was to establish present environmental conditions along the project corridor through available data/information supported by field studies, wherever necessary, to predict the impacts on relevant environmental attributes due to the construction and operation of the proposed sewage facilities, to suggest appropriate & adequate mitigation measures to minimise/reduce adverse impacts and to prepare an Environmental Impact Assessment (EIA) report including Environmental Management Plan (EMP) for timely implementation and scheduling of the mitigation measures. The EIA has been carried out on the Priority Projects. The list of priority projects is as follows:

Component	Description
Sewers (New)	Field survey to confirm alignment and invert levels of the proposed sewers. Determine the feasibility of installing pipes or develop a plan for installation in another alignment. Installation of new domestic trunk and lateral sewers in tannery industrial area.
Sewers (Old)	Inspection of existing main trunk sewers for cleaning and rehabilitation planning. Investigation for Rehabilitation
Pumping Stations (New)	Bhagwatdas Ghat Nala Pumping station

	Panki pumping station, Panka MPS
Pumping Stations (Old)	Physical condition and capacity of mechanical equipment, rising mains and civil structures and identify repair needs for Parmat PS, Nawab Ganj PS, Muir Mill PS, Guptar Ghat PS, and CSPS at Jajmau. Lakhanpur PS in District-III
STP (New)	Proposed Panka Bahadur Nagar STP
STP (old)	Physical condition and capacity of mechanical, electrical equipment, rising main and civil structures, and identify repair or replacement needs for Jajmau STPs. Augmentation of capacity of Jajmau 130mld STP

10.1.3 EIA Methodology

An EIA study basically includes establishment of the present environmental scenario, study of the specific activities related to the project and evaluation of the probable environmental impacts, thus, leading to the recommendations of necessary environmental control measures. The EIA study has also been carried out from the environmental point of view so as to ensure the sustainability of the project.
An EIA study, thus, necessarily includes collecting detailed data and information on the existing environmental set up for establishing "Baseline Environmental Scenario" and study of related data on the proposed activities, i.e., "Project Description" or project data due to construction and operation of the project. The project data is then superimposed on the baseline data and the resultant environmental conditions and environmental impacts associated with construction and operations are predicted with the help of effective and appropriate impact prediction tools and procedures under "Assessment of Environmental Impacts". To mitigate the adverse impacts on the environment, the necessary environmental control, protective and mitigation measures are finally recommended as "Environmental Management Plan".

The major environmental disciplines in this EIA study include water, wastewater, air and sludge quality, land use & socio-economics. The EIA study has been conducted emphasizing the impact of the different components of the existing sanitation system as well as impact of the proposed sewage treatment plant (STP). The main components of the project on which EIA study has been conducted are – rehabilitation of existing sewers and pumping station, construction of trunk sewers, Bhagwatdas ghat nala and Panki pumping station and proposed Panka Bahadur Nagar STP. The entire EIA study has been carried out within existing policy, legal and administrative framework considering the applicable environmental legislation, regulations and guidelines.

Secondary data was collected with respect to physical, biological and human environment of the study area and other relevant information about the project. Primary field data was generated in the study area on soil and groundwater. A comprehensive database was established after completion of both primary and secondary data collection.

In the way of the study, firstly the relevant aspects of the natural and socio-economic environment are described and the potential beneficial and adverse impacts on the social and natural environment during the implementation and operation phase of the project have been identified. The environmental impacts associated with construction and operation of proposed project was then determined through appropriate impact prediction tools and procedures. An Environmental Management Plan (EMP) was formulated for implementing the proposed mitigative measures as well as institutional arrangements required for the purpose.

So in brief, the scope of the EIA study includes:

- To collect relevant primary and secondary data pertaining to the city and the existing and proposed facilities in reference to priority projects.
- To identify the major impacts such as land acquisition, disposal site, change in landscape, land-use and vegetation, ground water contamination due to seepage at the STP, pollution and

hydrological change in receiving bodies of treated water, sludge production and disposal or reuse, odour production, health hazard of plant operator, etc. of the proposed interventions of the project.

- To carry out the mitigation measures for the risk in construction and operation of the STP due to accident, power cut etc. and to formulate the necessary mitigation and monitoring plan to reduce the impact of the proposed pumping stations and STP.

The methodology adopted is presented in the form of flow chart in Figure 10.1.

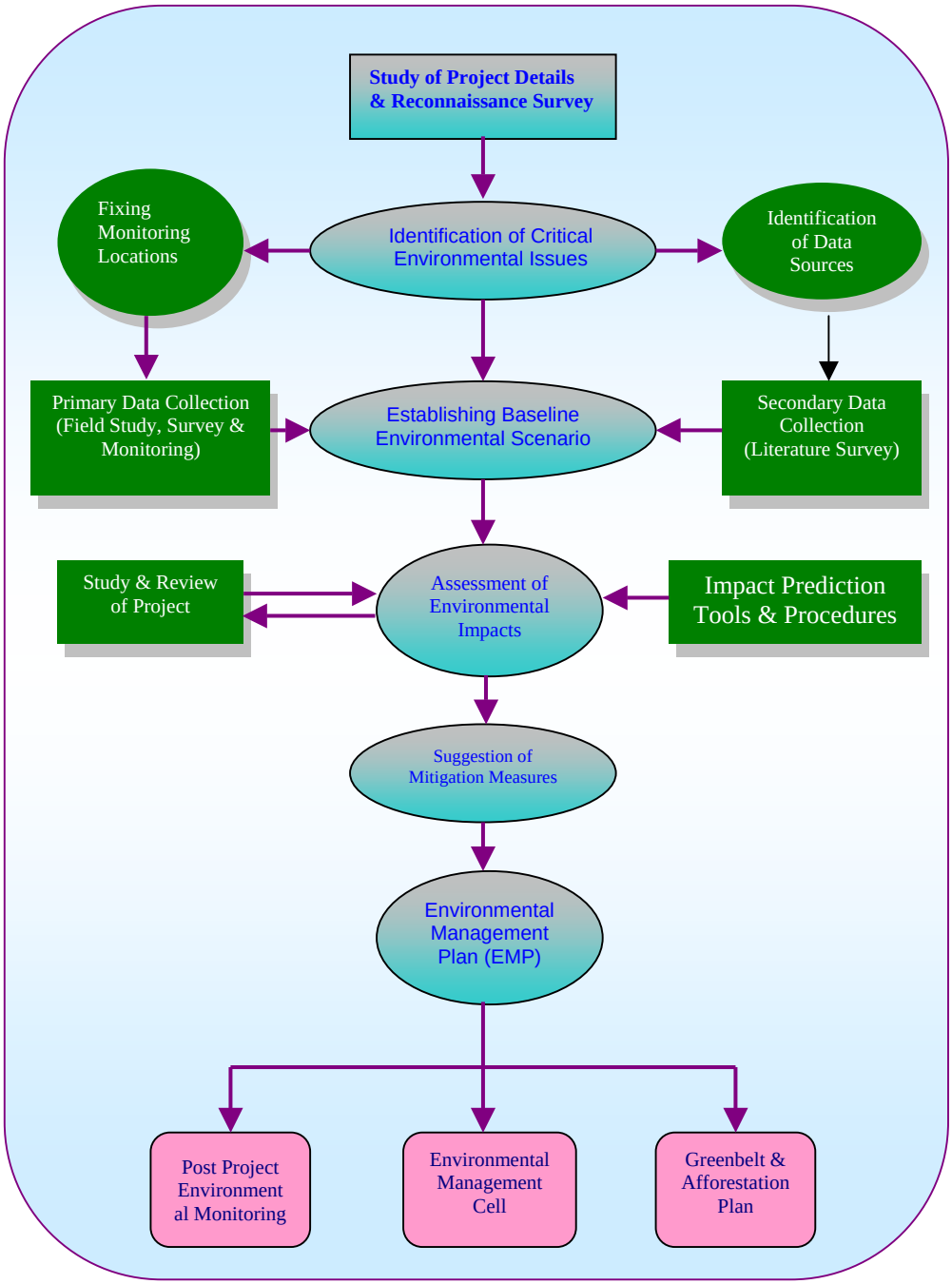


Figure 10.1 Schematic Diagram for Approach and Methodology of EIA

10.2 POLICY, ADMINISTRATIVE AND LEGAL FRAMEWORK

This section takes an account of all the relevant policies & the legal framework with respect to the sewerage projects. The administrative framework existing in the country is also documented.

10.2.1 Policy

The National Water Policy of India adopted in September 1987 states that:

1) Water resources development projects should as far as possible be planned and developed as multipurpose projects. Provision for drinking water should be a primary consideration. The other uses being in priority order as the following: irrigation, hydropower, navigation, pisciculture and industrial and other uses, unless otherwise dictated by area-specific requirements;
2) The integrated and co-ordinated development of surface and ground water and their conjunctive use should be envisaged at the project planning phase and should form an essential part of the project. There should be a close integration of water and land use policies.
3) There should be an integrated and multi-disciplinary approach to the planning formulation, clearance and implementation of projects, including catchment management, environmental and ecological aspects, the rehabilitation of affected people and command area development.

The Water (Prevention and Control of Pollution) Act and the Environment Protection Act promulgated in 1974 and 1986 respectively deal with the prevention and control of water pollution. The latter is considered as an umbrella act covering all aspects of the environment, under which the Central Government can take appropriate measures for:

- Protecting and improving the quality of the environment, and
- Preventing, controlling and abating environmental pollution.

The Pollution Control Boards (PCB) were established under this Act both at the Central Government and also at the State Government level for each state.

10.2.2 Administrative Framework

(1) Ministry of Environment and Forests (MoEF)

MoEF is the nodal agency, in the administrative structure of Central Government, for planning, promotion, co-ordination and overseeing the various environmental protection and forest conservation programmes. The ministry is responsible for effective implementation of environmental legislation through its various divisions, created for this purpose, at central government level and also through Central Pollution Control Board, State Departments of Environment and Forests and State Pollution Control Boards and Pollution Control Committees in the Union Territories, which serve as implementing agencies of the Ministry. Besides several legislative measures taken by the Ministry to protect the wholesomeness of the environment, a National Conservation Strategy and a Policy Statement on Environment and Development, 1992, National Forest Policy, 1988 and Statement on Abatement of Pollution, 1992 have also been evolved to tackle the environmental protection issues effectively.

The principal activities undertaken by MoEF consist of conservation & survey of flora, fauna, forests and wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the framework of legislations.

The main tools employed for achieving the above objectives include surveys, impact assessment, control of pollution, regeneration programmes, support to organisations, research and development, collection and dissemination of environmental information and creation of environmental awareness among target groups and stake holders at all levels of the country's population. Realizing the need for authoritative statistical data on environment, the work relating to collection, collation and analysis of environmental data and its depiction has been constantly taken-up through various projects.

The main functions of the Ministry are:

- Environmental Policy Planning
- Ensure effective implementation of legislation
- Monitoring and control of pollution
- Eco-development
- Environmental Clearances for industrial and development projects
- Environmental Research
- Promotion of environmental education, training and awareness
- Coordination with concerned agencies at the national and international levels
- Forest conservation development and wildlife protection
- Biosphere reserve programmes

(2) National River Conservation Authority (NRCA)

The NRCA was established in 1985 under the chairmanship of the Prime Minister as "The Central Ganga Authority", and laid down the policies for works to be taken up under the Ganga Action Plan. In July 1995, the Central Ganga Authority has been redesignated as the National River Conservation Authority (NRCA). It is the highest authority for policy framing for implementing the river action plans.

National River Conservation Directorate (NRCD), within the MoEF has been entrusted with the implementation of the National River Conservation Plan (NRCP) and National Lake Conservation Plan (NLCP). The NRCD coordinates the implementation of the schemes under the river and lake action plans. The main objective is to improve the water quality of the major rivers and lakes that are the major fresh water sources in the country, through the implementation of pollution abatement schemes.

Activities taken under NRCP

The activities under NRCP include the following:

- Interception and diversion works to capture the raw sewage flowing into the river through open drains and divert them for treatment
- Sewage treatment plants for treating the diverted sewage
- Low cost sanitation works to prevent open defecation on riverbanks
- Electric crematoria and improved wood crematoria to conserve the use of wood and help in ensuring proper cremation of bodies brought to the burning ghats
- River Front Development works such as improvement of bathing ghats, etc.
- Public awareness and public participation
- HRD, Capacity Building, training and research in the areas of river conservation
- Other minor miscellaneous works

The major action plans that are carried out by the NRCD are:

- Ganga Action Plan – Phase I & II

- Yamuna Action Plan - Phase I &II
- Gomti Action Plan – Phase I & II
- Damodar Action Plan
- Sutlej Action Plan
- Plan for Khan River basin
- Plan for Sabarmati River basin
- 7 additional towns of Tamil Nadu
- 1 additional town of Maharashtra
- 1 additional town of Goa

(3) Central Pollution Control Board

The Central Pollution Control Board (CPCB), a statutory organisation, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It provides technical services to the Ministry of Environment and Forests under the provisions of the Environment (Protection) Act, 1986. The principal functions of the CPCB are as given below:

1) Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air and water;
2) Plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water and air pollution;
3) Co-ordinate the activities of the State Boards and resolve disputes among them;
4) Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement;
5) Plan and organise training of persons engaged in programme on the prevention, control or abatement of water and air pollution;
6) Organise through mass media, a comprehensive mass awareness programme on the prevention, control or abatement of water and air pollution;
7) Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement;
8) Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;
9) Disseminate information in respect of matters relating to water and air pollution and their prevention and control;
10) Lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air; and
11) Perform such other function as may be prescribed by the Government of India.

(4) State Pollution Control Board

The functions of the State Board under the Air and Water Act are:

1) To plan a comprehensive programme for the prevention, control or abatement of air pollution, or streams and wells in the State.
2) To advise the State Government on any matter concerning the prevention, control or abatement of air and water pollution;
3) To collect and disseminate information relating to air and water pollution;
4) To collaborate with the Central Board in organizing the training of persons engaged or to be engaged in programmes relating to prevention, control or abatement of air and water pollution and to organise mass-education programme relating thereto;
5) To inspect, at all reasonable times, any control equipment, industrial plant or

manufacturing process and to give, by order, such directions to such persons as it may consider necessary to take steps for the prevention, control or abatement of air pollution;

6) To inspect air pollution control areas at regular intervals to assess the quality of air and take steps for the prevention and control of air pollution in such areas;
7) To inspect sewage or trade effluents, treatment plants and the system for the disposal of sewage or trade effluents or in connection with the grant of any consent;
8) To lay down or modify annual effluent standards for the sewage and trade effluents and for the quality of receiving waters resulting due to discharge of effluents;
9) To advise the State Government with respect to the suitability of any premises for an industry which is likely to cause air pollution;
10) To evolve economical and reliable methods of treatment of sewage and trade effluents, with regard to conditions of soils, climate, water resources and flow characteristics of water in streams and wells of different regions;
11) To evolve methods of utilisation of sewage and suitable trade effluents in agriculture;
12) To evolve efficient methods of disposal of sewage and trade effluents on land;
13) To advise the State Government with respect to the location of any industry, the carrying on of which is likely to pollute a stream or well.

(5) Uttar Pradesh Jal Nigam (UPJN)

UPJN is a Corporation of the State Government of UP. It was created in 1975 under the provisions of UP Water Supply and Sewerage Act, 1975 by converting the State Local Self Government Engineering Department into UP Jal Nigam. The UPJN is entrusted with the job of development of water supply and sewerage sector in the State. It has also been designated as the implementing agency for the NRCP and NLCP in the State of UP.

The Ganga Pollution Control Unit in Kanpur of UP Jal Nigam was basically formed to undertake the construction, execution of the assets that were created under the Ganga Action Plan. Under this, different pumping stations and sewage treatment plants were built to take care of the sewage and effluent flowing into the Ganga river. Since then, it has been a primary body also responsible for the operation and maintenance of these assets. As per the order from the Central Government, the operation and maintenance of these assets were supposed to be transferred to the local body. However, they have not been transferred except some of the pumping stations.

(6) Kanpur Jal Sansthan

Kanpur Jal Sansthan was established in the year 1975 under UP Water Supply and Sewerage Act 1975 as a local authority for water supply and sewerage services in the city. After creation of the Jal Sansthan, the water supply and sewerage works were taken out from the activities of the Nagar Nigam and entrusted to the Jal Sansthan. Mayor of the city is the Chairman of the Jal Sansthan.

Under the UP Water Supply and Sewerage Act, 1975 following are the functions of the Jal Sansthan:

1) To plan, promote and execute schemes of and operate an efficient system of water supply;
2) Where feasible, to plan, promote and execute schemes of, and operate, sewerage, sewage treatment and disposal and treatment of trade effluents;
3) To manage all its affairs so as to provide the people of the area within its jurisdiction with wholesome water and where feasible, efficient sewerage service;
4) To take such other measures, as may be necessary, to ensure water supply in times of any emergency;
5) Such other functions as may be entrusted to it by the State Government by notification in the Gazette.

(7) Kanpur Nagar Nigam

On a broader level, the Nagar Nigam handles the responsibilities like health and sanitation, primary education, solid waste management, plantation, slaughterhouses, cleaning of roads, etc.

With special reference to the underground drainage system, KNN is involved in:

- Cleaning of surface drains and desilting of deep drains
- Construction and maintenance of surface drains, deep drains along the road and lanes within municipal maintenance

Kanpur Nagar Nigam currently is not engaged in any of the sewerage related infrastructure execution, operation and maintenance in the city. However, with the orders from the Government regarding the merger of Jal Sansthan with Nagar Nigam, in future there might be a possibility that the O&M of sewerage infrastructure may come under the purview of Nagar Nigam and Jal Sansthan jointly.

10.2.3 Legal Framework

The various rules and regulations are summarized in the Table 10.1

Table 10.1 Summary of the Relevant Indian Rules

Environment Legislation	Salient Features
Forest (Conservation) Act, 1980 – as amended in 1988	The Central Government enacted The Forest (Conservation) Act in 1980 to stop large scale diversion of forest land for non-forest use. As amended in 1988, the Act requires the approval of the Central Government before a State "de-reserves" a reserved forest, uses forest land for non-forest purposes, assigns forest land to a private person or corporation, or clears forests land for the purpose of reforestation. Such diversion is generally allowed on the advice of an Advisory Committee constituted under the Act. In case of such diversion of forest land, compensatory afforestation has been made mandatory
Wildlife Protection Act	An act to provide for the protection of wild animals, birds and plants and for matters connected therewith. The provisions under this act are: • Section 9 of the Act says that no person shall hunt any wild animal specified in Schedule I • The act prohibits picking, uprooting, damaging, destroying, acquiring any specified plant from any forest land • It bans the use of injurious substances, chemicals, explosives that may cause injury or endanger any wildlife in a sanctuary • No alteration of the boundaries of a National Park shall be made except on a resolution passed by the Legislature of State • Destruction or damaging of any wildlife property in national Park is prohibited.
Water (Prevention and Control Pollution) Act, 1974 - as amended in 1978 &1988	The Act vests regulatory authority on the State Pollution Control Boards and empowers them to establish and enforce effluent standards for industries and local authorities discharging effluents. Following are the important provisions under this Act which are to be compiled with: • Provide the State Pollution Control Board (SPCB) any information which is sought for preventing or controlling pollution of water regarding the construction, installations, operation or the treatment and disposal system of an industrial establishment • Not to discharge, knowingly, any effluent into the stream sewers or on land of quality which is not conforming to the standards prescribed by the SPCB • Furnish information to the SPCB and other designated agencies of any accident or unforeseen event, in which effluents not conforming to the prescribed standards are being discharged or likely to be discharged into a stream or sewer or on land Comply with the directions issued in writing by the SPCB, within the specified time. • Comply with the condition as prescribed in the "Consent to Establish" or "Consent to Operate" for discharge of effluent into stream or sewers or on land. Responsibilities • Obtain "Consent to Establish", prior to taking any steps to establish any industry or any treatment and disposal system, which is likely to discharge effluents. • Obtain "Consent to Operate", prior to commencing operation of any industry or any treatment and disposal system, which is likely to discharge effluents.

Environment Legislation	Salient Features
	• Apply for renewal of the "Consent to Operate: before the expiry of validity period along with the prescribed fee.
Water (Prevention and Control of Pollution) Cess Act, 1977 including Rules	An act to provide for the levy and collection of a cess on water consumed by persons carrying on certain industries and by local authorities to augment resources for the SPCBs. As per the provision of Section 3, all specified industries under the Water (Prevention and Control of Pollution) Cess Act, 1977 are liable to pay cess in the prescribed rate made under the statute. It is provided under Section 5 that every specified industry or local authority is liable to furnish cess to respective authorities. Also suitable meters shall be installed by all specified industries and local authorities for the purpose of measuring the quantity of water consumption. To encourage capital investment in pollution control, the Act gives a polluter a 70 per cent rebate of the applicable cess upon installing an effluent treatment plant
Air (Prevention and Control of Pollution) Act, 1981 - as amended in 1987	An act providing for prevention, control and abatement of air pollution. • Section 21 of the Air Act specifies that no person shall without the consent of the State Board establish or operate any industrial plant in any air pollution control area. • It is also provided in the statute that industrial units cannot discharge any pollutants into the air in excess of the standards of the standards prescribed by the State Board. The States are required to prescribe such "Emission Standards" for industry and automobiles after consulting with the Central Board and noting its Ambient Air Quality Standards. • Furnish information to the SPCB and other designated agencies of any accident or unforeseen event, in which emissions of air pollutants occurred in excess of the prescribed standards or are likely to occur. Comply with the directions issued in writing by the SPCB, within the specified time. • Comply with the condition as prescribed in the "Consent to Establish" or "Consent to Operate" for emissions Responsibilities • Obtain "Consent to Establish", prior to establishing any industrial plant in an air pollution control area, which is likely to emit air pollutants. • Obtain "Consent to Operate", prior to commencing operation of any industrial plant which is likely to emit air pollutants in an air pollution control area,. Apply for renewal of the "Consent to Operate: before the expiry of validity period along with the prescribed fee.
The Environment (Protection) Act, 1986	The Environment (Protection) Act was conceived as an "umbrella legislation" seeking to supplement the existing laws on the control of pollution (the water Act and the Air Act) by enacting a general legislation for environment protection and to fill the gaps in regulation of major environmental hazards. • Section 3(1) of the Act empowers the Centre to " take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution". • It also authorizes the government to make rules on any aspect related to environment protection. • No industries can discharge any solid, liquid or gaseous substances beyond the permissible limit as laid down by

Environment Legislation	Salient Features
	the Central Government on its behalf • Comply with the directions issued in writing by the Central Government within a specified time as mentioned in the order • Furnish information to the prescribed agencies of any accident or unforeseen event, in which environmental pollutants occurred in excess of the prescribed standards are being discharged, or are likely to be discharged in the environment. Responsibilities • Obtain prior "Environmental Clearance" from MoEF in case of a new project or for modernisation/expansion of the existing project and in respect of projects falling under EIA notification
Environment (Siting for Industrial Projects) Rules, 1999	*The Environmental Guidelines for Siting of Industries has been formulated for specific areas to be avoided for siting of industries. These rules are meant for protection of the sensitive areas such as national parks, sanctuaries, wetlands and archaeological monuments.*
Environment Impact Assessment Notification (amended up to June 2002)	Through this Notification, the MoEF made Environment Impact Assessment (EIA) statutory for 31 different activities. • Any person who desires to undertake any new project/ expansion or modernisation of any existing industry listed in Schedule 1 of the notification shall submit an application to the MoEF for environmental clearance. (Note: This Schedule I does not include sewerage projects) • The reports submitted with the application is reviewed by the Impact Assessment Agency which further prepares a list of recommendations based on the technical assessment of documents and data. • The assessment shall be complete within a period of 90 days on receipt of the application. The clearance granted is valid for a period of 5 years. • Further whoever applies for environmental clearance shall submit to the SPCB/PCC's 20 copies of the relevant documents as mentioned in Schedule IV of the notification for conducting public hearing. • The SPCB/PCC's shall publish a notice for public hearing in at least 2 widely circulated newspapers in the region of the project; one in English and the other in vernacular language. SPCB is responsible for mentioning the date, time and venue of the public hearing.
	• All affected persons can participate in the public hearing
The Hazardous Wastes (Management and Handling) Rules, 1989	• These rules aim at providing control for the generation, collection, treatment, transport, import, storage and disposal of hazardous wastes. • These Rules provide for effective inventorisation and controlled handling and disposal of hazardous waste. • Occupiers responsibility to ensure proper handling and disposal of hazardous waste either by themselves or through the operator of hazardous waste management facility • Restriction on handling of hazardous wastes without prior authorization • Packaging, labelling and transportation of hazardous waste to be done in the specified manner • Occupier generating hazardous wastes, or operator handling facility to submit annual returns in the prescribed

Environment Legislation	Salient Features
	format. • Occupier or operator handling facilities to report to SPCB in prescribed forms, in case of accident at the hazardous waste handing site or during transportation.
The Municipal Solid Wastes (Management and Handling) Rules, 2000	• Every municipal authority will be responsible for the implementation of the provisions under these rules. • The municipal authority shall make an application in Form-I for grant of authorization for setting up waste processing and disposal facility from State Board. • The municipal authority shall comply with the implementation schedule under Schedule I. • The municipal authority shall furnish its annual report in Form II on or before 30th June every year. • Any municipal solid waste shall be managed in accordance with the procedure laid down in Schedule II. • The waste processing and disposal facilities to be set up by Municipal authority shall meet the specifications and standards specified in Schedule II and IV.
Bio- Medical Waste (Management and Handling) Rules, 1998	• The occupier of an institution generating bio-medical waste shall take all steps to ensure that such waste is handled without any adverse effect to human health and environment • Bio-medical waste shall be treated and disposed of in accordance with Schedule I and in compliance with the standards prescribed in Schedule V. • The occupier should set up requisite bio-medical waste treatment facilities in accordance with the time frame in Schedule VI • Bio-medical waste shall be segregated into containers/bags at the point of generation as per Schedule II prior to its storage, transportation, treatment and disposal. • If a container is transported from the premises of the generation point to any waste treatment facility, it will also carry information as in Schedule IV apart from that prescribed in Schedule III. • Bio-medical waste shall be transported in vehicles as authorized for the purpose by the competent authority • No untreated bio-medical waste shall be kept stored beyond 48 hours. Occupier/operator shall submit an annual report to the prescribed authority (SPCB) in Form II by 31st January every year for the preceding year.
The Land Acquisition Act, 1894	The Act seeks to set out the circumstances and the purposes for which private land can be acquired by the Central/ State Government. The procedure under the Act is briefly listed below. Stage I • Publication of a preliminary notification by the Government that land in a particular locality is needed or may be needed for a public purpose or for a company • Entry of authorised officers on such land for the purpose of survey and ascertaining whether it is suitable for the purpose in view • Filing of objections to the acquisition by persons interested and enquiry by Collector Stage II • Declaration of intended acquisition by Government

Environment Legislation	Salient Features
	• Publication of declaration as required by the Act • Collector to take order from the Government for acquisition and land to be marked out, measured and planned Stage III • Public notice and individual notices to persons interested to file their claims for compensation • Enquiry into claims by Collector • Award of Collector • Reference to court • Stage IV • Taking of possession of the land by the Collector • Payment of compensation

10.2.4 Emission Standards for Water, Air, Noise and Effluent

(1) River Water Quality Standards

Until recently the only criteria available for classification of water bodies was as per the 'Designated Best Use' (DBU) prescribed by Bureau of Indian Standards and Central Pollution Control Board (CPCB) way back in 1981. According to this concept, out of various purposes for which the water body is used, the one that requires highest quality of water is taken as the benchmark and classified as 'Designated Best Use'. According to this criteria water bodies are divided in five categories viz.:

Class A: Drinking water source without conventional treatment, but with chlorination
Class B: Outdoor bathing
Class C: Drinking water source with conventional treatment
Class D: Propagation of wildlife and fisheries
Class E: Irrigation, industrial cooling and controlled waste disposal

This criteria lays down reference values for among others pH, Dissolved oxygen, Biological oxygen demand, Coliform etc. For instance specified limits for DO, BOD and coliform for Class A are 6 ppm, 2 ppm and 50/100 ml, respectively. For lower category such as Class D, specified values for these indicators are 4 ppm, 6 ppm and 5000/100 ml, respectively.

Recently, CPCB has revised the primary quality for class B regarding coliform number as; faecal coliform: <500 MPN/100ml (Desirable), <2,500 MPN/100ml (Maximum permissible).

As of now this criteria is followed by various agencies responsible for management and control of water quality in the country including the two ongoing programmes viz. National River Conservation Plan and National Lake Conservation Plan.

Central Pollution Control Board (CPCB) has proposed a new criteria for classification of water bodies. The new approach is based on the premise of maintaining and restoring 'wholesomeness' of water for the health of ecosystem and environment in general; and protecting the designated organised uses of water by human beings and involving community for water quality management.

The new classification system proposes three categories or tiers of indicators of water quality depending on the ease or complexity involved in their determination with regard to knowledge, skills, and equipment. Secondly, it classifies water bodies into three broad categories viz.:

Class A : Excellent (Long term goal)
Class B : Desirable level of wholesomeness (Medium term goal)
Class C : Minimum acceptable level (Short term goal)

Table 10.2 Key Indicators of Inland Surface Water Quality under the Revised Criteria Proposed by CPCB

Indicator	Unit	A-Excellent	B-Desirable	C-Acceptable
DO	(% saturation)	90-110	80-120	60-140
BOD	(mg/l)	<2	<5	<8
Faecal Coliform	MPN/100 ml	<20	<200	<2000

(2) Effluent Standard

Effluent discharge standards are specified with reference to the type of industry, process or operations and in relation to the receiving environment or water body such as inland surface water, sewers, land

or sea.

Table 10.3 Standards for Different Receiving Water Bodies

Indicator	Inland surface water	Public sewers	Land for irrigation	Marine outfall
Suspended solids	100	600	200	100
Oil and grease	10	20	10	20
BOD_5	30	350	100	100

Note: *All values are in mg/l and are the maximum permissible levels.*
Source: *Pollution control acts, rules and notifications issued hereunder, CPCB, September, 2001.*

The general BOD limit specified for discharge of wastewater from typical industrial sources or domestic wastewater is same at 100 mg/l. However, the rules specify that the discharge limits can be made further stringent if the concerned pollution control authority finds it appropriate depending on the condition of the receiving environment and severity of the discharges from various sources.

NRCD has specified guidelines for discharge of domestic effluents in the river, which is given in Table 10.4.

Table 10.4 Standards for Treated Wastewater Quality

Sr.	Parameter	Value (Irrigation Field/River)
1.	pH	5.5 – 9.0
2.	Biochemical Oxygen Demand, mg/l	$\leq$ 30
2.	Total Suspended Solids, mg/l	$\leq$ 50
3.	Faecal Coliform Count, MPN/100ml	$\leq$10,000

NRCD have conveyed the recommendations of the Expert Committee through their letter no DO. No. A-33013/1/99-NRCD dated 5th October 1999, suggesting that the maximum permissible value for Faecal Coliform in treated water should not exceed 10,000 MPN per 100 ml sample irrespective of its mode of disposal in river or its use for irrigation to grow either restricted or unrestricted crops. However the STP is designed to meet the discharge guideline of NRCD for <1000 MPN/100 ml sample. NRCD guidelines also suggest BOD and TSS concentration to be less than 30 mg/l and 50 mg/l, respectively.

(3) Standards for Irrigation

In order to protect various water bodies, standards for treated industrial waste / treated domestic waste have been prescribed by CPCB, New Delhi. These standards are different for different types of receiving bodies. Treated effluent / treated sewage to be discharged into any of the following shall meet the relevant standards as prescribed by CPCB:

i) into inland surface water,
ii) into municipal sewers,
iii) on land for irrigation,
iv) into marine coastal water.

If treated sewage is to be used for irrigation, upper limits for important parameters shall be:

Table 10.5 Treated Water Quality for Irrigation

Parameter	Unit	Limits
BOD_5	mg/l	100
Suspended Solids	mg/l	200
Dissolved Solids	mg/l	2100
pH		5.5-9.0
Oil & Grease	mg/l	10
Arsenic	mg/l	0.2
Boron	mg/l	2.0
Cyanide	mg/l	0.2
Chloride	mg/l	600
Sulphate	mg/l	1,000

Source: CPCB, Stds for discharge of Ind./Dom. Wastewater

(4) Ambient Air Quality Standards

The CPCB has notified the National Ambient Air Quality Standards (NAAQS) in Schedule VII of these Rules, which are reproduced in Table 10.6.

Table 10.6 National Ambient Air Quality Standards

Pollutant	Time weighted	Concentration in ambient air ($\mu g/m^3$)			Method of measurement
	Average	Industrial	Residential	Sensitive	
SO_2	Annual*	80	60	15	1. Improved West & Gaeke method
	24 hrs**	120	80	30	2. Ultra violet fluorescence
NO_x	Annual	80	60	15	1. Jacob & Hochheiser modified (Na-Arsenite) method
	24 hrs	120	80	30	2. Gas phase chemi-luminescence
SPM	Annual	360	140	70	Average flow rate not less than
	24 hrs	500	200	100	1.1 m^3/minute
RPM	Annual	120	60	50	
	24 hrs	150	100	75	
Pb	Annual	1.00	0.75	0.50	AAS method after sampling using
	24 hrs	1.50	1.00	0.75	EPM 2000 or equivalent paper
CO$^{\$}$	8 hrs	5	2	1	Non dispersive infrared spectroscopy
	1 hour	10	4	2	

Note:
* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform intervals.
** 24 hourly /8 hourly values to be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.
$ Values in mg/m^3

10.2.5 Ambient Noise Standards

The standards for ambient air quality in respect of noise are given in Schedule III under the rules and are reproduced in Table 10.7.

Table 10.7 Ambient Air Quality in Respect of Noise

Area code	Category of area	Limits in dB (A) Leq	
		Day time	Night time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence zone	50	40

Note 1: Day time is reckoned in between 6 am to 10 pm
2: Night time is reckoned in between 10 pm to 6 am
3: Silence zone is defined as areas up to 100 metres around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
4:Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

10.2.6 JBIC's Environmental Guidelines

A fundamental principle of JBIC, as a government financial institution, is to confirm that the executor of a project proposed for JBIC financing takes into account appropriate environmental considerations. If, during the course of establishing the project meets acceptable environmental considerations, and JBIC finds that environmental considerations for the project are not appropriately addressed and the project carries significant risk of negative environmental impact, JBIC will require the project executor, to improve the project's environmental consideration.

Screening differentiates JBIC-financing projects on the basis of grouping them into 3 categories, A, B, and C, in accordance with the extent of the environmental impact(s) and/or JBIC's involvement in the project. Category A and B projects are deemed to have a significant likelihood of affecting the environment, as suggested by JBIC's experience. Sewerage projects fall under Category B projects.

(1) Standards to Confirm Appropriate Environmental Considerations

Natural Environment

JBIC confirms, in principle, that the project will comply with the laws and regulations and environmental standards pertaining to natural environments in the country where the project is located. In the event that environmental standards in the country where the project is located diverge significantly from Japanese or international standards (standards, etc. such as those provided in other environmental guidelines of World Bank and other standards of which appropriateness are recognized internationally), or that local environmental regulations are yet to be established in some areas, Japanese or international standards are taken into account to confirm that appropriate environmental considerations are made.

Social Environment (particularly Involuntary Resettlement)

In addition to considerations for natural environments, appropriate considerations, including adequate explanation, must be given to the social environment, particularly when local and neighbouring populations will be subject to involuntary resettlement, with a view to obtaining their consent. In the event that any problem arises, JBIC will confirm the appropriateness of environmental considerations by referring to internationally recognized principles and procedures.

10.3 BASELINE ENVIRONMENTAL STATUS

10.3.1 Study Area

Kanpur is situated on the bank of river Ganga between 25°26' and 16°58' north latitude and 79°31' and 80°34' east longitude. The city is bounded between two rivers namely Ganga in the north and Pandu in south. The city is spread in an area of 299 sq.km and is 425 km from Delhi and 90 km from Lucknow.

10.3.2 Physical Environment

(1) Topography

The topography of Kanpur city is generally flat. A ridge line divides the town in two parts, one sloping towards river Ganga and the other towards Pandu river in the south.

(2) Geology and Geomorphology

Geologically the district exposes Quaternary sediments differentiated into older alluvium consisting of oxidised, brown, yellow and khaki coloured sediments. Geomorphologically, the terrain of Kanpur is differentiated into lowland and upland. The upland, known as Varanasi plain lies in Yamuna-Ganga interfluve with elevations of 125 to 141m above msl. The ground of Varanasi plain is silty to clayey, flat and has relict fluvial features like tals and palaeochannels in Bilhaur and Derapur tehsils. The lowland with elevations of 110 to 135m above msl consists of older flood plain (terraces T1 and T2) and active flood plain. River bed and flood plains of Ganga, Yamuna and Sengar rivers make active flood plain of each river, it is wide and sandy along Ganga and Yamuna but narrow and silty along Sengar.

(3) Soil Quality

The soils of this zone are alluvial, highly productive and constitute one of the most fertile belts of India. Salt affected soils (Usar lands) are found in patches in the study area. They have medium to strong salinity and very high alkaline soil reaction. They have a poor nutrient status i.e. they are low in organic matter, low to medium in available phosphorous (P) and potash (K) and critical in zinc and copper.

According to the data quoted in "REIA for Ganga Action Plan Support Project in Kanpur", there are four mapping units (MU) in Kanpur.

The primary data analysis results of soil are given in Appendix A10.1

10.3.3 Climate and Meteorology

Climate of Kanpur is tropical in nature. The city encounters seasonal variation of climate throughout the year with high temperatures during summer, cold weather during winter and sufficient rain during monsoon.

Calm wind conditions prevail during winter between November-February. Average wind speed during this period is 5 to 10 kmph from N/NW direction. Occasional dust storms prevail with high wind speeds in summer. Winds are relatively stronger during monsoon from S/SW. having velocity range of 10 to 30 kmph.

The hottest months are May and June with mercury levels touching 40°C to 45°C. Usually summers are dry with 35 to 70% RH levels. Temperature falls to 6.5 to 10°C during December and January. There are instances of temperatures reaching as low as 1°C during peak winter and maximum

temperature as high as 48°C during peak summer.

The RH during summer is 35 to 70%, in winter 55 to 86% and in monsoon period 60 to 93%. Onset of monsoon starts during late June and continues till October. The annual rainfall is in the range of 420 to 1300 mm per year with average being 821 mm per annum. Sporadic rains may be seen during winter from north west monsoon.

The average climatological table is given in Table 10.8.

Table 10.8 Climatological Table Based on Observations from 1951 to 1976

Month		Air Temperature (^{0}C)		Rainfall				No. Of Days With Wind Speed (Km.P.H.)			
		Daily Max.	Daily Min.	Monthly Total	No. Of Rainy Days	Total In Wettest Month With Year	Total In Driest Month With Year	62 Or More	20-61	1-19	0
January	I	22.7	8.5	21.1	1.5	74.7	0.0	0	0	22	9
	II					1948		0	0	24	7
February	I	26.4	11.3	12.5	1.0	97.5	0.0	0	0	22	6
	II					1928		0	1	24	3
March	I	32.5	16.6	6.2	0.7	77.2	0.0	0	0	27	4
	II					1944		0	2	28	1
April	I	38.3	22.0	4.5	0.5	94.2	0.0	0	1	26	3
	II					1909		0	2	26	2
May	I	41.4	26.5	9.8	0.8	47.2	0.0	0	1	28	2
	II					1969		0	2	28	12
June	I	40.1	28.7	65.4	3.3	378.7	6.0	0	2	26	2
	II					1916	1969	0	3	25	2
July	I	34.3	26.7	229.8	12.0	704.1	36.6	0	1	29	1
	II					1924	1970	0	1	28	2
August	I	32.2	25.9	289.5	13.3	664.2	40.0	0	0	28	3
	II					1921	1965	0	0	27	4
September	I	33.0	24.9	124.4	6.5	527.6	5.2	0	1	27	2
	II					1915	1966	0	0	27	3
October	I	32.7	20.2	60.7	2.1	335.3	0.0	0	0	24	7
	II					1955		0	0	22	9
November	I	29.0	13.2	1.0	0.2	92.2	0.0	0	0	19	11
	II					1894		0	0	17	13
December	I	24.2	8.9	7.7	0.7	82.6	0.0	0	0	18	13
	II					1967		0	0	21	10

Source: Indian Meteorological Department, Pune

10.3.4 Surface Water

The existing surface water bodies in the city limits are classified as rivers, open drains with direct outfall into the rivers, ponds/stagnant water bodies within city, waterlogged areas and the areas affected due to poor management of domestic sewage.
(1) Ganga River

The Ganga has a total length of 2,525 km from the sources in the Himalayas to its mouth in the Bay of Bengal.

The water flow in the Ganga varies between a mean minimum of 72.6 m^3/s and a mean maximum of 8,860 m^3/s. After tapping water for the Upper and Lower Ganga Canals a minimum water flow of 6m^3/s is maintained in the Ganga near Kanpur. At Kanpur the river course has shifted from the right bank to the left bank from 1920. Therefore, a channel from the river course to Bhaironghat had to be made for the main water supply intake of Kanpur.

The quality of Ganga water intake point has been satisfactory between the years 1997 and 2001 with DO ranging from 7.5 mg/l to 9.1 mg/l. CPCB carried out water quality monitoring at selected locations on Ganga river which have been given in Table 10.9.

Table 10.9 Water Quality of Ganga River

Location	DO (mg/l)	BOD (mg/l)	Coliforms (MPN)
Incoming water	8.9	<1	80
Ganga Channel adjoining city	3.2	10	
At mid-stream of city right stream	7.5	2-3	230
mid stream	8.0	1-2	
At downstream near Shekhpur right stream Midstream	2.6 8.8	7 1-2	
Near Motherpur village Right stream Mid-stream	 7.8 8.6	 3 1	230

Source: Environmental Status Report of Kanpur, CPCB, 2001

(2) Pandu River

The Pandu river is a meandering river. It flows into Ganga at a point of 25 km downstream of Kanpur. The highest water level in the river is 119.6 m MSL and the mean water level is 114.5 m MSL. The Pandu river is polluted by the discharge of fly ash from the power station in Panki causing grey colour and high turbidity, and by the discharge of wastewater from Kanpur via the COD nala, the Ganda nala and the Halwa Khanda nala. The water quality of river Pandu is given in 10.10.

Table 10.10 Water Quality of Pandu River

Location	DO (mg/l)	BOD (mg/l)	Coliforms (MPN)
Incoming water	8.2	4	300
Downstream of city	4	11	1,700

Source: Kanpur Environmental Status Report, 2002

Table 10.11 Pollution Load of Drains in Kanpur

Name of drain	Discharge (mld)	BOD (mg/l)	SS (mg/l)	BOD load (kg/day)	SS load (kg/day)
Ranighat drain	0.8	110	219	88.0	175.2
Sisamau drain	114.0	174	30	37,620.0	37,620.0
Muir mill drain	2.2	138	136	303.6	299.2
Police lines drain	0.4	221	211	88.4	84.4
Jail drain	0.3	111	233	33.3	69.9
Pumping station drain	-	310	533	0.0	0.0
Panki drain	17.0	145	10,204	2,465.0	173,468.0
Panki ind drain	28.0	70	164	1,960.0	4,592.0
Ganda nala drain	74.6	193	235	8,206.0	16,337.4
Halwa kanda drain	5.7	183	201	1,043.1	1,145.7
COD drain	6.0	130	312	780	1,872.0
Irrigation canal	140.0	310	533	2,4360.0	46,200.0

Source: Kanpur Environmental Status Report, 2002

Various drains carrying city sewage and industrial effluent are polluting the river indiscriminately. Pollution load from these drains discharging directly into the rivers are shown in Table 10.11.

(3) Ponds and Stagnant Water Bodies

A study carried out by CPCB indicates that the naturally existing water bodies in the city are water pool near Allen Forest and water ponds in the rail yard area along GT road near tatmill. Water quality in the pond near rail yard is degraded. The two water tanks at Motijheel were used as freshwater reservoirs for drinking water supply to the city, but now abandoned due to excess silting and damage to the feeder canal. Other fresh water bodies in the city are the upper Ganga canal network flowing in the south city.

10.3.5 Groundwater

Uttar Pradesh Pollution Control Board carries out regular monitoring at selected locations in the nearby villages, which are summarised in Table 10.12 and 10.13. Hexavalent chromium has been found to be nil, except at one location but which is still within the limits. The primary survey carried out for ground water revealed no such alarming levels of heavy metals including hexavalent chromium.

Table 10.12 Groundwater Results of Villages near Kanpur

Sr.	Location of hand pump	Date	pH	Conductivity	Alkalinity	Chlorine	Cr^{+6}	Ammonia N_2 - NH_4
				(meter/sm^{-1})	(mg/l)	(mg/l)	(mg/l)	(mg/l)
1	Opp. LML Nauraya Khera Panki	09/08/01	7.3	362.5	192	1.39	Nil	ND
2	Near Mr. Kalli's House, Vazidpur, Jajmau	10/08/01	7.1	344	240	279.72	Nil	ND
3	Near Mr. Kalli's House, Vazidpur, Jajmau	12/01/02	8.4	302	284	1091.45	Nil	ND
4	Off. LML Nauraya Khera, Panki	13/01/02	8.2	51.4	276	35.98	Nil	ND
5	Off. LML Nauraya Khera, Panki	10/06/02	8.2	68.7	288	11.99	Nil	ND
6	Near Kalli house Vazidpur, Jajmau	11/06/02	7.2	527	324	522	Nil	ND
7	Near Bhoot nath chouraha Jajmau	08/01/03	7.2	31.8	208	27.98	Nil	ND
8	Off. Rota pump at on Prakash house, Panki	09/01/03	6.8	233	224	579.71	Nil	0.38
9	Near Kalli house Vazidpur, Jajmau	03/05/03	6.7	561	336	1287.35	0.03	ND
10	Off. Rota pump, Panki	03/05/03	7.2	353	432	629.68	Nil	0.415

Source: Uttar Pradesh Pollution Control Board

Table 10.13 Analysis Report of Underground and SW of Naurayakhera Village, Parli - July 2004

Bamti	1	2	3	4	5	Pond/SW
	HP Depth					
	80ft	40ft	100ft	120ft	160ft	
Colour	Colourless	Colourless	Colourless	Light Yellow	Colourless	Light Brown
pH	7.6	7.5	7.2	7.2	7	7.2
Conductive (ms/m)	188	197.5	122.8	124	147	180
Alkalinity	200	440	180	192	192	384
Chloride	188	226	230	210	330	312
Ammonia	Nil	Nil	Nil	Nil	Nil	Nil
Cr^{+6}	Nil	Nil	1.78	7.4	2	Nil

Source: Uttar Pradesh Pollution Control Board

10.3.6 Ambient Air Quality

The average ambient air quality data monitored for Kanpur is given in Table 10.14. It is seen from the table that the levels of SPM and RPM are exceeding the limits specified. This is mainly due to the emissions generated by vehicles and other industries.

Table 10.14 Ambient Air Quality Data (1999 – 2003)

Locations	Place/ Category	Year 1999			Year 2000			Year 2001		
		SPM	SO_2	NO_X	SPM	SO_2	NO_X	SPM	SO_2	NO_X
Kidwai Nagar	Residential	474	22	17	461	21	18	558	18	15
Fazal ganj	Industrial	566	21	18	503	21	18	609	19	16
Dypty ka Padav	Commercial	542	21	17	422	19	17	581	18	15

Locations	Place/ Category	Year 2002			Year 2003			Year 2004			
		SPM	SO_2	NO_X	SPM	SO_2	NO_X	SPM	RPM	SO_2	NO_X
Kidwai Nagar	Residential	438	07	14	410.5	8.08	17.20	431.37	183.25	8.25	20.24
Fazal ganj	Industrial	509	07	15	439.06	7.07	17.84	431.07	208.99	7.185	18.03
Dypty ka Padav	Commercial	460	6.0	10	397.4	6.9	17.9	486.13	202.78	7.46	18.66

Standards

Annual Average	SPM	RPM	SO_2	NOx
Residential/ Commercial	140	60	60	60
Industrial	360	120	80	80
Sensitive zone	70	50	15	15

10.3.7 Ambient Noise

Uttar Pradesh Pollution Control Board conducts regular monitoring at selected locations within the city. The latest available data for noise monitoring available for June 2004 is given in Table 10.15.

It is seen from the table that at most of the places the ambient noise levels are above the standards.

Table 10.15 Ambient Noise Levels in Kanpur

Monitoring Station	Monitoring Date	Time	Sound Level dB(A)	Leq. (min) dB(A)	Leq. (max.) dB (A)
Railway Colony Govind Nagar	27/6/04	10:30 to 10:39	77.65	50.2	29.9
		22:10 to 22:19	64.95	54.3	75.7
Depty Parao	27/6/04	11:10 to 11:19	71.35	56.6	84.8
		22:40 to 22:49	61.06	53.2	75.9
Saresh Bagh	27/6/04	12:30 to 12:39	69.24	54.2	92.4
		00:15 to 00:24	62.55	54.0	74.1
Chacha Nehru Hospital	27/6/04	11:45 to 11:54	62.58	52.7	75.2
		23:35 to 23:44	61.91	54.2	72.7

10.3.8 Waste Water Characteristics

(1) Existing Treatment Plant Facilities at Jajmau

Three Sewage treatment plants (STP) are in operation in Kanpur. All three plants are located in the same area near Jajmau, on the eastern side of the city. There are two STPs of the Upflow Anaerobic Sludge Blanket (UASB) type, of which the construction was funded by the Indo-Dutch programme.

5 mld UASB STP

A pilot sewage treatment plant based on new technology "Upflow Anaerobic Sludge Blanket" was constructed and commissioned in 1989.

This plant is designed for treatment of 5,000 m^3/d of domestic wastewater. The plant functions at full capacity, but it also receives some tannery effluent, which has to be discontinued, since the tannery wastewater has adverse effects on the UASB process and on the quality of the sludge, which is used in agriculture.

The plant consists of coarse screens, UASB reactor, polishing pond and sludge drying beds. The UASB reactor has a retention time of 6 hours and a BOD reduction of 60% (from 200 to 80mg/I).
The polishing pond effluent has a BOD in the range of 45 - 80 mg/I. The retention time is 24 hours. The pond water depth is 1.2m. Anaerobic conditions appear to prevail in the pond, due to a too high organic surface loading.

The dried sludge is sold to farmers. The final effluent flows into a nala and subsequently into the Ganga. The biogas is used for production of electricity. There is no odour nuisance.

The effluent quality is not meeting the standard parameters for land application due to present characteristics of sewage reaching to treatment plant and also due to illegal discharge of tannery wastewater into domestic sewers. The tannery wastewater contains high sulphide contents in the range of 30 to 50 mg/l due to use of basic chromium sulphate and sodium salt for leather tanning which affects the performance of the sewage treatment plant.

The parameters that were proposed and that are being achieved are shown in Table 10.16.

Table 10.16 Parameters Proposed and Achieved for 5 mld STP

Parameters	Influent		Effluent after UASB Reactor		Effluent after post treatment	
	Designed	Achieved	Designed	Achieved	Designed	Achieved
BOD	220	250-350	-	150	30	75-125
TSS	500	800-1000	-	500	50	70-150

Source : UPJN

Table 10.17 Analysis Results for 5 mld Domestic Wastewater Treatment Plant

Parameters	Influent			Effluent			Polishing Pond		
	Jan-04	Mar-04	Jun-04	Jan-04	Mar-04	Jun-04	Jan-04	Mar-04	Jun-04
BOD	329	293	289	171	166	171	105	115	115
Filtered BOD	136	129.5	160	59	89	101	35	56	78
COD	1209	1138	1027	473	452	479	219	262	300
DO	-	-	-	-	-	-	-	-	-
pH	8.2	8.1	8.3	7.5	7.6	7.6	8.1	8.2	8.1
Temperature	18.9	27.2	31.5	18.9	27.2	31	18.7	26.8	31
TSS	1218	949	1069	455	465	409	134	140	152
VSS	470	276	406	204	226	178	89	106	88
TDS	3010	2355	2960	2840	2045	2560	2705	1865	2385
TFS	2945	2015	2650	2685	1895	2390	2540	1745	2265

Source: UPJN

36 mld UASB STP

The 36 mld wastewater treatment plant for the treatment of tannery wastewater of 175 tanneries (presently 354 tanneries) was constructed and commissioned in 1994 after evaluating the performance of pilot plant which was basically designed for optimising the dilution ratio for tannery waste water and domestic wastewater. For further treatment of tannery wastewater after UASB reactors, a conventional post treatment plant was constructed in year 1996.

This plant is designed for treatment of 36,000 m^3/d of mixed tannery and domestic wastewater. The tannery effluent, 8,000-9,000 m^3/d, passes through fine screens and coarse screens into two circular equalization tanks with Venturi aeration.

The domestic wastewater, maximum flow of 27,000-28,000 m^3/d, passes through similar fine screen (6 mm slot width). The tannery effluent and the domestic wastewater are mixed, and distributed by means of 4 pumps over 2 parallel UASB reactors, with a retention time of 8 hours. The mixed influent has a BOD of about 650mg/l.

The wastewater is equally distributed over the bottom surface of the reactors by means of top feeding. Originally, a distribution system at the bottom of the reactors was applied, but this has been abandoned due to clogging problems.

The UASB effluent is further treated in a closed aeration tank, mainly for oxidation of sulphides. A diffused air aeration system is applied.

The effluent of the aeration tank is mixed with a solution of aluminium sulphate to improve the clarification process. Subsequently, the wastewater passes through 3 circular clariflocculator tanks. The effluent has a BOD in the range of 80-230 mg/l. The effluent is pumped into the irrigation water channel to the sewage farm.

The sludge is dewatered in drying beds. The sludge, with a high chromium content, is dumped in an uncontrolled manner. A controlled safe landfill for disposal of the sludge does not exist yet.

The biogas is mixed with biogas from the anaerobic sludge digesters of the adjacent 130 mld WWTP. The biogas is treated in a scrubber installation for removal of sulphur according to a patented system. The sludge from the scrubber plant is dewatered in centrifuges. The tanneries use the sulphur containing sludge in the tanning process.

The biogas is compressed and subsequently used for generation of electricity. The produced electricity is sufficient for all electricity requirements of the three WWTPs.

The effluent quality does not fulfill the discharge standards. There is little odour nuisance.
The plant was basically designed for removal of BOD and TSS. The parameters, which were proposed and are being achieved, are shown in Table 10.18.

Table 10.18 Parameters Proposed and Achieved for 36 mld STP

Parameters	Influent (1:3)		Effluent after UASB Reactor		Effluent after Post Treatment	
	Designed	Achieved	Designed	Achieved	Designed	Achieved
BOD	750	300-450	260	170-250	140-175	100-200
TSS	1600	1000	600	400	200	250

Source: UPJN

Although the plant is functioning satisfactorily on design parameter basis, the plant still needs some more modifications to enhance the treatment plant efficiencies.

Various factors are contributing towards the improper functioning of the plant:

1) This plant was designed for 175 tanneries but now 354 tanneries are in operation. Among them most of the tanneries have adopted chrome tanning process due to which the concentration of chrome and sulphides have increased which affects the process of UASB reactors.
2) Due to increase in number of tanneries, the discharge at intermediate pumping stations has increased. The pumping capacity for increased discharge is inadequate.
3) The quality of the treated effluent is meeting the design parameters for which the plant was designed. However, the treated effluent needs 2nd stage post treatment since it is not meeting standard parameters.

Table 10.19 Analysis Results for 36 mld UASB Tannery Waste Water Treatment Plant

Parameters	Influent			Effluent			Post Treatment		
	Jan-04	Mar-04	Jun-04	Jan-04	Mar-04	Jun-04	Jan-04	Mar-04	Jun-04
BOD	384	293	307	340	166	175	321	258	170
Filtered BOD	158	129	164	107	89	100	86	98.8	83
COD	1404	1138	1177	963	452	498	703	447	460
DO	-	-	-	-	-	-	-	-	-
pH	8.2	8.1	8.3	7.6	7.6	7.5	8.1	7.7	7.7
Temperature	18.6	27.2	31.5	18.6	27.2	31	18.2	27.8	31
TSS	1326	949	1052	891	465	501	651	366	428
VSS	535	276	433	316	226	236	231	194	187
TDS	3325	2355	3150	2755	2045	2590	2680	2960	2460
TFS	3260	2015	2650	2605	1895	2410	2495	2845	2340

Source: UPJN

130 mld STP

This plant based on activated sludge process was constructed and commissioned in January 1999. Since its commission, illegal discharge from tanneries and industrial wastewater from various industries situated in city areas is being discharged regularly to 90" outfall sewer, reaching the main pumping station from where sewage is pumped to this plant.

This plant is designed for treatment of 130,000 m^3/d of domestic wastewater, consisting of primary sedimentation tanks, aeration tanks (surface aeration), clarifiers, sludge digestion and mechanical sludge dewatering. The effluent is pumped into the channel to the sewage farm. The plant is in operation from 1999. The final effluent BOD is generally below 30 mg/l. The parameters, which were proposed, and being achieved are shown in Table 10.20.

Table 10.20 Parameters Proposed and Achieved for 130 mld STP

Parameters	Influent		Effluent	
	Designed	Achieved	Designed	Achieved
BOD	300	350	30	40-50
TSS	600	1000	50	100

Source: UPJN

The tannery wastewater and industrial wastewater contains leather flushings, hair, chromium, sulphides and other toxic elements for which the plant has not been designed. Consequently, the components of the equipment are corroded, specially the centrifuges. Apart from it oxygen demand increases due to instantaneous consumption of oxygen by sulphides present in the effluent. The plant is now running at 1/3rd of its capacity.

Table 10.21 Analysis Results for 130 mld ASP Domestic Wastewater Treatment Plant

Parameters	Influent			Effluent		
	Jan-04	Mar-04	Jun-04	Jan-04	Mar-04	Jun-04
BOD	323	317	296	60.3	77.1	32
Filtered BOD	136	119	138	31.4	22.1	23
COD	1165	1201	1018	143	262	150
DO	-	-	-	1.2	0.7	2.4
pH	8.2	8.3	8.3	7.9	7.9	8.2
Temperature	19	27.2	31.5	11.3	24	29
TSS	1213	980	1033	151	142	101
VSS	473	275	425	100	92	75
TDS	3145	2240	2880	1530	1765	1045
TFS	2945	2145	2670	1280	1620	960

Source: UPJN

Sewage Farm

The effluents of the two WWTPs (36mld and 130mld) are pumped into a channel that transports water to the sewage farm with a total area of about 4,400 ha. From the channel the irrigation water is fed by gravity to the farm lands. It is to be mentioned that the crops that are grown include wheat, rice, potato and vegetables for cooked consumption, cattle fodder and flowers.

10.3.9 Existing Sludge Quality at Different STP Sites

The UPJN measures the NPK values in the sludge samples of 5 mld and 130 mld on regular basis. Due to the treatment of tannery wastewater in the same premises, chromium contamination is seen in the groundwater and soil samples in the nearby lands. Therefore, chromium levels are also tested at regular intervals in the sludge samples. The results of the analysis are given in Table 10.22 and 10.23.

Table 10.22 NPK Values in Sludge Samples of 5 mld and 130 mld STP's

Particulars	October 2000			May 2002		
	%N	% P_2O_5	% K_2O	%N	% P_2O_5	% K_2O
5 mld UASB	0.98	0.38	0.24	1.54	1.15	1.07
130 mld UASB	0.95	0.45	0.24	1.61	1.12	1.04

Source: UPJN

Table 10.23 Analysis of Total Chromium in Sludge Samples of 5 mld and 130 mld STP's

Particulars	Total Chromium
5 mld UASB	2.7 mg/g
130 mld UASB	2.4 mg/g

Source: UPJN

10.3.10 Chromium Detection in Domestic and Tannery Wastewater

The tannery wastewater and sludge are also analysed regularly by UPJN to check the levels of chromium. The results of the same are given in Table 10.24 and 10.25.

Table 10.24 Results of Total Chromium (mg/l) in Tannery Wastewater

Samples	Feb-01	Sep-01	Jun-02
Tannery wastewater, Jajmau	13	21	20
Influent 36 mld UASB	9.7	24	11
Effluent after UASB	Absent	1.2	0.3
Final Effluent	Absent	0.42	1.1
Dry Sludge (36 mld tannery waste)	18.3	20	30
Dry sludge after treatment	14	18	26

Source: UPJN, Kanpur

Table 10.25 Total/ Hexavalent Chromium Contents (mg/l) in Domestic Effluent

Samples	Apr-02	Dec-04
	Total Chromium	Hexavalent Chromium
Trunk Sewer	Absent	10.9.2
Sewage Pumping Station CSPS	14	17.05
Final Effluent (5 mld UASB)	0.03	12.84
Final Effluent (130 mld)	1.1	8.14
5 mld UASB dry sludge	8	-
130 mld ASP dry sludge	8.1	-
Tannery Wastewater Jajmau	-	111.2
Final Effluent of 36 mld UASB	-	199.3
Effluent collected from sewage channel, Jajmau	-	76.8

Source: UPJN, Kanpur

10.3.11 Common Chrome Recovery Plant (CCRP)

A proposal to install a common chrome recovery plant at the site is under consideration for removal of chromium from the tannery wastewater prior to its treatment. However, so far this proposal is pending and has not been implemented. Under this proposal, a common chrome recovery plant will be commissioned in which there will be a mechanism to collect chrome liquor from individual tanneries and bring it to the CCRP.

10.3.12 Hazardous Waste Management Facility at Rooma, Kanpur

Government of India under the bilateral cooperation framework has received financial support from Government of Netherlands under the Ganga Action Plan Support Project (GAPSP) to set up a Hazardous Waste Treatment and Disposal Facility at Rooma, District Kanpur. Under this proposal the chrome containing sludge after the chrome recovery at Jajmau will be transported to this facility. This will be a secured landfill site with leachate collection and removal.

10.3.13 Solid Waste Management

The responsibility of solid waste collection and disposal lies with Kanpur Nagar Nigam. The Nagar Nigam collects approx. 1500 tons of domestic and commercial garbage from the city.

The collection of solid waste is done in two phases. The first stage is primary collection in which the waste is collected on hand carts and carried to rubbish depots called primary collection centres (PCC)

from where it is disposed to disposal sites by trucks, tractors, tippers, etc. The frequency of collection varies depending upon the type of locality. There are about 110 primary collection centres in the city built along the road sides in various localities.

No dump site has been identified for disposal of solid waste so far. The city administration since beginning has adopted the practice of dumping on low-lying areas within the city and along the roadsides. The prominent open dump sites in the city are near Chakeri, near IOCL, Indira Nagar, along the by-pass road and fly ash disposal site of power plant.

10.3.14 Biological Environment

The animal species encountered are quite similar to those in other areas. The areas around the STP site is more or less agricultural and hence there is nothing specific to that area.

Breeding bird species encountered were all common species like Black Kite *Milvus migrans,* Egyptian Vulture *Neophron percnopterus,* Red wattled Lapwing *Vanellus indicus,* Little Owl Athene noctua, Little Green Bee-eater *Merops orientallis,* Black-crowned Finch-lark *Eromopterix nigriceps*, Red-Winged Bush-Lark *Mirafra erythroptera*, Crested Lark *Galerida cristata*, Plain Sand Martin *Riparia paludicola*, Black Chat Drongo *Dicrurus adsimilis,* Jungle Crow *Corvus macrourus*, Brown Rock Chat Cercomela fusca and Pied Bush Chat *Saxicola caprata*. Wintering bird species included Steppe Eagle Aquila nipalensis, Crested Honeybuzzard *Pernis ptilorhynchus*, Wood Sandpipe *Tringa glareola.*

Soil quality at the STP site is relatively poor. The land is only partly cultivated. Large areas are considered wasteland. Flora and fauna are therefore fairly uniform throughout the area.

The floral composition of the floodplain bordering the Pandu river is relatively uniform with a seasonal variation in dominant species in the project area mainly Eucalyptus, Ritha and Teak trees are present.

Data on the river bottom flora and fauna are lacking. The riverbed is not a very rich ecosystem, as a result of the continuous transport of sediments, smothering sedentary bottom dwellers, lack of light and river water pollution.

In view of the above-mentioned information, the STP site is not an area of ecological significance.

(1) Species of Commercial Interest

No species of commercial interest are known to occur in the area. Most likely, Pandu river is totally devoid of fish species.

Ganga flood plains support a wide-range of fish including Carp, Cat Fish, Snake Head etc. The major carps are Rohu (Labeo rohita), Catla (Catla catla), and Mrigal (Cirrhinus mrigala). They breed and spawn in the clear, oxygenated water of the hilly areas. Both adults and juveniles then disperse down-stream over the floodplain.

Hilsa is sensitive to water quality and only found in relatively clean water. The adult hilsa migrates between the sea and spawning grounds in the estuary. The juveniles disperse upstream from the estuary to the nurseries.

(2) Rare or Endangered Species

No rare and endangered species as indicated in Schedule One of the Wildlife (Protection) Act are known to be found in the site area.

Indian White-beaked Vulture *Gyps bengalensis*, formerly a very common scavenger in Kanpur, encountered in flocks of over 500, has suffered from a major disease, most probably a virus, and numbers seem to have been drastically reduced since mid 2000.

(3) Sensitive Habitats and Reserves

There are no (Forest) Reserve areas in the project area.

10.3.15 Socio-Cultural Environment

(1) Demographic Profile of Kanpur

The demographic profile for Kanpur is described with respect to total population, workers' category, population of scheduled castes and tribes, and literacy levels from Tables 10.26 to 10.29, respectively.

Table 10.26 Population of Kanpur in the Last 4 Decades

Year	Population (M.C.)	Area (M.C.)	Population growth rate
1971	761,319	180 Sq.km	3.8
1981	1,171,260	200 Sq.km	3.6
1991	1,801,938	226 Sq.km	3.5
2001	2,772,212	300 Sq.km	3.4

Table 10.27 Workers Category in Kanpur (2001 Census)

Workers Category	2001	
	No. of workers	% of total workers
Cultivators	66,731	18.6%
Agri. Labourers	39,330	11%
Livestock, Fishing, Forestry	4,614	1.28%
Mining and Quarrying	117	0.03%
Household Industry	3,885	1.08%
Construction	11,631	3.5%
Trade and Commerce	17,224	4.81%
Transport, Comm. and storage	41,549	11.61%
Other services	172,432	48.2%
Total Workers	357,725	
Marginal Workers	212	0.059%
Total Population	2,772,212	
Workers as percent of total population	13%	

Table 10.28 Schedule Caste and Schedule Tribe Population in Kanpur

Name	Level	Schedule Caste Population			
		Male	Female	Sex Ratio	Proportion to total population
Kanpur (M Corp)	Town	151,568	130,800	130,800	862.98
Kanpur CB	Town	5,053	5,053	4,20	854.94
		Schedule Tribe Population			
Kanpur (M Corp)	Town	736	681	925.27	0.06
Kanpur CB	Town	29	30	1,034.48	0.06

Table 10.29 Literacy Rate in Kanpur

Name	Level	Literacy Rate		
		Persons	Male	Female
Kanpur (M Corp)	Town	78.74	82.89	73.91
Kanpur CB	Town	73.93	77.84	69.02

(2) Socio-Economic Status of Panka Bahadur Nagar

The proposed 200 mld (Year 2030) STP will be situated at the Panka Bahadur site, approximately 12 kms from the city of Kanpur. The socio economic profile of the adjoining villages, i.e., Panka Bahadur Nagar and Chitepur are given below.

Panka Bahadur Nagar, which is the site chosen for the proposed STP is situated on the bank of Pandu river. The village is well connected to Kalpi road with a pucca road.

Since the proposed STP will be located at village Panka Bahadur Nagar, it becomes necessary to understand the socioeconomic situation of the adjoining villages, i.e., Panka Bahadur Nagar and Chitepur so that the positive or the negative impacts arising out of the project on the socio economic environment can be correctly analysed. Details on the demography, schedule caste population, literacy rate and the overall facilities available are given in Tables 10.30 to 10.33.

Table 10.30 Demography of Panka Bahadur Nagar and Chitepur

Name of Village	No. of households	Total Population				Population in age group of 0 – 6 years			
		Persons	Male	Female	Sex Ratio	Persons	Male	Female	Sex Ratio
Panka Bahadur Nagar	360	1,904	1,010	894	885	353	175	178	1,017
Chitepur	128	701	383	318	830	124	87	57	851

Table 10.31 Schedule Caste Population in Panka Bahadur Nagar and Chitepur

Name of Village	Persons	Male	Female	Proportion of SC to total population
Panka Bahadur Nagar	844	439	405	44.3
Chitepur	258	142	116	36.8

Table 10.32 Literacy Rate in Panka Bahadur Nagar and Chitepur

Name of Village	Number of Literates			Literacy Rate (%)		
	Persons	Male	Female	Persons	Male	Female
Panka Bahadur Nagar	995	612	383	64.2	73.3	53.5
Chitepur	404	265	139	70.0	83.9	53.3

Table 10.33 Facilities Available in Panka Bahadur Nagar

Education	One primary school: Approximately 50 children and 5 teachers
	One private junior high school: Approximately 100 children and 5 teachers
Medical Facilities	No proper medical facilities available
Water Supply	Around 5 wells
	10 India mark – 2 hand pumps
Electricity	Entire village is electrified
	Around 3 transformers in the village

(3) Land Use

The landuse break up of Kanpur is given in Table 10.34.

Table 10.34 Landuse Pattern in Kanpur

Land Use Type	Area (sq. km.)	% of Total Area (M.C.)
Residential	150	50%
Commercial	mix	
Industrial	50	16.6%
Park and Open space	35	11.6%
Roads and Railways	2500 km	
Rivers/Water Bodies	Ganga river	
Agriculture	43	14.3%
Forests	4.5	1.5%
Vacant Land	17.5	5.8%

Source: Kanpur Nagar Nigam

(4) Traffic

The traffic conditions in Kanpur are extremely poor. Lack of an efficient public transport system creates problems for everyday conveyance and travelling. Cycle rickshaws are a common mode of transport and occupy most of the road space. In addition they are extremely slow and therefore cause traffic congestion at important intersections. The city lacks adequate road network and infrastructure. The existing meter gauge railway line is leading to traffic blocks and air pollution problems due to increased idling time of vehicles at intersections.

(5) Public Health

The health data for Kanpur has been mainly gathered taking into account the water borne diseases. This is because with reference to the sewerage project, generally it is the unhygienic conditions that prevail throughout the city and their impact on contamination of the drinking water.

It is seen from the data that the occurrence of water borne epidemics have been nil in the last 3-5 years, however, there have been occurrence of water borne diseases in the past few years. Data available from 1996 to 2000 is given in Table 10.35

Table 10.35 Trend of Water Borne Diseases in Kanpur

Description	1996	1997	1998	1999	2000
No. of cases of gastro	315	230	350	250	127
No. of deaths of gastro cases	5	2	2	3	1
No of jaundice cases	106	63	44	53	39
No. of deaths of jaundice cases	29	19	22	20	11

Source: CMO, Kanpur

Various health disorders are also associated with supply of contaminated water and other sanitation facilities available in the city. The relationship between the project activities and facilities and the water borne diseases is given in Table 10.36

Table 10.36 Health Disorders Associated with Water Supply and Sanitation Projects

Project Activities and Facilities	Water Borne Diseases	Water Related Diseases	Soil Pollution	Chemical toxicity
River Water Supply	+	-	-	+
Ground Water Supply	+	-	-	+
Water Storage	+	+	-	-
Stand Pipes	+	+	-	-
Wastewater irrigation	+	+	+	+
Sewers cleaning and repairs	+	-	+	+
Tanneries effluent handling	+	-	-	+

Source : CMO, Kanpur
Note: Water borne diseases includes diarrhoea, dysentery, typhoid
Water related diseases includes malaria, filariasis, dengue, etc
Soil pollution includes hookworm, roundworms and other helminths

Malaria is prevalent in Kanpur city from July to October, every year corresponding to rainy season and the subsequent period of water retention and stagnation. Concentration of P. vivax cases occurs along the Ganga with a high frequency in Jajmau and Nawabganj areas. In this respect the entire river bed area poses serious health hazard for vector borne diseases due to stagnation of clear and dirty water in pools.
Although malaria cases are seen on a rise in the last 4 years, there have been no major outbreaks of any water borne diseases or epidemics in the last 3-5 years. Cases of malaria registered with the Chief Medical Officer (CMO), Kanpur during the years 2000 – 2004 is given in Table 10.37.

Table 10.37 Trend Analysis of Malaria Cases

Species	2000 – 2001	2001 - 2002	2002 - 2003	2003 - 2004
P. falciparum	2	3	Nil	4
P. vivax	370	355	400	571

Source: Chief Medical Officer, Kanpur

The areas in Kanpur that are prone to water borne diseases are:

- Sakera
- Juhi Param Purwa and Juhi Garha
- Babu Purwa
- Colonel ganj
- Talak mahal
- Begum ganj
- Rail bazaar

(6) Water Supply

About 300 mld of water is being supplied to the city by Jal Sansthan of which about 63% of water demand is met by surface water sources and the remaining 37% from ground water. The treated water from Benajhabar water works is being sent to various zonal pumping stations for storage and distribution to local network after disinfecting. There are 26 such zonal pumping stations in the city covering six supply zones. In the existing water supply, treatment and distribution network is quite old and inadequate. Table 10.38 shows the drinking water sources and the quantity supplied to the city.

Table 10.38 Water Supply in Kanpur

Sources	Installed Capacity (mld)	Actual Supply (mld)	Remarks
Surface Water (River Ganga)			
Ganga Channel, Bhaironghat	300	200	Contaminated but fit as a drinking water source
Upper Ganga Canal	200	Nil	Presently not in use due to silting of feeder canal
Ground Water			
Deep bore wells	52 wells	100	52 wells provided by Kanpur Jal Sansthan. Fit for drinking
Private bore wells in dwellings	Unaccounted	Unaccounted	Most of the dwellings in new residential colonies have private bore wells

Source: Environmental Status Report for Kanpur, CPCB 2002

In most of the instances, treatment given by Jal Sansthan at water works and zonal pumping stations are satisfactory but the water quality at the receiving end were sometimes found to be deteriorated.

The CPCB report has identified certain problems associated to drinking water quality

- The main intake at Bhairon ghat pumping station is located in the proximate downstream of Ranighat nala and other minor streams discharging sewage into the channel. This is of great concern as raw water source gets contaminated and becomes a potential source for spread of diseases.
- Leakage and intrusion of sewage and other contaminated effluent into the distribution system is common problem in the city affecting the drinking water quality at the receiving end.
- Due to heavy silting in supply canal, raw water is not reaching the tanks for treatment at Benajhabar water works.

10.3.16 Existing Situation of Sewerage System in Kanpur

Lack of adequate sewerage system has adversely affected the city's sanitary conditions. Accumulation of stagnant water can be seen along the roads, open plots and along the railway tracks and in many localities in the city. Various problems associated to lack of sewer networks and the main cause of pollution in Ganga are listed below:

- About 42 tonnes of BOD and 282 tons of solids are being added to the receiving water bodies, i.e., river Ganga and Pandu from the wastewater being generated from domestic and industrial sources in the city.
- Discharge of untreated effluent is depleting the dissolved oxygen levels resulting in death of aquatic life during lean flow of rivers. Such instances were reported in the downstream of the city.
- Spread of diseases due to water contamination is common.
- The areas not covered by the sewerage system or areas with non-functional sewerage network are severely affected due to stagnation of sewage on the roads and open plots adjoining the building blocks.
- Open drains carrying sewage across the city overflow during monsoons and directly overflow into the river.
- The old sewerage system is prone to frequent choking of sewer lines leading to overflow of sewage on roads.
- At present only the main city district is sewered. The areas not covered by sewerage system are using septic tanks for disposal of sewage, which often overflows on the roads.
- About 260 mld waste flows directly into Ganga in contrast to the capacity of the trunk sewer which can carry only 160 mld.
- Damaged manholes, sewer defects particularly around the nala and connections of nala to the sewerage system have led to the increased risk of solid waste entering and blocking the system. There is currently no way of controlling the amount of stormwater that enters the system at locations where drains have been diverted. Stormwater overloads the sewer system and causes overflows to the river. Augmentation of trunk sewers and treatment capacities to deal with stormwater runoff is too costly. Therefore, a solution is required for stormwater by-pass.
- The collection system covers about 30 % of the city area and most of this is within the old, densely populated centre core. The total amount of wastewater measured in drains and at the STPs in 1997 was about 370 mld of which 160 mld was intercepted under GAP-I. At present, average inflow to the treatment plants is 72 mld, only 20% of the total wastewater generated.
- A separate collection system for the tannery industries located in the Jajmau area conveys wastewater using pumping stations directly to the 36 mld UASB. Originally designed for 9 mld, it now collects approximately13 mld of tannery wastewater.

A comprehensive proposal is required for providing adequate sewerage systems to improve sanitary conditions and reduce the impact on water quality of receiving streams and river Ganga.

10.4 ANALYSIS OF ALTERNATIVES

10.4.1 Project Benefits and Positive Impacts

Objective of implementation of the sewerage and pollution control projects is to ameliorate overall development and betterment of public health and hygiene coupled with upgradation of environmental management in the target project area through abatement of pollution; improvement of public health and aesthetics leading to improvement in quality of living and inducing economic growth. The project therefore, is associated with following benefits and positive impacts:

- The collection and treatment of untreated wastewater before entering the rivers will improve water quality of the rivers and river environment.

- The project will improve river water quality of upstream of the city, where municipal water supply intake is located.
- Proper collection, treatment and disposal system of wastewater will reduce the risks of parasitic infections, incident of various diseases including malaria, typhoid etc.
- A proper wastewater handling and disposal arrangement will minimize the chances of contamination of ground and surface water.
- Such provisions assist to maintain ecological balance by reducing damages to flora and fauna.
- Controlled reuse of wastewater supplements agricultural activities and development and sustenance of environmental protection components like greenbelt development.
- Improvement in the existing sewerage system will help reduce the nuisance in streets and road blockages.
- Development of the project will encourage increased economic activities like commercial, industrial, etc. and will generate enhanced employment alternatives and economic growth for the city.
- Improvement in the existing sewerage facilities will help tourism and boost the economy of the area.
- Public health gains such as increased output through improved health resulting in higher economic activity and productivity.
- The construction activity can provide opportunities to the local population and residents of the neighbouring area to earn. They may come to provide labour or to service the construction camps.
- Nutrient rich treated water and dried sludge can be used for irrigation
- Kanpur is located upstream of Allahabad and the project in Kanpur benefits the large bathing population in Allahabad and then Varanasi.

10.4.2 With and Without Proposed Project

With and without project scenarios of Ganga Basin are compared in the following table.

Table 10.39 Comparison of With and Without Project in the year 2015

	Without Project (incl. sanctioned)	**With Project**
Estimated wastewater discharged in 2015	396.9 mld	396.9 mld
Treatment capacity in 2015	160 mld	203 mld
Diversion to Pandu River basin in 2015	135.8 mld	193.9 mld
Untreated wastewater in 2015	101.1 mld	0 mld
Percentage of untreated wastewater in 2015	25 %	0 %
Estimated BOD discharge (untreated + treated)	35.13 ton-BOD/day	6.09 ton-BOD/day
BOD concentration at upstream (u/s) of city (Assumption)	2.5 mg/l	2.5 mg/l
BOD contribution to the River (if treated water is used for irrigation)	+3.8 mg/l (+3.2 mg/l)	+0.6 mg/l (+0.0 mg/l)
BOD concentration at downstream (d/s) of city (if treated water is used for irrigation)	6.3 mg/l (5.7 mg/l)	**3.1 mg/l (2.5 mg/l)**
Bathing environment for bathing	Raw wastewater is discharged in the Ganga, which is causing unhygienic condition for bathing	All raw wastewater except District IV and some part of District II will be intercepted and treated before entering the Ganga. Bathing environment will be improved.
Protection of water source of drinking water	Raw wastewater is discharged upstream of the municipal water intake and pollution of the source will be increased as the intake area is developed.	The raw wastewater discharged upstream of the municipal intake will be intercepted and treated and thus the source will be protected.
Water quality of effluent of existing and proposed STP	Bacteria pollution because of no disinfection facility	Chlorination will be applied to all existing and proposed STP. Bacterial pollution will be reduced

Note: 1) The dry flow of the Ganga Rover is used for analysis.
2) BOD concentrations of untreated and treated wastewater of 300 mg/l and 30 mg/l are used for analysis.
3) The sanctioned project includes 200 mld STP at Bingawan and is assumed to be implemented.

If the project are implemented (with the project scenario), 100 % of the wastewater discharged to the river at present will be intercepted and treated in 2015 while if the project are not implemented (without the project scenario) 75 % is treated and the rest of wastewater discharged finds its way to the Ganga degrading its water quality and river environment. The preliminary estimation shows that the BOD concentration in downstream of Kanpur will be increased to 6.3 mg/l without the project and 3.1 mg/l with the project assuming 2.5 mg/l at upstream of the city. If treated effluent is used for irrigation, the BOD concentration in 2015 with the project will be 2.5 mg/l.

10.4.3 Alternatives

Different treatment processes are available for biodegradation of organic material present in domestic wastewater. Individual treatment process has its own limitation and advantage in terms of land requirement, environmental impacts, power consumption and operation and maintenance.

Four treatment processes have been selected for detailed evaluation before finalising the suitable one that would be environmentally, technically and financially viable option. This has been summarised in table 10.40.

Regarding the parameters, their related importance in the comparison of alternative sewage treatment processes has been decided in view of the following site constraints:

- Power Constraint: - Power outages frequently happen in Kanpur, thus a technology with a high dependency on power for effective and reliable treatment of wastewater should not be desirable.
- Land Constraint: - the city is densely populated and hence, offer few choices for locating the STP.

The site is surrounded by Pandu river in the south. It is bounded by agricultural area and villages in other three directions. Sufficient land is not available at this site for providing waste stabilisation ponds. Also there is potential for re-use of treated effluent for irrigation.

Hence, for this site UASB followed by AL and chlorination would be a better environmental solution.

Table 10.40 Analysis of Alternative Sewage Treatment Technologies (based on 100 mld Capacity) at Proposed Panka Site

Parameters	Waste Stabilisation Pond	Activated Sludge Process	UASB + AL+Chlorination	AL+ Maturation Ponds
Treated Water Quality	BOD: 30 mg/l TSS: 50mg/l Faecal Coliform: 1000 MPN/100ml			
Irrigation Reuse	Applicable as per Indian Standards	Applicable as per Indian Standards	Applicable as per Indian Standards	Applicable as per Indian Standards
Air Quality	Maximum odour	Moderate odour	Moderate odour	Medium odour
Possibility of ground water pollution	Maximum	Minimum	Marginal	Marginal
Maintenance	Minimal	Maximum	Moderate	Moderate
Power Requirement	515 kWh/day	19,951 kWh/day	3,634 kWh/day	17,879 kWh/day
Land Area Required	101 ha	20 ha	16.15 ha	55 ha
Estimated Investment cost	Rs. 516.7 million	Rs. 452.3 million	Rs. 361.0 million	Rs. 333.3 million
O & M Cost	Rs. 6 million	Rs. 40.7 million	Rs. 16.2 million	Rs. 32.2 million
Capitalised Cost	Rs. 609 million	Rs. 979 million	Rs. 514 million	Rs. 827.8 million
Conclusion	Not recommended because sufficient land is not available at Panka	Not recommended due to high O&M cost	Recommended	Not recommended due to high land requirements and higher capital cost

10.5 PREDICTION OF IMPACTS: CONSTRUCTION PHASE

10.5.1 General

This section identifies environmental implications, both beneficial and adverse, of the proposed priority projects. Where possible, the magnitude of the impact is identified. However, it should be noted that at the feasibility stage of the project, an overall identification and assessment of the impacts is possible from the available information

General discussions and site-specific impacts that are predicted to be generated by major components of the project are presented in this section.

The majority of the impacts identified are temporary and restricted to the construction phase. The actual benefit of the total "priority projects" cannot be estimated until commissioning has been completed.

The potential impacts will be seen during the construction phase where major disruption in the local areas is likely to take place. However, most of the impacts of this nature are temporary in nature and cease once the construction activities are completed. It therefore becomes important to ensure that the construction activities are completed in the least possible time. A detailed analysis of such impacts arising on various environmental parameters is given in this chapter. These impacts comprise:

1. Soil quality impacts
2. Air quality impacts
3. Noise and vibration
4. Water quality impacts
5. Loss of ecological habitat
6. Loss of agricultural land and trees
7. Impacts on cultural assets
8. Demolition of buildings/resettlement
9. Severance /disruption
10. Traffic impacts
11. Visual impacts
12. Waste disposal (solid and liquid)
13. Public health impacts
14. Socio-economic impacts

The construction activities will lead to localised increases in dust and suspended particulate matter in the ambient air. Noise impact on nearby communities will be significant. The sewer laying work within the city is likely to disrupt vehicular traffic, pedestrian access and consequently commerce and business. Careful management can mitigate this impact, but some disruption is unavoidable. The impacts of construction and operation phases of proposed project components on various environmental parameters have been summarised in Table 10.41.

10.5.2 Beneficial Impacts of the Project during the Construction Phase

Beneficial impacts of the project will not be realised during the construction phase, when most of the impacts are usually adverse, though of short duration and temporary. The tremendous beneficial impacts of the project will be observed only in the operation phase of the Project.

The beneficial impact of the construction phase of the Project would be the potential for employment of local population during construction stage, and the associated increase in trade and business, which would have a positive impact on the economy and the population, as long as it lasts.

10.5.3 Sewerage and Pumping Station Impacts: Construction Phase

(1) General

Most of the proposed trunk sewers are being laid alongside the right of way of roads. However, within the city limits the sewer lines will cross some busy areas and therefore adequate attention should be paid to such areas. Outside the city limits the sewers will be laid in the undeveloped or under developed areas

(2) Soil Quality

During laying the sewers, top soil will be displaced and permanent loss of top soil may occur if it is not stored and replaced. The sewer lines under the priority projects will be laid within the city. Therefore, the economic benefits associated with topsoil will not be significant in this case. Once excavation is completed the soil quality can be restored. The impact thus will be of temporary duration. In certain areas where the sewer lines will cross agricultural patches of land and areas with plantation, special care should be taken to store the topsoil. However, agricultural land is encountered only between Panka MPS and Panka STP.

(3) Air Quality

- During the construction phase, air quality will be deteriorated by the increase in the suspended particulate matter in the atmosphere during excavation and removal of the excavated earth. It will also be deteriorated due to vehicular movements near the site of laying the sewers. The impact will remain adverse during construction stage. Increase in particulate matter during construction will cause inconvenience to the people staying and working nearby.
- Vehicular movement to transport sewer pipes and earth moving equipment will give rise to smoke, hydrocarbons, carbon monoxide and NO_x emissions.
- Fugitive emissions during load/ unloading of equipments, material transport is possible.

The nature of the impacts though are temporary and localized, it is important to formulate mitigation plant to reduce the impacts.

(4) Noise

At the construction site various machineries and equipments will be employed such as excavators, cranes, concrete mixer, pay loaders, etc., which will generate high noise. Workers and labours in the vicinity of these machineries are likely to be affected with the noise generating activity.

Noise levels near the construction site will be in the range of 90-105 dB(A), when all the equipments work together. Hence workers near the machineries will be exposed to high noise levels.

The impact will however be temporary in nature and suitable measures should be taken to minimise the impact.

(5) Receiving Water Quality

If excavated material is not properly stacked, it will find its way during monsoon run off into the ponds, lakes, nalas and the rivers, thus increasing suspended solids in the receiving water body. However, if due care is taken then this will not cause any impact to the nearby water bodies.

(6) Ecology

Construction of the sewerage system will not have any impact on the ecological aspects of the area.

(7) Land Use

Construction of the sewerage system will not make any impact on the land use pattern of the area, as most of the sewers will be laid on the right of way of the roads. However, construction of STP will have a localised change in land use pattern.

(8) Heritage and Historical Sites

There will not be any impact on cultural assets during the construction phase of the sewerage system. The proposed trunk sewer will not pass through any significant historic or archaeological sites as such no impacts are anticipated.

(9) Severance/Acquisition

The sewerage system will be installed part by part. Only part of an area will be disturbed at a time and that too for a temporary period, indicating that severance experienced by the people will be for a short time at each particular site.

The sewer line from Makrikhera to the Panki pumping station and later to Panka STP crosses 2 railway tracks (meter gauge and Delhi – Lucknow line). It also crosses railway tracks that are private to a power station. Towards Panki pumping station, it also crosses the Kalpi road and the highway and a flyover. The sewer line also crosses the Panki irrigation channel.

Three new pumping stations are proposed and the land belongs to Government (Min. of Defence and Kanpur Development Authority). Land acquisition is not required.

Name of Facility	Required Land (ha)	Existing land use
Panki Pumping Station	1	Ordinance factory (belong to Min. of Defence
Panka Main Pumping Station	1	Belong to KDA (Kanpur Development Authority)
Bhagwatdas Ghat Nala Pumping Station	1	Ordinance factory (belong to Min. of Defence)

The proposed Bhagwatdas ghat nala pumping station is situated near the crematoria. The approach road towards this is very narrow and extremely populated.

(10) Traffic

The traffic will have to be diverted during sewer laying, as much of the roads will be occupied for sewerage work. Traffic congestion will be experienced on the roads connected to the sewerage sites. Although the impacts will be limited for a temporary period, the severity of the impact would be high during the construction phase.

Important areas that will be affected during construction are areas near Panki IPS and MPS, Panki road, Kalyanpur area near the railway crossing and old GT area.

The important locations where heavy traffic or crossings will be encountered are as follows:

Name of the Stretch		Physical Condition
Near Kalyan pur railway crossing	:	Rail way crossing
Near Tambeshwar temple	:	Rail way crossing
Near Tambeshwar temple about 150 m from the first crossing	:	Rail way crossing
Railway crossing near Panki railway station	:	Rail way crossing
By pass fly over near Panki road	:	Heavy Traffic
Near Mall road, Phool bagh crossing	:	Rail way crossing and traffic

However, trenchless technology will be adopted to mitigate the impacts.

(11) Visual Impacts

The visual impact during sewer laying will be unaesthetic because of dusty atmosphere, water spreading, muddy soil all around project site. Broken roads and pavements will add to the shabby look. The area will look crowded, however these impacts will be temporary.

(12) Public Health

During the laying of sewer lines, there is a possibility that water used for construction will get accumulated in the nearby areas forming small stagnant pools. If left unattended, it can become a cause for breeding of mosquitoes. The suspended matter may affect those with respiratory tract problems and those suffering from asthma.

However, if due precautions are taken from the beginning, this will not lead to any adverse impacts and will be of a temporary nature.

(13) Socio-economic

The construction of sewer lines is likely to affect the economic activity of the hawkers and the small street side vendors and shops. This is because no people would like to visit the areas where construction would be taking place. Construction activities will also cause inconvenience and hindrance for the hawkers to make business. Areas affected will be areas near Kalyanpur crossing and Panki road.

Although the sewerage activity is temporary, lasting for 2 - 3 months in each locality, moderate impacts on this aspect will be seen. However, the positive aspect of this activity is that not much socio-economic changes are expected in the area. It may create temporary job opportunities for a few persons in the area as construction labourers, traders and contractors etc. for that period. This impact will be beneficial.

10.5.4 Sewage Treatment Plant Impacts: (Construction Phase)

(1) General

The intensity of the impacts depends on the area to be covered by the treatment plant, which depends in turn on the process and the flow to be treated. Basically the proposed treatment processes will be UASB + AL + Chlorination. The proposed treatment has been selected after analysing other treatment technologies, which is given in Chapter 3.

The construction impacts are also related to the phasing of the works. In general the impacts will be more intense during the first phase of works because the land use of the site will change radically. A

description of the impacts during construction stage is described below.

(2) Soil Quality

The present land requirement for the option selected for treatment plant is 46 ha. Whatever the alternative, the topsoil of the area that will be covered by the treatment units will be definitely lost. The topsoil of the other parts of the plant site that will be temporarily disturbed or excavated during the construction phase, will have to be restored after construction.

(3) Air Quality

The air quality during the construction phase will be slightly deteriorated due to increased concentration of SPM in the air. However, the area selected for the treatment plant is purely agricultural with no settlements or human habitation. Hence this impact will be insignificant in nature with respect to inconvenience caused to people.

(4) Noise

Noise levels at the STP is expected to increase up to 80 to 90 dB(A) during the construction phase. Since the area is agricultural with no habitation nearby, high levels of noise will not cause any discomfort. However, the workers and the labourers employed during the construction might face inconvenience and suitable measures will have to be accordingly adopted.

Since nearest villages are at some distance of proposed STP site, the adverse impact will not be significant.

(5) Receiving Water Body

Pandu river is very close to the proposed Panka STP site. If excavated material is not properly stacked, it will find its way, especially during monsoon into the natural drains, which shall lead into silting and weed growth.

(6) Ecology

At the proposed STP sites, the impact will be largely felt since agricultural land will be converted into non-agricultural land. The crops grown on this land are wheat, rice, mustard, all kinds of vegetables. Since the land is mostly agricultural, no specific faunal species are found in the area.

(7) Cultural Assets

There will not be any impact on the cultural assets in the project area because there are no such assets near the proposed sites. In any case, construction activity will not last long and will not involve any blasting or other techniques, which might damage or weaken the nearby structures.

(8) Land Acquisition / Severance

The land for the STP site will have to be acquired (in part or in total), but there are no public utilities on the site which will get affected if the land is acquired. A transmission tower and high tension line are situated at the proposed STP site. Care will be taken so as not to construct any structure very close to the tower.

The technology adopted for proposed Panka STP requires 45 ha land. The resettlement is avoided by selecting appropriate sites without displacement of villages, and 45 ha will be acquired in agricultural land. The STP site is located in Panka Bahadur village and the information of land owners has been

collected during the field visit as Table below and attached as Appendix A. The revenue map is also shown in Figure 10.2.

STP	Land use	Name of village	No. of land owners affected
Panka STP (45 ha)	Agricultural land	Panka Bahadur	68

Figure 10.2 Revenue Map of Panka STP

(10) Traffic

Currently the traffic in Kanpur city is heavy and it is expected that the construction materials have to be transported through the city. This will lead to traffic congestion within the city limit. Traffic congestion during material loading/unloading at the site will also cause inconvenience to the surrounding lands and farmers.

(11) Visual Impacts

The visual impacts at the construction site of the treatment plant will be unaesthetic. The dumping of construction materials will not look any better. The dust at the site will be carried over to nearby areas in windy or stormy weather conditions. Broken pavements and opened roads would add up giving an unaesthetic look to the construction site. However the impact will be temporary and localised.

(12) Spoil Disposal

The spoil will be generated during construction of the treatment plant by way of rejected plant materials, bushes during site clearing, excess earth, etc. The spoil will have to be disposed of in a proper manner at the pre-identified safe disposal sites. Suitable dumping sites will have to be identified near the proposed treatment plant location for any of the options. If not disposed of in an environmentally compatible manner, it may create minor adverse impacts in the surrounding area.

(13) Public Health

Since there is no habitation near the STP site, adverse impacts to the people in terms of health is not anticipated. Workers are usually the immediately affected people if unsanitary practices are adopted on the construction site. High fever, diarrhoea, malaria and other epidemic diseases may occur frequently in the labour camp. The impact will thus be adverse but it will be avoidable by providing adequate sanitation facilities for the labour camps.

(14) Socio-Economic

In general the construction of the sewage treatment plant will have some positive impact on the economy of a few families who may get financial benefits for a year or two, improving their annual income. The sale of private lands to the UPJN may also bring profits to landowners in the area.

Some additional jobs in the construction sector will be created due to the project.

10.6 PREDICTION OF IMPACTS: OPERATION PHASE

10.6.1 General

The operation phase of the Project will include collection of sewage from individual service connections and its conveyance through branch and trunk sewers to sewage treatment plants. It also includes the operation of sewage treatment plants. The predicted impacts of these activities are discussed below.

Overall, the predicted adverse impacts during the operational phase will be minor as compared to the construction phase. During the operation phase all the beneficial impacts of the project will be realised.

10.6.2 Beneficial Impacts of the Project during the Operation Phase

The rehabilitation and extension of sewerage and the treatment of all the city sewage will improve the quality of life and the life style of the people. Better sanitation facilities mean better health conditions, and a cleaner environment. The risk of contagious diseases can be minimised and to an extent even mitigated. Laying of trunk sewers in the city would reduce the chances of contamination of the groundwater and in the water supply pipelines leading also to reduced incidence of diseases, improved health, and economic well being of the community.

Also, the discharge of sewage wastewater in the nalas, and the discharge of sullage into road drains and then into nalas, which emanate foul smells and are unsightly, will be eliminated.

In sum, the overall impact of the project on the socio-economic environment is expected to be beneficial and positive. The residents of Kanpur will benefit due to the improvements in public health.

10.6.3 Sewerage and Pumping Station Impacts (Operation Phase)

The impacts of sewerage and pumping station during operation phase are summarized in Table 10.40.

10.6.4 Sewage Treatment Plant Impacts (Operation Phase)

(1) Receiving Water Quality and Treated Effluent Re-use

Panka STP

The wastewater after treatment will be generated at the tune of 200 mld (year 2030), 120 mld (year2015). It is proposed that the treated wastewater will be used for irrigation of the agricultural fields near the Panka site. Currently there is plenty of land available at the adjoining villages of Panka, Bhausingh, Bhimsen, Chitepur, Mauja and Sarhad. There is a potential to use the treated wastewater. Although there is no norm or a ratio to estimate the quantity of wastewater per hectare of land, considering the previous trend and after studying few reports, it can be safely presumed that 1 mld of treated wastewater is sufficient to irrigate a land of 20 ha.

The potential of land irrigation was calculated by referring to "Practical Handbook on Public Health Engineering by G.S. Bajwa, pp 900, published by Deep Publishers, Shimla".
Accordingly the calculations are as follows:

Irrigation intervals during summer		5 days
Irrigation intervals during winter		10 days
Hydraulic loading rate for sandy soil	=	200 – 250 m^3/ha/day
Loading Rate/ha/day in summer	=	250 /5 = 50 Cu.M /ha/day
Loading Rate/ha/day in winter	=	250 /10 =25 Cu.M /ha/day
Area required for 200mld	=	200000/50
	=	4000 ha required during summer
For 1 mld area required is	=	4000/200 = 20 ha required during summer

It is proposed that from the total amount of wastewater generated, partial quantity will be used for irrigation, while the remaining wastewater will be discharged into the river.

Currently the crops grown are rice, wheat, pulses, mustard and vegetables. The present practice of the farmers is to use ground water for irrigating their lands. From discussions with various officials, it was understood that the continuous use of groundwater is resulting in depletion of the groundwater resources. With the use of treated effluent for the crops, there will be sufficient reduction in the use of groundwater. Further, there will also be reduction in power consumption that is now being used to pump the ground water.

Considering this, it can be concluded that the application of treated water for agricultural use will prove beneficial both for safe disposal of effluent and secondly beneficial to the farmers.

However, there should be certain norms and standards that should be followed while practicing this method and they are being discussed in the chapter on Mitigation Measures.

During the rainy season, the amount of wastewater to be used for irrigation will reduce drastically since much of the land will receive good rainfall in the months of July and August. Since the treated sewage will be further diluted, it will not pose any risk towards the pollution of the river. However, the Pandu river is too much silted and it is important to make the river flowing before discharging any wastewater into the river.

Jajmau STP

The treated effluent is currently used for irrigation of the lands nearby. However, after the augmentation it is important to treat the effluent effectively to reduce the chances of chromium

contamination before using it for irrigation. In absence of a chromium recovery plant, achieving this would be difficult.

Remedial Measures

- Isolation of illegal tannery wastewater mixing with STP
- Establishment of a common chromium recovery plant

(2) Use of Sludge for Land Application

The sludge produced at the proposed Panka and augmented Jajmau STP will have the following characteristics.

	N % (W/W)	P % (W/W)	K % (W/W)
Sludge	1.7	0.9	0.2

Since the sludge at Jajmau contains chromium, it is not advisable for applying it in the agricultural fields. It should be ideally treated in the chrome recovery plant and later transported to the hazardous waste facility at Rooma.

Application of sludge to land will improve the soil conditions of the area and supplement conventional fertilizers with usually at a little or no cost. The organic matter increases the soil's ability to hold water, and opens up the soil to allow better air and water movements into the soil. Application of sludge will permit easier root penetration and reducing water runoff and soil erosion.

Sludge produced at the proposed Panka STP site can be sold directly to the farmers near the site. On average the sludge production at Panka STP will be to the tune of 66.4 m^3/day from the sewage treatment plant. It will be dried on the sludge drying beds. The average sludge production for the augmented Jajmau STP will be 86.52 m^3/day. During the drying process, there will be a nuisance of insects around the sludge drying beds. It can be minimised by spraying insecticides in the area, also by proper maintenance of sludge drying beds, and proper drainage. The wet sludge should be raked often and the dried sludge removed frequently.

The dried sludge can be given or sold to farmers as manure if it can be handled properly by them. The value of sludge as an organic fertiliser has long been recognised and this offers reduced fertiliser costs to the farmer. Monitoring of the quality of the sludge is however required, especially the monitoring of the heavy metals. The sludge should also not contain non-degradable materials. Movement of sludge tankers from sewage treatment to agricultural land can create traffic problems and give rise to noise and odour nuisance.

(3) Odour Production

There is a possibility of generation of localised odours in the case of UASB reactors and sludge drying beds proposed at the site of *Panka*. Since there is no habitation near the STP site, generation of odour will not lead to any inconvenience. Further, the technology adopted will ensure that no or minimum odour is generated. Plantation and other mitigative measures will help in controlling the smell.

(4) Noise Level

Higher noise levels will be generated near the DG sets and gas engines. Although this will be significant, the impact of the noise will be reduced by enclosing the noise generating equipments in a double walled structure.

(5) Land Acquisition

It is estimated that 45 ha of land will be acquired for the construction of the proposed treatment plant at Panka. No relocation of people will take place during the project.

Land will be acquired with appropriate compensation. Land is normally acquired under the provisions of the Land Acquisition Act, 1894 which is general and basic law in the country for the acquisition of land for public purposes and companies. This Act was comprehensively amended in the year 1984, taking into consideration the recommendations of the Law Commission, the Land Acquisition Review Committee.

There are two types of compensation. Monetary compensation has to be provided to direct Project Affected Persons (PAPs) if their houses have to be acquired and demolished. It has to be provided also to indirect PAPs for their agricultural land to be acquired. Alternate land has to be provided to displaced persons for their resettlement. If land for resettlement can not be provided or PAPs are not willing to resettle in the new resettlement site, then monetary compensation has to be provided to direct PAPs for their homestead (i.e. residential) land to be acquired.

The list of landowners from which this land will be acquired is attached as Appendix A10.3. The most commonly grown crops in the area are wheat, rice, mustard and vegetables. The average income generated ranges between Rs. 15,000 – 20,000 per hectare per year.

This will ensure that the farmers selling their land will not be affected.

(6) Worker's and Public Health

Even though the STP will be useful to improve the health of the citizens, it may not be so in regard to the health of the workers who are operating the plant. In the operation phase of the STP, care needs to be taken for the workers' health. The workers may suffer from epidemic diseases, malaria and respiratory diseases. The impact on their health would be adverse and significant. The workers should be provided with safety equipment for safe handling of the sewage treatment plant - sewage and sludge - and must be instructed in its use. This will eliminate any possibility of adverse health effects on the workers during plant operations. Adequate medical help should also be provided.

Similarly, the farmers will also have to be protected against infection, and special equipment, especially to handle the sludge, should be made available and they should be educated on how to wear it.

10.7 ENVIRONMENTAL MITIGATION PLAN

10.7.1 Introduction

The objective of preparing an Environmental Mitigation Plan (EMP) is to formulate measures, whose implementation will:

1. Mitigate adverse effects on various environmental components and resources as have been identified in the EIA study;
2. Protect Environmental Resources wherever possible;
3. Enhance the value of the environmental component wherever possible.

The EMP also includes a plan for monitoring so as to enable evaluation of the success or failure of environmental management measures and reorientation of the plan if found necessary.

The mitigation measures to be adopted cover both the construction phase and the operation phase. These measures normally are short term during the construction phase and long term during the operation phase.

The community must be informed in advance about the benefits of the project and possible inconvenience to them. The implementing agency must seek co-operation of the local authorities, and execute the project effectively and efficiently. Success of the project depends upon participation and support of the community. Efforts need to be made to involve the population at different stages of project execution and in subsequent maintenance. The construction work should be carefully planned and managed in order to cause minimum disturbances to people.

A summary of the mitigation measures proposed during construction and operation phases are presented in Table 10.41. The description of each mitigation measure in detail is described below.

10.7.2 General Mitigation Measures

(1) Construction Phase

The construction phase impacts have been outlined in previous section. All these adverse impacts have been taken into consideration. Following measures should be adopted in general for all activities:

1. Minimum damage to existing flora and fauna, structures, electricity and telephone cables
2. Minimum disturbance to the local activities and business should be ensured.
3. The sewer pipes should be stacked properly in a pre-determined location and should not be cluttered around blocking the pedestrian area alongside the roads.
4. Excavated earth should be prevented from getting washed into drainage channels, rivers and canals.
5. Surplus excavated earth should be disposed of immediately.
6. Measures should be taken to prevent direct discharge of polluted waters from construction activities into lake, rivers and irrigation canals.
7. Dust pollution should be controlled with the measures outlined in the Table 10.41.
8. Pavements and roads should be repaired immediately following the construction activity and the project and surrounding area should be restored to as near as possible pre-project conditions.
9. Adequate measures should be taken to minimise construction related noise.
10. Proper precautions should be taken against risk of accidents.

(2) Operation Phase

Following mitigation measures are suggested considering all the adverse impacts:

1. The treated water quality should be maintained as per the requirements.
2. Air and noise quality should be monitored and corrective action taken in case it exceeds applicable norms.
3. Proper precautions should be taken for the good health of the operators and the population.

10.7.3 Mitigation Measures for Sewerage and Pumping Stations

Selection of route for sewers is one of the most important activities in the pre-construction phase. In order to minimise adverse environmental impacts and land acquisitions, to avoid resettlement and rehabilitation problems and in general, from a social point of view, to minimise severance and other problems due to pipe laying activities, the sewers will be laid along the roads.

Construction of the sewerage system will comprise: carrying the pipes to the site, excavation, laying the sewer pipeline, making good of the site after laying the pipeline, disposal of spoil/excavated material.

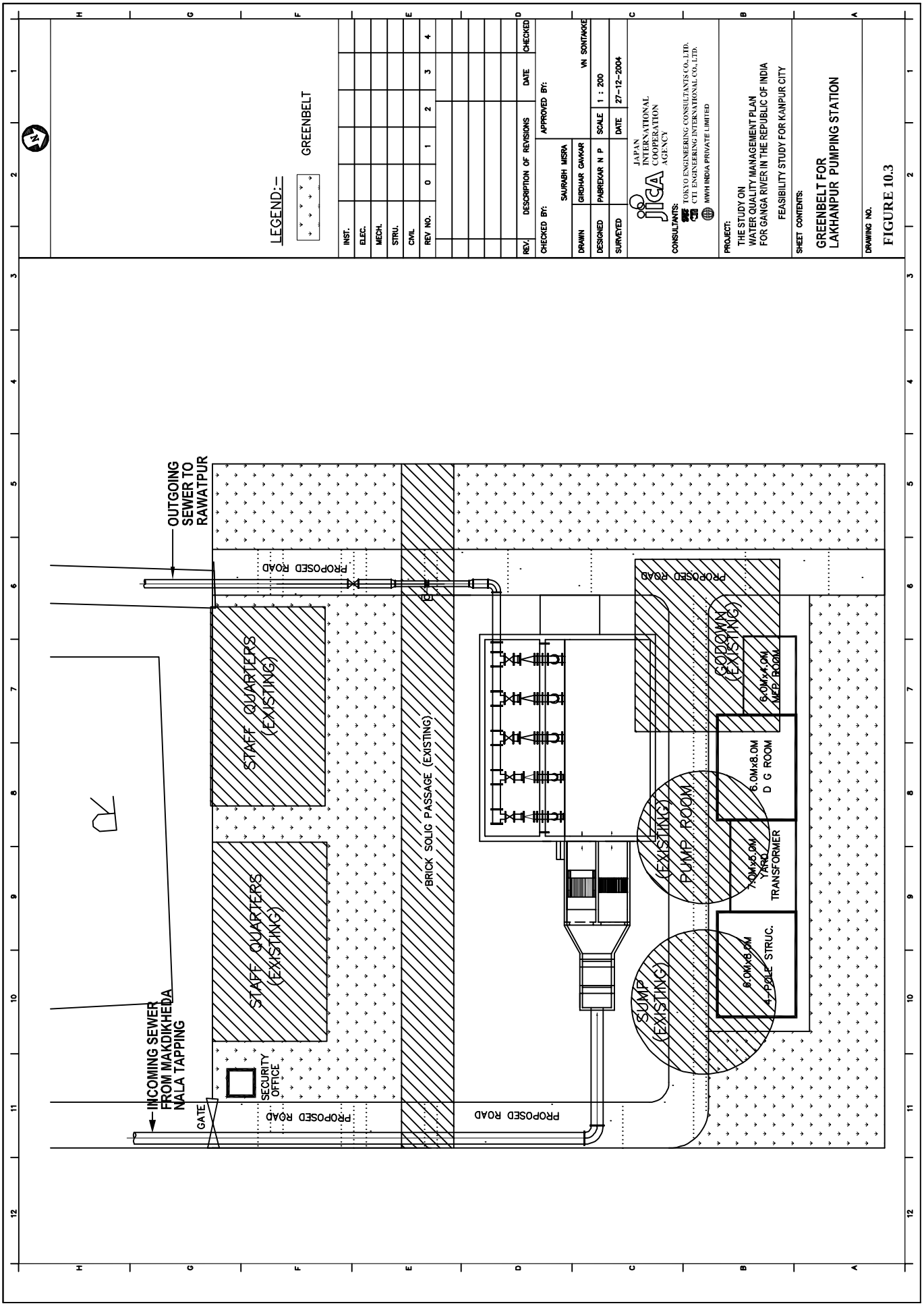
All relevant codes of practice should be followed during detail engineering and construction phases to ensure pipelines safety and protection against corrosion.

The risk of accidents should be minimized by taking all the proper precautions during the sewer laying activity.

In some narrow roads and busy crossings, care must be taken for proper diversions of the traffic with the help of the traffic police.

Care should also be taken to avoid damaging existing infrastructure, telephone and power supply electric cabling, poles etc. and minimizing the construction level impacts.

A greenbelt has been proposed for the new pumping stations at Lakhanpur, Bhagwatdas ghat nala, Panki and Panka. A sketch of the greenbelt areas for the same is shown in Figures 10.3 to 10.6.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SURVEYED DATE 27-12-2004
JAPAN INTERNATIONAL COOPERATION AGENCY
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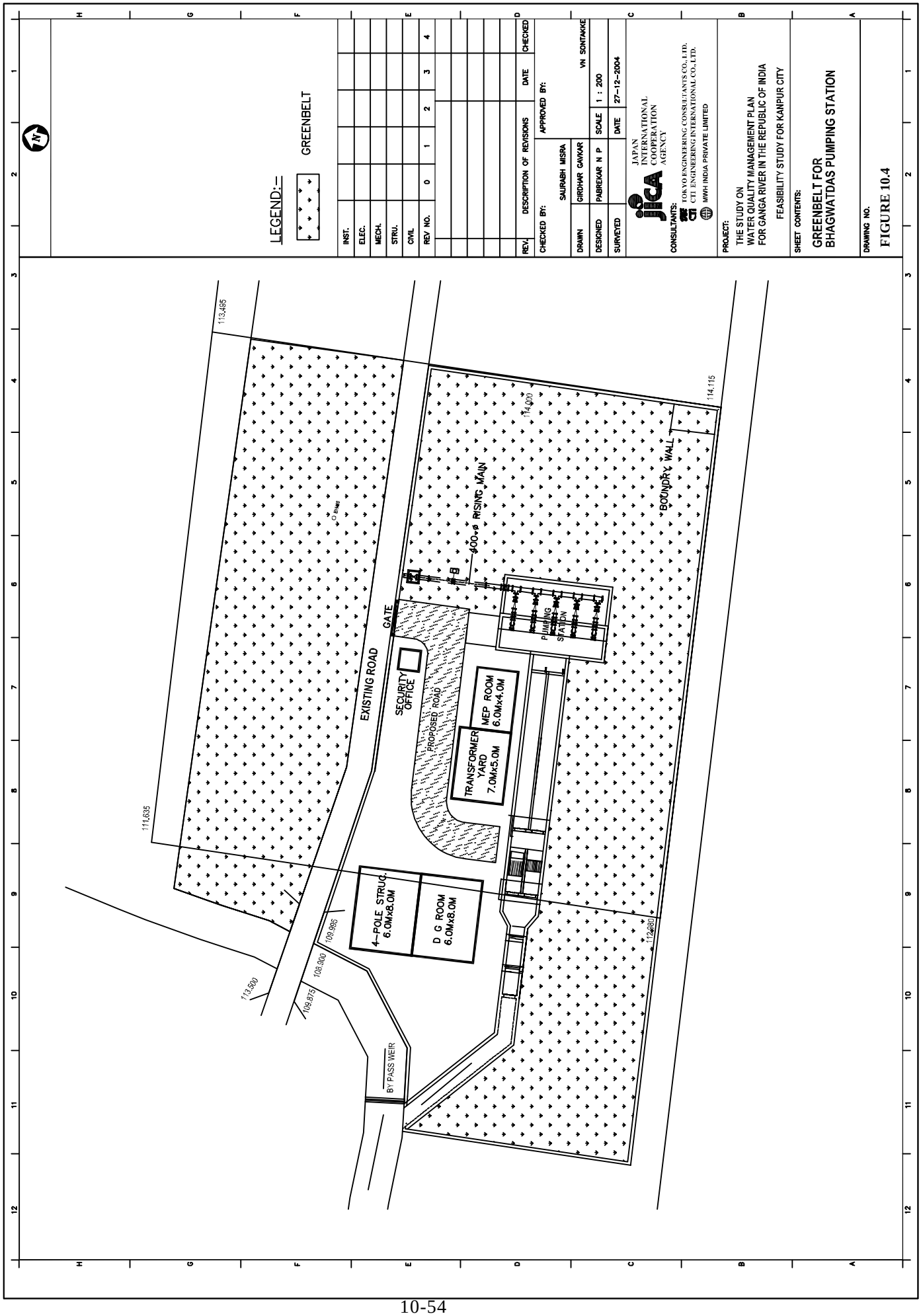
CONSULTANTS:
TOKYO ENGINEERING CONSULTANTS CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
MWH INDIA PRIVATE LIMITED
PROJECT:
THE STUDY ON
WATER QUALITY MANAGEMENT PLAN
FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR KANPUR CITY
SHEET CONTENTS:
GREENBELT FOR
LAKHANPUR PUMPING STATION
DRAWING NO.
FIGURE 10.3
OUTGOING SEWER TO RAWATPUR
INCOMING SEWER FROM MAKDIKHEDA NALA TAPPING
GATE
SECURITY OFFICE
STAFF QUARTERS (EXISTING)
STAFF QUARTERS (EXISTING)
BRICK SOLIG PASSAGE (EXISTING)
PROPOSED ROAD
PROPOSED ROAD
PROPOSED ROAD
PROPOSED ROAD
SUMP (EXISTING)
PUMP ROOM (EXISTING)
GODOWN (EXISTING)
6.0M×8.0M D G ROOM
7.0M×5.0M YARD TRANSFORMER
6.0M×8.0M 4 - POLE STRUC.
6.0M×4.0M MCP ROOM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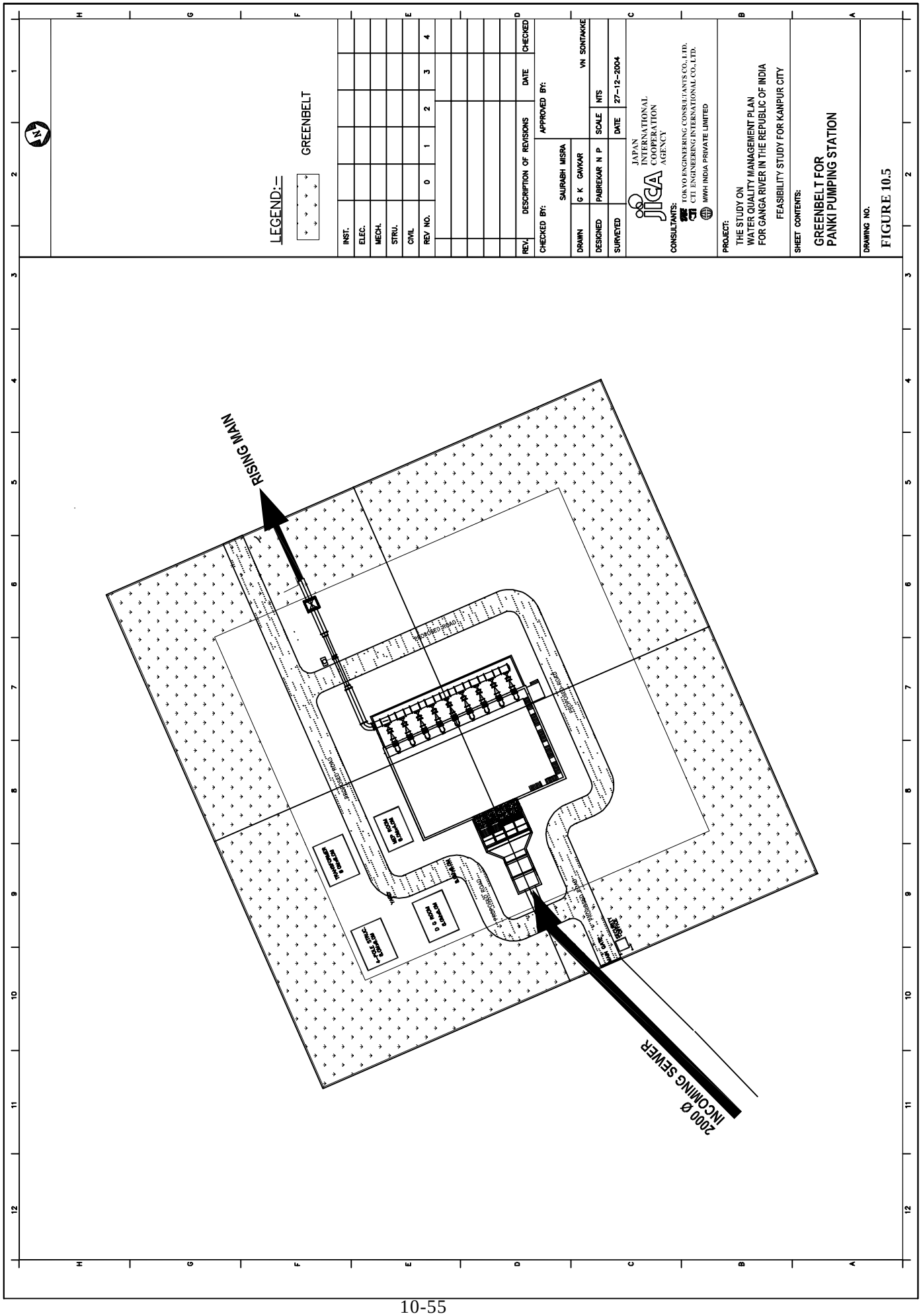
FOR GANGA RIVER IN THE REPUBLIC OF INDIA
FEASIBILITY STUDY FOR KANPUR CITY
SHEET CONTENTS:
GREENBELT FOR
BHAGWATDAS PUMPING STATION
DRAWING NO.
FIGURE 10.4
113.495
114.000
114.115
111.635
113.500
109.875
108.900
109.995
112.880
400ø RISING MAIN
BOUNDRY WALL
EXISTING ROAD
GATE
SECURITY OFFICE
PROPOSED ROAD
PUMPING STATION
MEP ROOM 6.0M×4.0M
TRANSFORMER YARD 7.0M×5.0M
4-POLE STRUC. 6.0M×8.0M
D G ROOM 6.0M×8.0M
BY PASS WEIR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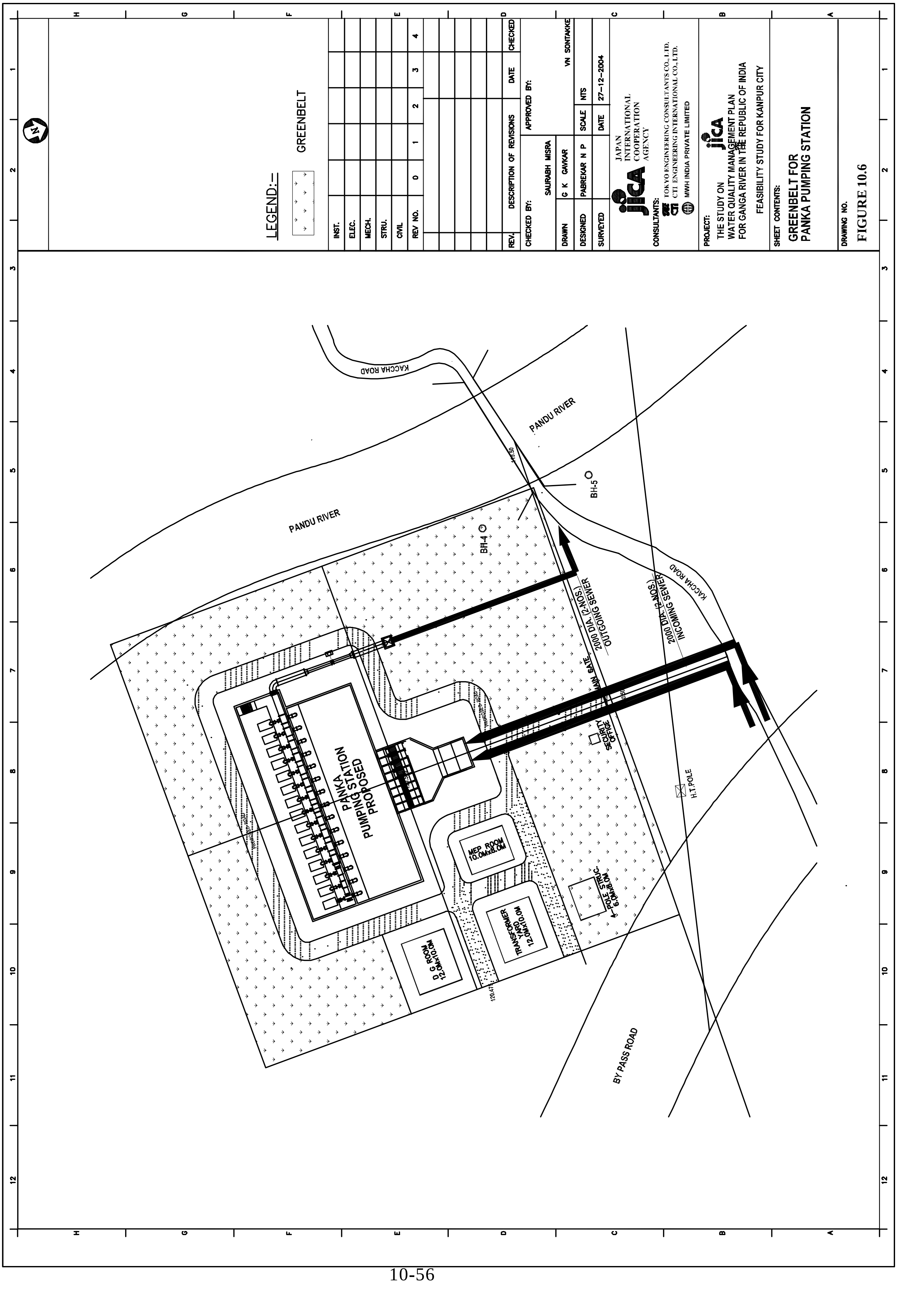
FEASIBILITY STUDY FOR KANPUR CITY
SHEET CONTENTS:
GREENBELT FOR
PANKI PUMPING STATION
DRAWING NO.
FIGURE 10.5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GREENBELT FOR
PANKA PUMPING STATION
DRAWING NO.
FIGURE 10.6
KACCHA ROAD
PANDU RIVER
PANDU RIVER
BH-5
BH-4
2000 DIA. (2-NOS.)
OUTGOING SEWER
2000 DIA. (2-NOS.)
INCOMING SEWER
KACCHA ROAD
MAIN GATE
SECURITY OFFICE
PANKA
PUMPING STATION
PROPOSED
PROPOSED ROAD
H.T.POLE
MEP ROOM
10.0Mx8.0M
4-POLE STRUC.
6.0Mx8.0M
TRANSFORMER
YARD
12.0Mx10.0M
D G ROOM
12.0Mx10.0M
BY PASS ROAD

10.7.4 Mitigation Measures for Sewage Treatment Plant

Treated Water Quality

First and foremost, care should be taken to ensure adequate treatment to meet the discharge standards. Since it is recommended that the treated wastewater be reused for irrigation purposes, the treated wastewater should meet the required standards for irrigation re-use and be conveyed upstream of an area that can be irrigated.

Treated water quality should be monitored carefully so as to meet the discharge standards effectively. Figure 10.7 demonstrates the use of treated effluents for various purposes. However, in the case of Kanpur the treated effluent will be used for agricultural irrigation and excess being disposed into the river.

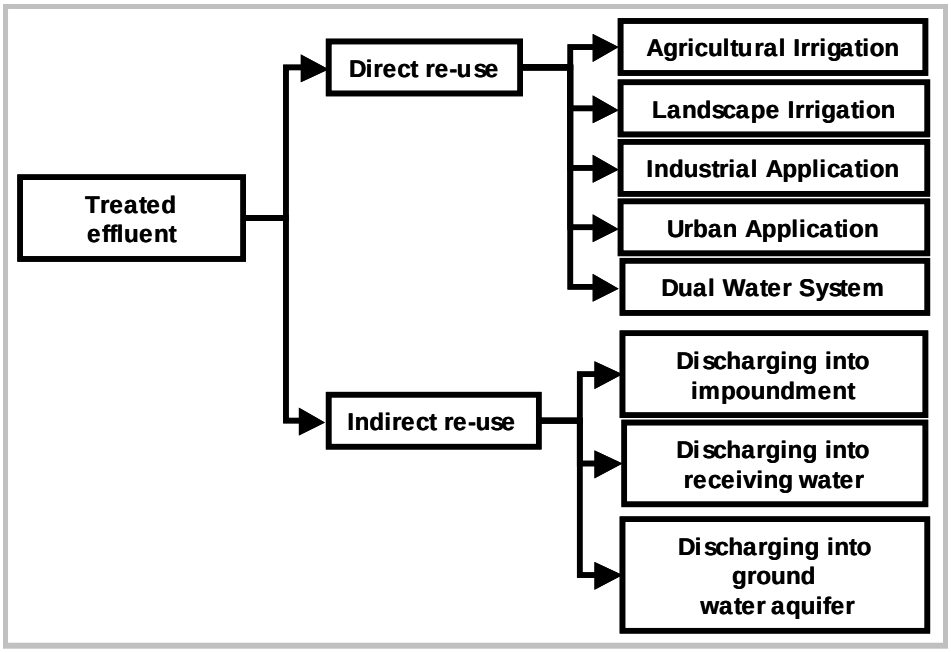


Figure 10.7 Direct and Indirect Use of Treated Effluent

Sludge Disposal

The sludge from the treatment plant should be disposed of in an environmentally acceptable manner. The sludge should be dewatered in sludge drying beds and the dried sludge is proposed to be used as fertiliser since it is biological in nature and has soil quality enhancing properties. However, the following precautions should be taken in the treatment, handling and disposal of the sludge:

- to rake the wet sludge frequently and remove dried sludge immediately,
- to facilitate proper drainage to avoid standing water leading to mosquito breeding,
- to store the dry sludge in a covered place before its distribution to farmers,
- to develop a green belt all around treatment plant
- to take care that the operators handling the sludge are properly clothed with gloves and gum boots and will not handle the sludge with bare hands.

Workers' Health

The workers' health should be monitored with medical check-ups at the time of joining and thereafter annually. In between, in case of any complaints, respiratory ailments, accidental chlorine leakage, etc.,

medical check-up should be conducted.

All the workers should be trained in first aid and emergency medical health should be available round the clock. It is also recommended from the safety point of view that one officer of the managerial cadre is available on duty at all times.

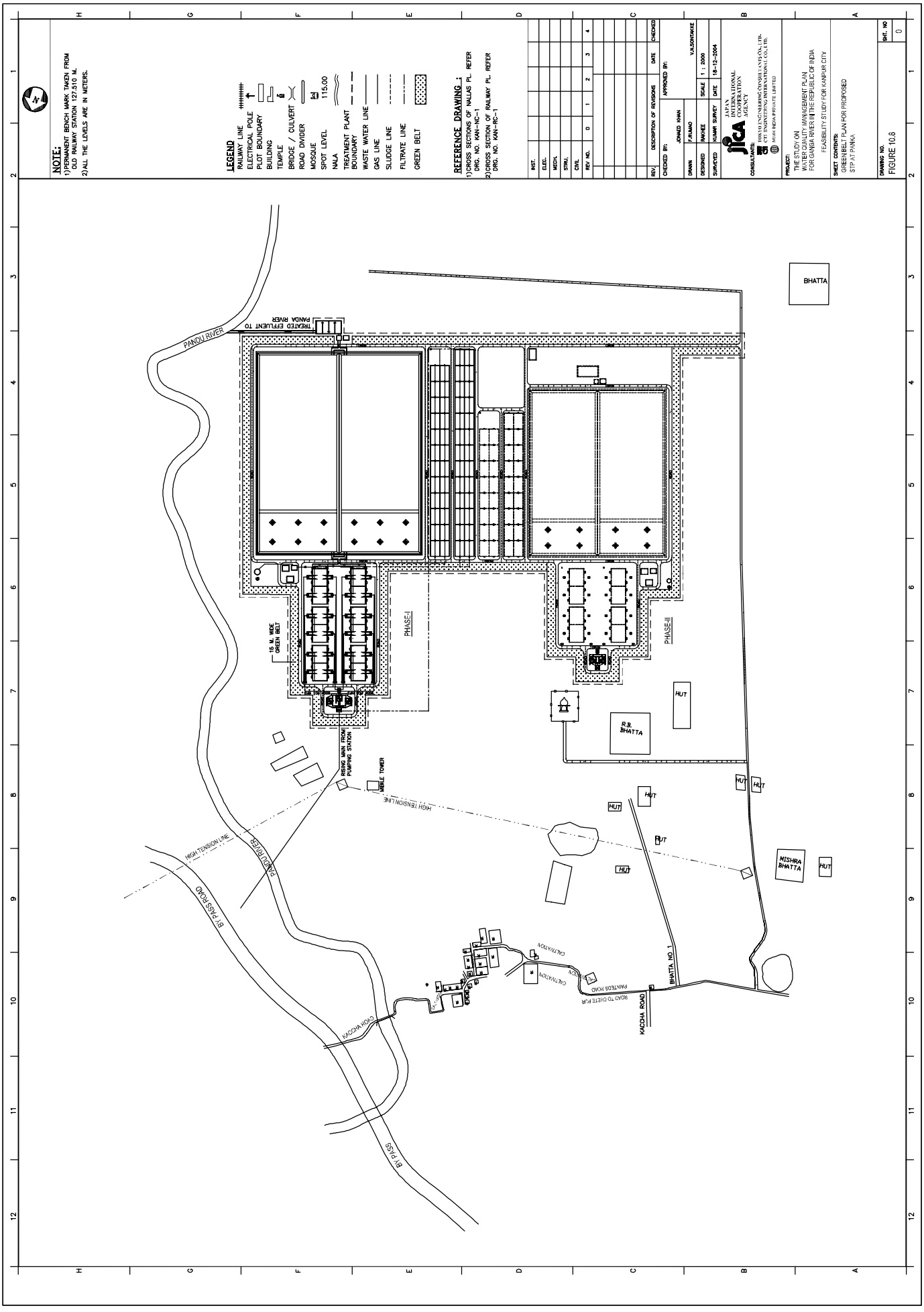
R & R Issue

No relocation of people will take place during the project. Land will be acquired for which adequate compensation will be given as per the government rate and market rate. This will ensure that the farmers selling their land will not be affected.

Greenbelt Plantation

A 15 m greenbelt all along the plant boundary is proposed. Even within the plant premises, vacant land will be used to plant trees. The species should be selected considering the local flora and species. Development of green belt will minimise the noise levels to the outside of the plant boundary and filter the odour levels to a considerable extent. Greenbelt will also give an aesthetic cover to the plot area and the activities going on within the plant will not pose any disturbance to the local people outside.

The greenbelt area for the proposed STP site is given in Figure 10.8.


NOTE:
1) PERMANENT BENCH MARK TAKEN FROM OLD RAILWAY STATION 127.510 M.
2) ALL THE LEVELS ARE IN METERS.
LEGEND
RAILWAY LINE
ELECTRICAL POLE
PLOT BOUNDARY
BUILDING
TEMPLE
BRIDGE / CULVERT
ROAD DIVIDER
MOSQUE
SPOT LEVEL 115.00
NALA
TREATMENT PLANT BOUNDARY
WASTE WATER LINE
GAS LINE
SLUDGE LINE
FILTRATE LINE
GREEN BELT
REFERENCE DRAWING :
1) CROSS SECTIONS OF NALAS PL. REFER DRG. NO. KAN-NC-1
2) CROSS SECTION OF RAILWAY PL. REFER DRG. NO. KAN-RC-1
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APPROVED BY: V.K.SONTAKKE
DRAWN F.AHMAD
DESIGNED RAKHEE
SURVEYED KUMAR SURVEY
SCALE 1 : 2000
DATE 18-12-2004
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SHEET CONTENTS:
GREEN BELT PLAN FOR PROPOSED STP AT PANKA
DRAWING NO. FIGURE 10.8
SHT. NO 0
PANDU RIVER
TREATED EFFLUENT TO PANDA RIVER
PHASE-I
PHASE-II
15 M WIDE GREEN BELT
RAW SEWAGE MAIN FROM PUMPING STATION
MOBILE TOWER
HIGH TENSION LINE
R.B. BHATTA
HUT
BHATTA
MISHRA BHATTA
BHATTA NO. 1
KACCHA ROAD
BY PASS ROAD
PANKI TO CHETTE PUR ROAD
CULTIVATION

Table 10.41 Summary of Environmental Impacts and Environmental Mitigation Plan

Environmental Issues	Adverse Impact	Nature of Impact	Proposed Mitigation Measures	Implementing Authority
CONSTRUCTION PHASE				
Soil Quality	- Due to excavation and earthwork: soil erosion, loss of top soil, silting and blocking of drainage/ nalas, which can cause slush; damage to existing structures - Due to compacting: loss of original quality, reduction in fertility	Significant and Permanent	- Stabilise all slopes with provision of benches/pitching - Avoid earthwork during monsoon - Provide adequate cross drainage facilities - Restrict traffic movements and use low ground pressure machines - Preserve top soil to be replaced after the completion of construction activity; avoid wet soils - Dispose of surplus earth after raising levels and refilling trenches, in low lying areas with proper compacting and planting of surfaces - Plant shrubs/trees/grass on exposed slopes and surfaces	Contractor/ UPJN
Air Quality	- Localised increase in dust due to excavation & earthwork - Temporary increase in the levels of SO_2/NOx, from construction equipment and vehicles	Significant and Temporary	- Dust control through sprinkling / washing of construction sites and access roads particularly in congested areas - Use of dust cover over construction material - Dust collectors should be used in all drilling operations - Unnecessary idling of trucks should be avoided - Construction material trucks to be covered to minimise spills - Preventive maintenance of construction equipment and vehicles to meet emission standards - Construction requiring heavy traffic street closing/ diversion to be carried out during night time	Contractor/ UPJN
Noise Pollution	- Increase in noise levels due to construction work, transport of construction materials etc.	Significant and Temporary	- Equipment emitting noise over 90 dB should be avoided - Where residences are located within 200 m and in sensitive areas like hospitals, schools, zoos, noisy construction work should be carried out in day time only - Equipment maintenance strengthened to keep them low noise - Sound barriers should be installed if needed	Contractor/ UPJN

Environmental Issues	Adverse Impact	Nature of Impact	Proposed Mitigation Measures	Implementing Authority
CONSTRUCTION PHASE				
Water Quality/ Drainage	- Increase in turbidity affecting surface water quality - Sanitary pollution	Significant	- Ensure steps to prevent earth and stone from silting up the nalas and drainage systems - Control run off and soil erosion through proper drainage channels and structures; improve existing cross drainage and provide extra cross drainage works wherever necessary - Provide adequate sanitation facilities to construction site workers	Contractor/ UPJN
Loss of Natural Vegetation	- Loss of avenue trees and natural vegetation, especially in the clearance for treatment plant site	Significant and Permanent	- Replantation on treatment plant area, as well as around the periphery - Replantation of avenue trees and ensuring proper care for growth	UPJN/ Forest Deptt./ Contractor
Traffic	- Traffic jams, bottlenecks, delays and inconveniences to general public - Serious disruptions of vehicular traffic, pedestrian access and commerce	Significant and Temporary	- Co-ordinate and plan all activities in advance - Adequate actions to direct traffic in consultation with highway and traffic police - Minimise vehicle movements - Preference for unused or low traffic roads - Construction of temporary roads and diversion of traffic - Use local construction materials to avoid long distance transportation, especially of earth and stones - Seek public co-operation through public awareness	Contractor/ UPJN/Traffic Police
Social Disruptions	- Disruptions in utility services - Social hostility due to employment of outsiders on construction activities	Significant and Temporary	- Minimise interruptions to services through proper planning and scheduling of activities and strong inter-departmental co-ordination - Preference should be given to local labour/skilled persons during construction, operation and maintenance	UPJN/ Traffic Police/ Contractor
Risk of Accidents	- Endangering lives of people/workers during construction due to inadequate safety measures	Significant	- Adequate traffic control measures should be taken - Sign board warning presence of open sewer trench - Guard rails to protect pedestrians - Strong safety policy for workers; protective helmets to be provided	Contractor/ UPJN

Environmental Issues	Adverse Impact	Nature of Impact	Proposed Mitigation Measures	Implementing Authority
Aesthetic Conditions	- Visually anaesthetic conditions due to cluttering of waste, and spoils, dug up roads and pavements	Significant and Temporary	- Enhance aesthetics through proper housekeeping of construction site - Disposal of construction wastes at the approved sites quickly - Repair pavements and roads after sewer laying work is completed - Completing the construction activity by removing all spoils	Contractor/ UPJN
Land Acquisition	- Inadequate compensation - Inadequate utilities in the rehabilitation area - Relocation trauma and infections and other diseases in the new location	Significant and Permanent	- Minimise relocation - Advance realistic payments to be made to relocated (estimation for compensation for land and property should be made on the prevailing market rates) - Provision of clean drinking water to national potable water standards, sanitation, proper drainage at new locations	UPJN
Existing Infrastructures	Site clearance and works: - Damage existing structures, - Affect electricity supply and telecommunication lines, - Clutter road sides with pipes, - Cause general nuisance to public	Not Significant and temporary	- Minimum damage to existing structures, flora and fauna, avenue trees and other natural vegetation, electricity & telephone lines and other infrastructure services - Cleared earth and debris should be properly disposed off - Storage sites should be identified for stacking pipes so as not to clutter road sides	Contractor/ UPJN
Construction Camps	- Prevalence of unsanitary conditions and practices like open air defecation - Possibilities of public health problems - Piling of garbage from workers	Significant and Temporary	- Adequate measures such as provision of septic tanks/pit latrines around the construction camp sites - Provision of clean drinking water to potable water standards - Collection of garbage in garbage cans in fixed places and disposal of it regularly	Contractor/ UPJN
Public and Workers' Health	- Adverse health of workers due to unsanitary practices and spreading of diseases from vectors	Significant and Temporary	- Workers are the immediately affected people - Proper sanitation and drinking water should be provided - Medical facilities to be provided to prevent communicable diseases	Contractor/ UPJN

Environmental Issues	Adverse Impact	Nature of Impact	Proposed Mitigation Measures	Implementing Authority
OPERATION PHASE				
Air Quality	- Problems of bad odour from the treatment plant	Significant	- Some bad odour from sewage treatment plant is unavoidable; however, steps should be taken to minimise odour by proper maintenance and housekeeping of the treatment plant	UPJN/KJS Operator
Water Quality	- Overflow of sewers and breakdown of treatment plant leading to failure in meeting the requisite standards - Poor performance will affect the proposed reuse for irrigation, and also the receiving water body	Significant	- Preventive maintenance of all components should be performed regularly - Relevant standby equipment and spare parts should be provided; standby power generation should be provided at pumping stations, if any - Proper response plan must be prepared and all workers must be trained to tackle emergencies	UPJN/KJS Operator
Sludge Treatment & Disposal	- Improper treatment of sludge could lead to putrefaction and other related problems such as bad odour, health effects etc.	Significant	- Sludge should be treated properly and dewatered - Dried sludge should be disposed of in a specified landfill site with proper precautions or given for land application to farmers, if it can be handled properly by them	UPJN/KJS Operator
Aesthetic	- Pumping stations, treatment work site might pose an unaesthetic sight but it affects only close residents	Not significant	- Sewage plant should be located away from the densely populated residential areas - Plantation of trees in and around the pumping stations/treatment plant would improve the aesthetics	UPJN/KJS Operator
Public Health	- Mixing of sewage with drinking water - Outbreak of waterborne diseases - Unhealthy conditions: mosquito breeding over sludge drying beds, etc.	Significant	- Any such health risk to public should be minimised by proper maintenance and operation of sewers, pumping stations, treatment plant etc. - In case of failure, inform relevant authorities to alert public at risk so that precautions might be taken	UPJN/KJS Operator

Environmental Issues	Adverse Impact	Nature of Impact	Proposed Mitigation Measures	Implementing Authority
OPERATION PHASE				
Workers Health & Safety	- Workers may be inflicted by endemic & other diseases such as malaria or respiratory ailments - Accidents and loss of lives may occur during sewer cleaning & maintenance - Non availability of emergency medical facilities at all times during day & night	Significant and Permanent	- Proper house keeping of the plant to prevent unsanitary conditions - Regular medical check ups and immediate treatment of affected workers - Maintenance personnel should not perform dangerous tasks when alone, enter the manholes without checking for gas and without proper protective clothing, enter the manholes without ropes and harnesses firmly tied - Manholes should not be left open especially in busy roads, near schools and residential areas	Operator/ KJS / UPJN
Economically Weaker Sections	- Filthy, unaesthetic conditions in slums, open defecation, foul smells, piling of garbage, endemic and epidemic diseases of residents	Significant	- Provision of sanitation facility should be extended to slums; if possible, shallow sewers should be laid to drain these areas - In areas that cannot be sewered, on site sanitation facilities like pit latrines/community ablution blocks should be provided - The residents should be educated on personal hygiene practices and the importance of sanitation and public health	UPJN/ KJS
Social Disruptions	- Breaking of sewer lines by farmers for irrigation as sewage would be a continuous source of water for irrigation	Significant	- The sewers should be patrolled and any unauthorised human activity should be discouraged - Farmers should be educated on health effects of using untreated sewage for irrigation, especially the effect of sewage flooding due to breakage of sewers with risks of epidemics	Operator/ UPJN/ KJS

Table 10.42 Scoping Matrix for Project Components

Environmental Elements / Development Scheme		Social Environment								Natural Environment							Pollution				
		Land Acquisition	Economic Activity	Traffic/Public Facilities	Cultural Properties	Water Right/Right of Common	Public Health Condition	Solid Waste	Risk	Topography and Geology	Soil Erosion	Groundwater	River Water Quality	Flora and Fauna	Local Meteorology	Landscape	Air Pollution	Water Pollution	Soil Contamination	Noise and Vibration	Odour
Sewage Treatment Plant	C	A -	A+	B -	D	C -	C -	B -		D	B -	D	C -	D	D	B -	B -	C -	D	A -	D
	O		A+	D	D	C -	B+	-	C -	D	D	D	A+	D	D	B -	D	-	D	C -	C -
Pumping Station	C	C -	A+	B -	D	C -	C -	B -		D	B -	D	C -	D	D	-	B -	C -	D	A -	D
	O		A+	D	D	C -	B+	-	C -	D	D	D	B+	D	D	B -	D	-	D	C -	C -
Installation of Main Trunk Sewer	C	D	C -	A -	D	D	C -	B -		D	B -	D	C -	D	D	D	B -	C -	D	A -	D
	O		C+	D	D	D	A+	-	C -	D	D	D	A+	D	D	D	D	-	D	D	D
Rehabilitation of Existing Trunk sewer	C	D	D	B -	D	D	C -	B -		D	D	D	D	D	D	D	B -	C -	D	A -	D
	O		D	D	D	D	B+	B+	C -	D	D	D	B+	D	D	D	D	-	D	D	D

Remarks:
C: Indicates construction (rehabilitation) stage. O: Indicates operation stage.
A+: Strong positive impact A -: Adverse negative impact
B+: Moderate positive impact B -: Moderate negative impact
C+: Low positive impact C -: Low negative impact
D: No impact foreseen

Table 10.43 Analysis of Siting of the Panka Sewage Treatment Plant Drainage District III – 120,000 m^3/d in 2015, 200,000 m^3/d in 2030

Issues	STP at Panka
Natural Parameters	
Soil Quality	• Construction of plant at this site will not have major impact on soil quality.
Air Quality	• Present location is away from the residential areas and outside (but not far from) the boundary of proposed development by KDA
Water Quality	• Treated water will be used for irrigation purpose in the surrounding area • The surplus water will be discharged into Pandu river passing near the village
Ecologically Sensitive Area	• Present location is not in forest or ecologically sensitive area and is not likely to have any adverse effect on the existing flora and fauna in the project area
Socio-Cultural Parameters	
Land Use Pattern	• The present location is undeveloped. Most of the part of land is being used in making brick by the brick kiln owner and the remaining land is used for agriculture. • The project is not expected to alter the land use in surrounding area drastically.
Socio-Economic Condition	• Positive impact on socio-economic condition due to increase in employment opportunities during construction and operation and maintenance of the plant
Public Health	• Proper housekeeping and maintenance of the plant required to offset problems of mosquito breeding and other nuisances
Archaeological/ Historical area	• Present location does not affect any historical/ or archaeological heritage
Aesthetic and Visual	• Present location does not pose such serious aesthetic and visual problems as it is away from dense residential areas
Project Implementation Parameters	
Land Availability & Land Cost	• Location of treatment plant away from inhabited areas (46 ha required) • The present location is outside the boundary of expected development • Land cost here is reasonable
Sewage Collection	• Sewage from entire District III can be brought to this site effectively
Pumping	• Will involve 3 sewage pumping stations: Lakhanpur, Panki and Panka near to Pandu river.
Treatment Plant	• Treatment plant consists of Primary Treatment, UASB reactors followed by Facultative type Aerated Lagoons and Chlorination
Sludge Disposal	• Treated sludge is well mineralised; it can be used as manure for agriculture
Reuse –Irrigation potential of Treated Sewage	• Treated water is proposed to be used for irrigation purpose. • The treated water meets discharge standards applicable for its use for agriculture • Irrigation fields are surrounding the STP site and the owners are ready to accept the water

10.8 ENVIRONMENTAL MANAGEMENT, TRAINING, AND MONITORING PLAN

10.8.1 General

The success of the Environmental Mitigation Plan depends on the efficiency of the organisational set up responsible for the implementation of the programme.

For a sanitation project of this magnitude, the Environmental Management Plan needs to be entrusted, in both the construction and the operation phases, to an Environmental Management Group, and regular monitoring of various environmental parameters is also necessary to evaluate the effectiveness of the management programme so that necessary corrective measures could be taken in case there are some drawbacks in the proposed programme.

Thus, the Environmental Management Plan will consist of:

- Setting up an Environmental Management Cell to implement the mitigation measures in operation phase;
- Ensuring a proper operation and maintenance of the treatment works;
- Ensuring a proper maintenance of the sludge drying beds and the disposal of dry chemical sludge in a proper landfill site;
- Monitoring the waste and treated water quality;
- Monitoring the built in pollution control equipment, for vehicles and equipment;
- Maintaining tree plantations around the pumping stations and the periphery of the sewage treatment plant.

Details of the Management Cell and the monitoring requirements needed to ensure that construction and operation follow best environmental practices are given in this section.

10.8.2 Environmental Management Cell

The Environmental Management Cell (EMC) will be part of the staff in charge of the operation and maintenance of the sewerage works, since the laboratory will be housed at the treatment plant site. But this staff will be in charge of the overall management of the environmental aspects of the Sanitation Project.

The staff will be provided by the operator of the treatment plant, in case the operation and maintenance of the treatment plant is subcontracted by UPJN.

Under the supervision of an Environmental Engineer, the EMC will comprise of an Environmental Scientist, a Chemist and a Biologist, plus three assistants, as shown in the following organisation chart. The Environmental Engineer would report directly to the Top Management of UPJN. The organisational chart is shown in Figure 10.9

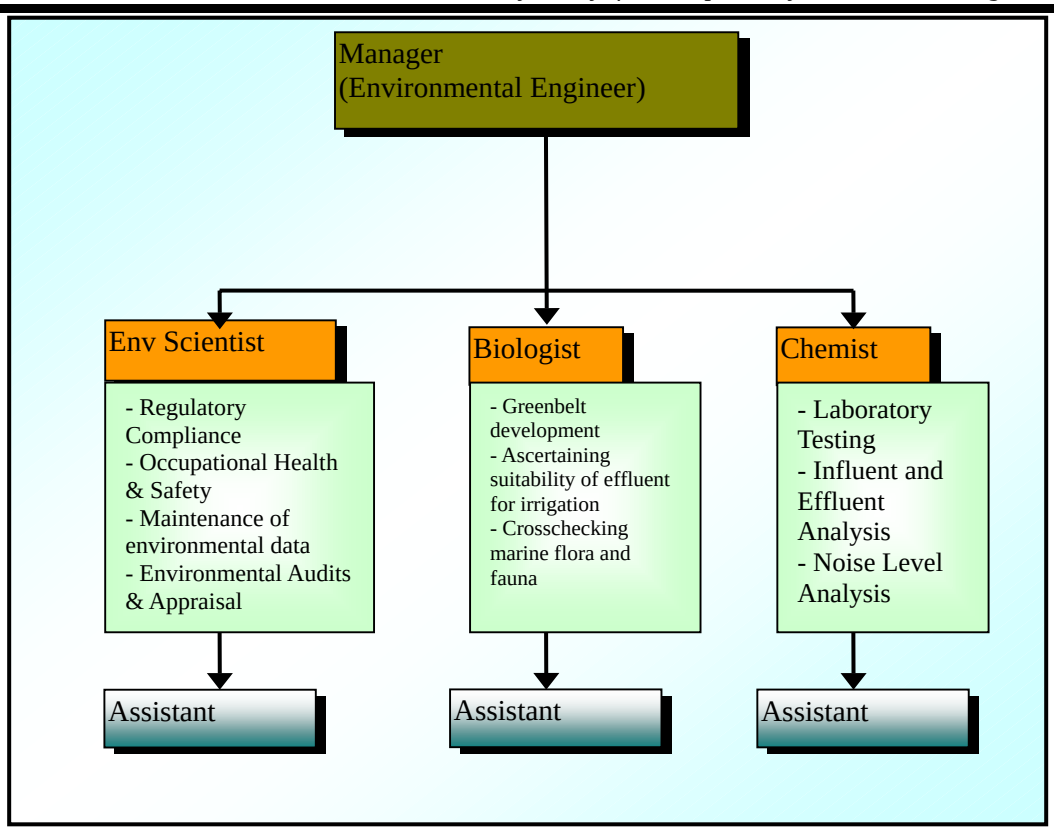

Figure 10.9 Environmental Management Cell

The main functions of the EMC will be:

- Collecting water, air, soil and sludge samples;
- Analysing the samples collected or getting analysis done from outside sources;
- Preparing and updating a database of environmental parameters;
- Implementing the environmental control and protective measures;
- Controlling the sludge treatment, disposal and re-use;
- Collecting statistics of health of workers and the population of surrounding areas;
- Ensuring the development and maintenance of the green belts;
- Monitoring the progress of implementation of Environmental Management Programme;
- Coordinating the environment related activities within the project as well as with outside agencies.

10.8.3 Monitoring Plan

To evaluate the effectiveness of the Environmental Management Plan, regular monitoring of the important environmental parameters will be taken up by UPJN with or without the help of outside agencies. The schedule duration and parameters to be monitored by the environmental team are described below and summarised in Table 10.44.

(1) Water Quality

The sampling of various inlets and outlets will be carried out for analysis of relevant parameters. The analysis will be done once in a month both at the inlet and outlet of the treatment plant and at strategic locations within the treatment plant. Some of the parameters will be tested daily. This practice would help UPJN evaluate the performance of individual units of the sewage treatment plant and take corrective measures if the results are not satisfactory.

(2) Air Quality

Ambient air quality should be monitored for SO_2, NO_x, SPM, etc. At the STP, H_2S and CH_4 should be monitored. Instruments like high volume air samplers and other monitoring kits should be used for the purpose of air quality monitoring. For the operation period, monitoring points should be fixed in consultation with the UPPCB.

(3) Noise Monitoring

Noise levels should be monitored in working environment, main noise producing sources such as the DG sets, pumping stations, over the boundary and around the sewage treatment plant.

(4) Green Belt and Compensatory Plantation

Continuous vigil and monitoring of the green belt around the treatment plant and trees planted around the pumping stations as well as the avenue trees planted, should be done for its growth and well being.

(5) Environmental Testing Laboratory

A well equipped laboratory for routine analysis of raw sewage and treated wastewater as well as for ambient air quality and sludge analysis should be provided at the sewage treatment plant site. The biological testing facility should be provided in this laboratory in addition to chemical analysis of water. The record of analyses should be maintained at the plant site for all the parameters mentioned in the Monitoring Plan.

10.8.4 Environmental Training

The environmental monitoring plan will be successful only if it is implemented by trained and skilled staff. The training of the qualified staff should be necessary not only in day to day operation and maintenance of the treatment plant, but also in environmental aspects.

It will be essential to involve the staff who will be responsible for the execution of the Environmental Management Plan, in the construction phase, as well as to train the staff in practising the mitigation actions and the day to day monitoring programme during the operation phase of the water supply units.

The training should include:

- Basic concepts of pollution control techniques in the various methods of sewage treatment,
- Operation and maintenance of the sewage treatment plant,
- Emergency preparedness to handle adverse situations,
- Principles of wastewater analysis,
- Other environmental monitoring techniques,
- Development of green belt and its maintenance,
- Sewage farming,
- Communication with farmers and general public.
- This training is different from the mandatory training required for operation and maintenance of the sewage treatment plants.

Table 10.44 Environmental Monitoring Plan

Environmental Quality	Monitoring Parameters	Schedule and Duration of Monitoring
Waste and Treated Water Quality	All physico-chemical and bacteriological parameters as per UPPCB standards; pH, temperature, TDS, TSS, DO, BOD, COD, heavy metals and *E coli.* etc.	- Quarterly Analysis - Monitoring point will be the inlet and outlet of the treatment plant - Technical criteria should be based on UPPCB standards/ guidelines
Ambient Groundwater	pH, TDS, nitrates, fluorides, nitrites, and heavy metals	- Once in 4 months - At sewage treatment plant location near sludge drying beds - Technical criteria should be based on UPPCB standards/ guidelines
Ambient Water Quality of Receiving Body	pH, TDS, TSS, BOD, COD, hardness, nitrates, heavy metals	- Quarterly - At discharge points according to the option selected - Technical criteria should be based on UPPCB standards/ guidelines
Ambient Air Quality	SPM, NO_x, CO, SO_2, H_2S, CH_4	- Construction period: 3 times a year (January, May and October) Monitoring point will be near construction sites and residential areas - Operation period: 24 hour samples, for one week, quarterly; Monitoring points will be fixed in consultation with the UPPCB - Technical criteria should be based on UPPCB standards/ guidelines
Ambient Noise	Noise level	- Operation period: Quarterly monitoring will be undertaken as appropriate; Monitoring points should be at pumping stations, near treatment plants - Technical criteria should be based on UPPCB standards/ guidelines

10.8.5 Costs of EMP

The block and recurring costs for the implementation of the Environment Management Plan is given in Table 10.45 and 10.46, respectively.

Table 10.45 Block Costs for EMP

Components	Cost (Rs.)
Establishment of EMC	500,000

Table 10.46 Recurring Costs for EMP

Components	Frequency	Costs (Rs./ year)
Waste water and Treated Water Quality	Quarterly	52,500
Groundwater	Quarterly	60,000
Surface Water (Receiving Water Body)	Quarterly	60,000
Ambient Air Quality	Quarterly	30,000
Ambient Noise	Quarterly	30,000
Environmental Audit	Once in year	200,000
Running Costs for EMC	Monthly	2,400,000
Total		2,832,500

10.9 RISK ANALYSIS & CONTINGENCY PLAN

10.9.1 General

The sanitation project comprises sewer laying, construction of sewage treatment plants and their operation. The risk involved in laying the sewers is mainly for pipelines of DN 600 and larger which require lifting by cranes. The risk of mechanical equipment failure and thereby occurrence of accidents cannot be overlooked.

Contingency measures plans have been prepared for:

- Sewage treatment works that could reasonably be expected to cause significant environmental impacts as a consequence of operational disruption (i.e. maintenance, etc. or breakdown);
- Accidents which may occur while laying sewers or during construction of the treatment works;
- Discharge of sub-standard wastewater into the environment from treatment plant that could cause a significant public health impact, and which therefore requires a continuous system of influent/effluent monitoring to identify potential problems as and when they arise.

In the preparation of the contingency measures:

- The most likely causes of process disruption/breakdown have been identified;
- An attempt has been made to estimate their probability of occurrence;
- The possible resultant environmental adverse impacts are presented;
- The recommended courses of action to minimise the severity of the impacts have been highlighted;
- The responsible agency who will act in case of emergencies has been indicated.

Table 10.47 gives the potential risks due to construction, operation and maintenance and corrective actions. The major risks, which can result in breakdowns and disruptions, are described below.

10.9.2 Power Supply

One of the main reasons for disruption during the operation phase of the treatment works is very likely to be power cuts due to a transmission line problem and/or energy shortage. Power cuts and the reasons for them should be monitored in advance so as to set a reliability analysis at the new treatment plant.

It is recommended that the new treatment plant influent pumping station is equipped with a branched

connection to ensure continuity of operation in case one line remains out-of-order. It also suggested that standby power generators are provided to ensure at least minimum services in case of prolonged power cuts.

Also the technology chosen should be able to survive short spells of power cuts.

10.9.3 E&M Equipment Disruptions

Operational disruption due to E&M equipment can be avoided by spare parts and stand-by provision available at site.

O&M instructions and manuals should be provided by the contractor of the treatment plant with training of the operation staff for the new plant.

Table 10.47 Risk Assessment and Contingency Plan

	Works	Risks	Impact	Corrective Action Plan	Responsibility
1. Accidents related to Construction					
1.1	Sewerage	Accidents due to pedestrians falling into the open trenches	Significant	- Excavated trenches should be provided with adequate barricades - Signboards in bold letters to be displayed in prominent places - Solid planks with guard rails should be provided across the trenches for crossing	Contractor/ UPJN
		Accidents due to vehicular traffic and risk to pedestrians, workers, vehicle drivers	Significant	- Traffic diversions and signboards should be displayed prominently - Proper lighting should be provided at night time - Co-ordination with traffic police in managing traffic	Contractor/ UPJN
		Accidents due to failure of machinery such as cranes	Significant	- Workers to be trained on contingency management - Emergency medical help should be available immediately - The contractor should have a proper safety policy issued to workers and should strictly comply with all the safety regulations	Contractor/ UPJN
		Accidents due to carelessness of workers	Significant	- Workers should be provided with protective clothing and helmets - Workers should not be allowed to work when alone - Workers should be trained on first aid - Emergency medical help should be available immediately	Contractor/ UPJN
1.2	Treatment Plant & Pumping Stations	Risk of accidents	Significant	- During construction effective safety and warning measures including all the above mentioned safety precautions should be followed by the contractor and UPJN should insist on compliance by contractor - Lighting of construction site and safety signs to be installed	Contractor/ UPJN

	Works	Risks	Impact	Corrective Action Plan	Responsibility
2. Accidents related to Operation & Maintenance					
2.1	Sewers	Accidents to operator/UPJN/KJS personnel	Significant	- Operators should not enter the manholes when alone - Operators should check for gases before entering the manholes - Operators should wear protective clothing, helmets and masks - Operators should enter the manhole by lowering themselves with a rope or a harness tied safely above - Manhole covers should be lifted using proper lifting keys - Emergency medical services should be available round the clock - At least one person of Management level should be on duty at all times	Operator/ KJS/ UPJN
2.2	Treatment Plant	- Breakdown of wastewater treatment units (or overall poor condition)	Not Significant	- The treatment plant will require regular maintenance (preventive maintenance rather than reactive maintenance should be insisted upon)	Operator/ UPJN/ KJS
		- Breakdown of mechanical equipment	Not Significant	- Adequate standby for pumps and motors should be provided - Adequate quantities of reliable spare parts should be available on site - Presence of mechanics to take corrective action - All standby equipment should be regularly checked to ensure full working order	Operator/ UPJN/ KJS
		Maintenance of sludge drying beds: - risks of perpetuation of mosquitoes and other vectors - risk of bad odours - risk of groundwater pollution.	Not Significant	- Sludge drying should be maintained properly - Wet sludge should be raked frequently and dry sludge should be removed and stored/disposed off - Ensure proper drainage - Operator should ensure that there is no standing water on the SDB	Operator/ UPJN/ KJS
2.3	Treatment Plant (continued)	- Failure of biological process due to toxicity, poor maintenance, etc. (contamination of the effluent with toxic industrial effluents is the major reason for failure of biological treatment systems)	Significant	- The secondary biological treatment should be by passed and the water should be discharged after primary treatment only - All relevant authorities should be informed on potential health risk to public - The biological process should be revived	Operator/ UPJN/ KJS

	Works	Risks	Impact	Corrective Action Plan	Responsibility
				- Inoculation or addition of nutrients should be carried out, if needed	
2.4	Pumping Stations	- Breakdown of pumping stations leading to flooding and consequent public health problems as well as general nuisance to public	Significant	- Pumping stations should be avoided as far as possible and in cases where it is not possible, their numbers should be minimised - All pumps should be wear resistant - Standby pumps should be provided and they should be regularly checked to ensure full working condition when needed - Safety overflow should be provided at all pumping stations leading to a ditch or preferable a drain. These emergency overflows should be designed to ensure minimum environmental nuisance, in case of use	Operator/ UPJN/ KJS
		- Power failure leading to flooding of sewage on streets and other problems	Significant	- Standby diesel generators should be provided to cater for a minimum of 1.5 times the average dry weather flow so as to avoid flooding - Emergency overflows as above, should also be provided along with the DG sets as a precaution	Operator/ UPJN/ KJS

10.10 CONCLUSIONS

The objective of implementing the sewerage project in Kanpur is to stop the flow of untreated sewage into the river Ganga and improve the water quality in Ganga along with the sanitary conditions of the city. A sewerage project with such an objective is associated with positive impacts:

The most important are listed below:

- The collection and treatment of untreated wastewater before entering the rivers will improve water quality of Ganga and Pandu rivers.
- Those areas which are presently overflowing with sewage will improve as the sewage will be tapped and diverted through underground drainage systems.
- Risks due to water borne diseases will reduce since at many places the existing sewer lines will be rehabilitated. The contamination of the water supply line with the sewer will reduce considerably
- Effective planning of sewage pumping stations and the treatment plant will ensure that wastewater does not percolate to sub surface layers of soil and contaminate the ground water.
- Treated effluent use in agriculture will help the farmers to enrich their soil fertility. Groundwater consumption will reduce.
- Sludge generated during the treatment process can be used as manure in the nearby agricultural fields
- Improvement in existing sewerage system will reduce the leakages and overflowing of sewage on the roads and streets.
- The construction activities will provide the local people with some employment.

10.10.1 Overall Impacts

The sewerage project to be implemented in Kanpur for improvement of the river water quality, although would improve the environmental conditions of the city, there will be still some areas that would require more focus and attention.

- Many of the areas will still not be connected directly to the sewers and wastewater will continue flowing through the drains.
- Wherever lateral sewer networks and house to house sewer connections are not in place, indiscriminate sewage flow will continue to occur
- If the implemented projects are not operated and maintained effectively, the purpose of the Ganga River Action Plan will not be achieved.

10.10.2 Conclusion

Overall it can be concluded that the priority projects that will be implemented will have a positive effect on the improvement of the quality of the river. The mitigation measures, if followed correctly will not have any adverse impacts on the environment.

CHAPTER 11

COST ESTIMATION AND IMPLEMENTATION PROGRAMME

CHAPTER 11 COST ESTIMATION AND IMPLEMENTATION PROGRAMME

11.1 CAPITAL COST ESTIMATION OF THE PRIORITY PROJECTS

Cost estimates for various works are worked out on the basis of prevailing Schedule of Rates and market rates. Rates for land acquisition are obtained from Finance and Revenue Department, Govt. of Uttar Pradesh. All the figures are in Rs.

Unit prices for the estimate of capital costs are, in principle, derived from the list of prices provided by UPJN. However, prices not provided by UPJN are calculated using Kanpur rates on the basis of Delhi Schedule of Rates taking localities and deflator into account. Furthermore, prices of items such as sewer pipes, reinforcing steel bars, manhole covers and so on that are not found in UPJN Schedule or DSR are obtained by quotation. The following are cost estimation conditions.

1) The rates assumed for major civil works are based on UPJN Schedule of Rates for Kanpur and market rates.
   - To apply schedule of rates provided by UPJN in principle.
   - For rates of items not provided by UPJN, to use modified rates based on Delhi Schedule of Rates.
   - To use market prices for items not available in (1) and (2).
2) Costing of electrical equipment is based on the price list of standard suppliers.
3) Costing of the pump houses is based on actual quantities worked out from preliminary design.
4) Costing of pumps and motors is based on the price of reputed suppliers, and other facilities like screens, pipes, valves etc. are based on prevailing market rates.
5) Current market rates have been considered for pipes, reinforcement steel, structural steel and specialized items like geo-synthetics etc.
6) For STPs based on UASB technology, costs have been calculated on the basis of preliminary design of process units.
7) Physical contingencies: 5% of capital cost
8) Engineering costs (detailed design (6%) and project management (5%)): 11 % of capital cost
9) Project administration: 5 %, including the cost of "Environment Monitoring Plan", which is discussed in the section on Environmental Impact Assessment.

The capital costs of each component are provided in the relevant Chapters and the abstract of cost estimation is shown in Table 11.1.

11.2 IMPLEMENTATION PROGRAMME

In the F/S, a detailed list of the works identified for implementation of the priority projects has been provided.

The implementation programme for the priority projects in Kanpur (Table 11.2) has been prepared considering the following assumptions.

1) Necessary technical and financial sanctions and inter government agreement (between Japanese Government and Indian Government) shall be finalised within 2005.
2) Process of appointment of Project Management Consultant for the project shall start by July 2006 by NRCD, Ministry of Environment and Forests, Government of India.
3) Appointment of consultants for detailed engineering and preparation of detailed project reports and tender documents for project component shall be completed within 2006.
4) Actual execution of various priority project components shall start from 2007.

5) During execution, various project components shall be executed in parallel.
6) UPJN, Lucknow, will acquire 100 % of the land required for construction of proposed sewage treatment plants and pumping stations before the commencement of tendering.

11.3 OPERATION & MAINTENANCE COST ESTIMATION

The following is the summary of the basis of preliminary estimation of operation & maintenance (O&M) cost for the proposed sewerage system.

(1) Estimation Conditions

1) Sewers and rising mains

- Annual maintenance cost of trunk sewers: @ 0.5% of capital cost (New & Replacement)
- Annual maintenance cost of rising mains: @ 0.25% of capital cost
- Annual maintenance cost of branch sewers: @ 0.5% of capital cost
- Annual operation cost: manpower cost
- Manpower cost - As per actual salaries and proposed staff requirement [*1]
- The capital cost of existing and sanctioned sewers is estimated based on unit cost of proposed facilities or Master Plan (M/P).

2) Pumping stations

- Power cost (required power) - Rs. 3.25 per unit
- Diesel cost (for power cut) - As per market rate
- Annual power cost is estimated based on average flow
- Maintenance of civil works: @ 1.5% of capital cost of civil works
- Maintenance of mechanical & electrical (M&E) works: @ 3% of capital cost of M&E works
- Manpower cost - As per actual salaries and proposed staff requirement [*1]
- The capital costs of existing and sanctioned pumping stations are estimated based on unit cost of proposed facilities or M/P.

3) Treatment plants

- Power cost (required power) - Rs. 3.25 per unit
- Gas power generator installed in the STP will be used during power cut
- Chemicals – actual cost
- Maintenance of civil works @ 1.5% of capital cost of civil works
- Maintenance of M&E works @ 3% of capital cost of M&E works
- Manpower cost - As per actual salaries and proposed staff requirement [*1]
- The capital costs of existing and sanctioned treatment plants are estimated based on unit cost of proposed facilities or M/P.

Note: [*1] The manpower requirement of O&M for sewers, pumping stations and treatment plants for 2015 is proposed in the PART IV of VOLUME IV-2, Institutional Development Programme.

(2) Facilities Considering for O&M Cost Estimation

The O&M costs of all facilities including existing, sanctioned and proposed facilities are estimated.

(3) Power Supply Conditions

The O&M costs in following two cases in terms of power supply conditions are estimated.

- Operation by power from grid (24 hours a day)
- Operation by power from grid (20 hours a day) and diesel (4 hours)

(4) Estimation Results

Table 11.3 presents annual O&M costs of all major facilities including existing, sanctioned and proposed facilities for 2015 and the following table summarises annual O&M costs for 2015.

Summary of Annual O&M Costs in 2015 (Kanpur)

(1,000 Rs./year)

Facility	Case-1 Grid Power Supply only	Case-2 Grid Power Supply supplemented by Diesel
(1) Sewers and rising mains	30,798	30,798
(2) Pumping stations	99,654	135,084
(3) Sewage Treatment Plants	130,064	130,064
Total	260,516	295,946

Note: The O&M cost includes all major existing, sanctioned and proposed facilities.

Table 11.1 Abstract of Project Cost Estimation (Kanpur)

	Sewerage District	Capital Cost (Rs.)	Contingencies	Detailed Design	Supervision	Project Adminisrtation	Total Cost (Rs.)	Land Acquisition	Total Project Cost (Rs.)
			5%	6%	5%	5%			
SEWERAGE SCHEMES									
Installation / Replacement of Trunk Sewer									
From Sisamau Nala to Parmat SPS	I	32,186,000	1,609,000	1,931,000	1,609,000	1,609,000	38,944,000		38,944,000
From Rawatpur to Hudson School Crossing then to Cantonment	I	575,871,000	28,794,000	34,552,000	28,794,000	28,794,000	696,805,000		696,805,000
Tannery Area Trunk Sewer	I(CE)	137,929,000	6,896,000	8,276,000	6,896,000	6,896,000	166,893,000		166,893,000
From Kiwad Nagar to Munshipruwa SPS	II	68,613,000	3,431,000	4,117,000	3,431,000	3,431,000	83,023,000		83,023,000
Trunk Sewer in District III	III	431,192,000	21,560,000	25,872,000	21,560,000	21,560,000	521,744,000		521,744,000
Construction of Sewerage Pumping Station					0				
Bhagwandas Ghat SPS	I	35,458,000	1,773,000	2,127,000	1,773,000	1,773,000	42,904,000	0	42,904,000
Lakhanpur SPS	III	43,407,000	2,170,000	2,604,000	2,170,000	2,170,000	52,521,000	0	52,521,000
Panki SPS	III	85,376,000	4,269,000	5,123,000	4,269,000	4,269,000	103,306,000	0	103,306,000
MPS at Panka STP	III	144,592,000	7,230,000	8,676,000	7,230,000	7,230,000	174,958,000	0	174,958,000
Construction of Sewerage Treatment Plant					0				
Panka STP (UASB)	III	380,721,000	19,036,000	22,843,000	19,036,000	19,036,000	460,672,000	65,745,000	526,417,000
Augmentation of Sewerage Treatment Plant					0				
Jajmau STP (ASP)	I(CE)	114,073,000	5,704,000	6,844,000	5,704,000	5,704,000	138,029,000		138,029,000
Rehabiltation of Existing Trunk Sewer					0				
Desilting, Detailed Investigation	I	185,064,000	9,253,000	11,104,000	9,253,000	9,253,000	223,927,000		223,927,000
Rehabilitation	I	676,271,000	33,814,000	40,576,000	33,814,000	33,814,000	818,289,000		818,289,000
Desilting, Detailed Investigation	II	19,396,000	970,000	1,164,000	970,000	970,000	23,470,000		23,470,000
Rehabilitation	II	83,824,000	4,191,000	5,029,000	4,191,000	4,191,000	101,426,000		101,426,000
Rehabiltation/Upgrading of Existing Pumping Station					0				
Guptarghat SPS	I	292,000	15,000	18,000	15,000	15,000	355,000		355,000
Muirmill SPS	I	479,000	24,000	29,000	24,000	24,000	580,000		580,000
Parmat SPS	I	66,864,000	3,343,000	4,012,000	3,343,000	3,343,000	80,905,000		80,905,000
Nawabganj SPS	I	7,604,000	380,000	456,000	380,000	380,000	9,200,000		9,200,000
Jajmau SPS (ASP)	I(CE)	9,750,000	488,000	585,000	488,000	488,000	11,799,000		11,799,000
Rehabilitation of Existing STP					0				
Jajmau STP (UASB, Pilot, 5 mld)	I(CE)	8,739,000	437,000	524,000	437,000	437,000	10,574,000		10,574,000
Jajmau STP (ASP, 130 mld)	I(CE)	64,800,000	3,240,000	3,888,000	3,240,000	3,240,000	78,408,000		78,408,000
Total		3,172,501,000	158,627,000	190,350,000	158,627,000	158,627,000	3,838,732,000	65,745,000	3,904,477,000

Table 11.2 Implementation Schedule of Priority Projects (Kanpur)

(Unit: Rs.)

	Capital Cost	Detailed Design Cost	Total Project Cost	2007	2008	2009	2010	2011	2012
				Capital and Detailed Design Cost Schedule					
Construction of Trunk Sewer									
From Sisam Nala to Parmat SPS	32,186,000	1,931,000	38,944,000	1,931,000	6,437,000	6,437,000	6,437,000	9,656,000	3,219,000
From Rawatpur to Hudson School Crossing then to Cantonment	575,871,000	34,552,000	696,805,000	34,552,000	115,174,000	115,174,000	115,174,000	172,761,000	57,588,000
Tannery Area Trunk Sewer	137,929,000	8,276,000	166,893,000	8,276,000	27,586,000	27,586,000	27,586,000	41,379,000	13,792,000
From Kiwad Nagar to Munshipruwa SPS	68,613,000	4,117,000	83,023,000	4,117,000	13,723,000	13,723,000	13,723,000	20,584,000	6,860,000
Trunk Sewer in District III	431,192,000	25,872,000	521,744,000	25,872,000	86,238,000	86,238,000	86,238,000	129,358,000	43,120,000
Construction of Sewerage Pumping Station									
Bhagwandas Ghat SPS	35,458,000	2,127,000	42,904,000	2,127,000	7,092,000	7,092,000	7,092,000	10,637,000	3,545,000
Lakhanpur SPS	43,407,000	2,604,000	52,521,000	2,604,000	8,681,000	8,681,000	8,681,000	13,022,000	4,342,000
Panki SPS	85,376,000	5,123,000	103,306,000	5,123,000	17,075,000	17,075,000	17,075,000	25,613,000	8,538,000
MPS at Panka STP	144,592,000	8,676,000	174,958,000	8,676,000	28,918,000	28,918,000	28,918,000	43,378,000	14,460,000
Construction of Sewerage Treatment Plant									
Panka STP	380,721,000	22,843,000	526,417,000	22,843,000	76,144,000	76,144,000	76,144,000	114,216,000	38,073,000
Augmentation of Sewerage Treatment Plant									
Jajmau STP (ASP)	114,073,000	6,844,000	138,029,000	6,844,000	22,815,000	22,815,000	22,815,000	34,222,000	11,406,000
Rehabiltation of Existing Trunk Sewer									
District I									
Detailed Investigation	185,064,000	11,104,000	223,927,000	11,104,000	185,064,000				
Sewer desilting, flow diversion and rehabilitation	676,271,000	40,576,000	818,289,000			40,576,000	225,424,000	225,424,000	225,423,000
District II			0						
Detailed Investigation	19,396,000	1,164,000	23,470,000	1,164,000	19,396,000				
Sewer desilting, flow diversion and rehabilitation	83,824,000	5,029,000	101,426,000			5,029,000	27,941,000	27,941,000	27,942,000
Rehabiltation of Existing Pumping Station			0						
Guptarghat SPS	292,000	18,000	355,000	18,000	146,000	146,000			
Muirmill SPS	479,000	29,000	580,000	29,000	240,000	239,000			
Parmat SPS	66,864,000	4,012,000	80,905,000	4,012,000	33,432,000	33,432,000			
Nawabganj SPS	7,604,000	456,000	9,200,000	456,000	3,802,000	3,802,000			
Jajmau SPS (ASP)	9,750,000	585,000	11,799,000	585,000	4,875,000	4,875,000			
Rehabilitation of Existing STP									
Jajmau STP (UASB, Pilot)	8,739,000	524,000	10,574,000	524,000	4,370,000	4,369,000			
Jajmau STP (ASP)	64,800,000	3,888,000	78,408,000	3,888,000	32,400,000	32,400,000			
Total	3,172,501,000	190,350,000	3,904,477,000	144,745,000	693,608,000	534,751,000	663,248,000	868,191,000	458,308,000

(Unit:million Rs.)

Items		Total	2007	2008	2008	2009	2009	2010
Capital Cost		3,172.51	0.00	693.61	489.15	663.25	868.19	458.31
Detailed Design Cost		190.36	144.75	0.00	45.61	0.00	0.00	0.00
Contingencies		158.63	0.00	34.68	24.46	33.16	43.41	22.92
Supervision		158.63	0.00	34.68	24.46	33.16	43.41	22.92
ProjectAdmin		158.63	0.00	34.68	24.46	33.16	43.41	22.92
Total Cost		3,838.76	144.75	797.65	608.14	762.73	998.42	527.07
Land Acquisition		65.75	65.75	0.00	0.00	0.00	0.00	0.00
Total		3,904.51	210.50	797.65	608.14	762.73	998.42	527.07

Detaied Design
Construction Cost

Table 11.3 Operation and Maintenance Cost Estimation (Kanpur)

									Power condition : Grid power supply (24 hours a day)					Power Condition : Grid power (20 hours a day) and diesel power (4 hours) supply						Assumptions and Conditions for Estimation	
		Status	Sewerage District	Ave. Capacity at 2015 (mld)	Diameter (mm)	Length (m)	Unit Cost (Rs./m)	**Capital Cost (Thousand Rs.)**	Staff Cost (Thousand Rs. /year)[3]			**Maintenance Cost (Thousand Rs.)**	**Total O&M Cost (Thousand Rs. /year)**	Staff Cost (Thousand Rs. /year)				**Maintenance Cost (Thousand Rs.)**	**Total O&M Cost (Thousand Rs. /year)**	Basis of Capital Cost	Basis of Maintenance Cost
1	**Trunk Sewer**																				
	Existing	E	I		300-2300	46,286	see relevant part	1,209,984				6,050	6,050					6,050	6,050	MP Unit cost base	@ 0.5 %
	Existing/Rehabilitation (District I)	E/R	I		1500-2250	14,995	see relevant part	510,588				2,553	2,553					2,553	2,553	MP Unit cost base	@ 0.5 %
	Proposed (Jajmau Tannery Area - Trunk)	P	I		800-1600	4,530		99,805				499	499					499	499	F/S estimate (except trenchless)	@ 0.5 %
	Proposed (Jajmau Tannery Area - Lateral)	P	I		300-700	3,885		30,124				151	151					151	151	F/S estimate (except trenchless)	@ 0.5 %
	Replacement (Gulf club to Chhabilepur)	P	I		1600	1,000	see relevant part	23,152				116	116					116	116	MP Unit cost base	@ 0.5 %
	Proposed (Sisamau nala tapping facility)	P	I		400	1,210		32,186				161	161					161	161	F/S estimate (except trenchless)	@ 0.5 %
	Replacement (Hudson school)	P	I		700-2200	9,866	see relevant part	302,549				1,513	1,513					1,513	1,513	MP Unit cost base	@ 0.5 %
	Existing	E	II		600-1800	20,646	see relevant part	278,334				1,392	1,392					1,392	1,392	MP Unit cost base	@ 0.5 %
	Existing/Rehabilitation (District II)	E/R	II		838	4,030	see relevant part	45,112				226	226					226	226	MP Unit cost base	@ 0.5 %
	Replacement (Kidwai Nagar Police Line)	P	II		700-2000	3,800	see relevant part	57,062				285	285					285	285	MP Unit cost base	@ 0.5 %
	Proposed (Trunk Sewer to Lakhanpur PS PS)	P	III		600-900	2,450		35,115				176	176					176	176	F/S estimate (except trenchless)	@ 0.5 %
	Proposed (Trunk Sewer to Panki PS)	P	III		600-2000	4,930		159,317				797	797					797	797	F/S estimate (except trenchless)	@ 0.5 %
	Proposed (Trunk Sewer to Panka STP)	P	III		1800-2000	6,940		170,341				852	852					852	852	F/S estimate (except trenchless)	@ 0.5 %
	Sub Total					**124,568**		**2,953,668**				**14,768**	**14,768**					**14,768**	**14,768**		
2	**Branch Sewer**																	0	0		
	District I (Center)		I	(1,961 ha x 65% x 385 m/ha)		490,740	1,000	490,740				2,454	2,454					2,454	2,454	Unit cost base	@ 0.5 %
	District I (East)		I	(3,664 ha x 50% x 385 m/ha)		705,320	1,000	705,320				3,527	3,527					3,527	3,527	Unit cost base	@ 0.5 %
	District II		II	(2.706 ha x 65% x 385 m/ha)		677,177	1,000	677,177				3,386	3,386					3,386	3,386	Unit cost base	@ 0.5 %
	District III		III	(1,868 ha x 60% x 385 m/ha)		431,508	1,000	431,508				2,158	2,158					2,158	2,158	Unit cost base	@ 0.5 %
	Sub Total					**2,304,745**		**2,304,745**				**11,524**	**11,524**					**11,524**	**11,524**		
3	**Rising Main**																	0	0		
	From Parmat SPS (1)	E	I		200	1,000	4,420	4,420				11	11					11	11	RM of Bhagwatdas PS cost base	@0.25%
	From Parmat SPS (2)	A	I		600	1,000		8,315				21	21					21	21	F/S Estimate	@0.25%
	From Nawabganj SPS	E	I		450	1,500	4,420	6,630				17	17					17	17	RM of Bhagwatdas PS cost base	@0.25%
	From Muilmill SPS	E	I		400	735	4,420	3,249				8	8					8	8	RM of Bhagwatdas PS cost base	@0.25%
	From Guptarghat SPS	E	I		150	300	4,420	1,326				3	3					3	3	RM of Bhagwatdas PS cost base	@0.25%
	From Bhagwatdas Ghat SPS	P	I		400	1,210		5,350				13	13					13	13	F/S Estimate	@0.25%
	From Lakhanpur SPS	E/R	III		600	650		5,423				14	14					14	14	F/S Estimate	@0.25%
	From Panki SPS	P	III		1200	260		2,095				5	5					5	5	F/S Estimate	@0.25%
	From MPS at Panka STP	P	III		1400	1,500		12,771				32	32					32	32	F/S Estimate	@0.25%
	Sub Total					**8,155**		**49,579**				**124**	**124**					**124**	**124**		
	Total							**5,307,991**		**0**	**0**	**26,416**	**26,416**		**0**	**0**	**0**	**26,416**	**26,416**		
									4,382				**30,798**	**4,382**					**30,798**	**See IDP report for staff cost**	

		Status	Sewerage District	**Ave. Capacity at 2015 (mld)**	Civil Cost (Thousand Rs.)	E & M Cost (Thousand Rs.)	Utility Cost (Thousand Rs.)	**Total Capital Cost (Thousand Rs.)**	Staff Cost (Thousand Rs. /year)[3]	Power Cost (Thousand Rs. /year)	Chemical Cost (Thousand Rs. /year)	**Maintenance Cost (Thousand Rs. /year)**	**Total O&M Cost (Thousand Rs. /year)**	Staff Cost (Thousand Rs. /year)	Power Cost (Thousand Rs. /year)	Chemical Cost (Thousand Rs. /year)	Diesel Cost (Thousand Rs. /year)	**Maintenance Cost (Thousand Rs. /year)**	**Total O&M Cost (Thousand Rs. /year)**	Basis of Capital and Opearation Cost	Basis of Maintenance Cost
4	**Pumping Station**																				
	5 small existing PSs in District I [1]	E	I	24	16,554	73,770	0	90,324		2,655	-	2,461	5,116		2,213	-	2,469	2,461	7,143	Bhagwandas PS F/S cost base	@1.5% of civil, 3.1% of E&M
	Guptarghat SPS	E/R	I	4	2,759	12,295	0	15,054		425	-	410	835		354	-	412	410	1,176	Bhagwandas PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Muilmill SPS	E/R	I	4	2,759	12,295	0	15,054		425	-	410	835		354	-	412	410	1,176	Bhagwandas PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Parmat SPS	E/R	I	54	4,401	28,743	0	33,144		2,353	-	928	3,281		1,961	-	2,469	928	5,358	F/S Estimate	@1.5% of civil, 3.0% of E&M
	Nawabganj SPS	E/R	I	6	4,139	18,443	0	22,581		637	-	615	1,253		531	-	617	615	1,764	Bhagwandas PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Jajmau SPS (for ASP)	E/A	I	165	74,168	97,598	0	171,765		6,571	-	4,040	10,612		5,476	-	6,365	4,040	15,881	Panki PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Jajmau SPS (for UASB)	E/A	I	18	12,416	55,328	0	67,743		1,912	-	1,846	3,758		1,593	-	1,852	1,846	5,291	Bhagwandas PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Bhagwatdas Ghat SPS	P	I	8	5,518	24,590	0	30,108		850	-	820	1,670		708	-	823	820	2,351	F/S Estimate	@1.5% of civil, 3.0% of E&M
	7 small existing PSs in District II [2]	E	II	68	46,903	209,015	0	255,918		6,691	-	6,974	13,665		5,576	-	823	6,974	13,372	Bhagwandas PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Rakhimandi SPS	S	II	86	38,657	50,869	0	89,526		3,425	-	2,106	5,531		2,854	-	3,317	2,106	8,278	Panki PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Mushipurwa SPS	S	II	70	31,465	41,405	0	72,870		2,788	-	1,714	4,502		2,323	-	2,700	1,714	6,738	Panki PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Ganda nala SPS	S	II	45	20,228	26,618	0	46,845		1,792	-	1,102	2,894		1,493	-	1,736	1,102	4,331	Panki PS F/S cost base	@1.5% of civil, 3.0% of E&M
	MPS at Bingawan STP	S	II	200	89,900	118,300	0	208,200		7,965	-	4,898	12,863		6,638	-	7,715	4,898	19,250	Panki PS F/S cost base	@1.5% of civil, 3.0% of E&M
	Lakhanpur PS	E/R	III	16	10,278	27,707	0	37,985		850	-	985	1,835		708	-	823	985	2,516	F/S Estimate	@1.5% of civil, 3.0% of E&M
	Panki PS	P	III	80	35,960	47,320	0	83,280		3,186	-	1,959	5,145		2,655	-	3,086	1,959	7,700	F/S Estimate	@1.5% of civil, 3.0% of E&M
	MPS at Panka STP	P	III	120	54,608	77,213	0	131,821		8,602	-	3,136	11,737		7,168	-	8,332	3,136	18,636	F/S Estimate	@1.5% of civil, 3.0% of E&M
	Sub Total				**450,711**	**921,507**	**0**	**1,372,218**		**51,124**	**0**	**34,406**	**85,530**		**42,604**	**0**	**43,950**	**34,406**	**120,960**		
									14,124				**99,654**	**14,124**					**135,084**	**See IDP report for staff cost**	
5	**Treatment Plant**																	0			
	Jajmau STP (UASB, Pilot)	E	I	5	10,321	2,592	2,950	15,863	0	385	62	233	680	0	385	62	-	233	680	Panka STP F/S cost base	@1.5% of civil, 3.0% of E&M
	Jajmau STP (UASB)	E/A	I	52	107,336	26,962	30,681	164,979	3,313	4,009	645	2,419	10,385	3,313	4,009	645	-	2,419	10,385	Panka STP F/S cost base	@1.5% of civil, 3.0% of E&M
	Jajmau STP (ASP)	E	I	130	194,810	140,267	10,067	345,144	9,187	28,978	1,950	7,130	47,245	9,187	28,978	1,950	-	7,130	47,245	Jajmau augement cost base	@1.5% of civil, 3.0% of E&M
	Jajmau STP (ASP)	A	I	43	64,437	46,396	3,330	114,163	0	9,585	645	2,358	12,588	0	9,585	645	-	2,358	12,588	F/S Estimate	@1.5% of civil, 3.0% of E&M
	Bingawan STP (UASB)	S	II	200	412,832	103,698	118,003	634,533	8,184	15,418	2,480	9,303	35,386	8,184	15,418	2,480	-	9,303	35,386	Panka STP F/S cost base	@1.5% of civil, 3.0% of E&M
	Panka STP (UASB)	P	III	120	247,699	62,219	70,802	380,720	7,458	9,251	1,488	5,582	23,779	7,458	9,251	1,488	-	5,582	23,779	F/S Estimate	@1.5% of civil, 3.0% of E&M
	Sub Total				**1,037,434**	**382,134**	**235,834**	**1,655,402**	**28,142**	**67,626**	**7,270**	**27,026**	**130,064**	**28,142**	**67,626**	**7,270**	**0**	**27,026**	**130,064**		
	Total				**1,488,145**	**1,303,641**	**235,834**	**3,027,620**	**42,266**	**118,751**	**7,270**	**61,431**	**229,718**	**42,266**	**110,230**	**7,270**	**43,950**	**61,431**	**265,148**		
	Grand Total							**8,335,611**	**46,648**	**118,751**	**7,270**	**87,847**	**260,516**	**46,648**	**110,230**	**7,270**	**43,950**	**87,847**	**295,946**		

Note:
(1) 5 small existing PS in District I : total capacity is 24 mld: IPS (No.1 to 4) at Jajmau, Shayam Nagar SPS
(2) 7 small existing PS in District II : total capacity is 68 mld : Barra No.2, 4, 8 SPS, Barra World Bank K Block PS, Barra World Bank I Block SPS, Hitkari Nagar SPS, Yashoda Narar SPS
(3) See Institutional Development Programme (ID) report for Manpower (Staff) Cost.
E: Existing, S: Sanctioned, P: Proposed, A: Proposed augementation

Appendix A

Appendix A 3.1
Technical Evaluation for Selection of Pumps

Sewage pumps are used to lift liquid wastes from one level of the collection system to another (as in the case of intermediate pumping stations) or to the treatment plant for treatment (as in the case of main pumping stations).

At larger pumping installations, a large quantity of materials, such as rags, jute bags, fibre and plastic pouches is found in sewage. Proper efficient screening shall be done before the sewage enters into the wet well of the pumping station. A sewage pump shall be reliable, unchokable and accessible for quick maintenance, be robust and wear resisting. The type of pump to be installed at each pumping station shall be judged on its technical merits in relation to the rate of pumping, total head, physical composition of the sewage, septicity and requirement of preliminary treatment before pumping.

Pumps may be classified on the basis of the purpose or the application they serve, the material of construction, the liquids they handle, and orientation in the space. A more basic system of classification is to categorize the pumps on the principle by which the energy is supplied to the pump. Under this system, all pumps may be divided into two major categories.

Dynamic, in which energy is continuously added to increase the fluid velocities within the machine to values in excess of those occurring at the discharge such that subsequent velocity reduction within or beyond the pump produces a pressure increase.

Displacement, in which energy is periodically added by application of force to one or more movable boundaries of any desired number of enclosed, fluid containing volumes, resulting in a direct increase in pressure upto the value required to move the fluid through valves or ports into the discharge line.

Dynamic pumps may be further sub-divided into several categories of centrifugal pumps and other special-effect pumps, like jet pumps and hydraulic ram pumps etc. Displacement pumps are essentially divided into reciprocating pumps and rotary pumps.

Reciprocating pumps are suitable for applications where the required capacity is expected to be virtually constant over a wide range of system head variations. Another factor that has to be taken into consideration is that the output from the reciprocating pumps is pulsating. Where this is objectionable, rotary pumps are preferred over the reciprocating pumps. However, the application of rotary pumps is limited to low to medium pressure ranges.

In India, for sewage pumping application centrifugal pumps are in use. A centrifugal pump consists of a set of rotating vanes, enclosed within a housing or casing and used to impart energy to a fluid through centrifugal force. Thus, stripped of all the refinements, a centrifugal pump has two main parts.

- A rotating element, including an impeller and a shaft
- A stationary element made up of a casing, stuffing box, and bearings.

In this type of pump, the liquid is forced by atmospheric pressure or other pressure, into a set of rotating vanes. These vanes constitute an impeller, which discharges the liquid at its periphery at a higher velocity. This velocity is converted into pressure energy by means of a volute or by a set of stationary diffusion vanes surrounding the impeller periphery. Pumps with volute casings are called volute pumps, while those with diffusion vanes are called diffuser pumps.

Depending on the location of motor with respect to the pump, centrifugal pumps can be divided into two types, namely the conventional centrifugal pumps and the submersible centrifugal pumps. The broad classification of the commonly used pumps is shown in the following Figure 3.1.

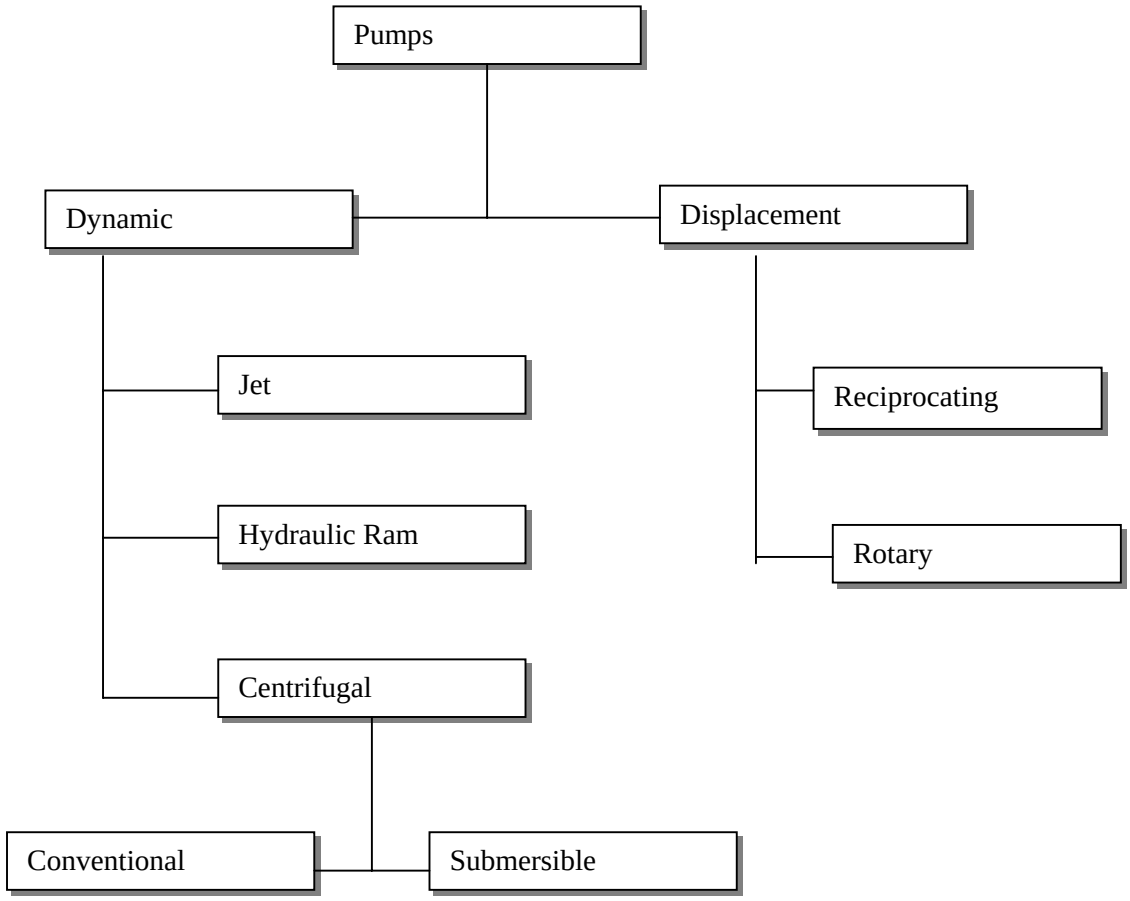

Figure 3.1: Pump Classification

3.1.1 Conventional Centrifugal Pumps

A conventional centrifugal pump is more specifically described as an end-suction, volute-type, with an overhung impeller of either the non-clog or the radial flow type or the mixed flow type pump.

The installation of conventional centrifugal pump requires considerable length of drive shafting. The addition of this shafting, of the many line bearings, and of an external lubrication system represents a major portion of the total installed cost. Furthermore, power losses increase rapidly due to elongation of shafts.

Conventional centrifugal pumps operate within a dry well adjacent to the wet well. The pumps are connected with the wet well through a suction line. One of the major drawbacks with these pumps is that they generally do not work with any suction lift. Instead they need a suction head or minimum submergence for trouble free pumping. Therefore, it is always advisable to install these pumps at such a level that the impeller or the volute of the pump is positioned below the low water level of the wet well to ensure a positive suction or prime.

3.1.2 Submersible Centrifugal Pumps

Submersible centrifugal pumps are based on modern developments and have integral motors with special seals suitable for operation below liquid level. The pump, along with the motor, is submerged into the wet well and does not need a dry well for installation. The pumps are fitted with semi-open type of impellers cutting and tearing contra-block system, which efficiently handles jute bag pieces, long fibres, plastic bags & pouches, cigarette buts, solid admixes, etc. which are generally present in sewage in India.

Submersible centrifugal pumps eliminate the need for extended shafting, shaft couplings, a stuffing box, a sub-surface motor stand, and an expensive dry well.

Submersible centrifugal pumps are available with closed coupled submersible motors. The pumps are supported by guide rails, which make it possible to lower and lift the pumps by means of a chain hoist. During this operation, the discharge is connected and disconnected without dewatering the wet well.

Motors for this type of pump are hermetically sealed, employing a double mechanically sealed oil chamber with moisture sensing probe to detect any influx or conductive liquid past the outer seal.

Due to their inherent advantages over conventional centrifugal pumps, submersible centrifugal pumps have been popular all over the world, for pumping municipal wastewater. Over the past ten years, the application of submersible centrifugal pumps has become very popular in India, for pumping municipal wastewater and is replacing conventional centrifugal pumps.

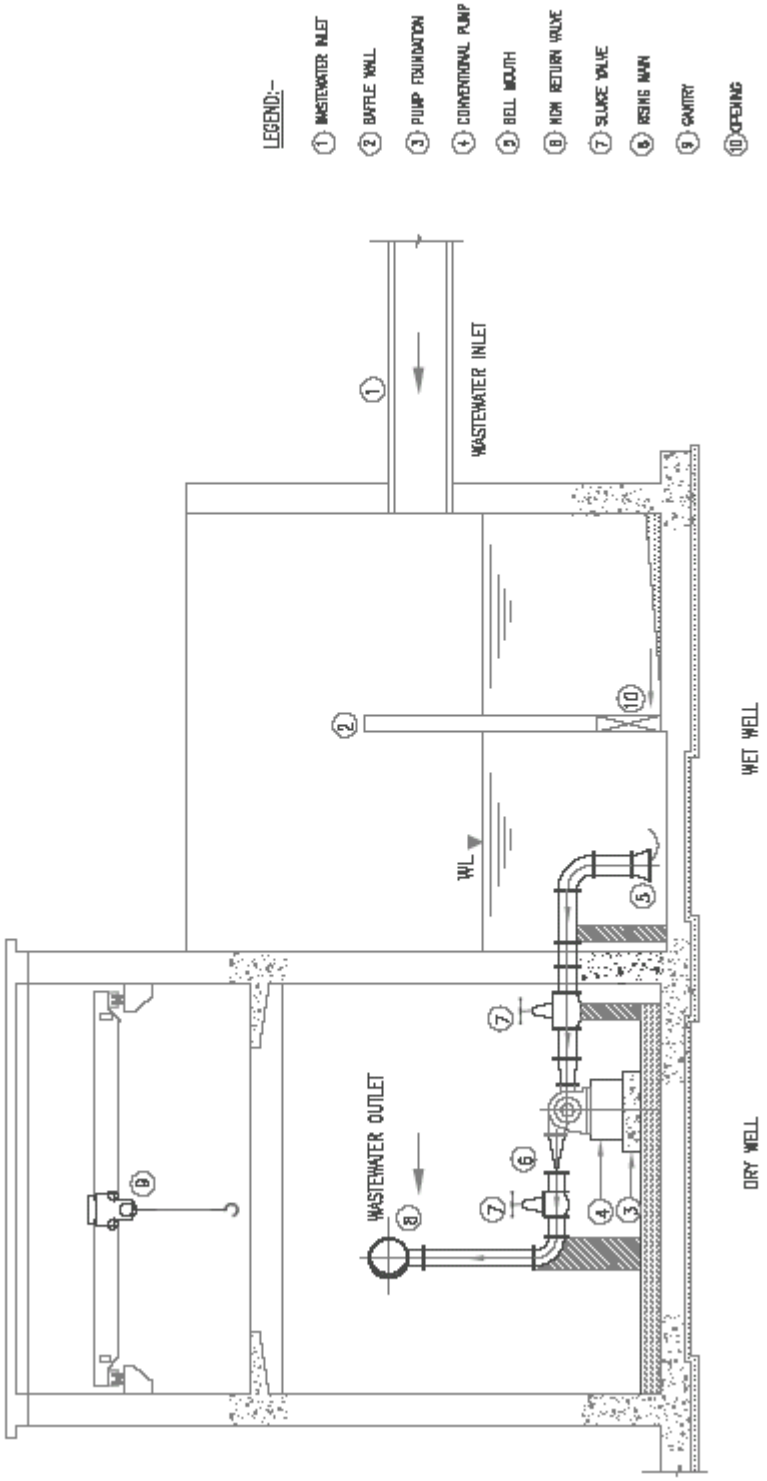

Figure 3.2 Schematic of Conventional Centrifugal Pump

Pump

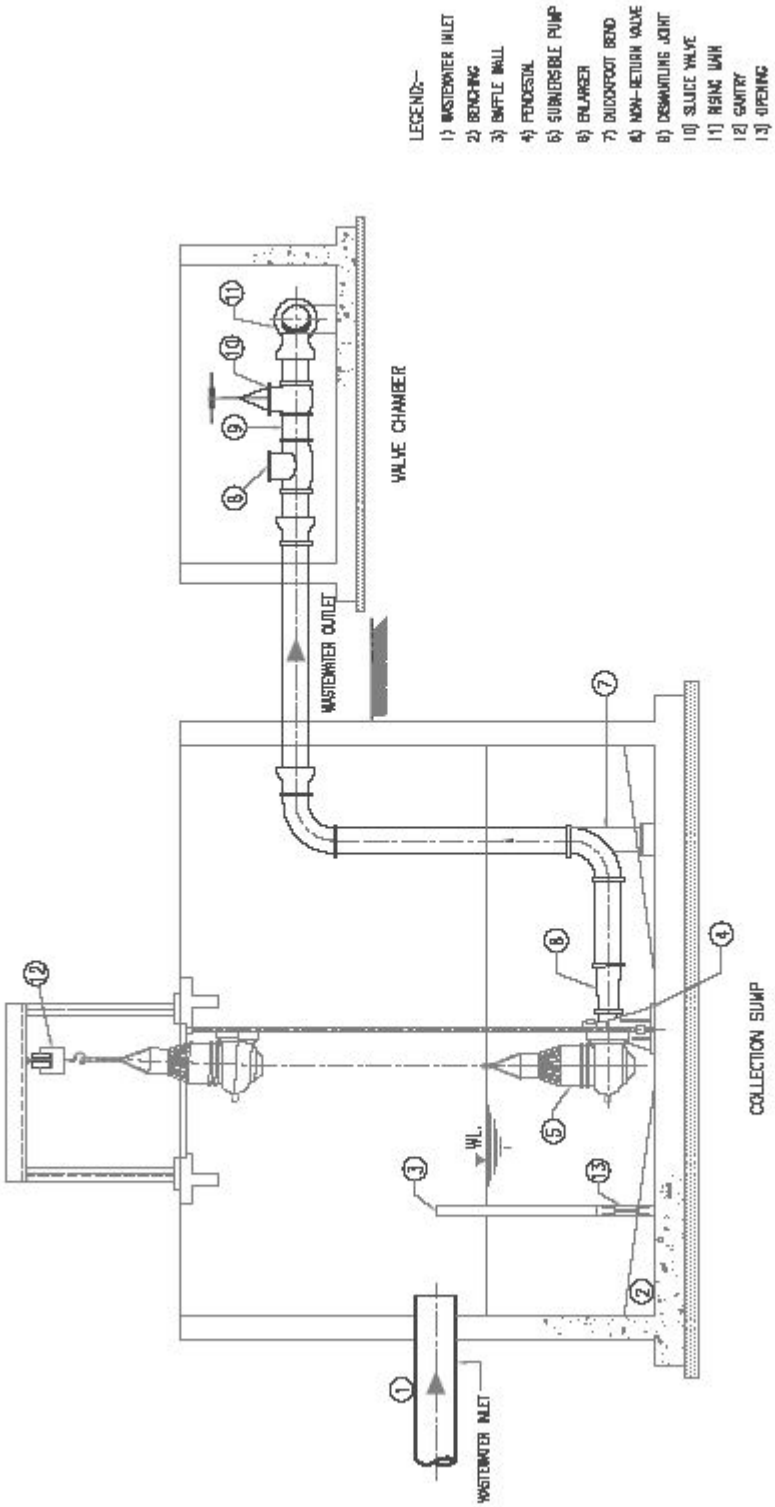

Figure 3.3 Schematic of Submersible Centrifugal Pump

A technical evaluation has been carried out for selection of pumps. For this purpose, conventional centrifugal pumps and submersible centrifugal pumps have been compared.

3.1.3 General Comparison of Conventional Centrifugal Pumps and Submersible Centrifugal Pumps

The conventional centrifugal pumps and submersible centrifugal pumps have their own advantages and disadvantages. The merits and demerits of both types can be summarized as given the following table:

Comparison between Conventional Centrifugal pump vs. Submersible Centrifugal pumps

Sr.	Parameter	Conventional Centrifugal Pumps	Submersible Centrifugal Pumps
1	Civil structure to house the pumps	Superstructure is needed for protection of motors and therefore these pumps require a dry well in conjunction with a wet well (sump). Sectional view of a pumping station with conventional centrifugal pumps has been given in Figure 3.2	Both pump and motor are installed in the wet well. This saves substantial space and brings about significant saving in the civil engineering costs. Sectional view of a pumping station with submersible centrifugal pumps has been given in Figure 3.3
2	Land requirements	Require more space	Require very little space
3.	Piping	Extended	Shorter
4	Column pipes	Required	Not required
5.	Suction pipes	Required	Not required
6.	Discharge pipes	Required	Required
7.	Delivery piping and common header	Require column assembly	The discharge pipes of all pumps can be terminated at the common header, which is installed in a shallow valve chamber just adjacent to the collection sump
8.	Solid handling capacity	Lower (80 mm)	Higher (100 mm and above)
9.	Weight of pumps	Heavy	Relatively much lighter
10.	Lubrication	Special attention is required for lubricating lines of intermediate bearing support and further design is required to check intermediate floor for bearing supports, etc.	No such attention required. Further, the supports required for the intermediate bush bearings is also not applicable
11	Vibrations and noise	Large column lengths always cause vibrations and motor mounted on top causes noise pollution. The vibrations are also due to their heavy weight	Submersible centrifugal pump being a mechanically robust mono-block unit where impeller is mounted on the motor shaft which is supported by two sturdy bearing, ensures a mechanically

Sr.	Parameter	Conventional Centrifugal Pumps	Submersible Centrifugal Pumps
			robust design which in turn results in vibration free performance of the pump and further whatever vibrations that still remain, are damped because the pump is submerged in sewage
12.	Starts and stops	Capable of less stops and starts per hour (4 to 5) and hence requires more hydraulic retention time (5 minutes at peak flow) for wet well	Capable of relatively more starts and stops per hour (8 to 10). This results in reducing the hydraulic retention time (3.75 minutes at peak flow) of the sump, ensuring the compactness of wet well.
13.	Impeller	Closed impeller having both front and back shrouds. This type of impeller is not suitable for Indian sewage, which has solids like plastic bags & pouches and jute fibre. Choking and clogging of impeller is quite frequent	Fitted with specially designed and specially shaped single/double vane impeller of open type with contra-block cutting system. These two combined features make this pump truly non-clogging and therefore substantially more reliable under Indian conditions
14.	Motor	Squirrel cage induction motor is the prime mover, which is coupled with the pump by means of a rigid or flexible coupling	Squirrel cage motor is an integral part of the pump and fitted with an aluminium die cast rotor. This totally enclosed motor is equipped with sealing features to permit operation while submerged in a specified medium at a specified depth.
15.	Electrical cabling and control panels	Since conventional centrifugal pumps offer substantially reduced kilowatt consumption, the ampere consumption also reduces, resulting in reduction in size of motor cabling, length of cabling, reduction in capacity of transformer and generator set.	Cabling and control cabling is extended.
16.	Installation and removal	Installation and removal is cumbersome since the assembly is on a foundation and each pump has to be specially removed and then lifted	The pump installation and removal are automatic, without having to enter into the sewage pit. Guide rail system and guide pipe are provided to facilitate the automatic coupling of the pump

3.1.4 Operation and Maintenance Aspects

Operation and maintenance is an important aspect to be considered while selecting the type of pumps. It is therefore, necessary to consider ease of installation and removal, materials of construction, safety features and frequency of lubrication etc. as important parameters.

In case of conventional centrifugal pumps, frequent clogging of impeller are more due to its closed type design and lower solid handling capacity. Also, due to presence of line shaft bearings, there is a need of frequent lubrication. There is more wear and tear of glands and other parts due to extended shafts. It is not easy to install and remove these pumps because of their heavy weight and manual fixing onto the foundation.

In case of submersible centrifugal pumps, due to their semi-open type impeller, clogging is less frequent. Furthermore, the special contra-block cutting and tearing system provides on the suction side of the pump facilitates disposing off soft materials like plastic pouches, small jute pieces, which is very typical of sewage in India. Pump bearings are of anti-friction type and are maintenance free and are grease lubricated for long life. The bearings are capable of taking normal thrust loads due to unbalanced hydraulic loads on the impellers.

The maintenance of submersible centrifugal pumps is comparatively less because there are no line shaft bearings, which need reliable lubrication and periodic replacement. Only mechanical seal of this type of pump may need replacement after certain working hours, thereby reducing the maintenance cost substantially.

Selecting a pump with less moving parts and low RPM reduces wear and tear of parts and ensures trouble and maintenance free operations. Submersible pumps offer state of the art technology in pump protection ensuring trouble free operation in toughest applications.

The salient operation and maintenance features of conventional centrifugal pumps and submersible centrifugal pumps are given in the following table.

Salient Operation and Maintenance Aspects of Conventional Centrifugal Pumps and Submersible Centrifugal Pumps

Sr.	Conventional Centrifugal pumps	Submersible Centrifugal Pumps
1.	-	Thermistor sensors for motor protection
2.	-	Bearing monitors for trouble free and smooth operation
3.	-	Mechanical seal health monitors for ensuring an enhanced pump life
4.	Periodic greasing required	Lubricated for life bearings
5.	Absence of warning system results in abrupt failure giving no time for planning not allows selective maintenance	Early warning system allows ample planning time and selective maintenance
6.	More moving parts	Less moving parts
7.	Design incorporating multiple shafts, resulting in frequent alignment problems.	Compact design on single shaft.

With reference to the technical comparison between conventional centrifugal pumps and submersible centrifugal pumps it can be concluded that the submersible centrifugal pumps is based on modern developments in the technology of centrifugal pumps for sewage pumping applications. Development in impeller design like semi-open type with contra-block system, steel material of construction, better solid handling capacity, better design due to direct mounting of motor shaft on impeller, better design of motor stator rotor (aluminium die cast) makes the submersible centrifugal pumps technically more superior. The facility of guides rail system and automatic coupling facilitate better operation and maintenance. Also the submersible centrifugal pumps offering better safety and construction features ensure reliability and trouble free operation. However, availability of submersible pumps is limited to a specified capacity (usually a maximum of 300 HP) in India.

Based on the above technical evaluation, considering advantages, disadvantages, and also the past experiences of UPJN officials on existing installations, it was decided and recommended that for sewage pumping stations in Lucknow, submersible pumps shall be opted only upto 150 HP capacity and horizontal centrifugal pumps shall be opted for higher (>150 HP) capacities.

Appendix A 4.1

1.1 LAYING OF SEWERS USING TRENCHLESS TECHNOLOGY

1.1.1 Trenchless Options for Trunk Sewer

The selection of a trenchless option for the construction of a part of the proposed relief trunk sewer will avoid much of the disruption associated with traditional open cut construction. Trenchless construction involves access to the construction works at discrete points along the pipeline route rather than the disruption of a continuous corridor along the route with the requirement for temporary reinstatement and pavement patching. Site management of trenchless process involves the delivery of essential materials to these discrete intervention points in a timely fashion as opposed to the stringing out along the route of pipe and pipe bedding materials. Similarly, the removal of spoil material can be managed in a timely fashion with the attendant avoidance of disruption. However, it should be mentioned here that site management is the key to successful trenchless construction; a poorly organized site and bad practice can be immensely disruptive and damaging to the public interest causing damage to the perception of the implementing authority in a magnitude not dissimilar to open cut construction.

The selection of access points through specially constructed access shafts is important to minimize public disturbance, these access points can be 100-250 mm apart and the adjacent working areas if well managed can be minimized to the order of 30-70 square meters. Damage to adjacent buried infrastructure such as other utility services is always a risk. Careful survey and attention to local information can minimize this risk. Cooperation with other utility providers and the traffic authorities is an important contribution to successful installation. Careful selection of appropriate technology and materials will minimize future maintenance requirements. Trenchless methods can be expected to deliver better built quality for the most part, free from settlement and reinstatement problems.

There are a number of practical problems in the delivery of the trenchless option. Amongst the most important of these is the requirement for specialist product and equipment, much of which is not currently, available in India. Accordingly planning and selection place special burdens on the client, consultant and contractor. Sufficient time for detailed planning, discussion and programming is essential, detailed method statements and specifications are useful to the achievement of an understanding of all the key issues between the parties. This section of the report seeks to set out key issues for consideration to inform the selection process.

The proposed relief trunk sewer involves both trenched and trenchless components; the section identified for trenchless construction, presented in Table 4.9, is ideally suited being a deep sewer 3-10m to invert, located under a busy road where trenched construction would be enormously disruptive. The trenched component is also deep where connecting to the trenchless section; special measures should be taken here and for most of the trenched reaches to use modern practice of closed sheeting or trench boxes to minimize trench width and ensure worker safety.

Open cut construction can be accomplished with reduced disruption using a trench box or drag box method so that regardless of the depth to formation, that is, below the pipe bedding the trench can be excavated safely without battering back the trench sides, to a minimum width. Close sheeting can also be used to control trench width and maintain safe working conditions but is more time consuming to install and requires closer supervision; the trench sheets are liable to damage and may be regarded as project consumables whereas trench or drag boxes can be regarded as capital items and maintained as such. Careful use of a trench box not only restricts the width of the trench and hence the work site but also the length of pipeline open at any one time to about 6-8 metres. Temporary reinstatement of the pavement after backfill and consolidation can minimize the length of road closure necessary.

With good site management the activity zone of the narrow trench construction outlined above can approximate to the scale of a pipe-jacking site, though the site footprint is larger and cannot be selected at optimum points along the pipeline for minimum disruption. Traditional trenching practice usually involves the temporary storage of excavated material and pipe bedding on site, although this inevitably makes the site area larger and more disruptive. Coordinated truck movement to ship in bedding and product pipe can minimize the area required.

1.1.2 The Microtunnelling Option

There is a wide range of pipe jacking and microtunnelling processes and system providers from Japan, Europe and the US are working internationally. Pipe jacking, pipe ramming and microtunnelling methods have been used in India since about 1997 in Mumbai. Generally, in India the companies working in this sector have developed their own machinery and import specialist items on a project by project basis.

Pipe jacking is defined in the ISTT guidelines as a system for directly installing pipes behind a shield machine by hydraulic jacking from a drive shaft such that the pipes form a continuous string in the ground'. Typically pipe jacking can achieve tolerances of 75mm on line and 50mm on level. Microtunnelling is defined by ISTT as steerable remote control pipe jacking to install pipes of internal diameter less than that permissible for man entry. Microtunnelling was developed from pipe jacking by the Japanese in the early 1980's by the miniaturization of tunnel boring machines (TBMs) and the development of earth pressure balance and slurry microtunnelling machines. Introduced into Germany in the mid 80's the technology was extended by the development of auger machines suited to the sand, silt and clay soils in the Hamburg region. Microtunnelling is now used worldwide to construct 10-20% of new sewer lines. Typically microtunnelling can achieve tolerances of +/- 25 - 50mm on line and level depending on the procedure use.

For a detailed consideration of microtunnelling and selection of the most appropriate process the following basic factors should be reviewed:

- The diameter range of pipe, which can be installed - most machines can be used for a small range (2-3 times the standard size) by changing the cutting head or shield body.

- The type of pipe, which can be installed - pipe compressive strength and surface friction are important factors in determining the length of drive.

- The type of ground, which can be traversed, and the maximum hydrostatic head to be withstood - this will determine the cutting head, the spoil removal system and the need to counterbalance ground water.

- Machine accessibility - in the event of mechanical failure or unforeseen conditions or obstacles.

- The location of access points (drive and receiving shafts) - with respect to achievable drive length, drive shafts are generally larger and more costly than receiving shafts and consideration should be given to driving in both directions.

- The accuracy of alignment achievable - gravity sewers require a very accurate grade whereas pressure mains and casings can tolerate lesser accuracy.

- Sizes of shafts and access thereto - this will depend on the type of microtunnelling machine, hydraulic rams (single or double acting) and pipe length, access is important to operating efficiency and time is critical to avoid the build up of pipe friction.

- Lack of disruption and associated cost benefit - microtunnelling is a capital intensive process and often more costly than open cut pipeline construction at shallow laying depth. Evident reduction of disruption can be expressed as an engineering or social cost saving to justify the use of the procedure.

- Traffic patterns may influence the selection and number of access points, storage areas and support locations are also affected.

In respect of these basic criteria, microtunnelling appears to be appropriate technology for relief trunk sewer. With the wide range of sizes of pipe (1200mm –2400mm) required by flow capacity analysis; a decision shall be taken to rationalize construction to just two sizes to improve the viability of the microtunnelling option so that there is a minimum of disruption to the construction schedule. However, in this report the actual diameter is considered for further detailing. With use of high strength pipes and advanced microtunnelling technology access shafts can be at 200-300 meter centers; such drive lengths are readily achievable with good quality concrete. The route, for the most part could accommodate excavation to access the machine, in the event that this is required. However, there are some sections along the route, for example adjacent to the rail under bridges and in the vicinity of the nala crossing where construction of access shafts should be avoided to the extent possible to minimize disruption and technical problems. Accuracy of +/- 25-50mm is achievable with a variety of machines in drives of length up to 300m consistent with the grade tolerances for the gravity sewer. There are limitations on shaft size evident along the identified route; in the vicinity of the rail under bridge there is barely sufficient space to construct a reasonable sized shaft without significant disruption and concern must be raised about the extent of the footings and foundations for these engineering structures. The route is heavily trafficked and runs through both densely populated areas - the disruption of open trenching would generate a major public nuisance and substantial social costs.

1.1.3 Installation Options

Microtunnelling machines are generally classified in two groups according to the method of spoil removal

- Auger systems where spoil is transferred from the cutting head to the drive shaft by a system of auger flights located in the casing or product pipeline. A full face cutting head may be used to apply an earth pressure balance to support for the cutting face. Ground water can be controlled to a limited extent by earth pressure balanced by the cutting head; this may be supplemented with compressed air. Auger machines are ideally suited to working in cohesive silts and clays and can accommodate ground water pressure of up to 3m. Auger machines are limited by the torque they can apply, drives of about 130m are possible. The maximum size for auger machines is about 1 m diameter.

- Slurry systems where the spoil is mixed with water at the cutting head for transportation in a discharge pipe back to the surface. Settlement tanks and other separation devices allow the water to be recycled and solid waste is transported away. Use of a slurry system can balance high ground water head up to 30m. Slurry systems are suited to working in saturated sand and gravel strata.

- Cutting heads have been designed for working in rock. Such heads may incorporate a modified cone crusher to break up rocks and boulders up to 30% of the face size. The jacking arrangement will consist of a sturdy frame rigid enough to apply the required force through an arrangement of 2-6 hydraulic cylinders each capable of about 100-300 tons force.

Further classification arises from the operating procedures microtunnelling may involve

- A single stage process where the machine is propelled through the ground by jacking product pipes immediately behind the machine.

- A two stage process where special protective pipes are used to drive the machine the full length to the reception pit; product pipes are then jacked through the completed bore displacing the protective pipes which are recovered for re-use. This procedure reduces substantially the load on the product pipe. The annular space between the product pipe and the bore must be grouted.

- A pilot bore where an initial bore of small diameter is reamed out so that the product pipes can be inserted.

The system selected should fulfill the following requirements:

- The shield must be cylindrical to a fine tolerance - eccentricity or damage from prior use will affect steering capability.

- The jacking frame must be sufficiently robust to withstand the weight of the shield and pipes and not deflect during jacking.

- The cutter head and shield must be suitable for the prevailing ground conditions and ground water head.

- If needed face support should be maintained by earth or slurry pressure.

- It should be capable of dealing with rock or rubble included in the spoil up to 30% of the casing or product pipe diameter.

- The cutter head should be steerable with automatic control capable of programming to the appropriate alignment.

- The hydraulic jacks should apply the required jacking force slowly and evenly through a thrust ring, relief valves should prevent overload.

- It should include a data-logging device to display key parameters such as jacking force, jacking speed, earth or slurry pressure, machine deviation, steering roll and gradient in real time.

- It should be capable of installing a 200-300m pipeline to within +/-50mm of level.

- Addition of product pipe and adjustment of hose and cable lengths in the drive shaft must be readily accomplished.

Subject to confirmation that the soil type is essentially silt and sand, essentially free from larger rocky inclusions and that problems with ground water can be anticipated at the burial depths required, it seems likely that slurry shield type machine may be required. Even though serious ground water is less likely at the shallower depths where a 1200mm pipe (rising main) will be installed, the torque requirements for long length jacking will probably exceed machine capability for the auger type. Access shafts could be either rectangular or circular caisson type; the caisson type is probably well suited to the soil type but rectangular may minimize the width of carriageway required for the larger pipes on this scheme. Accordingly the potential for disruption along the proposed route is minimized.

1.1.4 Product Pipe Options

Product pipes are subjected to high compressive loads during jacking and microtunnelling. Pipe wall thickness and compressive strength determine drive length; drive length capability, normally 130-200m may be extended by use of lubrication and intermediate jacking stations. Long distance jacking methods combining highest grade pipe and highly developed methodologies can achieve drives in

excess of 400m. Japanese researchers are reported to be aiming for 1000m. However, for the present purposes consideration is given to methods comfortably associated with drives up to 130m. Depending on the selection and size of the shaft and installation equipment, short pipes (1.2 - 2.0m) may be required.

a) Concrete pipes

The vast majority of jacking pipes in use worldwide are manufactured from concrete to accepted standards such as BS EN 5911 pt120, DIN4035, JSWAS A2 or similar. The high compressive strength (70-90N/mm2) and the smooth low friction exterior surface required support centrifugal spinning as the preferred method of manufacture. This method has lost some popularity in recent years as high speed vibrated methods have been widely adopted for the production of inexpensive concrete pipe for laying in trench. However in the main jacking pipe markets, Japan and Germany spun pipe production remains popular. Where jacking pipe is made by contractors, wet cast molded methods can provide smooth pipe at low volume consistent with construction rate. Jacking pipe are furnished with butt ended joints with coupling rings of steel, stainless steel or GRP, of external diameter slightly smaller than the pipe outside diameter; the joint rings may be loose or bonded into molded rebated joint surfaces. Butt joints provide the maximum area for load transfer. Elastomeric seals are used between the joint ring and the pipe spigot. Modern jacking pipe joints usually employ seals that combine compression seal and lip seal characteristics. Jacking pipes are supplied with load transfer rings usually of particle board, plywood or plastic bonded onto the pipe at the socket end; squareness of ends is critical, a key element of the pipe specification. Vertical cast pipe are demoulded green and air cured, they may be subject to some distortion of ends due to differential drying shrinkage. Concrete pipes are vulnerable to acid attack, which can be a problem where septicity is permitted to develop in the sewer; high ambient temperature, long retention times and shallow grade can be contributory factors. Concrete pipe may be protected by addition of PVC or HDPE lining.

b) Clay pipes

Stoneware pipes are manufactured in diameters up to DN 1200. Recognised standards include DIN 1230 or BS EN 295 pt 7. Stoneware pipes possess particularly high compressive strength. They are manufactured in the UK, Germany and the USA. Stoneware pipes are resistant to all substances found in sewage or soil and have excellent wear resistance. The joint profiles and butt ends are machined to a high standard. The majority of jacking pipes in the range DN200-600 are of vitrified clay. Hybrid clay lined concrete pipes are made in Japan and Germany. Clay pipes are not available for the 2400 mm sizes required at Lucknow.

c) GRP Pipes

GRP pipes such as Hobas are also used for pipe jacking, the sandwich construction of their composite wall providing sufficient wall thickness for a modest end load capability. They are also chemically resistant. Hobas pipe is the dominant pipe used for microtunnelling in the USA.

d) Polymer Concrete Pipes

Polymer concrete pipes were developed in Germany in the early 1990's, they combine the strength and wall thickness of concrete (90 N/mm^2) with the chemical resistance of clay or GRP. A manufacturing unit has recently been established in Malaysia.

e) Steel pipes

Steel Pipes have outstanding strength and toughness; this coupled with their weldability makes them attractive for use as casings or carrier pipes installed by pipe jacking or microtunnelling. However, they have low corrosion resistance and for this reason they have never been widely used in the sewage sector though they are commonly used for water and gas mains often with polymer coatings and

cathodic protection. Steel pipes are often used where a dynamic process such as pipe ramming is used for construction and where a two stage process like auger boring may be used to install other product pipes such as concrete inside the steel carrier pipe.

Centrifugally spun concrete pipe have been made in India for many years, it is expected that manufacture of such pipe designed according to overseas standards can be reinstated to meet the demands. Wet cast concrete pipe have also been made by pipe jacking contractors.

The process of pipe jacking or microtunnelling subjects the external surface of the pipe to significant abrasion as the pipe is pushed through the ground, the extent of abrasion

Depending on the strata, the length of drive and the lubrication. Even in strata free from rock, the paint or other coating on the tunneling machine may be damaged or removed altogether. Very high surface stress is induced in pipes during jacking, particularly when steering or correcting deviations from line or level, pipes are subject to a severe combination of compressive and transverse loads during installation, such stress may also damage the coatings applied to GRP or steel pipes and prejudice their durability.

Concrete, clay or polymer concrete pipe are preferred for medium and long distance jacking. The jacking pipe share of the overall pipe market is relatively small, generally less than 10%. Accordingly jacking pipes are specialty items with higher coat, due to low volume production and the provision of steel or plastic collars. However, the basic pipe cost is a small fraction of the pipeline construction cost, typically 15-20%. Pipe quality should not be compromised, the pipe is a vital component in the performance of the installation and in the subsequent utility and longevity of the installed asset. The pipe, once installed by pipe jacking or microtunnelling will be competently jointed and free from the soil settlement induced in trench construction; it can be expected to perform satisfactorily throughout its working life.

For the relief trunk sewer concrete pipe are recommended. They offer outstanding quality as jacking pipes from the installation perspective. Microtunnelling contractors worked in Mumbai have facilities to make their own pipes by wet casting.

The need for protection from H_2S corrosion is debatable. Instances of failure due to corrosion may vary from place to place and good operational practice may be sufficient to minimize acid attack.

1.1.5 Working Area Requirements

A limited space is required to stage a microtunnelling project, typically 350-500 m^2 – the largest space required will be at the drive shaft, receiving shafts are generally smaller. At the drive shaft additional space will be required for the processing and disposal of spoil; this may involve settlement tanks for slurry machine, a crane, a control cabin, pipe storage, vehicle access and support facilities like power generation and lubricant processing. A crane or gantry is used for lowering the machinery and product pipe into the drive shaft and for spoil removal. Overhead cables, buildings or trees should not restrict movement of the crane. The size of drive pit/shaft will depend on the size of the machinery employed, the length of pipe and the method of working. For a 1200 mm pipe a pit of 4 m x 7 m or shaft of diameter 4 m should be adequate, the receiving shaft used to recover the machine may be smaller say 4 m x 6 m. The DNH 2400 pipe may require a wider shaft 6 m x 8 m or 7 m diameter.

The drive/receiving pit may be constructed by sheet piling, by use of concrete caisson unit, by construction of a diaphragm walled shaft or a shotcreted shaft. The pit may be converted on completion to function as a manhole. In Europe, the use of pre-case caissons has become popular, standardizing shaft dimensions and influencing pipe and manhole design. Fabrication of similar pre-cast products in India should present no problem. Careful positioning and installation of the caisson shafts is required. The caisson becomes in effect the foundation stone of the new pipeline. Caisson units are designed with water proof seals and are bolted together in position and sunk as the spoil is

excavated. It is important to ensure that the caisson is truly vertical during the early stages of installation. The caisson must be designed to accommodate the thrust reaction force. The floor of the shaft must be sealed to the caisson and the structure prevented from floating or otherwise moving due to changes in ground water level.

For longer distance jacking a substantial thrust wall or thrust block will be necessary. Consideration must be given to lubricating pipes through injection point along the length of the drive by injection through the pipe wall. Intermediate jacking points enabling the full length of the drive to be move forward in sections will also be helpful to lengthen the drive, special interjack pipes with modified steel collars will be required for these stations. Limited numbers of drive pits/shaft, offsite pipe storage and coordinated spoil removal will significantly limit the congestion caused by site operation.

1.1.6 Ground Water

The ground water table in the proposed stretches ranges from 2.5 m to 10 m, thus ground water control will certainly be necessary and a gland wall seal or entry and exist lock arrangements will be needed when launching the machine. Furthermore, the probable ground water table will certainly be in the vicinity of the nala crossing, there will be ground water to deal with. Various dewatering options are available – sump drainage, ground water lowering and ground water damming by closed sheeting, caisson sheeting or other form of prefabricated sheeting. Ground water lowering by use of well pointing use of compressed air or other means should only be temporary measure because it can endanger shaft stability and adjacent structures; it can be used for example when placing the drive pit bottom or inserting or removing the machine.

1.1.7 Traffic Considerations

Inevitably there will be problems associated with traffic routing at the rail under bridge, Hazratganj junction, in front of the civil hospital (park road) and in the trenched reached. Some diversions and route planning will be necessary if working areas and access pits/shafts compromise traffic flow. However irksome this may be it will be significantly better than the disruption inevitable with open cut working, the impact of the working area being finite, temporary and minimal. Permits must be obtained in connection with working in the highway. Smooth progress with regard to the issue of such permits is essential to the execution of the micro-tunneling operations. It is customary practice for the client, in this case UPJN, to take responsibility for the grant of such permits as may be necessary. Permits will be needed for driving the sewer under the railway that bisects the proposed route; negotiations with the railway authority are understood to be particularly difficult and should be undertaken by UPJN by interaction between the agencies.

1.1.8 Contractor Experience

There is some pipe jacking and micro tunneling experience in India, particularly in Mumbai at this time, but local contractors wishing to bid for the relief trunk sewer will need to collaborate with overseas suppliers and equipment specialists to get the slurry shield microtunnelling machinery. A number of competent collaborators are either already active in marketing and the execution of initial projects but additional candidates from the Japan and US could be encouraged. It is however essential that the credentials of collaborative contractor teams are thoroughly checked and that the "experienced" staff is available at all critical times from planning through execution. The qualifications of staff must be properly documented giving full details of training and experience on similar projects and preferably in developing markets. Microtunnelling is a highly specialized skill; usually an engineer from the machine manufacturer can be available to ensure that local staff is properly trained, that equipment is properly used and maintained. Equipment suppliers providing training should be required to certify trainee competence after training and periods of supervised site experience. Technical visits by the product pipe manufacturer are also helpful particularly during product inspection and testing. These requirements could be written into the project bid documents.

1.1.9 Client Experience

Successful implementation of microtunnelling and other trenchless technologies and the establishment of an effective partnership between the UPJN and its suppliers depend upon an effective dialogue between the contractors and suppliers of technology and the Jal Nigam engineers. This dialogue is essential because there are few internationally recognized specifications available for trenchless technologies and the parties will have to develop a shared vision of the issues rather than fallback on a prescriptive relationship. A period of training is recommended for the executing engineering staff at all levels. A number of training organisations such as the UK's WTI and other specialist small consultants offer training packages, some leading to formal qualifications, other being simply familiarisation with the technologies. The depth of such courses is a function of the time and money invested by all parties concerned but they are nonetheless valuable if they can skill the engineers to interact with their contractors and particularly their overseas collaborators in regards to the operational issues thrown up by implementation of these technologies.

1.1.10 Programming

Sufficient time must be allocated for all essential operations, equipment and product supply and approval, sinking of shafts and caissons and machine maintenance and overhaul. Microtunnelling is a dynamic process, the transverse loads experienced by the pipe are time dependent, that is to say the pipe friction develops as the ground locks onto the pipe. For optimum working, every phase of the process must be conducted on schedule lest the machine or product pipeline still causing the contractor to abort the drive, construct an emergency shaft and excavate the machine. Delays due to breakdown or intermittent delivery of product pipe cannot be tolerated. The drive once commenced should be continuous until the machine arrives in the receiving shaft. This continuity of operation usually involves shifts working round the clock.

1.1.11 Method Statement

There are relatively few process and product standards available for the trenchless installation of pipelines and those that exist are limited in scope and inevitably are dated in respect to developing technology. Accordingly installation by trenchless means rely heavily on understanding between the supplier / contractor and the client or the clients the managing consultant. For the avoidance of doubt and the clarity of understanding the required to equitably resolve and adjudicate problems as they arise, clear documentation of the aims and objectives, goals and outcomes, and expectation of the parties is valuable at the precontractor stage. The client can reasonably be expected to have a simple and clear concept of expectation, for example a sewer line installed to line and level with specified performance characteristic. The contractor on the other hand as an understanding of the capability of the staff and their abilities to utilize their equipment to meet the clients needs in a specific environment, chosen by the client but unknown in detail to both parties. To facilitate this improvement dialogue, detail method statement and working procedures will be called for at the tender stage for discussion during bid evaluation.

1.1.12 Calculations

The contractor will be expected to submit calculations showing the maximum expected jacking force taking in to account the method face support, pipe frictional resistance, pipe weight, lubrication measures and the cutter characteristics, degree of over cut, soil type, groundwater, depth of cover, rate of advance, deviation from the line and level and steering measures. The pipe selected should be capable of carrying 300 to 400 % of this force without distress and thrust wall or caisson must also be capable of supporting this load with normal margins of safety. Jacking force should be monitored at all times: modern equipment has an automatic recording capability, at no time should the 80 % safe working load on the pipe be exceeded.

Appendix A 6.1 STP Design Spec

1.1 DESIGN SPECIFICATIONS FOR STP

1.1.1 Civil Works

Natural ground level of the treatment site is more or less flat with a moderate slope towards south i.e. Pandu river. Land area available at the western side of the identified plot is utilised for the proposed STP for Phase I.

(1) Design Loads

1) Dead Loads

Dead loads (D) shall mean the total weight of the structural components and/or foundations, all architectural appurtenances incorporated in the structure and all permanent externally applied loads. The unit weight of materials in general, shall be in accordance with IS:875. Also, the following unit weights shall be considered for the purpose of design.

- 6 mm thick chequered plate = 55 kg/sq.m
- 25 mm thick grating = 40 kg/sq.m
- Hand rail = 15 kg/sq.m

2) Live Loads

Live loads (L) shall mean, the total weight of moving or movable external loads on structures, buildings and/or foundations, produced by people, tools, furnishings of buildings, etc. which are not permanently fixed thereto.

However, weight for small equipments and miscellaneous facilities like following, which may be permanently fixed there to, shall be included in live loads.

- Local lighting facilities,
- Local instrumentation and electrical facilities and cables, and
- Local small pipings.

(2) Live loads on locations other than roofs

The design live loads shall be those appropriate to the actual situations but shall not be less than the following values.

Location	**Live Loads**
Office	400 kg/sq.m
Operating floors	500 kg/sq.m
Storage	750 kg/sq.m
Work shop light duty	500 kg/sq.m
Work shop medium duty	700 kg/sq.m
Work shop heavy duty	1,000 kg/sq.m
Platform	500 kg/sq.m
Staircase	500 kg/sq.m
Corridors	500 kg/sq.m
Walkways	500 kg/sq.m
Floor under conveyors	300 kg/sq.m
Kitchen, toilet	200 kg/sq.m

(3) Live Loads on Roof

i) Flat roof, sloping roof with slope < 10^o
a) With access : 150 kg/sq.m
b) Without access except for maintenance : 75 kg/sq.m
ii) Sloping roof with slope > 10^o

A	For roof membrane sheet or purlins	75 kg/sq.m less 2 kg/sq.m for every degree increase in slope over 10 degrees subject to minimum of 40 kg/sq.m
B	For member supporting the roof purlins such as trusses, beams and girders, etc.	2/3 of the load calculated in (ii) - (a)

(4) Wind Load

Wind loads (W) on plant buildings/structures shall be calculated in accordance with IS 875.
Reference : IS : 875 Part 3

(5) Seismic Load (S)

1) Reference : IS : 1893
2) Seismic zone : III
3) Basic seismic coefficient ( ) : 0.04
4) Importance factor (I) : 1.5
5) Seismic coefficient method (αh) : β I αo
where αh : Horizontal seismic coefficient
β : Soil foundation factor

(6) Equipment Loads

Equipment loads shall be defined as per the following three cases, according to the governing conditions of erection, operation and testing.

1) Equipment Loads for Erection

Equipment loads for erection (Ee) shall mean the weight of equipment during erection and exclude, the weight of internals, fluids and solids within the equipment, platforms, insulations and piping attached to the equipment.

2) Equipment Loads for Operation

Equipment loads for operation (Eo) shall mean the load of equipment during normal operating conditions, including the weight of internals, fluids and solids within the equipment and all materials permanently attached to the equipment, such as platforms, insulation and piping.

Vibration caused by operation of equipment shall be considered separately as vibration loads.

3) Equipment Loads for Testing

Equipment loads for testing (Et) shall mean the load of equipment during hydrostatic testing after erection/installation, including the weight of water within the equipment, piping and all materials permanently attached to the equipment, such as platforms, insulation and pipings.

(7) Piping Loads

Piping load (P) shall mean the weights of pipes, fittings, valves, insulations and the fluid contents of piping including the weight of cable ducts wherever installed.

Piping loads shall be assumed as the equivalent loads considering the pipe diameter and piping arrangement.

(8) Handling Device Loads

Handling device loads (H) shall mean the loads of cranes, hoists and lifts including the lifted weight in the normal operation

Handling device loads shall be increased with the following percentages to include adequate allowance for the following impact conditions.

1) Vertical Impact Loads

Frames supporting lifts and hoists	:	100%
Foundations supporting lifts and hoisting apparatus	:	40%
Vertical loads for electrical overhead cranes	:	25%
Hand operated cranes	:	10%

2) Horizontal Impact Loads

a. Overhead Cranes

Horizontal loads transverse to rails	10% of the maximum wheel loads of the crane applied at the top of rail
Horizontal loads along the rails	5% of all static wheel loads

b. Monorails

a) Transverse load : 20% of the lifted load
b) Longitudinal load : 10% of the lifted load, hoist and trolley

(9) Vibration Loads

Vibration loads (V) shall mean the vibration forces caused by heavy vibrating equipment or machinery and dynamic forces caused by fluids in the normal operation.

Frames, structures and foundations for machinery or equipment causing vibration shall be designed to limit vibrations to an acceptable level.

It shall be designed such that whether they are independent or part of the building, it shall not only safely carry the loads for such items, but also prevent resonance. Natural frequencies of frames, structures and foundations must differ by more than 30% from that of the machinery under operating conditions.

In the design of structures and/or foundations for the equipment and machinery with dynamic loads, the loads indicated by vendor in his documents shall be used. However, in the absence of such vendor data, the following loads shall be assumed as the equivalent static loads when the dynamic analysis is not carried out.

1) Reciprocating and Rotating (Centrifugal) Type

a)	Vertical direction	0.5 times the weight of equipment or machinery
b)	Horizontal direction	
i)	Along direction of rotation (perpendicular to centre line of shaft)	0.25 times the weight of equipment or machinery
ii)	Along direction of shaft axis	0.1 times the weight of equipment or machinery

(10) Thermal Loads

1. Thermal loads (T) shall mean, the forces caused by the thermal expansion or contraction of vessel or piping on the supporting structures and / or foundations. When the thermal expansion or contraction results in friction between the equipment and its support, the friction force shall be calculated in accordance with the following friction coefficients.

   - Steel to steel : 0.3
   - Steel to concrete : 0.4
   - Concrete to soil : 0.5

2. Pipe anchor points on pipe racks shall be designed in accordance with the actual anchor forces. These anchor forces shall be transferred to the appropriate resisting frames/bracing and foundations.
3. In the design of pipe supporting beams, the horizontal frictional forces exerted by expanding or contracting pipe or pipe racks shall be assumed by the 30% of the piping loads on the beams. These frictional forces shall not be transferred to the columns and foundations

(11) Earth Pressure

1. Earth pressure (Ep) shall mean pressure of the soil acting on the underground structures and / or foundations retaining walls, dikes etc.
2. Earth pressure at rest, acting on basement, trenches and pit shall be calculated from the following equations :
   a) Above ground water level
   $Pv = y\,ho + q$ (T/sq.m)
   $Ph = Ko\,Pv$ (T/sq.m)

b) Below ground water level

$Pv = yH1 + q + y1\ (ho-H1) + yw\ (ho-H1)$ (T/sq.m)

$Ph = Ko\ (yH1 + 1 + y1\ (ho - H1)) + yw\ (ho-H1)$ (T/sq.m)

where

Pv = Vertical soil pressure (T/sq.m)
Ph = Horizontal soil pressure (T/sq.m)
y = Unit weight of soil (T/sq.m)
ho = Soil depth from grade surface (m)
q = Distributed load on ground surface (T/sq.m)
H1 = Underground water level from grade surface (m)
y1 = Submerged weight of soil in water (T/sq.m)
yw = Unit weight of water (T/sq.m)
Ko = Ratio of horizontal to vertical pressure = $\tan^2 (45^o - Ø/2)$
Ø = Internal friction angle of soil = 30^o

3. Active and passive earth pressure acting on retaining wall shall be calculated from Coulomb's or Rankine's earth pressure equation.

(12) Liquid Pressure (LP)

1. Liquid pressure shall mean the pressure of liquid acting on the pit / basin structures
2. Liquid pressure shall be calculated by using the following equation

$P1 = y \times h1$ (T/sq.m)

where

P1 = Liquid pressure (T/sq.m)
h1 = Depth from liquid surface (m)
y = Unit weight of liquid T/sq.m

(13) Traffic Loads

Traffic loads for plant engineering and construction shall be defined according to the governing condition at the time construction. Unless otherwise specified, appropriate IRC (Indian Road Congress) loading shall be applied to the design of road crossing constructions such as drainage pipes and cable trench.

(14) Combination of Loads

1) Types of Loads

Unless otherwise specified, all loads listed herein, shall be considered in the design

D = Dead loads
L = Live loads
W = Wind loads
S = Seismic loads

Equipment loads (Ee, Eo, Et)

Ee = On erection condition
Eo = On operation condition
Et = On test condition
P = Piping loads
H = Handling device loads
V = Vibration loads
T = Thermal loads
Ep = Earth pressure
Lp = Liquid pressure

(15) Loading Combinations

Buildings, structures, foundations, and all structural components shall generally be designed for the following load combinations

Sr.	Load Combinations	Category of Loading Combinations
1)	Loading combinations for buildings	
	D + L + H	A
	D + L + H* + W	B
	D + L + H* + S	B
	D + W	B
2)	Loading combinations for equipment supporting structures **	
	D + L + Eo + P + H + T	A
	D + l + Eo + P + H* + R + W	B
	D + l + Eo + P + H* + R + S	B
	D + Ee + W	B
	D + L + Et + P + H*	A
3)	Loading combinations for pipe racks	
	D + L + P + T	A
	D + L + P + T + W	B
	D + L + P + T + S	B
4)	Loading combinations for equipment foundations	
	D + Eo + T	A
	D + Eo + T + W	B
	D + Eo + T + S	B
	D + Ee + W	B
	D + Et + 25% Wind	A
5)	Loading combinations for machine foundations	
	D + Eo + P	A
	D + Eo + P + V	A
6)	Loading combinations for sleeper and local support foundations	
	D + P + T	A
7)	Loading combinations for dykes, trenches and underground pits (***)	
	D + L + Ep + Lp	A

1) Notes

- A - Basic combination and no increase of allowable values shall be considered
- B - Combination considering wind loads/seismic forces or considering temporary erection. maintenance conditions
- (*) - Only dead load of handling device shall be considered in the design
- (**) - When the structural effect of the vibration loads are significant they shall be considered in the design.
- (***) - Traffic loads shall be considered, where required

(16) Load Factors for Limit State Design

Loads	**Item**	**Buildings (1)**				**Equipment Supporting Structures (2)**				
		Normal	**Wind**	**Eo**	**Stability**	**Normal**	**Wind**	**Eo**	**Erection**	**Test**
Dead loads	D	1.5	1.2	1.2	0.9/ ϕ 1.5	1.5	1.2	1.2	0.9 / ϕ 1.5	1.5
Live loads	L	1.5	1.2	1.2		1.5	1.2	1.2		1.5
Wind loads	W		1.2		1.5		1.2			
Seismic loads	S			1.2				1.2		
Equipment loads										
On erection condition	Ee								0.9 / ϕ 1.5	
On operation condition	Eo					1.5	1.2	1.2		
On test condition	Et									1.5
Piping loads	P					1.5	1.2	1.2		1.5
Handling device loads	H	1.5	1.2	1.2		1.5	1.2	1.2		1.5
Vibration loads	V									
Thermal loads	T					1.5	1.2	1.2		
Earth pressure	Ep									
Liquid pressure	Lp									

ϕ Value of 0.9 to be considered when stability against overturning of stress reversal is critical.

Loads	**Item**	**Pipe Racks (3)**			**Equipment Foundations (2)**				
		Normal	**Wind**	**Eo**	**Normal**	**Wind**	**Eo**	**Erection**	**Test**
Dead loads	D	1.5	1.2	1.2	1.5	1.2	1.2	1.2	1.5
Live loads	L	1.5	1.2	1.2					
Wind loads	W		1.2			1.2		1.2	1.5
Seismic loads	S			1.2			1.2		
Equipment loads									
On erection condition	Ee							1.2	
On operation condition	Eo				1.5	1.2	1.2		
On test condition	Et								1.5
Piping loads	P	1.5	1.2	1.2					
Handling device loads	H								
Vibration loads	V								
Thermal loads	T	1.5	1.2	1.2	1.5	1.2	1.2		
Earth pressure	Ep								
Liquid pressure	Lp								

Loads	**Item**	**Machine FDN (5)**		**Local FDN (6)**	**Dykes Trenches & U/G Pits (7)**
		Normal	**Vibration**	**Normal**	**Normal**
Dead loads	D	1.5	1.5	1.5	1.5
Live loads	L				1.5
Wind loads	W				
Seismic loads	S				
Equipment loads					
On erection condition	Ee				
On operation condition	Eo	1.5	1.5		
On test condition	Et				
Piping loads	P	1.5	1.5	1.5	
Handling device loads	H				
Vibration loads	V		1.5		
Thermal loads	T			1.5	
Earth pressure	Ep				1.5
Liquid pressure	Lp				1.5

(17) Safety Factors for Stability

All buildings, structures and foundations shall be designed, such that the safety factor shall not be less than the values mentioned before in any condition

Overturning : 1.5 during erection
: 1.5 during operation and testing
Sliding : 1.5
Buoyancy : 1.2

(18) Materials – Concrete

1) General

Unless otherwise specified in the drawings, material specifications shall conform to the following.

2) Cement

Cement used for all concrete works both above and below ground shall be ordinary Portland cement conforming to IS : 8112.

3) Aggregates

Aggregates used in the concrete works shall be locally available gravel or crushed stone conforming to IS : 383.

Unless otherwise specified, the maximum size of aggregates shall be as follows:

For large foundations and mass concrete	40 mm graded down (provided the pitch of reinforcement is more than 100 mm)
For others	20 mm graded down

4) Reinforcement

Reinforcement shall be high strength deformed bars and shall conform to IS: 1786.

5) Anchor Bolts

Anchor bolts shall be of structural steel quality conforming to IS: 2062.

6) Insert Plates

Insert plates shall be of structural steel quality conforming to IS: 2062 and shall be provided with mild steel lugs as per drawings/ standards.
Mild steel bars shall conform to IS: 432.

(19) Design Strength of Concrete

Unless otherwise specified, the design compressive strength of Cast-in-situ concrete at 28 days (conforming to IS: 456) shall be as follows:

Structural concrete (M 20)	200 kg/sq.cm
Liquid retaining structures (M 20)	200 kg/sq.cm
Paving (M 20)	200 kg/sq.cm
Grade slab (M 15)	150 kg/sq.cm
Leveling concrete (M 10)	100 kg/sq.cm
Filling / mass/ plum concrete (M 5)	50 kg/sq.cm

(20) Design Basis

1) Design Loads

1. Design loadings shall be as per design loads and shall be applied to the following
   - Design loads
   - Loading combinations
   - Safety factors for stability
   - Load factors for required strength
2. The calculation of stability and soil contact pressure of foundation shall be carried out on the basis of working load and allowable soil bearing capacity.
3. The resisting lateral force against the sliding of foundation shall generally be based on the friction force between the foundation and its supporting subsoil within factor of 0.5

2) Foundation Design Criteria

The foundation design criteria such as foundation depths, allowable soil bearing capacities, foundation settlement and soil design parameters shall be in accordance with relevant IS Codes and geotechnical survey report.

(21) Design Basis and Requirements

1. Framing systems shall be arranged so that the stiffness of structure can be well balanced and the structural stability can be secured
2. Expansion joints for the structure shall be provided every 45 to 50 meters in the longitudinal direction.
3. Structural analysis and section design shall be made in accordance with the applicable codes, standards and specifications and by using the authorised and approved methods.

4. In case of heavy and/or tall equipments installed on the reinforced concrete structure, the floor and beam arrangement shall be planned so that the firm anchoring and structural stability shall be assured.
5. Pits and basins shall be designed to withstand the water pressure, earth pressure, buoyancy and surcharge where required.

Pits and basins containing liquids shall be designed for both full and empty conditions and partition walls between compartments shall be designed for alternative liquid pressure on either side.

Dikes shall be designed to withstand the pressure of containing liquid for both full and empty conditions.

Liquid retaining structures shall be designed as per IS: 3370, with crack width criteria of 0.1 mm.

(22) Minimum Dimensions of Members

Member sizes shall be as per design requirements. However, minimum dimensions of structural members shall be as given below:

Grade slabs	150 mm thick
Floor slab (Non suspended)	150 mm thick
Floor slab (Suspended)	120 mm thick
Footings	200 mm thick
Underground pit/drain walls	150 mm thick
Water retaining walls	150 mm thick
Water retaining slabs (non suspended)	150 mm thick
Water retaining slabs (suspended)	120 mm thick
Columns and pedestals	230 mm width. 230 mm length
Beams	150 mm width. 300 mm depth
Insert plate	10 mm thick
Corner angle	8 mm thick

(23) Minimum Height of Plinth and Pedestals above Finished Grade Level

Building plinth	500 mm
Pedestals for structural columns	300 mm
Stair pedestals	200 mm
Ladder pedestals	200 mm
Equipment including pump etc.	300 mm

(24) Minimum Cover to Main Reinforcement

Reinforcement shall have concrete cover not less than twice the diameter of bar end. Minimum cover to main bar shall be:

1)	Slab	: Free face	25 mm
		: Face in contact with earth	30 mm
2)	Beam	: Top/Bottom	40 mm
		: Side	30 mm
		: Face in contact with earth	40 mm
3)	Column and pedestal	:Super structure	40 mm

		Face in contact with earth	40 mm
4)	Retaining wall	:Face in contact with earth	40 mm
	Basement and pit wall	:Free face	40 mm
5)	Liquid Retaining	:Face in contact with liquid	40 mm
	Structure :Face in contact with earth		40 mm
	Free face		40 mm
6)	Plinth beam	:Top and side	30 mm
		:Bottom	40 mm
7)	Foundation:	Bottom	50 mm
		:Top	50 mm

8) The above requirements shall not be applied to concrete construction of trench, local foundation, minor platform foundation, sump pit/manhole, paving and other miscellaneous concrete construction, for which minimum cover shall be 25 mm.

9) Minimum Bar Diameter

Major foundation	10 mm
Block foundation – main bars	10 mm
Block foundation – tie bars	8 mm
Minor foundation (local foundation etc.)	8 mm
Column, pedestal – main bars	12 mm
Column, pedestal – ties	8 mm
Beam – main bars	12 mm
Beam – anchor bars	10 mm
Beam – stirrups	8 mm
Slab – main bars	8 mm
Slab – distribution bars	8 mm
Wall – main bars	8 mm
Wall – distribution bars	8 mm
Minor elements such as chajjas, lintel beams etc.	8 mm

10) Bar Spacing[1]

	Minimum	**Maximum**
Foundations	125 mm	200 mm
Slabs	100 mm	300 mm
Stirrups for beams	100 mm	300 mm
Ties for columns, pedestals	100 mm	300 mm
Walls	100 mm	300 mm

(25) Foundations

1. Foundation shall be proportioned in such a way that the allowable soil bearing capacity is not exceeded and the resulting settlement is within the acceptable limit.
2. All major foundations shall be placed below the natural ground level even in places filled up during the site preparation.
3. Foundation sizes and depths shall be planned considering subsurface conditions and surrounding underground constructions such as adjacent foundations, underground pipes and cables, trenches, pits, roads as well as the slope of ground.

[1] Bar Spacing shall be provided in multiples of 25 mm

4. Isolated footing shall be planned for each foundation. However, where adjacent footings interfere with each other, combined footing may be provided.
5. Where applicable the elevation of foundation top shall be in accordance with the process, mechanical and piping requirements.

1) Foundations for Rotating and Reciprocating Equipment

1. Foundation for rotating and reciprocating equipment such as turbines, engines, compressors and generators shall be designed to secure the dynamic stability of the foundation system, as well as the static stability.
2. Dynamic stability for foundation supporting heavy vibrating equipment like the following shall be secured by dynamic analysis in general :
   - Heavy vibrating equipment
   - Equipment sensitive to vibration
   - Equipment causing large dynamic force

Unless otherwise specified foundation design shall follow general criteria indicated below :

Criteria		**Application**	
Dynamic analysis	Allowance amplitude2	Rotating	: P ≥ 400 kW
	Natural frequency of foundation	Reciprocating	: P ≥ 100 kW
	Natural frequency of foundation	Rotating	: P ≥ 100 kW
		Reciprocating	: P ≥ 40 kW
Foundation weight control	More than 3 x equip. Weight	Rotating	: P < 100 kW
	More than 5 x equip. Weight	Reciprocating	: P < 40 kW

P = Rated Power output of equipment (unit kW)

(26) General Requirements for Design

Following requirements shall be taken into account for foundation design in principle:

1. Foundation for heavy vibrating equipment shall be kept independent of building floors/foundations and other adjacent foundations.
2. Foundation weight shall be at least three times the weight of the rotating equipment and five times the weight of the reciprocating equipment
3. Foundation shall be of uniform rectangular/square shape.
4. Beams and columns of foundations shall be of uniform rectangular/square shape.
5. The horizontal eccentricity, in any direction, between the center of gravity of the machine - foundation system and the center of base contact area, shall be within 5%.
6. The geometric layout of the foundation and structure shall be basically symmetric with respect to the vertical plane passing through the rotational axis of the equipment.
7.

(27) Dynamic Analysis

1) General

Dynamic analysis shall be performed by suitable and approved method so that dynamic features can be evaluated correctly.
The following effects shall be taken into account:

[2] If the Suppliers requirement is available, it shall be considered

- Dynamic features of subsoil
- Dynamic features of supporting foundation system
- Dynamic effect of the foundation system
- Dynamic forces of equipment

2) Data of dynamic load to be used for the dynamic analysis, shall be supplied by equipment supplier and shall state unbalanced force due to :

- Eccentricity of dynamic mass of rotating equipment
- Different crank arrangement of reciprocating equipment

3) Evaluation of Dynamic Analysis

Frequency Ratio
Wherever possible the natural frequency of the foundation soil-system shall be higher that the highest disturbing frequency and the frequency ratios shall be less than 0.7. Where this is not possible, the natural frequency of the foundation soil system shall be kept lower than the lowest disturbing frequency. The frequency ratio in such cases shall not be lower than 1.50. While the above criteria shall be applied to all possible modes of vibration, it may be permitted to operate machines closer to the resonance in certain modes of vibration provided the resulting amplitudes do not exceed the permissible limit.

4) Allowable Amplitude Due To Dynamic Load

Amplitude of the foundation systems for vibrating equipment shall be calculated through dynamic analysis by using dynamic analysis by using dynamic load supplied by supplier and the allowable amplitude shall conform to supplier's requirement.
If supplier's requirements on amplitude are not specified, following criteria shall be applied. The amplitude of vibration of the foundation in any direction, at any point in the foundation of structure shall be such that, it will fall down the zone ACC' for the specific exciting frequency.

(28) Design Details

1) Anchor Bolts

1. In case of no tension load in the anchor bolts of equipment such as small towers, tanks, heat exchangers, pumps, blowers, compressors, etc. Anchor bolts shall generally be set in anchor boxes unless embedment is required. Minimum distance between the inside surfaces of the anchor boxes and the outside surface of the foundation shall be 75 mm.
2. In general, anchor bolts for structural steel columns are embedded into the pedestal.
3. Anchor bolts for heavy towers, which are subject to pull out force, shall be embedded into the foundation at the time of placing concrete using templates.
4.

2) Grouting

1) Unless otherwise specified by equipment manufacturers, top of foundations except for local foundations shall be provided with an allowance for grouting as specified below:
   a) Foundation for large heavy duty compressors, generator, etc. 50 mm
   b) Foundation for big towers (>20 m) 50 mm
   c) Other foundations 30 mm
2) All grout shall bee composed of one part cement and two parts clean sand. Grout material for heavy rotating machines shall be used in accordance with manufacturer's requirement where required.

(29) Foundation for Steel Structure

1. Generally tops of all foundations except for local foundation shall be provided with grouting of 30 mm thickness
2. All grout shall be composed of one part cement and two parts clean sand unless otherwise specified.
3.

(30) Covering for Pit/Basins

1. Open pits and basins without roofing or covering shall have safety railings. Stepladders shall also be provided for the pits and basins having a depth of more than 1.0m.
2. The minimum 600 mm diameter cover for access, shall be provided for Pits and Basins.

(31) Materials - Structural Steel

1) Design Basis and Requirements

1. Framing and bracing shall be planned so that the stiffness of the structure can be well balanced with the loads and the structural stability can be secured.
2. Vertical and horizontal bracings shall be arranged properly, considering the following requirements :
   - Plant layout
   - Equipment
   - Piping arrangement
   - Structural layout/construction, operation & maintenance requirement

   The vertical bracings furnished for lateral stability of structure may be knee braced, diagonal or "V" type and shall satisfy clearance and rigidity requirements.
3. Expansion joints for the structure shall be provided every 45 to 50 meters in the longitudinal direction
4. Structural analysis and members selections shall bee made in accordance with the applicable codes, standards and specifications and by using the authorised and approved methods

2) Bolt Holes

Bolt holes for structure bolts shall be as follows, unless otherwise specified on drawings.

a) Ordinary bolts : D + 2 mm
b) Anchor bolts : D + 5 mm

Where D = Nominal bolt diameter

3) Minimum Size of Structural Members

Columns, framing beams	:	ISMB 150, ISMC 150.
Bracing members	:	ISA 50 x 50 x 6
Column base plate		
For major structure	:	16 mm thick
For minor structure	:	12 mm thick

4) Gusset Plate

Thickness of gusset plate shall be a maximum of the followings:

a) Thickness required by design
b) mm

5) Connections

Unless otherwise specified.

1. Shop connections shall be welded and all welds shall be continuous structural welds. Where galvanizing is specified, seal welding is required at all shop connections prior to hot-dip galvanizing.
2. Field connections shall be bolted connections for all main framing and bracing members.
3. Field connection for ladder, handrails, post, stair stringers, removable members, platform framing members shall be made with black colts.
4. Bolted connection for structural members shall be made, with at least two bolts except for lacing bolts, where it may be with single bolt.
5. High tensile friction grip bolts shall be used for connections subjected to repetitive cycles of loadings.

6) Stopper to Hoist Beams

Removable stoppers, fixed with ordinary black bolts shall be provided on both sides of hoist beams.

7) Column Base

Steel column bases shall be designed to transfer all loads to the foundations or to the supporting reinforced concrete structure.

8) Deflection

Pipe Rack and Equipment Supporting Structure

Allowable deflection of beams and columns, to support pipe and / or equipment directly during normal operation, shall be as stated below, in fraction of the supported span of the beam.

i. Pipe rack beams	:	1/325 or less but not more than 30 mm
ii. Equipment supporting structure		
Equipment supporting beams	:	1/400 or less but not more than 30 mm
Other beams	:	1/325 or less but more than 30 mm

iii. Horizontal sway at top of column of each storey

For open framed structures	:	Height 1/200
For cladded structures	:	Height 1/400
iv. Cantilevers	:	1/250 but more than 20 mm at end

Crane Girders

Allowable vertical and horizontal deflection of girders for traveling cranes during normal operation, depending on types, shall be as stated below, in fraction of the supported span of the girders.

i) Hand operated crane	: 1/500
ii) Electric overhead traveling crane upto 50 T	: 1/750
iii) Electric overhead traveling crane over 50 T	: 1/ 1000
iv) Other moving loads such as charging cars	: 1/ 600
v) Monorails and hoist beams	: 1/500
vi) Joist	: 1/ 325
vii) Purlins, furring strips	: 1/200

(32) Floors, platforms and walkways

a) Platform and walkways shall be minimum 900 mm wide and shall be made of chequered plate flooring or grating flooring as specified in the drawings.
b) The minimum clear headroom over platforms and walkways shall be 2100 mm to the lowest point of overhead structural framing or equipment. This clearance may be reduced to 1800 mm locally for Support beams when structurally required.
c) Chequered plates shall be 6 mm thick.
d) Floor gratings shall typically be pressure locked or pressure welded type steel grating with bearing bars 25 x 5 mm x 30 centers with secondary cross bars 12 x 5 mm x 75 mm centers. Serrated style grating shall be used for stair treads. Landing and stair treads shall have full width chequered round nosing plates.
e) Openings more than 200 mm diameter on the floors, shall be guarded by surrounding toe plates of flat bar 100 x 6 mm.
f) Drip holes having 10 mm diameter shall be properly arranged on the chequered plate flooring of outdoor platforms and walkways.
g) High elevation platform and walkways around equipments (towers, tanks, etc.) shall be described in vessel standard and/or other engineering specifications.

(33) Staircases

a) Staircase shall be minimum 900 mm wide and shall be made of channel stringers with grating treads.
b) Unless otherwise specified, staircase shall have risers of not more than 200 mm and treads not less than 250 mm.
c) The vertical rise of stairs shall not exceed 4.0 m for the single unbroken flight.
d) The minimum length of landings shall be 900 mm in the direction of stairs.
e) The vertical clear headroom over stairs shall be 2100 mm.

(34) Ladders

a) Ladders shall be minimum 450 mm wide and shall be made of stringers with 20 mm diameters. MS rungs at 300 mm intervals.
b) The flight of Ladder without the intermediate platform shall not exceed 9 m.
c) Ladders over 4.0 m in height or originated from a point, which is 4.0 m or more above grade, shall be provided with safety cages, originating 2.1 m from the bottom.
d) Ladder access openings shall be provided with the safety chain.

(35) Hand Rails

a) Platform, walkways and stairs located 1 m above grade or floor shall be provided with handrails consisting of top rails, posts, mid-bars and toe plates.
b) Handrails shall be 1025 mm high.
c) All projecting cut edges on top rails be rounded to smooth finish

(36) Geotechnical Information

Five numbers of boreholes were taken at the identified site of Panka STP. The same data is used in the design of foundations.

(37) Reference

a) IS: 456 – 2000 :	Code of practice for plain and reinforcement concrete (Incor. amendment no.1) (third revision)
b) IS:3370 – 1967 (Parts I to IV)	Code of practice for concrete structures for the Storage of liquids
c) IS:269 – 1979	Specification for ordinary, rapid hardening and low heat Portland cement.
d) IS:875 – 1987	Code of practice of design load for building and structures (parts I to IV)
e) IS:1786 – 1979	Specifications for high yield deformed bars
f) IS:1893 – 1984	Criteria for earthquake resistant design of structures (fourth revision)
g) IS:4236 – 1993	Specification for earthquake resistant construction of building (second revision)
h) IS:1904 – 1986	Specification for design and construction of foundation in soils
i) IS:800 – 1984	Specification for general construction in steel
j) IS:2974 – 1979	Specification for design and construction of machine foundations
k) IS:13920 – 1993	Ductile detailing of reinforced concrete structures subjected to seismic forces
l) SP:34 (S&T)-1987	Handbook on concrete reinforcement and detailing
m) SP:16(S&T)-1980	Design aids for reinforcement concrete to IS:456 – 1978
n) SP:24-1983	Explanatory handbook on IS:456 – 1978
o) C.E.Reynolds	Reinforced concrete designer's handbook by J.C.Steedman
p) Jai Krishna	Plain and reinforced concrete Volume I & II – O.P Jain

1.1.2 Mechanical Works

The mechanical equipment consists of screens, grit removal mechanism, aerators, pumps, etc. The equipment is selected to suit the performance requirements and the prevailing site conditions. The requirements of mechanical equipment are described here under.

(1) Aluminium Gates

For the control of the flow and for maintenance of the mechanically raked screens, rising spindle aluminum gates are provided. The gates shall be single faced, rising spindle, flush bottom closing, wall mounted flange back frame. Aluminum sluice gates suitable for seating water head of 1.5m and mounting on the flat face of a wall, water sealing at two vertical sides, top an bottom side of gate frame by means of neoprene rubber seal fitted in gate aperture and having forced contact with gate slide, to be provided with aluminum frame and shutter, SS 304 spindle to suit distances as specified in the bill of quantities. All fasteners shall be in SS 304 and anchor bolts, EPDM rubber seals, SS 304 rubber seal retainer bars, CI stem guide bracket, SS 304 coupling, CI manually operated head stock.

(2) Screens

At STP, there will be six screen channels, each of 1800 mm width and 1000 mm liquid depth. Four channels are working which are provided with mechanical screens and two channels are standby which have manual screens. The mechanical screens will have 6mm clear opening and manual screens will have 12 mm clear openings.

1) Specifications of Mechanical Screens

Each mechanical screen shall mainly consist of the screen surface (bar screens), rotor arm (raking arrangement), chute and a drive system.

The frame is rigidly framed on all ends and anchored to the RCC channel top surface and to the bottom of the channel. The frame is curved in shape the curvature radius will match the rotor arm tip radius. The entire channel width and depth will be covered by the screen surface.
The rotor arm assembly will be placed on the inlet side of the screen. The rotor consists of two main Bearing Blocks having an axle running in their journals across the channel. Two rake arms at 180 degrees to each other, fixed to the axle, shall carry the retriever combs made of cast steel. The outer radius of the combs shall match the radius of the screen surface and the combs will engage into the bars to carry the trapped screenings to the top end of the screen. The bearing blocks are anchored to the RCC channel, parallel to the screen surface.

The cleaning rake will be revolving rake type with four steel combs. The rake will be suitably sized for heavy duty and shaped to effectively clean the bar screen. The sprocket chain will be split type. The screenings is to be dropped on conveyor about 600 mm above the top of the screen channel.
The chute shall be placed on the outlet side of the screen surface, near the top end and shall receive the screenings through an interceptor plate from the rotor arms combs. The client shall have to either place a conveyor belt to receive the screenings or have a mobile trolley under the chute.
The drive system operates the axle and correspondingly the rotor arms. The system consists of a motor of required HP driving a reduction gearbox, which in turn drives another gearbox through chain and sprocket transmission to obtain the desired RPM on the rotor. The system is assembled over a base frame that is anchored to the RCC channel top near the rotor.

The drive machinery includes TEFC motor, speed reducer, head shaft, etc. All fasteners will be of SS 316. All the steel structures shall be sand/ball blasted to near white and painted with two coats of zinc rich primer followed with two coats of epoxy paint.

The bar screens are fabricated from 50 mm x 10 mm mild steel flats spaced at required clear opening as mentioned above and fixed at an inclination of 75° to the structural steel frame work such that all bars project on upstream side and teeth of the rake engages within the clearances of the bars without hindrance.

A dead plate of not less than 6 mm thick is provided from top of the bar screen to prevent falling of screenings in the channel. It shall have pivot plate at the bottom for preventing jamming of bottom shaft. The complete unit above the floor will be totally enclosed with hinged clean out and inspection doors.

2) Conveyor

A common conveyor is provided for collecting screenings from four mechanised fine screens and will drop the screening in a trolley type container kept at one end of the conveyor for taking out the screening for disposal. The conveyor will also cover manually cleaned screen channel. The screening from manual screens will be put on conveyor manually.

Each assembly of conveyor will consist of two pulleys with their shaft and bearings for driving the belt and idler pulleys for supporting the belt. The upper level idler pulleys will have three roll twenty degree roughing idlers. The bottom level idlers for belt return will be flat roll-type.
At the end of the belt drive, an adjustable scrapper is provided on the screening hopper for diverting the screening through hopper to the container

The belt material will be two - ply nylon or equivalent with 3 mm neoprene covering on carrying side and 0.75 mm neoprene covering on pulley side. The speed of the belt will be between 25 m to 30 m per minutes. The width of the belt will be 750 mm

The power transmission will be by means of TEFC motor coupled to the reduction gears. The gears will have service factor of 2.

The whole conveyor will be supported on steel structure over the screen channel.

(3) Grit Chamber

Two grit chambers are provided for grit removal. It has a rotating grit scraping mechanism, adjustable influent deflector, reciprocating rake mechanism to remove the grit and organic return pump. The grit scraping mechanism shall have fixed bridge with rotating scrapper arms. The scrapper arms will have adjustable squeezes, which will scrap the grit to the grit sump. An overload alarm is provided. This arrangement will trip the machine in case of overload.

Suitable classifier mechanism along with the organic return pump will be provided. The reciprocating rake mechanism will lift the grit up. The reciprocating rake mechanism will be installed at about 35^{o} inclination. Chute is located at the top, through chute grit will fall to the ground/container, for further disposal. A grit cleaning arrangement is provided to remove organic particles from the grit and is pumped back to the inlet by an organic pump.

(4) Sludge Pumps

There will be two sludge pumping stations to pump out the sludge to sludge drying beds. Each sludge pumping station will have two pumps, one working and one standby. The required capacity of these pumps is 50 cum/hr so that sludge withdrawal from all reactors is completed during general shift of eight hours, with sufficient safety in operating time. The operating head of the pump will be 10.0 m. The sludge volume to be withdrawn from UASB reactors is approximately 563 cum/day.

The sludge pumps will be of centrifugal, non-clog submersible cavity type. The specifications are mentioned in the following table.

1	Liquid	Sludge
2	Capacity	50 cum/hour
3	Head	10.0 m
4	Solids size	40mm hard, incompressible 80mm soft, compressible
5	Temperature	Ambient
6	Specific gravity	1.1
7	Installation type	Fixed
8	Casing material	2.0 - 2.5% Ni CI
9	Impeller material	CF 8M
10	Motor body	CI IS 210 Gr FG 260
11	Seal cover	CI IS 210 Gr FG 260
12	Shaft	AISI 410
13	Guide pipe and chain	SS 304
14	Top cover	CI IS 210 Gr FG 260
15	Motor rating	30 kW
16	Motor RPM	Less than 980
17	Rated voltage	415 V
18	Frequency	50 Hz

The pump will have automatic coupling arrangement at discharge end for removal and refixing of the pump from top. A guide pipe/wire rope will be provided for smooth removal and lowering of pumps.

(5) Floating Type Aerators

8 nos. of 50 HP aerators are provided in the first compartment of facultative type of aerated lagoon. The purpose of aeration is for removal of anerobicity of the effluent and also for removal of residual BOD and sulphides present in the effluent from UASB reactor. These aerators will be of slow speed. The aerators will have minimum capacity of 1.5 kg oxygen/kWh oxygen transfer under field condition. The aerator will be fabricated from mild steel sheets of not less than 3 mm. The aerators will be dynamically balanced. The gears will be helical-type with service factor not less than 2.

The motors will be with TEFC enclosure. The aerators will be sand/ball blasted and will be epoxy painted after applying zinc rich primer.

Aerator are provided with helical gear box with a service factor of 2, casing in horizontal split condition with integrally cast mounting blocks with casing to facilitate 150mm adjustment of aerator cone in water. Also, aerators are provided with dry well arrangement on output shaft to make the output end of gear box leak proof.

Mounting studs with lock nuts and fasteners shall be in SS304

Rectangular/circular floats shall be in MS duly FRP coated with 4mm FRP lining thickness, hydraulically tested with mounting platform and handrails. The floats will be filled with polyurethane foam and will have ballast compartment at both ends to fill the ballast made up of RCC cubes to stabilise the floating aerator operation in water.

Mooring arrangement of nylon rope of sufficient length to secure floating aerator with RCC column shall be provided. Each float will be provided with lifting hooks and hooks for connecting mooring arrangement.

(6) Monorail Trolley and Chain Pulley Block

Monorail trolley and the chain pulley block will be provided for lifting of sludge pump. The trolley and the chain pulley block will be hand driven. The capacity of trolley and chain pulley block is 1 tonne, which is sufficient to remove complete pump set.

The trolley will be gear-less and will have four wheels to run on the lower flange of the rolled steel joist. The wheels will be of carbon steel casting. The trolley will have arrangement to fix the chain pulley block.
The chain pulley block will have spur type gears, load sheave, brake unit, hand chain wheel, loan chain wheel and hooks for suspension on monorail trolley and load.

(7) Biogas Holder

The biogas produced is to be utilised for power generation using fuel engine generator. The expected maximum gas generation will be about 1000 m^3/day. The capacity of biogas holder is provided for its storage for 6 hrs of retention time. The generation will depend on ambient temperature. To have uniform supply of required gas for power generation a gasholder has been included. Provision has been made for flaring of gas if there is excess.

The gas produced in the UASB reactors is to be led to the gasholder through a moisture trap and gas flow meter. The tap-offs are provided after the gas pipe enters the gasholder, one going to the generator room for supply to dual fuel engines and the other to the gas flaring equipment.

The biogas holder will be of the wet type with a sealing of water. The biogas holder would be a RCC circular structure. The gas dome would be fabricated from mild steel plate having minimum 6 mm thickness. Guide rails embedded in RCC structure facilitate the vertical movement of the gas dome. The gas dome surface shall be coated with 350-micron thickness.

One pressure release valve will be provided at the top of the dome, which will open out when the level reaches 100% value. One high-level limit switch will be provided at 95% to give an audible alarm signal in the control room.
At low-level, say 20%, the running engines will be shut off and the biogas holder will be allowed to rise again. However, in case of heavy leakage, or otherwise, if the level goes to a very low level of say 5%, the vacuum breaking glass will break and will prevent the biogas holder from any damages due to vacuum condition.

(8) Chlorine Mixer

Mechanical chlorine mixers suitable for a tank of size of 7.5m x 7.5m x 2.5m SWD are required. These mixers shall comprise of a suitable reduction gear box of worm wheel type driven by a 5 HP motor. It shall have turbine type impeller in SS 304 with output speed of 36 RPM.

(9) Gas Scrubber Unit and Gas Blowers

The biogas produced from the reactors contains corrosive gas H_2S at about 1% concentration and is at a very low pressuring (100 to 250 mm water column).
The biogas has to be supplied at 0.4 kg/sq.cm to the gas engine. H_2S content in the biogas shall be less than 0.1%. Thus the biogas needs to be pressurised and H_2S is to be reduced to less than 0.1%. The biogas consumption is about 135 cum/hr at full load. The gas scrubber and blower system is designed for 135 cum/hr.

First, H_2S is removed in scrubber. In the scrubber, the H_2S containing gas is contacted in counter current mode with a scrubbing liquid. Absorption of H_2S occurs in the scrubber under certain specific conditions and a chemical reaction with metal ions takes place.

H_2S when dissolved in aqueous medium is ionized to H+ and S^{2-}. The sulfur ions can be oxidized by polyvalent metal ions, such as those irons, which can exist in ferric (Fe^{3+}) or Ferrous (Fe^{2+}) form. When sulphide ion comes in contact with ferric ion, it is oxidized to elemental sulfur and gets precipitated. The ferric ion is in turn reduced to ferrous form. This reaction can be written as

$2Fe^{3} + S^{2-}$
$= \quad 2\ Fe^{2+} + S$

The ferrous ions can later be oxidized to ferric ions by reaction with oxygen in the atmosphere air. The oxidation of ferrous ion can be written as

$$4\ Fe^{2+} + O_2 + 4\ H^{+} = 4\ Fe^{3+} + 2\ H_2O$$

A root type blower has been considered to increase the pressure and since the engine may run at different times the biogas pressure is raised upto 1 kg/sq.cm and stored in a pressure vessel. The blower will operate on pressure switches and will be generally operated when biogas pressure in the pressure vessel drops below 0.6 kg/sq.cm and will stop as soon as the pressure develops to 1 kg/sq.cm. Since raising of gas pressure increases the temperature of the gas, an after cooler is provided. The cooling of the blower and after cooler will have cooling tower and cooling water pump.

(10) Biogas Flaring System

Gas flaring system will be installed to burn excess biogas generated at the STP. The burning capacity of the flare will be 250 cum/hr. The biogas flaring system will consist of the following:

- Moisture separator
- Flame arresters on pilot and main gas burner
- Non-return valve
- Pressure relief valve
- Flare gas burner (6m height from ground level)
- Pilot gas burner with push button ignition complete with ignition electrode
- Fusion plug

(11) Pure Gas Engine

1) Working Principal

A pure gas engine is has a conversion kit to run the engine with biogas. Gaseous fuel is added to the air, which is included at air intake manifold or before turbocharger. This mixture of air and gas is compressed in the cylinder just as air compressed in normal IC engine.

2) Components for Pure Gas Engines

- Gas engine
- Governor
- Direct coupling between alternator and the engine
- Air filtration
- All mountings shall be anti vibration type
- Gas train consisting of solenoid valve, regulator, low/high pressure switch, and filter
- All necessary safety measures
- Necessary accessories
- Alternator of required rating
- Fabrication of gas piping between regulator and gas control valve and air intake connection

The following aspects on auxiliary and utility system shall be taken into consideration for gas utilisation systems:

- Inlet air system,
- Filter or duplex filter to be located at an elevated position to prevent ingress of dust,
- Air inlet silencer, and
- All piping, ducting, supports, instrumentation and control.

3) Exhaust Gas System

Ducting with thickness 6mm, expansion joints upstream and down stream of turbocharger (if provided), silencer insulation etc. stack leading outside the building at safe height from ground level.

4) Safety Requirement

1. Anti vibration mounting for engine and alternators.
2. Enclosure ventilation/ cooling fans with drives.
3. Enclosure lighting
4. Inspection opening in the frame to permit easy inspection of the driving gear, lube oil pump, bearing etc.
5. Gas and fire detection system.
6. Explosion valve in DG room maintenance doors.
7. Crank case explosion relief valve.
8. Compression relief valve.

5) Cooling Water System

The cooling water system shall consist of the following:

1. Primary and secondary cooling water system (closed cycle) for engine cooling, lube oil cooling (if applicable) start up air compressor cooling (if applicable) etc.
2. For primary circuit, one CW pump shall be engine driven. During standby conditions, the engine jacket water shall be kept warm by means of thermostatically controlled electric heaters.

(12) Fire Fighting

Suitable number of portable extinguishers CO_2 and dry powder type shall be provided for all pump house, gas engine room, electrical and control room at strategic locations as per Indian tariff, advisor committee rules/ NFPA standards.

(13) Maintenance of Crane/ Hoists

Composite hoist double girder electrically operated overhead crane shall be provided for gas engine room.

(14) Ventilation Fans

Suitable number of ventilation fans shall be provided in gas engine room.

(15) Lube Oil System

- Motor driven pre-lube pump
- Duplex lube oil filter.
- Oil mist pipe leading to atmosphere at safe height.

- Lube oil centrifuges if necessary.

(16) Specific Requirements

1. All equipment and plant shall conform to the provision of statutory and other regulations in force in India and/ or in the state of Uttar Pradesh and local municipal authority such as Indian electricity act., Indian explosives act., Indian electricity rules, Environmental rules, obtaining of all permissions and approvals from the statutory authorities shall be the responsibility of the contractor.
2. All electrical and instruments in fuel gas and fuel oil system shall be flame proof/ intrinsically safe type/ increased safety type as per statutory rule prevailing in India.
3. All gas vent/ relief valve discharge shall be led to atmosphere at safe height.
4. Suitable drain and vents with valve shall be provided at lowest and highest points as per site layout.
5. All high temperature piping and ducting shall be insulated to keep outside surface temperature at 60^{o}C (worst ambient temp).
6. Level switches shall be provided in gasholder for automatic operation of gas burners.
7. All gas vent line shall be provided with flame arrestor.
8. Cooling tower shall be provided for cooling and shall be designed for total load arising from charge air cooling, lube oil cooling and engine cooling, booster compressor and re-circulation gas compressor cooling (if applicable).
9. The power generation plant shall be designed so that quality of liquid effluent if any shall meet the requirement of IS :2490.
10. All controls (electrical/ pneumatic devices) have failed safe features with redundancy as per good engineering practice.
11. All atmospheric tanks shall be designed to IS:803 or equivalent.
12. All pressure vessels shall be designed as per ASME SEC-VIII or IS-2825 or equivalent.
13. Pure gas engine alternator shall be packaged skid mounted type.
14. Generator plant shall be continuously rated and shall be suitable for black start. In particular the engine set shall be capable of start-up and running without water supply system for a minimum period of three (3) minutes for achieving black start.
15. All pumps in power generation package shall have 50% or minimum one stand by.
16. Generator shall be able to start when room temperature is 4 deg cel.
17. All valves in fuel oil shall be of welded construction. All drain and vent valves in lube oil line shall be lockable type. Lube oil lines after filters upto bearings shall be of stainless steel. Oil cooler tubes shall be of stainless steel.

(17) Instrumentation and control

Each generator unit shall be provided with complete instrumentation and control system for safe and reliable operation. The standard instrumentation and control system shall include the following relay based control

1. Pressure and temperature gauge for lube oil, primary and secondary CW, fuel oil, fuel gas, inlet and out let of engine, heat exchangers/ coolers, exhaust gas temp. outlet from cylinder and turbo charger (if applicable), pressure gauge for each pump discharge.
2. Gas flow meter inlet to engine.
3. Fault detectors with pressure and temperature switches for status indication, alarm and trip for high CW temperature, low lube oil pressure, high lube oil temp., high charge air temp. (if applicable) high and low fuel oil level in service tank, gas pressure low, low fuel oil pressure, makeup/ expansion water level low, pre lube oil pressure, high charge air temp., fire alarm, gas detection, air starting OK, vibration detection, over speed , over voltage , control air, pressure low, crankcase pressure abnormal starting fault, engine exhaust temperature - high and low etc.
4. Engine speed, running hour meter, watt meter etc,

5. Emergency stop-push button, auto manual selector switch.
6. Differential pressure gauge across lube oil and fuel oil strainer.
7. All tanks shall be provided with level gauge. Level switches shall be provided for fuel oil tanks.
8. Emergency shutdown provision acting on signal from gas detection equipment.
9. Thermostatic control in lube oil and CW system, charge air circuit by-pass shall be provided to control lube oil and jacket water temp.

(18) Layout

Layout of the powerhouse shall be developed to ensure operability maintainability and conformity to good engineering practice and suitable for future expansion. Suitable lay down area shall be provided for maintenance in powerhouse at one end. Necessary statutory clearance shall be observed while locating HT equipment and fuel oil installation.

Suitable platforms, walkways, stairs and handrails shall be provided for access and walk space for operation. Separate electrical room annex in engine room shall be provided for housing electrical equipment and panels. Space for office shall be provided adjacent to electrical room.

Necessary access to all on base equipment i.e. lubes oil console, fuel oil tanks, CW console etc. shall be provided. Space will be required for all heat exchangers.

Space provision in electrical equipment placement shall envisage safety clearances as per factory rules and IS rules as well as adequacy of same for maintenance, testing and data logging for panel boards, generators transformers and cabling.

1.1.3 Electrical & Instrumentation Works

The electrical system design for STP is based on electrical load requirements, i.e. connected load and peak load for functional and lighting requirements in various areas of the plant. The basic equipments are aerators, coarse & fine screens, grit removal mechanism, sewage pumps, aerators, chlorine mixer, chlorination system, sludge pumps, air compressors system and gas scrubbers etc. The utilities are administrative building with laboratory, panel room, plant area lighting, staff quarters etc.

The power distribution system to the plant has been considered based on the peak load requirements and captive power available from pure gas engine.

From installation and operation point of view, two main load centres are proposed, one for TSPS and one for STP. The installations for TSPS have been discussed in the earlier section.

The STP shall have one outdoor substation for receiving power from UPSEB. The power from UPSEB metering panel shall be fed to HT vacuum circuit breaker (VCB) panel with outgoing transformer feeder. HP power from VCB panel shall be fed to the transformer installed in the same substation.
One main electrical panel shall be installed in the electrical panel room.

One pure gas engine is proposed which shall be installed in the gas engine room. The power form pure gas engine panel shall be fed to aerators and other panels installed in a room near to the aeration tanks. This panel shall have two supplies, one from pure gas engine and other from local electric supply company - Uttar Pradesh State Electricity Board (UPSEB), which can be switched on in case of failure of the pure gas engine or insufficient availability of biogas. Power produced from pure gas engine will be supplied only to this panel (for aerators and chemical house & chlorination system load), as the generated power is sufficient only to take care of this load only. Since synchronising of captive generator and UPSEB's supply is not considered, as it is normally not permitted, interlocking provision is made between two supplies, so that only one supply can be put on at a time. The complete load of this load centre shall be generally on pure gas engine supply. In case of non-availability of

pure gas engine power supply, this load centre shall be switched over to UPSEB power. The biogas produced from the reactors will be utilised for the pure gas engine.

The electrical system incorporates all safety requirements as per I.E. rules and all the components considered be as per relevant IS standards. The single line diagram, as enclosed, provides general requirements of various units of electrical distribution system.

The various equipments and panels considered at STP are :

a) Main electrical panel
b) Aerator and chlorine house panels
c) Fine screen & grit chamber panel
d) Compressor panel
e) Gas scrubber panel
f) Sludge pump panels
g) Filtrate pump panels
h) Main lighting panel
i) Sub lighting panels
j) Administrative block cum laboratory power distribution board
k) Staff quarter power distribution board

(1) Power Supply

The electrical supply system for the STP will be as given hereunder:-

1) Normal Power Supply

UPSEB power for the TSPS & STP is proposed to get from the nearby UPSEB switchyard. It is presumed that power from the nearby UPSEB switchyard shall be released at 33kV by laying an overhead transmission line up to the TSPS site. Cost of this transmission line is covered under costing of TSPS. This power from the UPSEB metering panel to be installed at the point of supply in the TSPS, shall be received at the 33kV VCB panel proposed to feed 33kV power to TSPS as well as STP transformers.

In STP, 33 kV UPSEB power shall be fed from the main 33 kV VCB panel at TSPS. 33 kV power from this VCB panel at TSPS shall be transmitted to STP site by laying overhead transmission line. Power from transmission line shall be received at 33 kV outdoor isolator proposed to be installed near MEP room at STP. One 33 kV VCB panel shall be installed in MEP room which will receive power from outdoor isolator and will feed this power to transformers. Two numbers of transformers are proposed for each STP. Each transformer shall be rated to run the entire plant load. Power stepped down to 0.433 kV shall be fed to MEP by laying 1.1 kV 3.5 core cable.

The entire plant will be operated on 415 V, 3-Phase, 50 c/s 3 wire/4 wire system for which, one main electrical panel will be provided. The variation in the voltage is considered as $\pm$10% and frequency as $\pm$10% and combined voltage and frequency variation $\pm$ 3%.

Power for entire plant equipments and utilities shall be distributed from this panel.

2) Gas Engine Supply

The proposed STP will have its own generation system utilising the produced biogas with pure gas engine. One pure gas engine is proposed in STP area, which shall be capable of taking the entire load of aeration and chlorine house panel.

Both the supplies will operate independently and no paralleling will be done at any time.

1.1.4 Utilities

(1) Administration Building

Administrative block cum laboratory building of built-up area of 240 sqm is proposed at Panka STP. The proposed administrative block is a double storey structure. The laboratory is also provided in the same administrative building.

The laboratory along with rooms for plant manager and the supporting staff are provided in the administrative block. A storeroom for storing the chemicals and other materials is also provided. The office block is also equipped with a kitchen and sanitation facility.

(2) Laboratory

Laboratory for analysing the wastewater and sludge samples is proposed at the STP. It is located in the ground floor. The laboratory will be equipped with the required equipment so as to analyse the following parameters:

- pH,
- Bio-chemical oxygen demand (BOD),
- Chemical oxygen demand (COD),
- Total suspended solids (TSS),
- Total dissolved solids (TDS),
- Total solids (TS),
- Volatile suspended solids (VSS),
- Volatile fatty acids (VFA),
- Alkalinity,
- Sulphates,
- Sulphides,
- Nitrates,
- Sludge stability,
- Gases (CH_4, H_2S etc.)
- Fecal coliform count.

The working platforms in the laboratory are provided with glazed white tiles. Mosaic flooring is proposed in the laboratory. Sinks with water taps are proposed for cleaning of the glassware and other equipment. The list of laboratory equipment is presented in Table no. 6.4.

Table 6.4 : List of Laboratory Apparatus and Equipment

Sr.	Particular	Nos.
A	**Instrument**	
1	Oil free diaphragm type vacuum cum pressure pump	1
2	Laboratory hot air oven	1
3	Muffle furnace	1
4	Digital fully automatic electronically controlled BOD incubator	1
5	Electronically controlled incubator, 37 Degree Celsius	1
6	Specific ion electrodes of Orion USA make, Model-901. 1. Cyanide, 2. Chromium, 3. Copper, 4. Arsenic, 5. Mercury, 6. Boron, 7. Manganese, 8. Nickel, 9. Lead, 10. Cadmium, 11. Sulphide, 12. Silver, 13. Selenium.	1 each
7	Autoclave (vertical) working pressure 5.2 lb.psi 750 x 500 mm with SS basket, inner chamber SS, 6 kW with pedal lifting, pressure and temperature gauges and water level indicator with insulated radial locking arrangement	1
8	COD apparatus with 6 hot plates	1
9	Colony counter	1
10	Gas analyzer for CH_4, H_{2S}	1
11	UV-VS Spectrophotometer with personal computer	1
12	Gas chromatograph with thermal detector	1
13	Electron detector with printer, gas column	1
14	Refrigerator	1
15	Electronic single pan balance	1
B	**Air conditioning for laboratory and office building**	
1	1.5 tonne capacity room air conditioner	1
2	Air cooler for office	3
3	Personal computer and printer for data analysis and plant monitoring	2

(1) Water Supply

The STP is provided with water from the proposed tube well station. This tube well will also take care of the water requirement for the gardening, fire hydrant and other miscellaneous uses as well.
The water distribution will be done by means of 100 mm AC pipes for the administrative and staff quarters. Hydrants with valves are provided for cleaning and flushing of the units. Sufficient residual pressure will be available for cleaning purposes.

(2) Waste Collection and Disposal

Liquid Wastes

Liquid waste, generated at within the STP premises, is storm water as well as the sewage from the utility of the STP. Open drains of 230 mm x 300 mm depth are provided to take care of the water logging at STP. Sanitation facilities are provided for the proposed administrative building and the staff quarters. The sewage from the administrative block and staff quarters will be discharged into the sump well of main pumping station within the STP premises.

Solid Wastes

The solid waste generated within the treatment plant will be from the following units:

Screen Chamber

Large amount of floating materials and other inert material like cloth, plastic, wood etc will be there in the raw sewage. Screens are used to stop these materials into the treatment plant units. Two screens, one of 12 mm clear opening alongwith 25 x 25 mm aluminum wire mesh is provided. The screenings collected will be transferred to the conveyor belt and thus into a chute. The screenings will be transported to the disposal site by means of trucks/trailers.

Grit Chambers

Grit will be removed from the grit chamber by mechanical means. The grit removed from the tank will be taken to the near by landfill sites by means of wheelbarrows.

Staff Quarters and Office Building

The domestic solid waste from the administrative building and the staff quarters will be collected in the dust bins. Staff quarters will be provided with masonry dust bins of 1.5 x 1.5 x 1.25m depth, at the place of transporting points. The waste, which arises by street sweepings, will be transferred to the transporting points. The solid waste from the transporting points will be transferred to the disposal site by means of trucks or trailers.

(3) Security Room

Security will be provided to guard against vandalism of the STP property. The security staff is provided with a room at the gate for giving shelter against the vagrancy of the nature. The shelter will be made of brick masonry with RCC roof. The shelter will have the necessary electrical and mechanical furnishings as deemed necessary.

(4) Staff Quarters

Staff quarter will be provided at the treatment plant site for the operating and maintenance staff. The costs for providing the same have been included in the cost estimates of the treatment plants. Based on the NRCD guidelines, staff quarters are provided only for the staff at the operating level.

Table 6.5: Type and Size of Proposed Staff Quarters

Sr.	Designation	Type of Quarters	Plinth Area (sq.m)	Number of Quarters
1	Watchmen, gardeners and sweepers	A	34.2	4 (double storey)
2	Chemist & operator	B	45.6	7 (single storey)
3	Junior engineer	C	62.7	1 (single storey)
4	Sub-divisional engineer	D	86	1 (single storey)

(5) Internal Roads

The various units as well as facilities of the treatment plant are provided with a 4.0 meter wide asphalt road for comfortable movement of men and material within the plant premises. At places where vehicular traffic is not expected, particularly above underground/surface pipes or insufficient space for laying of roads, brick pavement having a width of 1.0 meter are proposed so that there is access from the 4.0 meter road to the destination.

(6) Plant Lighting

Sodium vapour lamps mounted on 9 m height steel/aluminium tubular pole are provided at every 30.0 m interval on the road for sufficient illumination and provide the treatment plant personnel with a smooth, glare and accident free environment due to bad illumination.

(7) Green Belt

There will be a green belt zone all around the treatment plant. The green belt will have various trees at every 20 meter interval, as they act as air purifiers. This will help in circumventing to some extent the odour problem in the eventuality of an improper operation of the treatment plant. Besides, a green belt will act as natural screen against the outside populace.

(8) Bypass Arrangement

A bypass arrangement has been considered for the STP in case of breakdowns. This is provided from downstream of grit chamber to downstream of UASB reactors. Here onwards, two different bypass arrangements shall be provided where one will connect to the facultative aerated lagoon and the other one will connect directly to the treated effluent channel.

Appendix A10.1

ESTIMATED PARAMETER VALUES OF THE SOIL SAMPLES COLLECTED ON DECEMBER 6, 2004

S. No.	Parameter	Soil-2	Soil-3	Soil-4	Soil-5	Soil-6	Soil-7	Soil-8
1.	pH	7.73	7.87	7.36	7.88	7.39	7.85	7.72
2.	Colour, Units	Blackish Brown	Brown	Black	Light Brown	Dark Brown	Brown	Brown
3.	Type of Soil	Silt	Clayey Silt	Clayey Silt	Silt	Silty Clay	Clayey Silt	Silty Clay
4.	Moisture Content %	14.65	15.21	27.39	6.86	15.9	18.78	14.78
5.	Bulk density, g/cm^3	1.04	1.25	1.09	1.19	1.14	1.05	1.10
6.	Conductivity, µS/cm	4410	163	556	139	165	244	191
7.	Organic Matter, %	6.15	2.53	2.91	2.90	2.76	2.53	2.87
8.	Chloride Cl^-, mg/l	3.135	0.12	0.16	0.576	0.16	0.168	0.128
9.	Sulphate SO_4^{++}, mg/l	0.736	0.083	0.442	0.047	0.208	0.045	0.066
10.	Nitrate NO_3^+, mg/l	0.047	0.053	0.051	0.054	0.015	0.025	0.014
11.	Calcium as $CaCO_3$, mg/g	23.90	21.55	15.48	23.78	3.83	4.15	20.74
12.	Calcium as CaCO, mg/g	13.38	12.07	8.67	13.31	2.14	2.32	11.61
13.	Iron as Fe_2O_3, mg/g	9.7	12.2	12.01	11.25	11.94	8.37	12.78
14.	Phosphorous as P_2O_5, mg/g	0.081	4.367	0.072	0.032	0.041	0.032	ND
15.	Sodium Na, mg/g	1.033	0.393	0.559	1.208	0.848	0.497	0.525
16.	Potassium K, mg/g	1.553	1.513	1.506	1.502	1.572	1.144	1.842
17.	Total Chromium Cr, mg/l	0.064	0.0084	0.0081	0.0493	0.0101	0.0305	0.0238
	Chromium as Cr^{+6}, mg/l	ND	ND	ND	ND	ND	ND	ND

Soil – 2 Soil sample of Bajipur, Jajmau
Soil – 3 Soil sample of staff quarters near 130 & 36 mld campus, Jajmau
Soil - 4 Soil sample of Bhagwat Das Nala (Proposed pumping station)
Soil - 5 Soil sample of proposed Panka main pumping station (MPS)
Soil - 6 Soil sample of proposed Panka sewage treatment plant (STP)
Soil - 7 Soil sample of proposed Panki intermediate pumping station (IPS)
Soil - 8 Soil sample of existing Lakhanpur pumping station

Appendix A10.2

ESTIMATED PARAMETER VALUES OF THE SURFACE WATER SAMPLE COLLECTED ON DECEMBER 6, 2004

S.No.	Parameter	Surface Water (SW-1)
1.	pH	7.34
2.	Colour, Unit on Co-Pt Scale	100
3.	Odour	Pungent Odour
4.	Taste	Not Done
5.	Temperature ^{0}C	18.5
6.	Turbidity, NTU	660
7.	Alkalinity, as $CaCO_3$, mg/l	878
8.	Total Hardness as $CaCO_3$, mg/l	364
9.	Total Dissolved Solids, mg/l	1644
10.	Free Residual Chlorine, mg/l	ND
11.	Chloride Cl^-, mg/l	285
12.	Sulphate SO_4^{++}, mg/l	136.4
13.	Nitrate NO_3^+, mg/l	9.47
14.	Fluoride F^+, mg/l	0.37
15.	Cyanide CN^+, mg/l	<0.01
16.	Calcium Ca, mg/l	41.4
17.	Iron Fe, mg/l	32.63
18.	Lead Pb, mg/l	0.18
19.	Total Chromium Cr, mg/l	2.63
	Chromium as Cr^{+6}, mg/l	<0.003
20.	Cadmium Cd, mg/l	0.02
21.	Zinc Zn, mg/l	0.77
22.	Boron B, mg/l	<5
23.	Copper Cu, mg/l	0.01
24.	Manganese Mn, mg/l	0.3797
25.	Arsenic As, µg/l	47
26.	Mercury Hg, µg/l	<0.2
27.	Selenium Se, µg/l	<0.2
28.	Aluminium Al, mg/l	<0.3
29.	DO, mg/l	Nil
30.	BOD 3 days, mg/l	180
31.	COD, mg/l	774
32.	Oil and Grease, mg/l	<1.0

SW-1 = Surface water behind sewage treatment plant (STP), Jajmau Kanpur

ANNEXURE 11.2

ESTIMATED PARAMETER VALUES OF THE GROUND WATER SAMPLES COLLECTED ON DECEMBER 6, 2004

S.No.	Parameter	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8
1.	pH	7.69	7.06	6.97	7.01	7.79	7.31	6.99
2.	Colour, Units	35	<5	<5	<5	<5	<5	<5
3.	Odor	Pungent Odor	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
4.	Taste	Not done						
5.	Turbidity, NTU	292	19.2	0.8	80	0.8	15.6	2.8
6.	Alkalinity, as $CaCO_3$, mg/l	510	529	367	361	500	249	627
7.	Total Hardness as $CaCO_3$, mg/l	280	396	510	392	48	336	464
78.	Total Dissolved Solids, mg/l	1423	729	866	835	878	538	1981
9.	Residual Free Chlorine, mg/l	ND	ND	ND	ND	ND	ND	ND
10.	Chloride Cl^-, mg/l	395	81	125	143	77	97	215
11.	Sulphate SO_4^{++}, mg/l	135	29	220	98	32	29	586
12.	Nitrate NO_3^+, mg/l	0.60	0.64	9.95	0.96	6.08	1.29	12.69
13.	Fluoride F^+, mg/l	0.97	0.69	1.11	0.86	2.49	1.55	1.32
14.	Cyanide CN^+, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
15.	Calcium Ca, mg/l	36	41	39.7	40.7	12.2	40.1	23.5
16.	Iron Fe, mg/l	35.51	1.99	0.44	1.98	0.37	0.80	0.75
17.	Lead Pb, mg/l	0.093	0.068	<0.01	0.0696	0.0563	0.021	<0.01
18.	Total Chromium Cr, mg/l	0.186	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
19.	Chromium as Cr^{+6}, mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
	Cadmium Cd, mg/l	0.016	<0.01	0.017	<0.01	<0.01	<0.01	<0.01
20.	Zinc Zn, mg/l	2.128	2.371	0.187	0.091	0.041	1.461	0.462
21.	Boron B, mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
22.	Copper Cu, mg/l	0.034	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1
23.	Manganese Mn, mg/l	0.304	0.066	0.060	0.196	<0.01	0.046	<0.01
24.	Arsenic As, µg/l	8.9	7.8	14.5	17.2	2.3	2.6	2.3
25.	Mercury Hg, µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
26.	Selenium Se, µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
27.	Aluminium Al,	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3

S.No.	Parameter	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8
	mg/l							
28.	Oil and Grease, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

GW-2 Ground Water of Bajipur, Jajmau
GW-3 Ground Water of Staff quarters near 1.30 & 36 mld campus, Jajmau
GW-4 Ground Water of Bhagwat Das Nala (Proposed pumping station)
GW-5 Ground Water of proposed Panka main pumping station (MPS)
GW-6 Ground Water of proposed Panka sewage treatment plant (STP)
GW-7 Ground Water of proposed Panki intermediate pumping station (IPS)
GW-8 Ground Water of existing Lakhanpur pumping station

Appendix A 10.3

Owners List at Panka Bahadur STP Village Panka Bahadur Nagar

Sr	Sr No. of Govt Owners	Kasra No.	Land in Ha	Owners Name
1	149	56	0.143	Sita Ram
2	164	57	0.092	Horilal, Vyas Lal, Ram Prakash, Om Prakash Kamal Kishore, Prem Narayan Jagat Narayan Raja Ram Srikanth
3	56	60	0.225	M Parvati
4	31	62	0.195	Choti lal
5	95	73	0.625	Ram Kumar, Choti Lal, Prem Narayan, Parvati satya Naryan Tilak singh
6	34	74	0.266	Choti Lal, Virender Kumar, rajender Babu, Jagat Pal shiv Hari Ganga Charan Ram Kumar, Prem Narayan Satya Narayan Chandra Wali, Krishna Kumar, shiv Kumar, Jay Kumar, Ashok Kumar
7	14	75	0.945	Kanaihal
8	123	76	0.515	Lakhan Lal, Balwant singh
9	153	77	1.783	Satya Narayan
10	54	81	1.56	Prem Narayan
11	162	82	0.26	Horilal, Vyas Lal, Ram Prakash, Om Prakash Kamal Kishore, Prem Narayan Jagat Narayan Raja Ram Srikanth
12	149	84	0.123	Sita Ram
13	12	84	0.492	Krishna Kumar, shiv Kumar, Jay Kumar ashok Kumar
14	19	133	0.291	Ganga Charan
15	27	144	0.007	Smt Chandrawali
16	177	145	0.064	Govt Land
17	110	146	1.339	Smt. Rupa Rani
18	6	151	0.64	Ashok Kumar Bajpai
19	23	152	0.649	Smt. Ganag Wati
20	79	153	1.004	Munni lal
21	3	154	1.701	Anil Kumar, Smt. Ruprani, Ashok Kumar, Sandeep Kumar
22	168	285	0.676	Govt Land
23	162	170	1.197	Horilal Vyas Lal Ram Prakash, Om Prakash Kamal Kishore, Prem Narayan, Jagat Narayan, Raja Ram Srikanth
24	121	174	0.292	Smt Rekhs Tripati
25		220	0.297	Ramswaroop, Shivanand, Narendra, Nandan Malik, Anil Kumar, Satish Kumar, Sandeep Kumar
26	90	226	0.799	Ravendra singh, Javendra singh, Dhirender singh, Bhupendersingh, Dharmender singh, Jaypal singh, Siv Lashan singh, Shailesh Kumar singh, Gokaran singh, Surendra Singh
27	146	227	0.256	Sunder singh, Yajuveder singh
28	90	228	0.051	Ravendra singh, Javendra singh, Dhirender singh, Bhupendersingh, Dharmender singh, Jaypal singh, Siv Lashan singh, Shailesh Kumar singh, Gokaran singh, Surendra Singh
29	166	229	0.072	Govt Land
30	90	229	1.28	Ravendra singh, Javendra singh, Dhirender singh, Bhupendersingh, Dharmender singh, Jaypal singh, Siv Lashan singh, Shailesh Kumar singh, Gokaran singh, Surendra singh
31	168	230	0.051	Govt Land
32	166	230	0.4	Govt Land
33	168	233	0.215	Govt Land
34	117	233	0.246	Ram Avatar
35	90	234	0.051	Ravendra singh, Javendra singh, Dhirender singh, Bhupendersingh, Dharmender singh, Jaypal singh, Siv Lashan singh, Shailesh Kumar singh, Gokaran singh, Surendra singh
36	90	235	0.666	Ravendra singh, Javendra singh, Dhirender singh, Bhupendersingh, Dharmender singh, Jaypal singh, Siv Lashan singh, Shailesh Kumar singh, Gokaran singh, Surendra Singh
37	166	236	0.369	Govt Land
38	117	237	0.061	Ram Avatar
39	146	238	0.297	Sunder singh, Yajuveder singh
40	146	239	0.338	Sunder singh, Yajuveder singh
41	124	240	0.876	Lalit Kumar singh, Amar singh, Vijay singh ajay singh, santosh Singh, Rajeder singh, smt. Kamlesh Kumari
42	177	241	0.036	Govt Land
43	94	242	0.88	Ram Narayan

Sr	Sr No. of Govt Owners	Kasra No.	Land in Ha	Owners Name
44	146	243	0.969	Sunder singh, Yajuveder singh
45	138	244	1.003	Shiv Nandan singh
46	174	245	0.076	Road
47	166	246	0.144	Govt Land
48	85	246	0.169	Ram chander
49	35	247	0.451	Smt. Chedna, Smt. Nandaki, Smt Vidya
50	166	248	0.02	Govt Land
51	169	248	0.113	Govt Land
52	100	248	0.133	Smt. Raj Kumari, Smt. shiv Kumari
53	11	249	0.353	Smt. Keshana, Smt, Ram Pyari
54	177	250	0.08	Govt Land
55	67	251	0.988	Babu Ram
56	143	252	0.773	Shiv Balak
57	32	253	0.258	Chote Lal
58	94	254	0.817	Ram Narayan
59	123	255	0.297	Lakhan Lal, Balwant singh
60	174	256	0.1	Road
61	15	257	0.072	Kanaiha lal Lakhan Lal, Balwant Singh
62	39	258	0.082	Jag Mohan Singh
63	39	259	1.5	Jag Mohan Singh
64	177	260	0.06	Govt Land
65	39	261	0.02	Jag Mohan Singh
66	18	262	0.072	Guru dayal
67	142	263	0.061	Shiv Balak, Babu Ram Ram Narayan
68	166	264	0.075	Govt Land
69	55	265	0.098	Chote Lal
70	142	266	0.02	Shiv Balak, Babu Ram Ram Narayan
71	33	267	0.041	Chote Lal, Guru Prasad
72	17	268	0.742	GuruPrasad
73	51	269	0.336	ChiniRam, Raj Ram, Jagdish, Ranjeeth
74	134	270	0.152	Shi Narayan
75	98	271	0.148	Rup Narayan
76	76	272	0.156	Smt MahaDevi
77	94	273	0.718	Ram Narayan
78	32	274	0.281	Chote Lal
79	175	275	0.174	Kalihan
80	172	276	0.42	Abadi
81	166	277	0.066	Govt Land
82	177	278	0.016	Govt Land
83		279	0.02	Govt Land
84	85	280	0.169	Ram chander
85		281	0.07	Govt Land
86	101	282	0.422	Ram Ratan
87	29	283	0.307	Smt Chitra Devi
88	87	284	0.143	Ram Swaroop Jag singh, Rup Ram shyam Babu, Ram Kanth
89	168	285	0.676	Govt Land
90	26	287	0.113	Chandrashekhar
91	87	289	0.174	Ram Swaroop Jag singh, Rup Ram shyam Babu, Ram Kanth
92	106	290	0.348	Ram Bajan, Lalu, shiv Nath Krishna Kumar, Shailender Kumar, Parveen Kumar, smt Chandra Mukhi, Smt Susheela
93	115	291	0.174	Raj Kumar, Ram Swaroop
94	139	291	0.174	Raj Kumar, Ram Swaroop
95	166	292	0.379	Govt Land
96	114	292	0.42	Ram Swaroop, shiv Narayan
97	167	293	0.225	Govt Land
98	167	294	0.809	Govt Land
99	10	295	0.82	smt Kamala Devi
100	108	296	0.102	smt Ramrathi
101	152	297	0.165	Smt Sundri Devi
102	113	299	0.176	Ram
103	173	300	0.041	Road
104	173	300	0.041	Road
105	177	302	0.079	Govt Land
106	166	305	0.154	Govt Land

Sr	Sr No. of Govt Owners	Kasra No.	Land in Ha	Owners Name
107	166	305	0.154	Govt Land
108	41	305	0.256	Jay shanker Kushwaha
109	167	305	0.328	Govt Land
110	21	305	1.126	Smt. Ganga Devi Ram Dhulari
111	81	306	0.807	Madir Lal, Jag Mohan, Mashi Lal
112	77	306	1.406	Mayur
113	130	312	0.758	Shivnath Sing, Jagatver Singh Jaswanth Singh, santhosh singh,Damara singh Smt Jasdev Devi
114	18	324	0.072	Guru Dayal
115	39	326	0.061	Jag Mohan singh
116	73	327	0.123	Man Singh, Lalit Kumar singh, amar singh Vijay Singh, ajay singh, Rajendra singh, Santosh singh smt. Kamlesh Kumari, sunder singh Yadurved singh
117	142	327	0.205	Shiv Balak, Babu Ram Ram Narayan
118	15	328	0.061	Kanaiha Lal Lakhan Lal, Balwanth Singh
119	39	329	0.051	Jag Mohan singh
120	18	330	0.061	Guru dayal
121	73	331	0.195	Man Singh, Lalit Kumar singh, amar singh Vijay Singh, ajay singh, Rajendra singh, Santosh singh smt. Kamlesh Kumari, sunder singh Yadurved singh
122	117	332	0.41	Ram Avathar
123	168	333	0.779	Govt Land