INVESTMENT GRADE ENERGY AUDIT REPORT

Ghaziabad Municipal Corporation, Uttar Pradesh

Submitted by

Energy Efficiency Services Limited

Submitted To

Ghaziabad Municipal Corporation

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ACKNOWLEDGMENT

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- Mr. Amit Yadav, DESL
- Mr. Prince Sarawagi, DESL

On Behalf of Energy Efficiency Services Limited
Signature

Mr. Pushpendra Chaudhary

Executive Summary

Background of the Project

The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched by Prime Minister of India in June 2015 with the objective of providing basic services (e.g. water supply, sewerage, urban transport) to households and building amenities in cities to improve the quality of life for all.

To facilitate market transformation and replicate Municipal Energy Efficiency Programme on a large scale in India, the Ministry of Urban Development (MoUD), Government of India signed a Memorandum of Understanding (MoU) with Energy Efficiency Services Limited (EESL), a public sector entity under Ministry of Power, Government of India on 28th September 2016 under AMRUT. This will enable replacement of inefficient pump sets in Public Water Works & Sewerage Systems with energy efficient pump sets at no upfront cost to the municipal bodies. The investment will be recovered from savings in energy costs.

Energy audit and optimizing energy consumption are mandatory reforms under AMRUT. Department of Urban Development, Government of Uttar Pradesh have jointly entered into an agreement on 9th February, 2017 in order to provide an overarching framework to facilitate engagement between state government and various ULBs (covered under AMRUT) of Uttar Pradesh. Under this agreement, EESL is undertaking the project to replace old inefficient pump sets by energy efficient pump sets in Ghaziabad City of Uttar Pradesh.

Description of Facilities

Ghaziabad is a city in the Indian state of Uttar Pradesh. It is sometimes referred to as the "Gateway of UP" because it is close to New Delhi, on the main route into Uttar Pradesh. It is a part of the National Capital Region of Delhi. It is a large and planned industrial city, with a population of 4,681,645[1]. Well connected by roads and railways, it is the administrative headquarters of Ghaziabad District as well as the primary commercial, industrial and educational center of western Uttar Pradesh.

Source of water in the city is bore well water and Ganga water. There are 223 tube wells (Bore-wells) serving the water demand of the Ghaziabad city. Pumps installed for providing water supply services in the city are tabulated in the following table below:

[1]http://www.census2011.co.in/census/district/511-ghaziabad.html

Description of facility and water storage capacity

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
1	3rd A Pump no -6	ground water	1	1.44	Distribution Network
2	3rd A Pump no -7	ground water	1	1.44	Distribution Network
3	3 F nehru Nagar	ground water	1	1.44	NA
4	Ram lila maidan no 3	ground water	1	1.44	Ghanta Ghar locality
5	Ghanta Ghar taxi Stand	ground water	1	1.44	Ghanta Ghar locality
6	Company Bang No 5	ground water	1	1.44	NA
7	Company Bang No 4	ground water	1	1.44	NA
8	Ashok Nagar	ground water	1	1.44	Distribution Network
9	Yashoda Hospital	ground water	1	1.44	Distribution Network
10	Holichild Barat Ghar	ground water	1	1.44	Distribution Network
11	Gandhi Park No-5	ground water	1	1.44	Distribution Network
12	Dayanad Nagar No 1	ground water	1	1.44	NA
13	Dayanand Nagar N0.2	ground water	1	1.34	Distribution Network
14	Paras Hotel Pump	ground water	1	1.44	Distribution Network
15	Kalkaghari Pump no 1	ground water	1	1.44	Distribution Network
16	Balupura Pump	ground water	1	1.44	Distribution Network
17	Maliwada Fire Brigade	ground water	1	1.44	Distribution Network
18	Pranghari	ground water	1	1.44	Distribution Network
19	Jai prakash	ground water	1	1.44	Distribution Network
20	Panch Wati	ground water	1	1.44	NA
21	Anand Vihar	ground water	1	1.44	NA
22	Kamla Quarter	ground water	1	0.74	Distribution Network
23	Laxhmi Vihar	ground water	1	1.44	Distribution Network
24	2A Nehru Nagar	ground water	1	1.44	Distribution Network
25	2 B nehru Nagar	ground water	1	1.44	NA
26	Sabhaghar Pump	ground water	1	1.44	Distribution Network
27	Nehru Nagar No 2	ground water	1	1.44	Distribution Network
28	Hind Park	ground water	1	1.44	Distribution Network
29	MB girls College	ground water	1	1.44	Distribution Network
30	Chandrapuri	ground water	1	1.34	Distribution Network
31	Town Hall Pump no 1	ground water	1	1.44	Distribution Network
32	DC garg Pump	ground water	1	0.74	Distribution Network
33	3B nehru Nagar	ground water	1	1.44	Distribution Network
34	Arjun Nagar	ground water	1	1.44	NA

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
35	Gandhi Nagar no 6	ground water	1	1.44	Gandhi Nagar , Nehru Nagar Supply
36	Payre lal pumping station	ground water	1	1.44	NA
37	Ram Nagar Teekona Park	ground water	1	1.44	Ram Nagar,gandhi Park
38	Nand Gram C Block	ground water	1	1.44	A Block, goghena locality
39	Nand Gram B Block	ground water	1	1.27	Distribution network
40	C block Ramlila Garond	ground water	1	1.27	Distribution network
41	Nand Gram No 1	ground water	1	1.44	Distribution network
42	Nand Gram E block	ground water	1	1.44	Distribution network
43	Nand Gram F block	ground water	1	1.44	Distribution network
44	Lohia Nagar Pump no 1	ground water	1	1.44	Lohia Nagar OHT (1200 KL)
45	Lohia Nagar Pump no 2	ground water	1	1.34	Distribution network
46	Gandhi Park	ground water	1	1.27	Lohia Nagar OHT(1200 KL)
47	Dina Ghari	ground water	1	1.44	Lohia Nagar OHT(1200 KL)
48	G block Patel Nagar	ground water	1	1.34	Lohia Nagar OHT(1200 KL)
49	Sanjay geeta Park	ground water	1	1.44	Lohia Nagar OHT(1200 KL)
50	B block market	ground water	1	1.34	Lohia Nagar OHT(1200 KL)
51	Patel Nagar B block	ground water	1	1.44	Distribution Network
52	Patel Nagar D block Mother dairy	ground water	1	1.44	Distribution Network
53	Banwari Nagar	ground water	1	1.27	Distribution Network
54	Shibbon Pura	ground water	1	1.44	Distribution Network
55	L block patel nagar	ground water	1	1.44	Patel Nagar, Udhal Nagar , Patel Marg
56	Dhookna Katha	ground water	1	1.34	Distribution network
57	Dhookna Mandir	ground water	1	1.44	
58	Gautam Nagar	ground water	1	1.44	NA
59	Bhonja	ground water	1	1.44	Distribution network
60	Lohia Nagar B ablock	ground water	1	1.44	Distribution network
61	lal Quarter No 1	ground water	1	1.34	Distribution network
62	lal Quarter No 2	ground water	1	1.44	Distribution network
63	Lal Quarter no 2 (rebore)	ground water	1	1.44	NA
64	MMG Pump no -1	ground water	1	1.44	MMG OHT (450 KL)
65	MMG Pump no 2	ground water	1	1.44	
66	Model Town Park No-1	ground water	1	1.44	Distribution network
67	Model Town Pump NO 2	ground water	1	1.44	NA
68	Model Town Pump No 4	ground water	1	1.44	Distribution network
69	New Bus adda No 1	ground water	1	1.44	NA

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
70	New Bus Adda Tank	ground water	1	1.44	NA
71	MB Girls Kela Kheda	ground water	1	1.44	Distribution network
72	Tar Factory	ground water	1	1.44	Distribution network
73	Chmada Patt	ground water	1	1.44	Distribution network
74	Jassipurs	ground water	1	1.44	Distribution network
75	Kella Masrasa	ground water	1	1.44	Distribution network
76	Lalten Factory	ground water	1	1.44	NA
77	Sarai Nagar	ground water	1	1.44	Distribution network
78	Kella Khada	ground water	1	1.44	NA
79	D-block No.1	ground water	1	1.44	NA
80	Hathi park No.2	ground water	1	1.44	NA
81	Tulsi park No.3	ground water	1	1.44	NA
82	C block No No 4	ground water	1	1.27	NA
83	Pumping station No.14	ground water	1	1.44	NA
84	Chiranjeevi vihar Tank No.1	ground water	1	1.27	NA
85	Shani mandir pump No.2	ground water	1	1.27	NA
86	Sec-1 park Chiranjeevi vihar No.3	ground water	1	1.27	Distribution network
87	C block No.1	ground water	1	1.27	C block OHT (2250KL)
88	A block park pump No.5	ground water	1	1.27	C block OHT (450KL)
89	3A block pump No.6	ground water	1	1.27	C block OHT (450KL)
90	1D block pump No.3	ground water	1	1.27	H block OHT (2250KL)
91	Govindpuram pump No.4	ground water	1	1.27	H block OHT (2250KL)
92	G-block pump No.2	ground water	1	1.44	H block OHT (2250KL)
93	C-block pump No.1	ground water	1	1.44	OHT (2250 KL)
94	C-block pump No.2	ground water	1	1.27	OHT (2250 KL)
95	Uttam public school No.3	ground water	1	1.44	OHT (2250 KL)
96	D-block No.5	ground water	1	1.44	OHT (2250 KL)
97	Mother Dairy No 8	ground water	1	1.27	NA
98	A-block pump No.4	ground water	1	1.44	OHT (2250 KL)
99	Rajnagar No.1	ground water	1	1.27	OHT (900 KL)
100	Ramlila Maidan No 10	ground water	1	1.44	NA
101	Sector-11 pump No.11	ground water	1	1.44	NA
102	GDA market No.3	ground water	1	1.44	OHT (900 KL)
103	Sector-8 pump No.7	ground water	1	1.44	OHT
104	Sector-6 pump No.2	ground water	1	1.44	OHT (900 KL)
105	Sector-9 pump No.9	ground water	1	1.44	OHT (900 KL)
106	F block tank compound	ground water	1	1.44	F block OHT (450 KL)

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
107	B-block No.4	ground water	1	1.44	F block OHT (450 KL)
108	Near forest dept. No.2	ground water	1	1.44	F block OHT (450 KL)
109	P-block No.7	ground water	1	1.44	F block OHT (450 KL)
110	L-block No.8	ground water	1	1.44	G block OHT (2250 KL)
111	L-block No.10	ground water	1	1.44	G block OHT (2250 KL)
112	G-block tank No.6	ground water	1	1.44	G block OHT (2250 KL)
113	N-block pump No.3	ground water	1	1.44	G block OHT (2250 KL)
114	loha mandi pump No.12	ground water	1	1.44	OHT (2250KL)
115	B-block park No.5	ground water	1	1.34	Distribution network
116	Ramlila maidan no.6	ground water	1	1.34	Distribution network
117	C-block nursery No.7	ground water	1	1.34	Distribution network
118	I-block park No.8	ground water	1	1.34	Distribution network
119	F-block park No.9	ground water	1	1.44	Distribution network
120	H-block tank No.10	ground water	1	1.27	Distribution network
121	Vivekanand nagar No.11	ground water	1	1.44	Distribution network
122	K-block No.7	ground water	1	1.27	Distribution network
123	Bahwali colony	ground water	1	1.27	NA
124	Shastri nagar No.6	ground water	1	1.27	distribution network
125	K-block No.5	ground water	1	1.27	distribution network
126	RDC building	ground water	1	1.44	distribution network
127	Dr.Mukherjee park	ground water	1	1.27	distribution network
128	GDA market sector-7 pump No.8	ground water	1	1.44	distribution network
129	P-block No.11	ground water	1	1.51	distribution network
130	Guldhar	ground water	1	1.44	distribution network
131	Ramlila Maidan sec 9	ground water	1	1.44	NA
132	E block sec 9	ground water	1	1.44	OHT (2250KL)
133	G block sec 9	ground water	1	1.44	NA
134	F block sec 9	ground water	1	1.27	NA
135	A block sec 9	ground water	1	1.44	OHT (2250KL)
136	C block Sec 9	ground water	1	1.44	OHT (2250KL)
137	Ambedkar Nagar Sec 9	ground water	1	1.44	NA
138	Zonal Office	ground water	1	1.44	OHT (2250KL)
139	H block sec 9	ground water	1	1.27	NA
140	Mirza Pur No 2	ground water	1	1.27	OHT (2200KL)
141	Mirza Pur No 3	ground water	1	1.44	Distribution Network
142	F block sec 12	ground water	1	1.27	NA
143	Mother dairy M block	ground water	1	1.44	NA

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
144	H block sec 12	ground water	1	1.27	Distribution Network
145	N block teachers colony	ground water	1	1.44	NA
146	D block sec 11	ground water	1	1.44	OHT (1200 KL)
147	B block sec 11	ground water	1	1.27	OHT (1200 KL)
148	E block sec 11 no -2	ground water	1	1.27	NA
149	E block sec 11 no -5	ground water	1	1.27	Distribution Network
150	G block sec 11 pump No.3	ground water	1	1.27	Distribution Network
151	G block Sec 11 No 4	ground water	1	1.27	NA
152	F block sec 11	ground water	1	1.27	Distribution Network
153	Awas Vikas Kashiram colony	ground water	1	1.27	OHT
154	Sudamapuri no 1	ground water	1	1.27	OHT (1250KL)
155	Sudamapuri no 2	ground water	1	1.27	OHT (1250KL)
156	Sudamapuri no 3	ground water	1	1.27	OHT (1250KL)
157	K block sec 9	ground water	1	1.27	NA
158	H block sec 9	ground water	1	1.27	NA
159	L block sec 9	ground water	1	1.27	Distribution Network
160	H block sec 9 rosevally school	ground water	1	1.44	Distribution Network
161	Bhud bharat nagar	ground water	1	1.27	NA
162	Sundar puri	ground water	1	1.44	NA
163	H block Kela Khada	ground water	1	1.27	Distribution Network
164	R block sec 12	ground water	1	1.27	Distribution Network
165	Sorvaday Nagr	ground water	1	1.44	Distribution Network
166	A-block Sec 11	ground water	1	1.27	Distribution Network
167	Dhara school	ground water	1	1.27	Distribution Network
168	B block Mata Colony	ground water	1	1.44	Distribution Network
169	Tilla More No 1	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,Brij Vihar,DLF,Pappu colony
170	Tilla More No 2	ground water	1	1.34	
171	Tilla More No 3	ground water	1	1.44	
172	Tilla More No 4	ground water	1	1.34	NA
173	Tilla More No 7	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
174	Tilla More No 9	ground water	1	1.34	NA
175	Tilla More No 10	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
176	Tilla More No 11	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
177	Tilla More No 12	ground water	1	1.27	Shalimar CWR,Rajander Nagar

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
					CWR,Shaed Nagar ,
178	Tilla More No 13	ground water	1	1.08	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
179	Tilla More No 14	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
180	Tilla More No 15	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
181	Tilla More No 16	ground water	1	1.27	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
182	Tilla More No 17	ground water	1	1.27	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
183	Tilla More No 18	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
184	Tilla More No 19	ground water	1	1.27	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
185	Tilla More No 20	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
186	Tilla More No 21	ground water	1	1.44	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
187	Sai upwan no 1	ground water	1	1.44	Mohan Nagar CWR
188	Sai upwan no 2	ground water	1	1.44	Mohan Nagar CWR
189	Sai upwan no 9	ground water	1	1.44	Mohan Nagar CWR
190	Sai upwan no 6	ground water	1	1.44	Mohan Nagar CWR
191	Sai upwan no 7	ground water	1	1.44	Mohan Nagar CWR
192	Sai upwan no 3	ground water	1	1.44	Mohan Nagar CWR
193	Sai upwan no 8	ground water	1	1.44	Mohan Nagar CWR
194	Kanha Upwan	ground water	1	1.44	Kanha Upwan Colony
195	Hindon No 1	ground water	1	1.27	distribution network
196	Hindon No 2	ground water	1	1.27	distribution network
197	Hindon No 4	ground water	1	1.272	distribution network
198	Hindon No 7	ground water	1	1.272	distribution network
199	Hindon No 8	ground water	1	1.272	distribution network
200	Hindon No 9	ground water	1	1.44	distribution network
201	Vasundhara sec 7/1	ground water	1	1.512	distribution network
202	Vasundhara sec 7/2	ground water	1	1.44	CWR
203	Vasundhara sec 7/3	ground water	1	1.248	distribution network
204	Vasundhara sec 7/4	ground water	1	1.248	NA

Sl. No.	Facility Name & Location	Source of water	Number of pumps at site	Pump flow (MLD)	Type of Storage/Distribution
205	Vasundhara sec 9/1	ground water	1	1.44	distribution network
206	Vasundhara sec 9/2	ground water	1	1.44	CWR
207	Vasundhara sec 11	ground water	1	1.44	
208	Sec 15	ground water	1	1.152	NA
209	Vasundhara sec 15	ground water	1	1.44	sec 15 CWR
210	Sec 19	ground water	1	1.344	NA
211	Sec 13	ground water	1	1.248	NA
212	Sec 2/2	ground water	1	0.744	NA
213	sec 2/3	ground water	1	1.344	NA
214	Vaishali sec 1	ground water	1	1.44	NA
215	Vaishali sec 3 no-1	ground water	1	1.44	Sec 3 CWR
216	Vaishali sec 3 no-2	ground water	1	1.44	
217	Vaishali sec 3 no-3	ground water	1	1.44	
218	Vaishali sec 5/4	ground water	1	1.44	NA
219	Vaishali sec 5/5	ground water	1	1.344	sec 5 OHT(2000KL)
220	Vaishali sec 6/8	ground water	1	1.344	Sec 6 OHT(1000 KL)
221	Vasundhara sec 6/9	ground water	1	1.44	NA
222	Ashirvad Sec 2	ground water	1	1.44	NA
223	Vasundhara sec 5	ground water	1	1.44	sec 5 CWR

Summary of Performance Evaluation of Pump sets

Based on the measurement and analysis carried out during the energy audit, the pump and pump set efficiencies for all operating pump sets have been estimated. The summary of results is provided in the table below.

Pump range and Efficiency evaluation metrics:

Sl. No.	Pump Type	Pump Capacity Range(kW)	Weighted Average Pump Efficiency (%)	Weighted Average Pump set Efficiency (%)
		CITY 1		
1	Submersible	7.5 -15	39.53	35.57
2	Submersible	15 - 23	43.04	38.74
		CITY 2		
1	Submersible	7.5 -15	41.42	37.28
2	Submersible	15 - 23	41.01	36.90
		CITY 3		
1	Submersible	7.5 - 15	35.68	32.11
2	Submersible	15 - 23	46.41	41.77
		Kavi Nagar		
1	Submersible	7.5 - 15	39.26	35.33
2	Submersible	15 - 23	36.66	33.00
		Vijay Nagar Zone		
1	Submersible	7.5 - 15	46.46	41.82
2	Submersible	15 - 23	35.38	31.84
		Mohan Nagar		
1	Submersible	7.5 - 15	36.72	33.05
2	Submersible	15 - 23	39.42	35.48
		Vasundhra Zone		
1	Submersible	7.5 - 15	44.67	40.20
2	Submersible	15 - 23	47.61	42.85

Performance Indicators

In order to evaluate the actual performance and efficiency of the each pump set, quantity of water pumped annual power consumption and specific energy consumption are provides in table below:

Performance Indicators of pump sets of Borewell of City-1 Zone

Sl. No.	Pump Reference	Status of the pump (Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m^3/hours)	Estimated Operating hours (hour/ annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
1	3rd A Pump no -6	Operating	38.9	15.4	63.6	5760	366,336	88,704	0.242	53.29	43.7
2	Ram lila maidan no 3	Operating	60.2	14.1	45.4	3960	179,784	55,836	0.311	64.36	52.7
3	Ghanta Ghar taxi Stand	Operating	58.5	20.2	38.2	5760	220,032	116,352	0.529	36.71	30.2
4	Ashok Nagar	Operating	45.2	20.8	85.1	5760	490,176	119,808	0.244	61.33	49.2
5	Yashoda Hospital	Operating	43.2	23.8	76.8	5760	442,368	137,088	0.310	46.30	37.2
6	Holichild Barat Ghar	Operating	46.9	22	89	5760	512,640	126,720	0.247	63.04	50.5
7	Gandhi Park No-5	Operating	41.9	23.1	42.3	5760	243,648	133,056	0.546	25.45	20.7
8	Dayanand Nagar N0.2	Operating	41.2	19.85	63.8	5760	367,488	114,336	0.311	43.94	35.6
9	Paras Hotel Pump	Operating	41.4	22.24	102.1	5040	514,584	112,090	0.218	63.07	50.7
10	Kalkaghari Pump no 1	Operating	40.9	21.3	86.4	5040	435,456	107,352	0.247	55.03	44.5
11	Balupura Pump	Operating	45.1	24	85.1	5760	490,176	138,240	0.282	53.04	42.9
12	Maliwada Fire Brigade	Operating	39.2	21.6	85.62	5040	431,525	108,864	0.252	51.61	41.4
13	Pranghari	Operating	39.7	14.3	41	5400	221,400	77,220	0.349	37.78	31.5
14	Jai prakash	Operating	40.9	17.6	89.9	5760	517,824	101,376	0.196	69.34	55.8
15	Kamla Quarter	Operating	39.2	16.2	43.1	5760	248,256	93,312	0.376	34.62	28.5
16	Laxhmi Vihar	Operating	41.4	14.35	48.5	5760	279,360	82,656	0.296	46.43	37.8
17	2A Nehru Nagar	Operating	42.2	17.6	55.9	5760	321,984	101,376	0.315	44.51	36.2
18	Sabhaghar Pump	Operating	40.9	16.4	42.1	5760	242,496	94,464	0.390	34.88	28.6

Sl. No.	Pump Reference	Status of the pump (Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m^3/hours)	Estimated Operating hours (hour/ annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
19	Nehru Nagar No 2	Operating	41.1	19.2	74.2	5760	427,392	110,592	0.259	52.69	42.9
20	Hind Park	Operating	41.9	19.2	66.7	5760	384,192	110,592	0.288	48.30	39.4
21	MB girls College	Operating	43.4	23.4	112.9	2880	325,152	67,392	0.207	69.45	54.9
22	Chandrapuri	Operating	38.7	22.2	30	4320	172,800	127,872	0.740	17.36	14.3
23	Town Hall Pump no 1	Operating	43.0	15.2	60.8	6120	350,208	87,552	0.250	57.16	46.8
24	DC garg Pump	Operating	27.6	10.5	11.8	5760	67,968	60,480	0.890	10.30	8.5
25	3B nehru Nagar	Operating	42.8	17.6	53.6	5760	308,736	101,376	0.328	43.29	35.7
26	Gandhi Nagar no 6	Operating	40.7	17.15	42.8	5760	246,528	98,784	0.401	33.74	27.9
27	Ram Nagar Teekona Park	Operating	26.3	24.9	63.9	5760	368,064	143,424	0.390	22.41	18.5
	Total (A)			**514.19**	**1,700.62**		**9,176,573**	**2,816,914**			

Performance Indicators of pump sets of Borewell of City-2 Zone

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m^3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
1	Nand Gram C Block	Operating	24.4	19.5	94.2	4320	406,944	84,240	0.207	39.1	32.1
2	Nand Gram B Block	Operating	35.3	18.9	108.5	4320	468,720	81,648	0.174	67.2	55.1
3	C block Ramlila Garond	Operating	25.1	14.0	78.4	8640	677,376	120,701	0.178	46.8	38.4
4	Nand Gram No 1	Operating	34.7	22.6	108.5	4320	468,720	97,509	0.208	55.4	45.4
5	Nand Gram E block	Operating	29.7	13.6	36.7	3600	132,120	48,960	0.371	26.6	21.8
6	Nand Gram F block	Operating	15.6	23.5	4.55	2880	13,104	67,680	5.165	1.0	0.8

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m^3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
7	Lohia Nagar Pump no 2	Operating	34.1	18.7	53	7920	419,760	148,104	0.353	32.0	26.3
8	Gandhi Park	Operating	59.0	22.9	63.3	7920	501,336	181,368	0.362	54.1	44.4
9	Dina Ghari	Operating	62.4	16.6	29.6	7920	234,432	131,472	0.561	36.9	30.3
10	G block Patel Nagar	Operating	55.6	26.5	62.7	7920	496,584	209,880	0.423	43.7	35.8
11	Sanjay geeta Park	Operating	57.9	14.4	23.7	7920	187,704	114,048	0.608	31.7	26.0
12	B block market	Operating	55.4	14.8	31.6	7200	227,520	106,560	0.468	39.3	32.2
13	Patel Nagar B block	Operating	42.7	23.8	99.9	3600	359,640	85,680	0.238	59.5	48.8
14	Patel Nagar D block Mother dairy	Operating	32.9	18.2	48.5	3600	174,600	65,520	0.375	29.1	23.8
15	Banwari Nagar	Operating	25.8	16.2	49.23	3600	177,228	58,320	0.329	26.1	21.4
16	Shibbon Pura	Operating	34.3	19.9	132.3	3600	476,280	71,640	0.150	74.9	62.0
17	L block patel nagar	Operating	36.6	17.4	77.5	4320	334,800	75,168	0.225	54.1	44.4
18	Dhookna Katha	Operating	33.3	25.3	117.9	4680	551,772	118,404	0.215	51.5	42.2
19	Dhookna Mandir	Operating	26.2	16.3	69.9	3600	251,640	58,572	0.233	37.3	30.6
20	Bhonja	Operating	33.6	15.8	84.2	4320	363,744	68,256	0.188	59.4	48.7
21	Lohia Nagar B ablock	Operating	40.5	19.9	67.3	7200	484,560	143,280	0.296	45.5	37.3
22	lal Quarter No 1	Operating	35.0	23.7	103.3	3600	371,880	85,320	0.229	50.7	41.5
23	lal Quarter No 2	Operating	34.6	17.0	94.3	3240	305,532	55,080	0.180	63.7	52.2
	Total (B)			**439.41**	**1,639.08**		**8,085,996**	**2,277,409**			

Performance Indicators of pump sets of Borewell of City-3 Zone

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
1	MMG Pump no -1	Operating	63.3	15.9	26.5	7920	209,880	125,928	0.60	31.92	28.7
2	MMG Pump no 2	Operating	63.3	7.5	9.7	7920	76,824	59,400	0.77	24.76	22.3
3	Model Town Park No-1	Operating	38.8	8.3	34.4	6480	222,912	53,784	0.24	48.68	43.8
4	MB Girls Kela Kheda	Operating	40.4	24.8	108	6480	699,840	160,704	0.23	53.23	47.9
5	Tar Factory	Operating	39.1	14.3	46	3600	165,600	51,480	0.31	38.03	34.2
6	Chmada Patt	Operating	39.3	22.1	113.8	6480	737,424	142,884	0.19	61.30	55.2
7	Jassipurs	Operating	37.0	10.8	48.2	7200	347,040	77,760	0.22	49.95	45.0
8	Kella Masrasa	Operating	37.9	21.6	78	5400	421,200	116,843	0.28	41.27	37.1
9	Sarai Nagar	Operating	39.9	16.5	28.3	5760	163,008	95,040	0.58	20.69	18.6
	Total (C)			**141.8**	**492.9**		**3,043,728**	**883,823**			

Performance Indicators of pump sets of Borewell of Kavi Nagar Zone

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
1	D-block No.1	Operating	46.37	16.1	37.8	7920	299,191	127,512	0.43	36.12	29.6
2	Hathi park No.2	Operating	45.20	21.4	12.0	7920	95,330	169,664	1.78	8.43	6.9
3	Tulsi park	Operating	44.57	22.7	64.3	7920	509,441	179,872	0.35	41.91	34.4

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/kL)	Pump efficiency (%)	Overall efficiency (%)
	No.3										
4	Pumping station No.14	Operating	39.01	23.4	77.7	7920	615,595	184,932	0.30	43.11	35.3
5	Chiranjeevi vihar Tank No.1	Operating	49.03	21.0	54.9	7920	434,966	166,267	0.38	42.58	34.9
6	Shani mandir pump No.2	Operating	49.95	20	44.1	8280	364,872	165,683	0.45	36.52	29.9
7	Sec-1 park Chiranjeevi vihar No.3	Operating	27.00	21.2	103.9	8280	860,292	175,904	0.20	43.84	35.9
8	C block No.1	Operating	40.25	20.6	20.8	8280	172,500	170,292	0.99	13.53	11.1
9	A block park pump No.5	Operating	44.44	20.5	79.6	8280	659,088	170,016	0.26	57.19	46.9
10	3A block pump No.6	Operating	45.23	24.6	62.0	8280	513,636	203,504	0.40	37.90	31.1
11	1D block pump No.3	Operating	45.00	23.8	93.4	8280	773,352	197,340	0.26	58.55	48.0
12	Govindpuram pump No.4	Operating	43.55	22.3	41.0	8280	339,480	184,644	0.54	26.58	21.8
13	G-block pump No.2	Operating	47.13	29.9	83.3	8280	689,724	247,217	0.36	43.65	35.8
14	C-block pump No.1	Operating	54.84	22.3	90.7	8280	750,996	184,644	0.25	74.04	60.7
15	C-block pump No.2	Operating	56.58	26.0	61.5	7200	442,800	187,440	0.42	44.37	36.4
16	Uttam public school No.3	Operating	58.21	30.6	71.1	7920	563,376	242,616	0.43	44.87	36.8
17	D-block No.5	Operating	56.27	20.0	43.7	7920	346,104	158,400	0.46	40.81	33.5

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/kL)	Pump efficiency (%)	Overall efficiency (%)
18	A-block pump No.4	Operating	55.69	21.1	33.7	7920	266,904	166,848	0.63	29.58	24.3
19	Rajnagar No.1	Operating	55.35	21.5	70.3	7920	557,040	170,016	0.31	60.21	49.4
20	Sector-11 pump No.11	Operating	51.79	24.3	30.5	7920	241,824	192,456	0.80	21.61	17.7
21	GDA market No.3	Operating	53.08	22.3	73.5	7920	582,120	176,880	0.30	57.99	47.6
22	Sector-8 pump No.7	Operating	50.64	20.8	38.6	7920	305,712	164,472	0.54	31.25	25.6
23	Sector-6 pump No.2	Operating	51.82	21.5	33.5	7920	265,584	170,016	0.64	26.87	22.0
24	Sector-9 pump No.9	Operating	49.81	18.5	33.5	7920	265,584	146,520	0.55	29.97	24.6
25	F block tank compound	Operating	53.66	15.1	26.7	7920	211,464	119,592	0.57	31.50	25.8
26	B-block No.4	Operating	56.52	17.4	32.0	7920	253,440	137,808	0.54	34.51	28.3
27	Near forest dept. No.2	Operating	53.52	24.7	62.3	7920	493,416	195,624	0.40	44.81	36.7
28	P-block No.7	Operating	58.67	26.1	32.2	7920	255,024	206,712	0.81	24.03	19.7
29	L-block No.8	Operating	54.78	20.3	34.7	7920	275,088	160,424	0.58	31.18	25.6
30	L-block No.10	Operating	52.76	19.6	47.3	7200	340,560	141,040	0.41	42.29	34.7
31	G-block tank No.6	Operating	54.49	15.5	45.2	7920	357,984	122,496	0.34	52.86	43.3
32	N-block pump No.3	Operating	58.58	27.1	44.4	7920	351,410	214,406	0.61	31.88	26.1
33	loha mandi pump No.12	Operating	55.33	17.4	59.2	2520	149,100	43,764	0.29	62.57	51.3
34	B-block park No.5	Operating	31.02	12.3	61.6	7920	487,555	97,768	0.20	51.35	42.1
35	Ramlila	Operating	28.31	20.4	87.7	7920	694,690	161,304	0.23	40.48	33.2

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/kL)	Pump efficiency (%)	Overall efficiency (%)
	maidan no.6										
36	C-block nursery No.7	Operating	28.80	11.8	55.4	7920	438,583	93,764	0.21	44.71	36.7
37	I-block park No.8	Operating	29.24	19.6	27.0	7920	213,787	154,880	0.72	13.40	11.0
38	F-block park No.9	Operating	31.06	12.2	59.5	7920	471,504	96,360	0.20	50.45	41.4
39	H-block tank No.10	Operating	29.08	22.3	114.8	7920	909,216	176,528	0.19	49.72	40.8
40	Vivekanand nagar No.11	Operating	28.77	19.8	88.7	7920	702,530	156,816	0.22	42.78	35.1
41	K-block No.7	Operating	27.64	18.3	88.5	7920	700,920	144,584	0.21	44.48	36.5
42	Shastri nagar No.6	Operating	28.40	23.9	138.1	7920	1,094,016	189,464	0.17	54.44	44.6
43	K-block No.5	Operating	28.55	13.7	34.5	7920	272,976	108,328	0.40	23.89	19.6
44	RDC building	Operating	29.91	14.2	35.2	2880	101,232	40,880	0.40	24.59	20.2
45	Dr.Mukherjee park	Operating	31.71	12.6	68.0	3240	220,320	40,806	0.19	56.83	46.6
46	GDA market sector-7 pump No.8	Operating	28.57	20.2	115.9	4320	500,688	87,408	0.17	54.33	44.5
47	P-block No.11	Operating	56.04	24.9	58.4	7920	462,792	197,472	0.43	39.73	39.3
48	Guldhar	Operating	33.42	17.4	58.6	2160	126,576	37,512	0.30	34.11	33.7
	Total (D)			**983.0**	**2,831.5**		**21,000,384**	**7,428,895**			

Performance Indicators of pump sets of Borewell of Vijay Nagar Zone

Sl. No.	Pump Reference	Status of the pump (Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
1	C block Sec 9	Operating	59.4	22.4	68.0	7920	177,408	177,408	0.33	59.8	49.1
2	Zonal Office	Operating	36.5	19.3	67.9	7920	152,856	152,856	0.28	42.7	35.0
3	Mirza Pur No 2	Operating	61.8	20.6	53.4	2880	59,328	59,328	0.39	53.2	43.6
4	Mirza Pur No 3	Operating	39.2	7.0	9.4	2880	20,218	20,218	0.74	17.5	14.3
5	H block sec 12	Operating	39.3	22.9	86.5	2880	65,952	65,952	0.26	49.3	40.5
6	D block sec 11	Operating	54.2	17.7	34.1	7920	140,342	140,342	0.52	34.6	28.4
7	B block sec 11	Operating	54.7	18.6	36.7	7920	147,312	147,312	0.51	35.8	29.3
8	E block sec 11 no -5	Operating	31.4	28.2	100.1	7920.0	223,344	223,344	0.28	37.0	30.4
9	G block sec 11 pump No.3	Operating	32.2	23.1	36.0	7920	182,952	182,952	0.64	16.7	13.7
10	F block sec 11	Operating	33.4	20.1	36.2	7920.0	159,192	159,192	0.56	19.9	16.4
11	Awas Vikas Kashiram colony	Operating	57.6	24.7	90.9	7920	195,941	137,808	0.27	70.3	57.6
12	Sudamapuri no 2	Operating	48.5	17.4	27.5	7920	137,808	137,808	0.63	25.5	20.9
13	Sudamapuri no 3	Operating	47.1	22.4	5.7	7920	177,180	177,180	3.95	4.0	3.2
14	L block sec 9	Operating	41.7	23.87	90.6	7920	189,050	189,050.4	0.26	52.6	43.1
15	H block sec 9 rosevally school	Operating	32.6	21.53	84.6	2880	62,006	62,006.4	0.25	42.5	34.9
16	H block Kela Khada	Operating	38.9	21.8	82.9	7920	172,656	172,656	0.26	49.1	40.3
17	R block sec 12	Operating	36.4	23.2	84.7	7920	183,427	183,427.2	0.27	44.2	36.2
18	Sorvaday Nagr	Operating	39.3	20.2	28.2	2880	58,176	58,176	0.72	18.2	14.9
19	A-block Sec 11	Operating	36.8	20.4	33.7	7920	161,568	161,568	0.61	20.2	16.6

Sl. No.	Pump Reference	Status of the pump (Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
20	Dhara school	Operating	37.5	15.0	80.4	7920	118,958	118958	0.19	66.7	54.7
	Total (E)			**410.4**	**1137.5**		**2,785,676**	**2,785,675**			

Performance Indicators of pump sets of Borewell of Mohan Nagar Zone:

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m^3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
1	Tilla More No 1	Operating	31.5	21.2	45.7	7200	329,040	152,640	0.46	22.6	18.51
2	Tilla More No 2	Operating	51.7	12.4	44.8	7200	322,560	89,496	0.28	61.9	50.73
3	Tilla More No 3	Operating	34.0	10.5	67.7	7200	487,440	75,600	0.16	68.8	59.67
4	Tilla More No 11	Operating	32.8	15.4	55.9	7920	442,728	121,968	0.28	39.5	32.41
5	Tilla More No 12	Operating	39.1	11.7	53.4	7920	422,928	92,426	0.22	59.5	48.75
6	Tilla More No 14	Operating	31.1	15.5	29.6	7920	234,432	122,760	0.52	19.7	16.15
7	Tilla More No 16	Operating	32.5	20.6	88.8	7920	703,296	163,152	0.23	46.5	38.10
8	Tilla More No 17	Operating	31.6	23.5	142.3	7920	1,127,016	186,120	0.17	63.5	52.06
9	Tilla More No 19	Operating	32.6	18.9	20.3	7920	160,776	149,688	0.93	11.6	9.53
10	Sai upwan no 1	Operating	37.8	17.1	59.4	7200	427,680	123,120	0.29	43.6	35.78

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m^3/hours)	Estimated Operating hours (hour/annum)	Estimated Total quantity of water pump (m^3/y)	Estimated Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/ kL)	Pump efficiency (%)	Overall efficiency (%)
11	Sai upwan no 2	Operating	40.3	24.9	100.9	7200	726,480	179,280	0.25	54.2	44.47
12	Sai upwan no 9	Operating	37.4	21.3	83.1	7200	598,320	153,360	0.26	48.5	39.74
13	Sai upwan no 6	Operating	48.4	23.6	62.7	7200.0	451,440	169,920	0.38	42.7	35.04
14	Sai upwan no 8	Operating	37.9	13.8	31.5	7200	226,800	99,360	0.44	28.7	23.54
15	Kanha Upwan	Operating	25.9	25.4	105.7	7560	799,092	192,326	0.24	35.7	29.29
	Total (F)			**275.8**	**991.8**		**7,460,028**	**2,071,217**			

Performance Indicators of pump sets of Borewell of Vasundhara Zone

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Operating hours (hour/annum)	Total quantity of water pump (m3/y)	Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/kL)	Pump efficiency (%)	Pump set efficiency(%)
1	Hindon No 4	Operating	33.5	15.0	34.7	4680	162,396	70,200	0.43	25.6	21.0
2	Hindon No 9	Operating	31.3	17.5	103.0	4680	482,040	81,900	0.17	60.3	49.5
3	Vasundhara sec 7/2	Operating	31.6	10.4	35.2	240	8,453	2,496	0.30	34.5	28.3
4	Vasundhara sec 9/1	Operating	33.6	7.7	33.3	7920	263,736	60,588	0.23	47.8	39.2
5	Vasundhara sec 9/2	Operating	34.0	8.1	39.1	7920	309,672	64,231	0.21	52.7	43.2
6	Vasundhara sec 11	Operating	33.0	6.4	30.0	7920	237,600	51,005	0.21	50.3	41.3

Sl. No.	Pump Reference	Status of the pump(Operating /Standby)	Total head (m)	Measured power consumption (kW)	Pumping quantity (m3/hours)	Operating hours (hour/annum)	Total quantity of water pump (m3/y)	Total power consumption Per year (kWh/annum)	Annual Specific Energy Consumption (kWh/kL)	Pump efficiency (%)	Pump set efficiency(%)
7	Vasundhara sec 15	Operating	43.8	14.3	66.4	7920	525,888	113,256	0.22	67.4	55.3
8	Vaishali sec 3 no-1	Operating	34.9	22.6	105.1	2880	302,688	65,088	0.22	53.4	43.8
9	Vaishali sec 3 no-2	Operating	34.0	18.7	55.8	2880	160,704	53,770	0.33	33.8	27.7
10	Vaishali sec 3 no-3	Operating	34.1	23.4	117.0	2880	336,960	67,392	0.20	54.1	44.4
11	Vaishali sec 5/5	Operating	62.3	12.2	35.0	3600	126,000	43,956	0.35	60.7	49.7
12	Vaishali sec 6/8	Operating	60.5	18.1	62.3	7920	493,416	143,352	0.29	68.9	56.5
13	Vasundhara sec 5	Operating	34.4	18.9	84.7	2880	243,850	54,432	0.22	50.1	41.1
	Total (G)			**160.9**	**672.9**		**2,634,098**	**871,665.6**			
	Total (A+B+C+D+E+F+G)			**2925.5**	**9,466.30**	**619,080**	**54,186,483**	**19,135,598**			

Summary of Project Cost Benefit Analysis

The energy saving has been calculated on the basis of energy audit activity conducted at Ghaziabad municipal pumping stations. Consequently, feasibility of individual projects has been discussed with ULB officials and different pump manufactures. The energy saving of this project has been calculated on the basis of the technical information shared by the manufacturers (for the recommended equipment) and operating information shared by pumping station personnel. The estimated energy saving is provided in the table below:

Summary of Energy efficiency measures identified during the audit of City -1

Sl. No.	Name of the station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Monetary Cost savings/annum (Rs. Lakhs)	Payback Period (months
1	3rd A Pump no -6	Replacement with energy Efficient pumps	24,072.5	1.2	1.91	8
2	Ghanta Ghar taxi Stand		54,875.0	1.2	4.36	3
3	Ashok Nagar		20,992.0	1.3	1.67	9
4	Yashoda Hospital		50,303.1	1.3	4.00	4
5	Gandhi Park No-5		84,324.2	1.1	6.70	2
6	Dayanand Nagar N0.2		45,642.6	1.2	3.63	4
7	Kalkaghari Pump no 1		26,586.4	1.3	2.11	7
8	Balupura Pump		39,642.9	1.3	3.15	5
9	Maliwada Fire Brigade		32,053.5	1.3	2.55	6
10	Pranghari		35,239.0	1.1	2.80	5
11	Kamla Quarter		46,825.9	1.1	3.72	4
12	Laxhmi Vihar		28,376.3	1.2	2.26	6
13	2A Nehru Nagar		38,632.8	1.2	3.07	5
14	Sabhaghar Pump		47,042.9	1.1	3.74	4
15	Nehru Nagar No 2		30,917.5	1.3	2.46	6
16	Hind Park		37,555.4	1.2	2.99	5
17	Chandrapuri		94,756.0	1.0	7.53	2
18	Town Hall Pump no 1		19,131.9	1.2	1.52	9
19	DC garg Pump		49,829.1	0.7	3.96	2
20	3B nehru Nagar		40,351.1	1.2	3.21	4

Sl. No.	Name of the station	Energy Efficiency Measures (EEM)	Annual Energy Savings (kWh/Annum)	Investment Cost (Rs. Lakhs)	Monetary Cost savings/annum (Rs. Lakhs)	Payback Period (months
21	Gandhi Nagar no 6		51,639.0	1.2	4.11	4
22	Ram Nagar Teekona Park		97,171.9	1.1	7.73	2
	Total (A)		**995,961**	**30.6**	**79.18**	**5**

Summary of Energy efficiency measures identified during the audit of City -2

Sl. No.	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
1	Nand Gram C Block	Replacement with energy Efficient pumps	38,460.1	1.2	3.06	5
2	C block Ramlila Garond		40,839.0	1.2	3.25	4
3	Nand Gram No 1		23,715.4	1.3	1.89	8
4	Nand Gram E block		29,514.4	1.0	2.35	5
5	Nand Gram F block		66,442.7	0.7	5.28	2
6	Lohia Nagar Pump no 2		80,985.2	1.2	6.44	2
7	Gandhi Park		47,172.8	1.3	3.75	4
8	Dina Ghari		62,784.7	1.2	4.99	3
9	G block Patel Nagar		84,597.0	1.3	6.73	2
10	Sanjay geeta Park		62,090.4	1.1	4.94	3
11	B block market		47,379.4	1.2	3.77	4
12	Patel Nagar B block		17,090.2	1.3	1.36	11
13	Patel Nagar D block Mother dairy		38,094.9	1.1	3.03	4
14	Banwari Nagar		35,649.8	1.0	2.83	4
15	L block patel nagar		19,554.8	1.2	1.55	9
16	Dhookna Katha		36,423.1	1.3	2.90	5
17	Dhookna Mandir		27,671.0	1.2	2.20	7
18	Bhonja		12,806.0	1.2	1.02	14
19	Lohia Nagar B ablock		54,100.1	1.2	4.30	3
20	lal Quarter No 1		27,189.9	1.3	2.16	7

Sl. No.	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
	Total (B)		**852,561**	**27.7**	**67.7**	**5**

Summary of Energy efficiency measures identified during the audit of City -3

Sl. No.	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
1	MMG Pump no -1	Replacement with energy Efficient pumps	62,430.9	1.14	4.96	3
2	MMG Pump no 2		32,910.8	0.84	2.62	4
3	Model Town Park No-1		10,926.9	1.02	0.87	14
4	MB Girls Kela Kheda		34,444.8	1.29	2.74	6
5	Tar Factory		21,089.3	1.23	1.68	9
6	Jassipurs		17,469.2	1.23	1.39	11
7	Kella Masrasa		44,477.6	1.24	3.54	4
8	Sarai Nagar		62,850.4	1.02	5.00	2
	Total (C)		**286,600**	**10.4**	**22.7**	**6**

Summary of Energy efficiency measures identified during the audit of Kavi Nagar

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
1	D-block No.1	Replacement with energy Efficient pumps	61,228.7	1.2	4.87	3
2	Hathi park No.2		146,193.6	0.8	11.62	1
3	Tulsi park No.3		76,816.8	1.2	6.11	2
4	Pumping station No.14		75,941.6	1.3	6.04	3
5	Chiranjeevi viharTank No.1		69,472.6	1.2	5.52	3

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
6	Shani mandir pump No.2		81,558.2	1.2	6.48	2
7	Sec-1 park Chiranjeev i vihar No.3		70,467.7	1.2	5.60	3
8	C block No.1		133,933.5	0.9	10.65	1
9	A block park pump No.5		37,071.3	1.3	2.95	5
10	3A block pump No.6		98,047.5	1.2	7.79	2
11	1D block pump No.3		41,967.8	1.3	3.34	5
12	Govindpuram pump No.4		115,226.0	1.2	9.16	2
13	G-block pump No.2		102,098.5	1.3	8.12	2
14	C-block pump No.2		73,730.4	1.3	5.86	3
15	Uttam public school No.3		93,778.7	1.3	7.46	2
16	D-block No.5		68,512.6	1.2	5.45	3
17	A-block pump No.4		97,052.7	1.2	7.72	2
18	Rajnagar No.1		30,066.4	1.3	2.39	7
19	Sector-11 pump No.11		132,613.5	1.1	10.54	1
20	GDA market No.3		38,945.1	1.3	3.10	5
21	Sector-8 pump No.7		91,779.0	1.2	7.30	2
22	Sector-6 pump No.2		105,398.7	1.2	8.38	2
23	Sector-9 pump No.9		83,321.6	1.1	6.62	2
24	F block tank compound		65,377.1	1.1	5.20	3
25	B-block No.4		70,552.0	1.2	5.61	3
26	Near forest dept. No.2		75,766.8	1.3	6.02	3
27	P-block No.7		136,460.3	1.2	10.85	1
28	L-block No.8		89,667.3	1.2	7.13	2
29	L-block No.10		59,493.1	1.2	4.73	3
30	G-block tank No.6		33,960.3	1.24	2.70	6
31	N-block pump No.3		120,964.3	1.24	9.62	2

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
32	B-block park No.5		26,764.1	1.23	2.13	7
33	Ramlila maidan no.6		72,033.8	1.24	5.73	3
34	C-block nursery No.7		33,425.2	1.14	2.66	5
35	I-block park No.8		122,146.3	0.92	9.71	1
36	F-block park No.9		27,598.2	1.23	2.19	7
37	H-block tank No.10		56,535.7	1.27	4.49	3
38	Vivekanand nagar No.11		65,086.7	1.24	5.17	3
39	K-block No.7		56,656.0	1.24	4.50	3
40	Shastri nagar No.6		50,747.1	1.29	4.03	4
41	K-block No.5		69,019.5	1.02	5.49	2
42	RDC building		25,885.6	1.02	2.06	6
43	Dr.Mukherjee park		8,560.3	1.23	0.68	22
44	GDA market sector-7 pump No.8		22,486.2	1.27	1.79	9
45	P-block No.11		79,753.9	1.27	6.34	2
46	Guldhar		17,648.9	1.23	1.40	11
	Total (D)		**3,311,811**	**64.7**	**263.2**	**3**

Summary of Energy efficiency measures identified during the audit of Vijay Nagar

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
1	C block Sec 9	Replacement with energy Efficient pumps	34,692.0	1.2	2.76	5
2	Zonal Office		63,654.9	1.2	5.06	3
3	Mirza Pur No 2		16,203.3	1.3	1.29	12
4	Mirza Pur No 3		14,182.9	0.7	1.13	7
5	H block sec 12		21,463.0	1.2	1.71	8
6	D block sec 11		71,706.0	1.2	5.70	3

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
7	B block sec 11		72,782.2	1.2	5.79	2
8	E block sec 11 no -5		102,344.0	1.3	8.32	2
9	G block sec 11 pump No.3		137,488.4	1.0	10.93	1
10	F block sec 11		111,834.2	1.0	8.89	1
11	Sudamapuri no 2		86,340.6	1.0	6.86	2
12	Sudamapuri no 3		164,941.4	0.7	13.11	1
13	L block sec 9		55,344.2	1.3	4.40	4
14	H block sec 9 rosevally school		25,972.2	1.2	2.06	7
15	H block Kela Khada		56,655.9	1.3	4.50	3
16	R block sec 12		74,397.6	1.3	5.91	3
17	Sorvaday Nagr		42,376.5	1.0	3.37	4
18	A-block c 11		112,873.2	1.0	8.97	1
	Total (E)		**1,265,252**	**20.1**	**100.7**	**2**

Summary of Energy efficiency measures identified during the audit of Mohan Nagar.

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
1	Tilla More No 1	Replacement with energy Efficient pumps	102,003.6	1.33	8.14	2
2	Tilla More No 11		53,245.9	1.43	4.24	4
3	Tilla More No 12		13,463.3	1.44	1.14	15
4	Tilla More No 14		85,112.9	1.19	6.81	2
5	Tilla More No 16		57,573.6	1.44	4.60	4
6	Tilla More No 19		120,380.0	1.02	9.65	1
7	Sai upwan no 1		47,347.3	1.44	3.82	5

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
8	Sai upwan no 2		48,318.6	1.51	3.85	5
9	Sai upwan no 9		50,756.3	1.48	4.12	4
10	Sai upwan no 6		70,691.5	1.48	5.66	3
11	Sai upwan no 8		56,008.8	1.19	4.51	3
12	Kanha Upwan		97,757.8	1.44	7.79	2
	Total (F)		**802569.6**	**17.8**	**65.3**	**3**

Summary of Energy efficiency measures identified during the audit of Vasundhara.

Site No. as in list	Name of the station	EEM Measure	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings per annum (Rs. Lakhs)	Payback Period (months)
1	Hindon No 4	Replacement with Energy efficient pump	43,245.0	1.02	3.44	4
2	Hindon No 9		13,517.4	1.27	1.07	14
3	Vasundhara sec 9/1		16,695.9	1.02	1.33	9
4	Vasundhara sec 9/2		13,050.7	1.02	1.04	12
5	Vasundhara sec 11		12,203.5	1.02	0.97	13
6	Vaishali sec 3 no-1		17,979.1	1.27	1.43	11
7	Vaishali sec 3 no-2		28,136.8	1.23	2.24	7
8	Vaishali sec 3 no-3		16,938.9	1.29	1.35	11
9	Vaishali sec 5/5		7,697.1	1.23	0.61	24
10	Vasundhara sec 5		16,330.4	1.27	1.30	12
	Total (G)		**185,795**	**13.9**	**10.5**	**16**
	Total (A+B+C+D+E+F+G)		**7,700,640**	**192.27**	**612.2**	**4**


अमृत
Atal Mission for Rejuvenation
and Urban Transformation


Ghaziabad Municipal Corporation
ISO 9001, 14001 & 18001 Certified Organization


EESL

Project Financials and proposed Business Model

Total Project cost (CAPEX)

The following are the key components considered while arriving at the total project cost:

i. Cost of pump, motor and other accessories (like NRV and gate valve), discovered through a transparent bidding process;
ii. Cost of dismantling, installation & commissioning, discovered through transparent bidding process;
iii. Project establishment and supervision charges of EESL at 5% of total cost of equipment including installation;
iv. Cost of preparation of IGEA, as per actual tendered cost, plus EESL's service charge at 15%;
v. All applicable taxes and duties as on actual basis; and
vi. Capitalized interest during the project implementation period.

Details of project capital cost are provided in the table below:

Project Capital Cost

Capital Cost Related assumption	Unit	Value
Number of Pumps	No.	136.00
Total Cost of Equipment including accessories	INR lakhs	192.27
Cost of pump	INR lakhs	117.37
Cost of NRV	INR lakhs	24.07
Cost of Gate valve	INR lakhs	30.49
Cost of monitoring and supervision equipment	INR lakhs	10.44
Installation and Commission Cost	INR lakhs	9.89
EESL's administrative and establishment charge	%	5.0%
Cost of preparation of DPR	INR lakhs	4.21
Total Project cost w/o Capitalized sheet	INR lakhs	206.09
Commissioning Details		
Total Months for Commissioning	Month	9
Capitalized interest	INR lakhs	11.55
Total Project Cost	INR lakhs	217.64

Operating Costs (OPEX)

The following are the key components considered while arriving at the operating cost for the project:

i. Project Establishment and Supervision charges of EESL at 4% of total project cost; and annual escalation of 5%.
ii. Actual incurred Repair & Maintenance charges, discovered through a transparent bidding process.

Details about project operating cost are provided in the table below:

Project Operating Cost

Operational Details	Unit	Value
EESL's administrative and establishment charges	%	4%

Financing Terms and other tax related assumptions

The following are the key financial assumptions used in developing the model. Financing terms and tax related assumptions are provided in the table below:

Financing terms and tax related assumptions

Financing Details		Value
Debt Percentage	%	70%
Cost of Debt	%	11%
Equity Percentage	%	30%
Cost of Equity (post- tax)	%	16%
Tax Details		
Income Tax Rate	%	34.61%
Income Tax Rate	%	30.0%
Surcharge	%	12.0%
Education Cess	%	3.0%
Goods and Service Tax	%	18.0%

Output - Annuity Payment to EESL

Based on the cost parameters and assumptions mentioned above, the annuity payment to EESL was computed. Details of annuity payment to EESL are provided in the table below.

Annuity payment to EESL

Year Calculations of annuity payment		1	2	3	4	5	6	7	Total
Total Debt to be repaid	INR lakh	37.47	35.08	32.70	30.32	27.93	25.55	23.16	212.21
Principal Repayment	INR lakh	21.67	21.67	21.67	21.67	21.67	21.67	21.67	151.71
Interest	INR lakh	15.79	13.41	11.03	8.64	6.26	3.87	1.49	60.50
Total Equity Repayments	INR lakh	24.35	22.07	19.80	17.53	15.25	12.98	10.71	122.69
Recovery of equity investment	INR lakh	9.29	9.29	9.29	9.29	9.29	9.29	9.29	65.02
Return on equity	INR lakh	15.06	12.78	10.51	8.24	5.97	3.69	1.42	57.67
R&M Charges	INR lakh	0.00	2.85	8.54	10.81	13.11	17.07	20.49	72.86
EESL's administrative and establishment charge	INR lakh	8.67	9.10	9.56	10.04	10.54	11.06	11.62	70.59
Annuity Payment to EESL	INR lakh	70.48	69.11	70.60	68.69	66.83	66.67	65.98	478.35
Service Tax on annuity payment	INR lakh	12.69	12.44	12.71	12.36	12.03	12.00	11.88	86.10
Annuity Payment to EESL incl. Service Tax	INR lakh	83.17	81.55	83.30	81.06	78.86	78.67	77.85	564.45
Total Savings	INR lakh	612.20	626.68	640.74	654.26	667.14	679.24	690.44	4570.71
Profit to ULB	INR lakh	529.03	545.14	557.44	573.21	588.28	600.58	612.58	4006.25
% of savings with ULBs	%								87.65

Based on the cost parameters and assumptions mentioned above, the annuity payment to EESL was computed. Details of annuity payment to EESL are provided in the table below

Sensitivity analysis

The sensitivity analysis has been conducted to determine the impact of change in capital cost and change in savings on the percentage of monetary share of accrued savings retained by the ULB. Project sensitivity analysis is provided in the table below.

Project sensitivity analysis

Change in Capital Cost	% of savings retained by the utility
-10%	88.70%
-5%	88.17%
0%	87.65%
5%	87.13%
10%	86.60%
-10%	86.23%
-5%	87.00%
0%	87.65%
5%	88.24%
10%	88.77%

Key facts of IGEA

Key facts of the project are as follows:

Particular	Unit	Value
Total Number of Pumps	Nos.	223
Total Number of Pumps Under Maintenance	Nos.	26
Total No of Pumps not in use/abandoned	Nos.	42
Total No Of Pumps Audited	Nos.	155
Total No of Pumps Consider for replacement	Nos.	136
Estimated present annual energy consumption	kWh	17,167,306
Estimated annual energy consumption with proposed EEPS	kWh	9,466,666
Percentage energy saving potential	%	44.8
Total project cost	Rs. Lakhs	217.64

Pre – implementation annual energy consumption (baseline) and post implementation annual energy consumption will be estimated based proposed Measurement and Verification (M & V methodology).

Rated and operating parameters of pump sets to be installed under this project along with other accessories are provided in the table below:

Key facts of pump sets to be replaced under this project

Pump Identification		Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Site No.	Pump House	Flow (m^3/h)	Head (m)	Motor rating (kW)	Flow (m^3/h)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
City 1 Zone											
Site No -1	3rd A Pump no -6	60	63	15	63.6	45.0	15.4	43.7	Yes	Yes	Yes
Site No -5	Ghanta Ghar taxi Stand	60	63	15	38.2	61.5	20.2	30.1	Yes	Yes	Yes
Site No -8	Ashok Nagar	60	63	22.4	85.1	49.8	20.8	50.3	Yes	Yes	Yes
Site No -9	Yashoda Hospital	60	63	22.4	76.8	47.8	23.8	38.0	Yes	Yes	Yes
Site No -11	Gandhi Park No-5	60	63	22.4	42.3	46.5	23.1	20.9	Yes	Yes	Yes
Site No -13	Dayanand Nagar N0.2	56	63	22.4	63.8	45.8	19.85	36.0	Yes	Yes	Yes
Site No -15	Kalkaghari Pump no 1	60	63	22.4	86.4	45.5	21.3	45.1	Yes	Yes	Yes
Site No -16	Balupura Pump	60	63	22.4	85.1	49.7	24	43.5	Yes	Yes	Yes
Site No -17	Maliwada Fire Brigade	60	63	22.4	85.6	45.2	21.6	42.3	Yes	Yes	Yes
Site No -18	Pranghari	60	63	15	41.0	44.3	14.3	31.0	Yes	Yes	Yes
Site No -22	Kamla Quarter	31	45	19	43.1	45.3	16.2	28.4	Yes	Yes	Yes
Site No -23	Laxhmi Vihar	60	63	15	48.5	46.0	14.35	38.1	Yes	Yes	Yes
Site No -24	2A Nehru Nagar	60	63	19	55.9	46.8	17.6	36.5	Yes	Yes	Yes
Site No-26	Sabhaghar Pump	60	63	15	42.1	46.9	16.4	28.6	Yes	Yes	Yes
Site No-27	Nehru Nagar No 2	60	63	23	74.2	45.7	19.2	43.2	Yes	Yes	Yes
Site No-28	Hind Park	60	63	19	66.7	46.5	19.2	39.6	Yes	Yes	Yes
Site No-30	Chandrapuri	56	63	23	30.0	43.3	22.2	14.2	Yes	Yes	Yes
Site No-31	Town Hall Pump no 1	60	63	15	60.8	47.6	15.2	46.9	Yes	Yes	Yes
Site NO-32	DC garg Pump	31	45	7.5	11.8	35.2	10.5	8.4	Yes	Yes	Yes
Site No-33	3B nehru Nagar	60	63	19	53.6	47.4	17.6	35.5	Yes	Yes	Yes
Site No-35	Gandhi Nagar no 6	60	63	23	42.8	45.3	17.15	27.7	Yes	Yes	Yes
Site No-37	Ram Nagar Teekona Park	60	63	23	63.9	38.3	24.9	18.4	Yes	Yes	Yes
City 2 Zone											
Site No -38	Nand Gram C Block	60	63	19	94.2	24.4	19.5	32.1	Yes	Yes	Yes
Site No -40	C block Ramlila Garond	53	63	15	78.4	25.1	14.0	38.4	Yes	Yes	Yes

Pump Identification		Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Site No.	Pump House	Flow (m^3/h)	Head (m)	Motor rating (kW)	Flow (m^3/h)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Site No -41	Nand Gram No 1	60	63	22	108.5	34.7	22.6	45.4	Yes	Yes	Yes
Site No -42	Nand Gram E block	60	63	15	36.7	29.7	13.6	21.8	Yes	Yes	Yes
Site No -43	Nand Gram F block	60	63	22.4	4.6	15.6	23.5	0.8	Yes	Yes	Yes
Site No -45	Lohia Nagar Pump no 2	56	63	22.4	53.0	34.1	18.7	26.3	Yes	Yes	Yes
Site No -46	Gandhi Park	53	63	22.4	63.3	59.0	22.9	44.4	Yes	Yes	Yes
Site No -47	Dina Ghari	60	63	22.38	29.6	62.4	16.6	30.3	Yes	Yes	Yes
Site No -48	G block Patel Nagar	56	63	22.4	62.7	55.6	26.5	35.8	Yes	Yes	Yes
Site No -49	Sanjay geeta Park	60	63	15	23.7	57.9	14.4	26.0	Yes	Yes	Yes
Site No -50	B block market	56	63	22.4	31.6	55.4	14.8	32.2	Yes	Yes	Yes
Site No -51	Patel Nagar B block	60	63	22.4	99.9	42.7	23.8	48.8	Yes	Yes	Yes
Site No -52	Patel Nagar D block Mother dairy	60	63	22.4	48.5	32.9	18.2	23.8	Yes	Yes	Yes
Site No -53	Banwari Nagar	53	63	15	49.2	25.8	16.2	21.4	Yes	Yes	Yes
Site No 55	L block patel nagar	60	63	15	77.5	36.6	17.4	44.4	Yes	Yes	Yes
Site No 56	Dhookna Katha	56	63	22.4	117.9	33.3	25.3	42.2	Yes	Yes	Yes
Site No -57	Dhookna Mandir	60	63	19	69.9	26.2	16.3	30.6	Yes	Yes	Yes
Site No -59	Bhonja	60	63	22.4	84.2	33.6	15.8	48.7	Yes	Yes	Yes
Site No -60	Lohia Nagar B ablock	60	63	22.4	67.3	40.5	19.9	37.3	Yes	Yes	Yes
Site No -61	lal Quarter No 1	56	63	22.4	103.3	35.0	23.7	41.5	Yes	Yes	Yes
City-3											
Site No -64	MMG Pump no -1	60	63	15	26.5	63.3	15.9	28.7	Yes	Yes	Yes
Site No -65	MMG Pump no -2	60	63	7.5	9.7	63.3	7.5	22.3	Yes	Yes	Yes
Site No -66	Model Town Park No-1	60	63	7.5	34.4	38.8	8.3	43.8	Yes	Yes	Yes
Site No -71	MB Girls Kela Kheda	60	63	22.3	108.0	40.4	24.8	47.9	Yes	Yes	Yes
Site No -72	Tar Factory	60	63	15	46.0	39.1	14.3	34.2	Yes	Yes	Yes
Site No -74	Jassipurs	60	63	22.5	48.2	37.0	10.8	45.0	Yes	Yes	Yes
Site No -75	Kella Masrasa	60	63	22.3	78.0	37.9	21.6	37.1	Yes	Yes	Yes
Site No -77	Sarai Nagar	60	63	22.3	28.3	39.9	16.5	18.6	Yes	Yes	Yes
Kavi Nagar Zone											

Pump Identification		Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Site No.	Pump House	Flow (m^3/h)	Head (m)	Motor rating (kW)	Flow (m^3/h)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Site No -79	D-block No.1	60	63	22.4	37.8	46.4	16.1	29.6	Yes	Yes	Yes
Site No -80	Hathi park No.2	60	63	22.4	12.0	45.2	21.4	6.9	Yes	Yes	Yes
Site No -81	Tulsi park No.3	60	63	22.4	64.3	44.6	22.7	34.4	Yes	Yes	Yes
Site No -83	Pumping station No.14	60	63	22.4	77.7	39.0	23.4	35.3	Yes	Yes	Yes
Site No -84	Chiranjeevi vihar Tank No.1	53	63	22.4	54.9	49.0	21.0	34.9	Yes	Yes	Yes
Site No -85	Shani mandir pump No.2	53	63	22.4	44.1	50.0	20.0	29.9	Yes	Yes	Yes
Site No -86	Sec-1 park Chiranjeevi vihar No.3	53	63	22.4	103.9	27.0	21.2	35.9	Yes	Yes	Yes
Site No -87	C block No.1	53	63	22.4	20.8	40.2	20.6	11.1	Yes	Yes	Yes
Site No -88	A block park pump No.5	53	63	22.4	79.6	44.4	20.5	46.9	Yes	Yes	Yes
Site No -89	3A block pump No.6	53	63	22.4	62.0	45.2	24.6	31.1	Yes	Yes	Yes
Site No -90	1D block pump No.3	53	63	22.4	93.4	45.0	23.8	48.0	Yes	Yes	Yes
Site No -91	Govindpuram pump No.4	53	63	22.4	41.0	43.6	22.3	21.8	Yes	Yes	Yes
Site No -92	G-block pump No.2	60	63	22.4	83.3	47.1	29.9	35.8	Yes	Yes	Yes
Site No -94	C-block pump No.2	53	63	22.4	61.5	56.6	26.0	36.4	Yes	Yes	Yes
Site No -95	Uttam public school No.3	60	63	22.4	71.1	58.2	30.6	36.8	Yes	Yes	Yes
Site No -96	D-block No.5	60	63	22.4	43.7	56.3	20.0	33.5	Yes	Yes	Yes
Site No -98	A-block pump No.4	60	63	22.4	33.7	55.7	21.1	24.3	Yes	Yes	Yes
Site No -99	Rajnagar No.1	53	63	22.4	70.3	55.4	21.5	49.4	Yes	Yes	Yes
Site No -101	Sector-11 pump No.11	60	63	22.4	30.5	51.8	24.3	17.7	Yes	Yes	Yes
Site No -102	GDA market No.3	60	63	22.4	73.5	53.1	22.3	47.6	Yes	Yes	Yes
Site No -103	Sector-8 pump No.7	60	63	22.4	38.6	50.6	20.8	25.6	Yes	Yes	Yes
Site No -104	Sector-6 pump No.2	60	63	22.4	33.5	51.8	21.5	22.0	Yes	Yes	Yes
Site No -105	Sector-9 pump No.9	60	63	22.4	33.5	49.8	18.5	24.6	Yes	Yes	Yes
Site No -106	F block tank compound	60	63	22.4	26.7	53.7	15.1	25.8	Yes	Yes	Yes
Site No -107	B-block No.4	60	63	18.65	32.0	56.5	17.4	28.3	Yes	Yes	Yes
Site No -108	Near forest dept. No.2	60	63	22.4	62.3	53.5	24.7	36.7	Yes	Yes	Yes
Site No -109	P-block No.7	60	63	22.4	32.2	58.7	26.1	19.7	Yes	Yes	Yes
Site No -110	L-block No.8	60	63	22.4	34.7	54.8	20.3	25.6	Yes	Yes	Yes

Pump Identification		Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Site No.	Pump House	Flow (m^3/h)	Head (m)	Motor rating (kW)	Flow (m^3/h)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Site No -111	L-block No.10	60	63	22.4	47.3	52.8	19.6	34.7	Yes	Yes	Yes
Site No -112	G-block tank No.6	60	63	22.4	45.2	54.5	15.5	43.3	Yes	Yes	Yes
Site No -113	N-block pump No.3	60	63	22.4	44.4	58.6	27.1	26.1	Yes	Yes	Yes
Site No -115	B-block park No.5	56	63	18.65	61.6	31.0	12.3	42.1	Yes	Yes	Yes
Site No -116	Ramlila maidan no.6	56	63	22.4	87.7	28.3	20.4	33.2	Yes	Yes	Yes
Site No -117	C-block nursery No.7	56	63	18.65	55.4	28.8	11.8	36.7	Yes	Yes	Yes
Site No -118	I-block park No.8	56	63	18.65	27.0	29.2	19.6	11.0	Yes	Yes	Yes
Site No -119	F-block park No.9	60	63	15	59.5	31.1	12.2	41.4	Yes	Yes	Yes
Site No -120	H-block tank No.10	53	63	22.38	114.8	29.1	22.3	40.8	Yes	Yes	Yes
Site No -121	Vivekanand nagar No.11	60	63	22.38	88.7	28.8	19.8	35.1	Yes	Yes	Yes
Site No -122	K-block No.7	53	63	18.65	88.5	27.6	18.3	36.5	Yes	Yes	Yes
Site No -124	Shastri nagar No.6	53	63	22.38	138.1	28.4	23.9	44.6	Yes	Yes	Yes
Site No -125	K-block No.5	53	63	15	34.5	28.6	13.7	19.6	Yes	Yes	Yes
Site No -126	RDC building	60	63	22.38	35.2	29.9	14.2	20.2	Yes	Yes	Yes
Site No -127	Dr.Mukherjee park	53	56	15	68.0	31.7	12.6	46.6	Yes	Yes	Yes
Site No -128	GDA market sector-7 pump No.8	60	63	22.38	115.9	28.6	20.2	44.5	Yes	Yes	Yes
Not in list-1	P-block No.11	63	63	22.38	58.4	56.0	24.9	35.8	Yes	Yes	Yes
Not in list-2	Guldhar	60	63	18.65	58.6	33.4	17.4	30.7	Yes	Yes	Yes
Vijay Nagar											
Site No -134	C block Sec 9	60	63	22.4	68.0	59.4	22.4	49.1	Yes	Yes	Yes
Site No -136	Zonal Office	60	63	22.4	67.9	36.5	19.3	35	Yes	Yes	Yes
Site No -138	Mirza Pur No 2	53	63	19.0	53.4	61.8	20.6	43.6	Yes	Yes	Yes
Site No -139	Mirza Pur No 3	60	63	7.5	9.4	39.2	7.0	14.3	Yes	Yes	Yes
Site No -142	H block sec 12	53	63	22.4	86.5	39.3	22.9	40.5	Yes	Yes	Yes
Site No -144	D block sec 11	60	63	22.4	34.1	54.2	17.7	28.4	Yes	Yes	Yes
Site No -145	B block sec 11	53	63	22.4	36.7	54.7	18.6	29.3	Yes	Yes	Yes
Site No -147	E block sec 11 no -5	53	63	22.4	100.1	31.4	28.2	30.4	Yes	Yes	Yes
Site No -148	G block sec 11 pump No.3	53	63	22.4	36.0	32.2	23.1	13.7	Yes	Yes	Yes

Pump Identification		Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Site No.	Pump House	Flow (m^3/h)	Head (m)	Motor rating (kW)	Flow (m^3/h)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Site No -150	F block sec 11	53	63	22.4	36.2	33.4	20.1	16.4	Yes	Yes	Yes
Site No -153	Sudamapuri no 2	53	63	22.4	27.5	48.5	17.4	20.9	Yes	Yes	Yes
Site No -154	Sudamapuri no 3	53	63	22.4	5.7	47.1	22.4	3.2	Yes	Yes	Yes
Site No -157	L block sec 9	53	63	22.4	90.6	41.7	23.9	43.1	Yes	Yes	Yes
Site No -158	H block sec 9 rosevally school	60	63	22.4	84.6	32.6	21.5	34.9	Yes	Yes	Yes
Site No -161	H block Kela Khada	53	63	22.4	82.9	38.9	21.8	40.3	Yes	Yes	Yes
Site No -162	R block sec 12	53	63	22.4	84.7	36.4	23.2	36.2	Yes	Yes	Yes
Site No -163	Sorvaday Nagr	60	63	22.4	28.2	39.3	20.2	14.9	Yes	Yes	Yes
Site No -164	A-block Sec 11	53	63	22.4	33.7	36.8	20.4	16.6	Yes	Yes	Yes
Site No -166	B block Mata Colony	60	63	22.4	0.0	0.0	0.0	-	-	-	-
Mohan Nagar											
Site No -167	Tilla More No 1	60	63	22.4	45.7	31.5	21.2	18.5	Yes	Yes	Yes
Site No -168	Tilla More No 2	56	63	15	44.8	51.7	12.4	50.7	Yes	Yes	Yes
Site No -174	Tilla More No 11	60	63	15	55.9	32.8	15.4	32.4	Yes	Yes	Yes
Site No -175	Tilla More No 12	53	63	15	53.4	39.1	11.7	48.8	Yes	Yes	Yes
Site No -177	Tilla More No 14	60	63	15	29.6	31.1	15.5	16.2	Yes	Yes	Yes
Site No -179	Tilla More No 16	53	63	22.4	88.8	32.5	20.6	38.1	Yes	Yes	Yes
Site No -182	Tilla More No 19	53	63	18.8	20.3	32.6	18.9	9.5	Yes	Yes	Yes
Site No -185	Sai upwan no 1	60	63	19	59.4	37.8	17.1	35.8	Yes	Yes	Yes
Site No -186	Sai upwan no 2	60	63	22.4	100.9	40.3	24.9	44.5	Yes	Yes	Yes
Site No -187	Sai upwan no 9	60	63	22.4	83.1	37.4	21.3	39.7	Yes	Yes	Yes
Site No -188	Sai upwan no 6	60	63	22.4	62.7	48.4	23.6	35.0	Yes	Yes	Yes
Site No -191	Sai upwan no 8	60	63	15	31.5	37.9	13.8	23.5	Yes	Yes	Yes
Site No -192	Kanha Upwan	60	63	22.4	105.7	25.9	25.4	29.3	Yes	Yes	Yes
Vasundhara											
Site No -198	Hindon No 9	60	63	23.0	103	30.9	17.5	49.5	Yes	Yes	Yes
Site No -203	Vasundhara sec 9/1	60	63	7.5	33.3	33.1	7.7	39.2	Yes	Yes	Yes
Site No -204	Vasundhara sec 9/2	60	63	7.5	39.1	33.0	8.1	43.2	Yes	Yes	Yes

Pump Identification		Rated parameters			Operating parameters (individual operation)				Accessories to be installed		
Site No.	Pump House	Flow (m^3/h)	Head (m)	Motor rating (kW)	Flow (m^3/h)	Total head (m)	Actual power consumption (kW)	Pump set efficiency (%)	NRV to be installed (Yes/No)	Gate valve to be installed (Yes/No)	Apparatus for Web based dashboard (Yes/No)
Site No -205	Vasundhara sec 11	60	63	7.5	30	32.5	6.4	41.3	Yes	Yes	Yes
Site No -207	Vasundhara sec 15	60	63	22.4	66.4	43.7	14.3	55.3	Yes	Yes	Yes
Site No -213	Vaishali sec 3 no-1	60	63	22.4	105.1	34.6	22.6	43.8	Yes	Yes	Yes
Site No -213	Vaishali sec 3 no-3	60	63	22.4	117	32.6	23.4	44.4	Yes	Yes	Yes
Site No -215	Vaishali sec 5/5	56	63	15.0	35	63.7	12.2	49.7	Yes	Yes	Yes
Site No -216	Vaishali sec 6/8	56	63	15.0	62.3	60.3	18.1	56.5	Yes	Yes	Yes
Site No -219	Vasundhara sec 5	60	63	23.0	84.67	33.7	18.9	41.1	Yes	Yes	Yes

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ABBREVIATIONS

AMRUT	Atal Mission Rejuvenation and Urban Transformation
APFC	Automatic Power Factor Control
BEP	Best Efficiency Points
BPS	Booster Pumping Stations
CEA	Certified Energy Auditor
CSPDCL	Chhattisgarh State Power Distribution Corporation Limited
DESL	Development Environergy Services Ltd. (Formerly Dalkia Energy Services Ltd.)
DSM	Demand Side Management
EC	Energy Conservation
EE	Energy Efficiency
EEM	Energy Efficiency Measure
EESL	Energy Efficiency Services Limited
GMC	Ghaziabad Municipal Corporation
HT	High Tension
HSC	Horizontal Split Casing
IGEA	Investment Grade Energy Audit
kVA	Kilo Volt Ampere
kW	Kilowatt
kWh	kilowatt Hour
LED	Light Emitting Diode
LT	Low Tension
MEEP	Municipal Energy Efficiency Programme
MoUD	Ministry of Urban Development
MoU	Memorandum of Understanding
OHT	Over Head Tank
O&M	Operation and Maintenance
PF	Power Factor
PS	Pumping Station
PWW&SS	Public Water Works & Sewerage Systems
RPM	Rotations Per Minute
R&M	Repair & Maintenance
ROE	Return on Equity
SEC	Specific Energy Consumption
SHPSC	State level High Powered Steering Committee
SLTC	State Level Technical Committee
SPS	Sewerage Pumping Station
STP	Sewerage Treatment Plant
SUDA	State Urban Development Agency
TOE	Tonne of oil equivalent
ULB	Urban Local Body
UM	Under Maintenance
VFD	Variable Frequency Drive
WTP	Water Treatment Plant
WDS	Water Distribution Station
GMC	Ghaziabad Municipal Corporation

1 Introduction

1.1 Background of the Project

The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched by Prime Minister of India in June 2015 with the objective of providing basic services (e.g. water supply, sewerage, urban transport) to households and build amenities in cities which will improve the quality of life for all.

To facilitate market transformation and replicate Municipal Energy Efficiency Programme on a large scale in India, Ministry of Urban Development (MoUD), Government of India signed a Memorandum of Understanding (MoU) with Energy Efficiency Services Limited (EESL), a public sector entity under Ministry of Power, Government of India on 28th September, 2016 under AMRUT. This will enable replacement of inefficient pump sets in Public Water Works & Sewerage Water Systems with energy efficient pump sets at no upfront cost to the Municipal Bodies. The investment will be recovered from savings in energy costs.

Energy audit and optimizing energy consumption are mandatory reforms under AMRUT. EESL and State Urban Development Agency (SUDA), Government of Uttar Pradesh have jointly entered into an agreement on 9th February, 2017 in order to provide an overarching framework to facilitate engagement between state government and ULB (covered under AMRUT) of Ghaziabad. Under this agreement, EESL is undertaking the project to replace old inefficient pump sets by energy efficient pump sets in Ghaziabad district of Uttar Pradesh.

According to MoUD, energy audits for improving energy use are one of the mandated reforms under the AMRUT and this initiative would help the cities significantly. "This will substantially reduce costs of operation of water supply schemes and public lighting that will ultimately benefit the citizens. EESL will be promoting use of energy efficiency programmes across the country and will ensure supply of latest technologies under these municipal programmes".

Energy cost accounts for 40 to 60 % of cost only for water supply in urban areas and energy efficiency interventions can reduce this cost by 20 to 40 %, depending on the type and age of pump sets being used for bulk water supply. By becoming energy efficient, ULB's can reap annually up to 4,800 MU and Rs.3,200 Crores besides avoiding the need for 3,300 MW of power.

Necessary interventions would be undertaken by EESL without any financial burden on ULB as cost of the proposed Municipal Energy Efficiency Programmes would be borne out of the savings. MoU states that performance contracting offers a mechanism for ULB to finance these projects without upfront investment.

As per the MoU, EESL will develop overall strategy for taking up energy efficiency projects in urban areas and to start with, will take up implementation of energy efficient pump sets in public water works and sewage systems, to be followed by similar interventions for public lighting, public transport systems and buildings.

EESL will provide or arrange project funding for implementation as required and will procure latest technology equipment and materials in a transparent manner besides ensuring repair and maintenance

services for the goods installed by it. EESL is in the process of implementing energy efficient pumps for 500 cities under AMRUT scheme of Government of India. After the agreement between the State Urban Development Agency, Government of Uttar Pradesh (SUDA) and Energy Efficiency Services Limited was signed successfully on 09th February 2017, EESL initiated an open tendering process for hiring Energy Auditing Agency through competitive bidding. Based on the bidding evaluation, DESL was selected for doing the energy audit for Ghaziabad city. EESL has engaged M/s Development Environergy Services Limited (DESL) for preparation of (IGEA) reports for PWW&SS with an objective to replace inefficient pump sets with efficient ones vide its work order Ref: EESL/06/2016-17/Energy Audit/Uttar Pradesh/LoA 1617033/9982 dated 16th March, 2017. Post the issuance of the LoA to M/s DESL, the kick-off meeting was held on 27th March, 2017 at Municipal Corporation Office of Ghaziabad.

1.2 Stakeholders Involved

There are many stakeholders involved in AMRUT. Their roles and responsibilities are already defined by the MoUD and other technical committee. Generally, the MoUD, EESL, ULB and State Urban Development Agency (SUDA) have major role to execute under AMRUT.

MoUD: The MoUD committee may co-opt any representative from any Government Department or organization as Member or invite any expert to participate in its deliberations. Key roles of MoUD include:

i. Allocation and release of funds to the States/UTs/Mission Directorate.
ii. Overall monitoring and supervision of the Mission.
iii. Advise to the State/UT/implementing agencies on innovative ways for resource mobilization, private financing and land leveraging.
iv. Confirm appointment of organizations, institutions or agencies for third party monitoring.

SUDA: State Urban Development Agency was setup to ensure the proper implementation and monitoring of the centrally assisted programme. SUDA provides technical support to districts/towns to achieve their targets and also help in monitoring the state training plan. They also provide guidance and supervise the programme implementation through visits to the project sites.

ULB: At the City level, the ULB will be responsible for implementation of the Mission. The Municipal Commissioner will ensure timely preparation of all the required documents. The ULBs will ensure city level approvals of IGEA and bid documents and forward these to the State level Technical Committee (SLTC)/ State level High Powered Steering committee (SHPSC) for approvals. The ULB will also be responsible for building coordination and collaboration among stakeholders for timely completion of projects without escalation of project cost.

SLTC: SLTC may co-opt member(s) from other State Government Departments/Government organizations and may also invite experts in the field to participate in its deliberations.

EESL: Ministry of Power has set up Energy Efficiency Services Limited (EESL), a Joint Venture of NTPC Limited, PFC, REC and POWERGRID to facilitate implementation of energy efficiency projects. It will promote energy efficiency programmes across the country and will ensure supply of energy efficient equipment under this municipal programme. Necessary interventions would be undertaken by EESL without any financial burden on ULBs as cost of the proposed Municipal Energy Efficiency Programmes would be borne out of annuity payments. EESL has been doing various Energy Efficient Programmes, list of same is provided below:

1. Domestic Appliances Programme (LED Bulbs, LED Tube lights, Fans, etc.)
2. Street Lighting National Programme
3. Agricultural Demand Side Management
4. Municipal Energy Efficiency Programme
5. Atal Jyoti Yojana (Solar LED Street Lights)

Energy Auditing Agency - DESL: EESL has engaged DESL for preparation of IGEA reports for public water works and sewerage systems with an objective to replace inefficient pump sets with efficient ones. DESL will conduct the energy audit activity at different ULBs and make DPR with financial projections for all the ULBs.

Pump Suppliers and Manufacturers: EESL has selectively taken on-board range of pump manufacturers and enquired with them regarding the necessary specifications of the products which can be used in line with the defined criteria according to EESL. All these manufacturers are rated manufacturers and comply with the quality and standards of their products.

1.3 Objective of the IGEA

Energy costs account for 40 to 60% of cost for water supply in urban areas and energy efficiency interventions can reduce this cost by 20 to 40%, depending on the type and age of pump sets being used for Public Water Works and Sewerage Systems (PWW&SS). The MoUD with support from EESL has designed framework project for Energy Efficiency in cities of India while giving priority to AMRUT and smart cities. The objective of this project and IGEA report is to provide maximum information for creating baseline and analysis of current energy and utilization of Public water works systems.

This project is to be co-implemented by EESL and the objectives of this project are as under:

- To create increased demand for EE investments by adopting a ULB approach to facilitate the development of customized EE products and financing solutions in ULB.
- To raise the quality of EE investment proposals from a technical and commercial perspective.
- To expand the use of existing guarantees mechanisms for better risk management by EESL to catalyze additional commercial finance for energy efficiency.
- To establish a monitoring and evaluation system for the targeted ULB.

Scope of Work of Detailed Energy Audit

The general scope of work for detailed energy audits under IGEA as per Schedule 'A' is as follows:

- Discussion with Key personnel and Site visits of the facility
    - Initial discussions with Key personnel such as Commissioner, Chief Officer, Electrical / Mechanical engineer and pump operators to explain the objectives of the project, benefits of energy efficiency, and the approach that will be followed in Energy Audit.
    - Purpose of this discussion will be to ensure that key personnel of ULB have adequate understanding of the project.
    - Visiting all the facilities within the scope of project by identified agency to ascertain the availability of data and system complexity.
    - Identified agency will formulate a data collection strategy.

- Data Collection
    - Current energy usage (month wise) for all forms of energy for the last three years (quantity and cost)
    - Mapping of process
    - ULB and pumping station profile including name of station, years in operation, total water quantity pumped in last three years
    - List of major pumping equipment and specifications
- Analysis
    - Energy cost and trend analysis
    - Energy quantities and trend analysis
    - Specific consumption and trend analysis
    - Pumping costs trend analysis
    - Scope and potential for improvement in energy efficiency
- Detailed process mapping to identify major areas of energy use
- To identify all areas for energy saving (with or without investment) in the following areas:
    - Electrical: Power factor management, transformer loading, power quality tests, motor load studies, lighting load, electrical metering, monitoring and control system
    - Water usage and pumping efficiencies (including water receipt, storage, distribution, utilization, etc.), pump specifications, break down maintenance
- Classify parameters related to EE Enhancements such as estimated quantum of energy saving, investment required, time frame for implementation, payback period and to classify the same in order of priority
- Undertake detailed financial analysis of the investments required for EE enhancements
- Design "Energy Monitoring System" for effective monitoring and analysis of energy consumption, energy efficiency.
- Correlate monthly pumping quantity data with electricity consumption for a period of last three years of normal operation for individual sections of the overall pumping station
- Recommend a time bound action plan for implementation
- The broad content of the IGEA report should be as follows:
    - **Executive summary:** Provides brief description of the facilities covered, measures evaluated, analysis methodology, results and a summary table presenting the cost and savings estimates for each recommended measure. It also includes a summary of the recommended measures and costs as well as the financial indicators of the Project.
    - **Background:** Background about the ULB and the project.
    - **Facility Description:** Details of the existing facilities targeted, such as water treatment & supply systems, sewage treatment and handling systems.
    - **Energy Scenario:** Energy consumption details of all facilities included in the audit and their energy sources.
    - **Baseline parameters and Adjustments:** Methodology followed in establishing the baseline parameters and criteria.
    - **Data Collection**: List the various types of data collected and their sources.
    - **System mapping**: Describe the methodology followed for system mapping and include the maps and process flow diagrams in the report.

- **List of Potential EEMs:** A list of all identified measures with estimates of the savings and payback periods on investments, and a summary of the selected EEMs chosen for further payback periods on investments, and a summary of the selected EEMs chosen for further development.

1.4 Methodology adopted for Energy Audit

A detailed energy audit was conducted at all the pumping stations falling under Ghaziabad Municipal Corporation from 27th March – 18th April and 10th May to 16th May 2017. The energy audit team of DESL comprised of BEE certified energy auditors/managers and pump experts. During the field visit, adequate numbers of portable energy audit instruments were used to carry out measurements of pump sets efficiency parameters. In addition to this, design and operational data was collected from logbooks, equipment manuals and pump manufacturers. Discussions were held with various technical and operating staffs of the ULB to understand the system and pump sets operations and requirements completely. The energy audit study mainly focused on the evaluation of operational efficiency/performance of the pump sets already installed in the premise from the energy conservation point of view.The methodology planned for accomplishing the above scope of work was divided into three phases as detailed below:

Phase 1: Inception

- Conduct kick-off meeting
- Pilot visit to a few sites to ascertain the availability of data, measurements points and system complexity
- Discussed and finalized the methodology for data collection as per job card.

Phase 2: Detailed energy audit

- Initial meeting with concerned staff of ULB at each site to brief them regarding the project
- Walk-through of the site along with pumping station/site personnel to understand the site conditions and equipment involved
- Assessment of data availability (historical data/technical data sheets of major equipment/maintenance practices/cost details/electricity bills, etc.) and placing request for required data
- Finalization of measurement points and support required from ULB staff
- Conducting measurements and data collection with support from ULB staff
    - Energy auditing instruments used during project are listed below:
        - Power analyser: For electrical parameters (V, A, kW, kVA, kWh, kVAh, PF, Hz and THD)
        - Ultrasonic flow meter: For water flow measurement
        - Ultrasonic thickness gauge: For pipeline thickness measurement
        - Digital pressure gauges: For suction and discharge pressure measurement
        - Lux meter: For lighting intensity measurement
    - Filling & signing of job cards
    - Parallel activities of noting observations on the following:
        - SLD (Site Layout Diagram) & PID
        - Operation & Maintenance practices
        - Instrumentation in place and

- Existing practices to monitor energy consumption.

Phase 3: Analysis and IGEA report preparation

- Compilation and analysis of data collected from site
- Performance assessment of the equipment
- Conceptualization and development of energy cost reduction projects
- Cost benefit analysis
- Review of adequacy of instrumentation for energy efficiency monitoring and
- Submission of IGEA report to ULB/ SLTC for approval.

2 Interaction with Facilities/ Key Personnel

The energy auditing team interacted for work proceeding and reporting of each other for efficient information exchange. The kick-off meeting was held under the chairmanship of Executive Engineer of Ghaziabad Municipal Corporation on 27th March, 2017 for discussing the data/information required and methodology to be followed. Also, the discussion on the support required from the ULB was held. The ULB appointed its staff to provide support and information for conducting energy audit. DESL provided day wise reporting to appointed staff of ULB regarding work status. Based on the work experience with ULB, one interim report was submitted to EESL.

The following important issues were discussed and appropriate guidance was provided to the team members. During the kick-off meeting and pre-site visit at bore wells on 27th March, 2017 following points were discussed:

- Support from the ULB will be given to the DESL team for conducting energy audit
- Energy audit will be conducted by DESL team in presence of EESL personnel and nodal official of ULB.
- Observations will be discussed with the appointed official of ULB and EESL
- DESL can communicate with ULB official regarding scheduling of sites for audit
- Support will be provided by ULB to obtain various data to create baseline of energy consumption, quantity of water pumped, etc.
- The letter of site activity conducted should be collected by DESL after finishing the site work
- DESL will regularly report the ULB official by informing the status of work and work schedule for on coming days
- The site work completion letter should contain the information of pumps measured and those under maintenance.
- DESL will report the status of work on a daily basis to project-coordinator of EESL
- DESL will submit the job card to EESL after completion of site work

EESL also appointed their staff to monitor audit works and to provide support and guidance for better quality of work flow. The appointed staff from EESL has been trained for the information exchange and to provide maximum support for the site to be ready for energy audit. The appointed staff of EESL held periodic discussions with DESL team members regarding the observation of energy audit and feasibility of EE projects at ULB.

2.1 Interaction with Pump Manufacturers

Some of the reputed pump manufacturers were selectively contacted regarding the costing and feasibility of different pump sets. The discussion with pump set manufacturers included the following points:

- Technical Feasibility of the suggested energy efficiency measures were discussed with the vendors.
- Commercial terms of EEM such as cost of equipment, auxiliary systems, and installation cost etc. were discussed with the vendors for assessing financial viability of EEM.

3 Project area and Facility description

3.1 General information about the city

Ghaziabad is a city of Uttar Pradesh and comes under Ghaziabad Municipal Corporation area. Ghaziabad is the administrative headquarters of Ghaziabad District and Ghaziabad Division. The city spreads over an area of 133.3 $km^2$and is governed by Ghaziabad Municipal Corporation. As per the previous Census, the population Ghaziabad city is provides in table no 1.

Table 1: Population of Ghaziabad city[1]

Census Year	Population (Nos.)
2001	3,290,586
2011	4,681,645

Ghaziabad the headquarters of the district of the same name that was established in 1976, lies on the Grand Trunk road about a mile east of the Hindon river in Lat. 280 40' North and Long. 770 25' East, 19 km. east of Delhi and 46 km. south-west of Meerut.

3.2 Accessibility to city from Metro cities & State capital

Rail

Ghaziabad railway station is on the Kanpur-Delhi section of Howrah-Delhi main line, Howrah-Gaya-Delhi line and New Delhi-Moradabad-Lucknow line. Local electric trains are available regularly from Ghaziabad for stations in the National Capital Region- Distance: New Delhi railway station (26 km), Old Delhi railway station (20 km), Hazrat Nizamuddin railway station (23 km), Anand Vihar (13 km). Local trains which run on reguler intervals are EMUs, MEMUs, and Passengers. Local trains start in the early morning and run till midnight. Ghaziabad electric loco shed serves the Delhi area. It houses and maintains India's fastest locomotives which are mostly used in Rajdhani, Shatabdi and Duronto Expresses.

The Delhi Metro extends to Dilshad Garden station which is situated at the Apsara Border. At present, it serves the areas of Shalimar Garden, Rajendra Nagar and other neighboring colonies. This line will be extended to New Bus Stand, Ghaziabad by 2016-17. Work for the same started in December 2014. Another station exists at Vaishali, which serves that area as well as Vasundhara and Indirapuram, and there is also a station at Kaushambi.

Road

Ghaziabad is well connected by road to other major cities of Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Haryana, Uttarakhand, Punjab and Rajasthan. Ghaziabad city is located to the east of New Delhi. Along with Noida, New Delhi and Gurgaon, it forms an important economic and industrial zone. Ghaziabad is located on the Great Grand Trunk Road. This means the city can be accessed from many parts of North India including many parts of Bengal, Bihar, Uttar Pradesh and Delhi. There are regular bus services ferrying passengers to and from Ghaziabad. The Uttar Pradesh State Road Transport Corporation is about to start the City Bus Service, which will connect Ghaziabad to Noida and Greater Noida.

[1] http://www.census2011.co.in/census/district/511-ghaziabad.html

Air

Hindon Airport is at Hindon Air Base, it is manned and operated by the Indian Air Force. IGI airport in New Delhi is the nearest airport to the Ghaziabad city.

3.3 Pumping Stations in the Ghaziabad city

The existing water source for the Ghaziabad city is ground water which is pumped out with the help of submersible pumps. In order to supply the drinking water, Nagar Nigam has installed 223 bore well pumping stations .The pictorial representation of the entire pumping station is provided in figure 1.

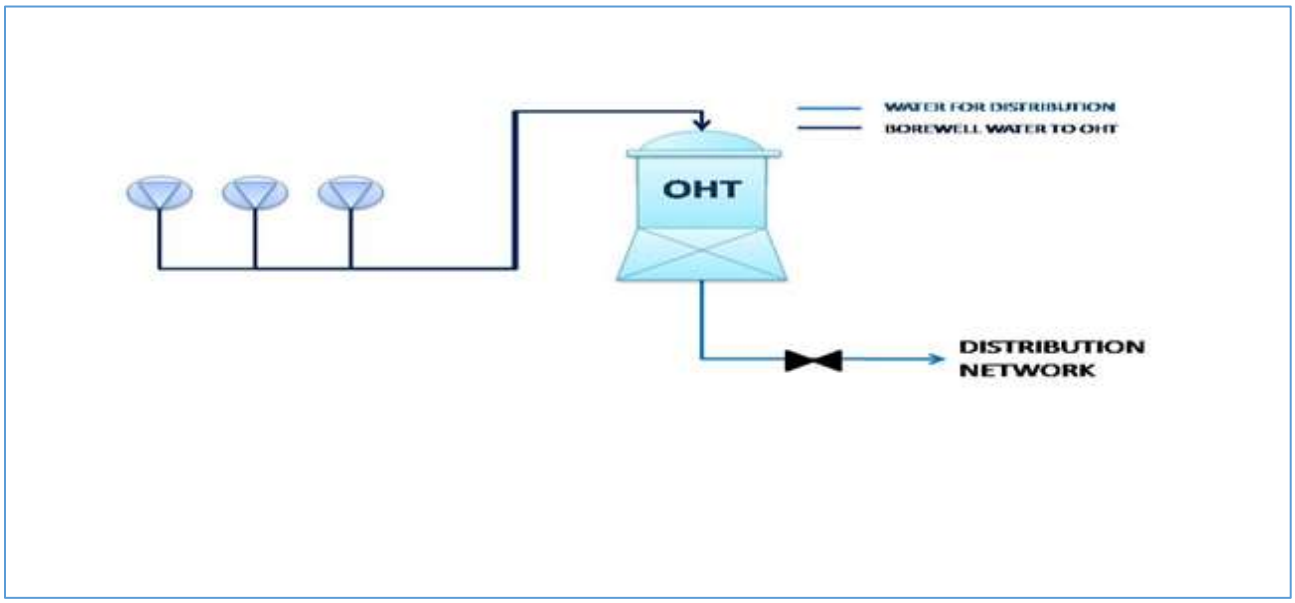

Figure 1: Ghaziabad pumping station overview

The details of the water pumping stations are provided below in the table 2.

Table 2: Details of bore well pumps

Sl. No.	Name of Pumping station	Capacity (MLD)	Source of Water	Distribution/Delivery area
1	3rd A Pump no -6	1.44	Ground Water	Distribution Network
2	3rd A Pump no -7	1.44	Ground Water	Distribution Network
3	3 F nehru Nagar	1.44	Ground Water	NA
4	Ram lila maidan no 3	1.44	Ground Water	Ghanta Ghar locality
5	Ghanta Ghar taxi Stand	1.44	Ground Water	Ghanta Ghar locality
6	Company Bang No 5	1.44	Ground Water	NA
7	Company Bang No 4	1.44	Ground Water	NA
8	Ashok Nagar	1.44	Ground Water	Distribution Network
9	Yashoda Hospital	1.44	Ground Water	Distribution Network
10	Holichild Barat Ghar	1.44	Ground Water	Distribution Network
11	Gandhi Park No-5	1.44	Ground Water	Distribution Network
12	Dayanad Nagar No 1	1.44	Ground Water	NA
13	Dayanand Nagar N0.2	1.34	Ground Water	Distribution Network
14	Paras Hotel Pump	1.44	Ground Water	Distribution Network
15	Kalkaghari Pump no 1	1.44	Ground Water	Distribution Network

Sl. No.	Name of Pumping station	Capacity (MLD)	Source of Water	Distribution/Delivery area
16	Balupura Pump	1.44	Ground Water	Distribution Network
17	Maliwada Fire Brigade	1.44	Ground Water	Distribution Network
18	Pranghari	1.44	Ground Water	Distribution Network
19	Jai prakash	1.44	Ground Water	Distribution Network
20	Panch Wati	1.44	Ground Water	NA
21	Anand Vihar	1.44	Ground Water	NA
22	Kamla Quarter	0.74	Ground Water	Distribution Network
23	Laxhmi Vihar	1.44	Ground Water	Distribution Network
24	2A Nehru Nagar	1.44	Ground Water	Distribution Network
25	2 B nehru Nagar	1.44	Ground Water	NA
26	Sabhaghar Pump	1.44	Ground Water	Distribution Network
27	Nehru Nagar No 2	1.44	Ground Water	Distribution Network
28	Hind Park	1.44	Ground Water	Distribution Network
29	MB girls College	1.44	Ground Water	Distribution Network
30	Chandrapuri	1.34	Ground Water	Distribution Network
31	Town Hall Pump no 1	1.44	Ground Water	Distribution Network
32	DC garg Pump	0.74	Ground Water	Distribution Network
33	3B nehru Nagar	1.44	Ground Water	Distribution Network
34	Arjun Nagar	1.44	Ground Water	NA
35	Gandhi Nagar no 6	1.44	Ground Water	Gandhi Nagar , Nehru Nagar Supply
36	Payre lal pumping station	1.44	Ground Water	NA
37	Ram Nagar Teekona Park	1.44	Ground Water	Ram Nagar,gandhi Park
38	Nand Gram C Block	1.44	Ground Water	A Block, goghena locality
39	Nand Gram B Block	1.27	Ground Water	Distribution network
40	C block Ramlila Garond	1.27	Ground Water	Distribution network
41	Nand Gram No 1	1.44	Ground Water	Distribution network
42	Nand Gram E block	1.44	Ground Water	Distribution network
43	Nand Gram F block	1.44	Ground Water	Distribution network
44	Lohia Nagar Pump no 1	1.44	Ground Water	Lohia Nagar OHT (1200 KL)
45	Lohia Nagar Pump no 2	1.34	Ground Water	Distribution network
46	Gandhi Park	1.27	Ground Water	Lohia Nagar OHT(1200 KL)
47	Dina Ghari	1.44	Ground Water	Lohia Nagar OHT(1200 KL)
48	G block Patel Nagar	1.34	Ground Water	Lohia Nagar OHT(1200 KL)
49	Sanjay geeta Park	1.44	Ground Water	Lohia Nagar OHT(1200 KL)
50	B block market	1.34	Ground Water	Lohia Nagar OHT(1200 KL)
51	Patel Nagar B block	1.44	Ground Water	Distribution Network
52	Patel Nagar D block Mother dairy	1.44	Ground Water	Distribution Network
53	Banwari Nagar	1.27	Ground Water	Distribution Network
54	Shibbon Pura	1.44	Ground Water	Distribution Network
55	L block patel nagar	1.44	Ground Water	Patel Nagar, Udhal Nagar , Patel Marg
56	Dhookna Katha	1.34	Ground Water	Distribution network
57	Dhookna Mandir	1.44	Ground Water	NA

Sl. No.	Name of Pumping station	Capacity (MLD)	Source of Water	Distribution/Delivery area
58	Gautam Nagar	1.44	Ground Water	NA
59	Bhonja	1.44	Ground Water	Distribution network
60	Lohia Nagar B ablock	1.44	Ground Water	Distribution network
61	lal Quarter No 1	1.34	Ground Water	Distribution network
62	lal Quarter No 2	1.44	Ground Water	Distribution network
63	Lal Quarter no 2 (rebore)	1.44	Ground Water	NA
64	MMG Pump no -1	1.44	Ground Water	MMG OHT (450 KL)
65	MMG Pump no 2	1.44	Ground Water	NA
66	Model Town Park No-1	1.44	Ground Water	Distribution network
67	Model Town Pump NO 2	1.44	Ground Water	NA
68	Model Town Pump No 4	1.44	Ground Water	Distribution network
69	New Bus adda No 1	1.44	Ground Water	NA
70	New Bus Adda Tank	1.44	Ground Water	NA
71	MB Girls Kela Kheda	1.44	Ground Water	Distribution network
72	Tar Factory	1.44	Ground Water	Distribution network
73	Chmada Patt	1.44	Ground Water	Distribution network
74	Jassipurs	1.44	Ground Water	Distribution network
75	Kella Masrasa	1.44	Ground Water	Distribution network
76	Lalten Factory	1.44	Ground Water	NA
77	Sarai Nagar	1.44	Ground Water	Distribution network
78	Kella Khada	1.44	Ground Water	NA
79	D-block No.1	1.44	Ground Water	NA
80	Hathi park No.2	1.44	Ground Water	NA
81	Tulsi park No.3	1.44	Ground Water	NA
82	C block No No 4	1.27	Ground Water	NA
83	Pumping station No.14	1.44	Ground Water	NA
84	Chiranjeevi vihar Tank No.1	1.27	Ground Water	NA
85	Shani mandir pump No.2	1.27	Ground Water	NA
86	Sec-1 park Chiranjeevi vihar No.3	1.27	Ground Water	Distribution network
87	C block No.1	1.27	Ground Water	C block OHT (2250KL)
88	A block park pump No.5	1.27	Ground Water	C block OHT (450KL)
89	3A block pump No.6	1.27	Ground Water	C block OHT (450KL)
90	1D block pump No.3	1.27	Ground Water	H block OHT (2250KL)
91	Govindpuram pump No.4	1.27	Ground Water	H block OHT (2250KL)
92	G-block pump No.2	1.44	Ground Water	H block OHT (2250KL)
93	C-block pump No.1	1.44	Ground Water	OHT (2250 KL)
94	C-block pump No.2	1.27	Ground Water	OHT (2250 KL)
95	Uttam public school No.3	1.44	Ground Water	OHT (2250 KL)
96	D-block No.5	1.44	Ground Water	OHT (2250 KL)
97	Mother Dairy No 8	1.27	Ground Water	NA
98	A-block pump No.4	1.44	Ground Water	OHT (2250 KL)
99	Rajnagar No.1	1.27	Ground Water	OHT (900 KL)
100	Ramlila Maidan No 10	1.44	Ground Water	NA
101	Sector-11 pump No.11	1.44	Ground Water	OHT (900 KL)
102	GDA market No.3	1.44	Ground Water	OHT (900 KL)
103	Sector-8 pump No.7	1.44	Ground Water	OHT
104	Sector-6 pump No.2	1.44	Ground Water	OHT (900 KL)
105	Sector-9 pump No.9	1.44	Ground Water	OHT (900 KL)

Sl. No.	Name of Pumping station	Capacity (MLD)	Source of Water	Distribution/Delivery area
106	F block tank compound	1.44	Ground Water	F block OHT (450 KL)
107	B-block No.4	1.44	Ground Water	F block OHT (450 KL)
108	Near forest dept. No.2	1.44	Ground Water	F block OHT (450 KL)
109	P-block No.7	1.44	Ground Water	F block OHT (450 KL)
110	L-block No.8	1.44	Ground Water	G block OHT (2250 KL)
111	L-block No.10	1.44	Ground Water	G block OHT (2250 KL)
112	G-block tank No.6	1.44	Ground Water	G block OHT (2250 KL)
113	N-block pump No.3	1.44	Ground Water	G block OHT (2250 KL)
114	loha mandi pump No.12	1.44	Ground Water	OHT (2250KL)
115	B-block park No.5	1.34	Ground Water	Distribution network
116	Ramlila maidan no.6	1.34	Ground Water	Distribution network
117	C-block nursery No.7	1.34	Ground Water	Distribution network
118	I-block park No.8	1.34	Ground Water	Distribution network
119	F-block park No.9	1.44	Ground Water	Distribution network
120	H-block tank No.10	1.27	Ground Water	Distribution network
121	Vivekanand nagar No.11	1.44	Ground Water	Distribution network
122	K-block No.7	1.27	Ground Water	Distribution network
123	Bahwali colony	1.27	Ground Water	NA
124	Shastri nagar No.6	1.27	Ground Water	distribution network
125	K-block No.5	1.27	Ground Water	distribution network
126	RDC building	1.44	Ground Water	distribution network
127	Dr.Mukherjee park	1.27	Ground Water	distribution network
128	GDA market sector-7 pump No.8	1.44	Ground Water	distribution network
129	P-block No.11	1.51	Ground Water	distribution network
130	Guldhar	1.44	Ground Water	distribution network
131	Ramlila Maidan sec 9	1.44	Ground Water	NA
132	E block sec 9	1.44	Ground Water	OHT (2250KL)
133	G block sec 9	1.44	Ground Water	NA
134	F block sec 9	1.27	Ground Water	NA
135	A block sec 9	1.44	Ground Water	OHT (2250KL)
136	C block Sec 9	1.44	Ground Water	OHT (2250KL)
137	Ambedkar Nagar Sec 9	1.44	Ground Water	NA
138	Zonal Office	1.44	Ground Water	OHT (2250KL)
139	H block sec 9	1.27	Ground Water	NA
140	Mirza Pur No 2	1.27	Ground Water	OHT (2200KL)
141	Mirza Pur No 3	1.44	Ground Water	Distribution Network
142	F block sec 12	1.27	Ground Water	NA
143	Mother dairy M block	1.44	Ground Water	NA
144	H block sec 12	1.27	Ground Water	Distribution Network
145	N block teachers colony	1.44	Ground Water	NA
146	D block sec 11	1.44	Ground Water	OHT (1200 KL)
147	B block sec 11	1.27	Ground Water	OHT (1200 KL)
148	E block sec 11 no -2	1.27	Ground Water	NA
149	E block sec 11 no -5	1.27	Ground Water	Distribution Network
150	G block sec 11 pump No.3	1.27	Ground Water	Distribution Network
151	G block Sec 11 No 4	1.27	Ground Water	NA
152	F block sec 11	1.27	Ground Water	Distribution Network
153	Awas Vikas Kashiram colony	1.27	Ground Water	OHT

Sl. No.	Name of Pumping station	Capacity (MLD)	Source of Water	Distribution/Delivery area
154	Sudamapuri no 1	1.27	Ground Water	OHT (1250KL)
155	Sudamapuri no 2	1.27	Ground Water	OHT (1250KL)
156	Sudamapuri no 3	1.27	Ground Water	OHT (1250KL)
157	K block sec 9	1.27	Ground Water	NA
158	H block sec 9	1.27	Ground Water	NA
159	L block sec 9	1.27	Ground Water	Distribution Network
160	H block sec 9 rosevally school	1.44	Ground Water	Distribution Network
161	Bhud bharat nagar	1.27	Ground Water	NA
162	Sundar puri	1.44	Ground Water	NA
163	H block Kela Khada	1.27	Ground Water	Distribution Network
164	R block sec 12	1.27	Ground Water	Distribution Network
165	Sorvaday Nagr	1.44	Ground Water	Distribution Network
166	A-block Sec 11	1.27	Ground Water	Distribution Network
167	Dhara school	1.27	Ground Water	Distribution Network
168	B block Mata Colony	1.44	Ground Water	Distribution Network
169	Tilla More No 1	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,Brij Vihar,DLF,Pappu colony
170	Tilla More No 2	1.34	Ground Water	NA
171	Tilla More No 3	1.44	Ground Water	NA
172	Tilla More No 4	1.34	Ground Water	NA
173	Tilla More No 7	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
174	Tilla More No 9	1.34	Ground Water	NA
175	Tilla More No 10	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
176	Tilla More No 11	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
177	Tilla More No 12	1.27	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
178	Tilla More No 13	1.08	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
179	Tilla More No 14	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
180	Tilla More No 15	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
181	Tilla More No 16	1.27	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
182	Tilla More No 17	1.27	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
183	Tilla More No 18	1.44	Ground Water	Shalimar CWR,Rajander Nagar

Sl. No.	Name of Pumping station	Capacity (MLD)	Source of Water	Distribution/Delivery area
				CWR,Shaed Nagar ,
184	Tilla More No 19	1.27	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
185	Tilla More No 20	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
186	Tilla More No 21	1.44	Ground Water	Shalimar CWR,Rajander Nagar CWR,Shaed Nagar ,
187	Sai upwan no 1	1.44	Ground Water	Mohan Nagar CWR
188	Sai upwan no 2	1.44	Ground Water	Mohan Nagar CWR
189	Sai upwan no 9	1.44	Ground Water	Mohan Nagar CWR
190	Sai upwan no 6	1.44	Ground Water	Mohan Nagar CWR
191	Sai upwan no 7	1.44	Ground Water	Mohan Nagar CWR
192	Sai upwan no 3	1.44	Ground Water	Mohan Nagar CWR
193	Sai upwan no 8	1.44	Ground Water	Mohan Nagar CWR
194	Kanha Upwan	1.44	Ground Water	Kanha Upwan Colony
195	Hindon No 1	1.27	Ground Water	distribution network
196	Hindon No 2	1.27	Ground Water	distribution network
197	Hindon No 4	1.27	Ground Water	distribution network
198	Hindon No 7	1.27	Ground Water	distribution network
199	Hindon No 8	1.27	Ground Water	distribution network
200	Hindon No 9	1.44	Ground Water	distribution network
201	Vasundhara sec 7/1	1.51	Ground Water	distribution network
202	Vasundhara sec 7/2	1.44	Ground Water	CWR
203	Vasundhara sec 7/3	1.24	Ground Water	distribution network
204	Vasundhara sec 7/4	1.24	Ground Water	NA
205	Vasundhara sec 9/1	1.44	Ground Water	distribution network
206	Vasundhara sec 9/2	1.44	Ground Water	CWR
207	Vasundhara sec 11	1.44	Ground Water	NA
208	Sec 15	1.15	Ground Water	NA
209	Vasundhara sec 15	1.44	Ground Water	sec 15 CWR
210	Sec 19	1.34	Ground Water	NA
211	Sec 13	1.24	Ground Water	NA
212	Sec 2/2	0.74	Ground Water	NA
213	sec 2/3	1.34	Ground Water	NA
214	Vaishali sec 1	1.44	Ground Water	NA
215	Vaishali sec 3 no-1	1.44	Ground Water	Sec 3 CWR
216	Vaishali sec 3 no-2	1.44	Ground Water	NA
217	Vaishali sec 3 no-3	1.44	Ground Water	NA
218	Vaishali sec 5/4	1.44	Ground Water	NA
219	Vaishali sec 5/5	1.34	Ground Water	sec 5 OHT(2000KL)
220	Vaishali sec 6/8	1.34	Ground Water	Sec 6 OHT(1000 KL)
221	Vasundhara sec 6/9	1.44	Ground Water	NA
222	Ashirvad Sec 2	1.44	Ground Water	NA
223	Vasundhara sec 5	1.44	Ground Water	sec 5 CWR

3.4 Historical Water Pumped and Energy Consumption Analysis

Historical data about water pumped and energy consumption of Ghaziabad Municipality Corporation is provided below in table 3.

Table 3: Historical water pumped and energy consumption data for last three years

Description	Zone	Total quantity of water pump (m^3/y)	Total power consumption Per year (kWh/annum)	Specific energy consumption (kWh/m^3)
Jan-14 to Dec-14		NA	NA	NA
Jan-15 to Dec-15		NA	NA	NA
Jan-16 to Dec-16	City1	9176572.8	2,816,914	0.31
	City2	8085996	2277409.4	0.28
	City3	3043728	883822.5	0.29
	Kavi Nagar	21000384	7428894.9	0.35
	Vijay Nagar	7687759.2	2785675.5	0.36
	Mohan Nagar	7460028	2071216.8	0.28
	Vasundhara	3653402.4	871665.6	0.24

3.5 Power Failure Data

The last year power failure data provided by ULB for pumping stations is provided in table 4.

Table 4: Historical power failure data

Description	Power failure in Hours/Day
Mar-16	3.0
Apr-16	3.0
May-16	3.0
June – 16	2.0
Jul-16	2.0
August – 16	2.0
September – 16	2.0
October – 16	2.0
November – 16	2.0
Dec-16	2.0
Jan-17	2.0
Feb-17	2.0
Average	**2.3**

Average monthly duration of power failure at Ghaziabad pumping stations is estimated to be 2 hours 15 minutes.

3.6 Rainfall and Climate data

Ghaziabad is connected to the national capital; its temperature and rainfall are similar to Delhi. Rajasthan's dust storms and snowfall in the Himalayas, Kumaon and Garhwal hills have their impact on its weather

regularly. The monsoon arrives in the district during the end of the June or the first week of July and normally it rains until October. The average rainfall and climate data is provid in table no 5.

Table 5: Rainfall and Climate data of Ghaziabad City[2]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. Temperature (°C)	14.3	17	22.7	28.6	33.2	34.1	31	29.7	29.1	25.6	20.1	15.7
Min. Temperature (°C)	7.6	10	15.1	20.8	26	28.3	27	26	24.5	18.6	11.7	8.1
Max. Temperature (°C)	21.1	24.1	30.3	36.4	40.5	39.9	35	33.4	33.8	32.7	28.5	23.4
Precipitation / Rainfall (mm)	22	12	19	4	8	42	232	268	147	42	5	9

3.7 Ground Water Profile

As the information received from the ULB, water availability for the city is primary the bore-well water. Present ground water available is at depth of 90-110 feet at different zones

3.8 Water Cost Estimation

During energy audit, data regarding various operation and maintenance expenses borne by ULB was collected for estimating water cost. A detail of expenditure by ULB during last year and estimated water cost is provided in the table 6.

Table 6: Water cost estimation.

Description Different cost components	Units	Values
Energy consumption cost (Electricity)	Rs. Lakhs	4061.9
Repair & Maintenance	Rs. Lakhs	257.2
Operation	Rs. Lakhs	595.7
Miscellaneous cost	Rs. Lakhs	NA
Total cost	Rs. Lakhs	4914.6
Annual water pumped to City	kL	60107870
Water cost	Rs./kL	8.2

The source of above values is as follows:

- The electricity cost has been derived on the basis of bills provided by the ULB.
- The repair and maintenance cost for three years has been provided by the ULB which is attached as Annex 7.
- Annual water pumped to the city is calculated on the basis of flow measurement done at the time of field study.

[2]https://en.climate-data.org/location/967663

4 Pumping Stations Performance Evaluation

Drinking water in the Ghaziabad city is supplied by Ghaziabad Municipal Corporation. Ground water is drawn through bore wells and then stored in the overhead tanks or supplied directly to the consumer.

4.1 Connected load at pumping stations

Based on the data collected for the pumping station from Ghaziabad Municipal office, details of connected load of pumping station is provided in the table 7.

Table 7: Connected load details of pumping stations.

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
3rd A Pump no -6	15	0.1	1	Fan
		0.373	1	Dosing Pump
3rd A Pump no -7	22.4	-	-	-
3 F nehru Nagar	22.4	-	-	-
Ram lila maidan no 3	15	0.07	1	Fan
		0.04	2	T-8 Tube Light
		0.373	1	Dosing Pump
Ghanta Ghar taxi Stand	15	-	-	-
Company Bang No 5	15	-	-	-
Company Bang No 4	15	-	-	-
Ashok Nagar	22.4	0	0	Nil
Yashoda Hospital	22.4	0.07	1	Fan
		0.1	1	incandescent bulb
		0.373	1	Dosing Pump
Holichild Barat Ghar	22.4	0.1	1	incandescent bulb
		0.373	1	Dosing Pump
Gandhi Park No-5	22.4	0.04	1	T-8 Tube Light
		0.07	1	Fan
Dayanand Nagar N0.1	22.4	-	-	-
Dayanand Nagar N0.2		0.07	1	Fan
		0.007	1	LED
Paras Hotel Pump	22.4	0.1	1	incandescent bulb
Kalkaghari Pump no 1		0.1	1	incandescent bulb
		0.373	1	Dosing Pump
Balupura Pump	22.4	-	0	Nil
Maliwada Fire Brigade	22.4	0.04	1	T-8 Tube Light
		0.04	1	Fan
		0.373	1	Dosing Pump
Pranghari	15	0.373	1	Dosing Pump
		0.04	1	T-8 Tube Light
Jai prakash	19	0.2	1	incandescent bulb
		0.1	1	incandescent bulb
Panch Wati	22.4			

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
Anand Vihar	22.4	0.1	1	incandescent bulb
Kamla Quarter	19	0.1	1	incandescent bulb
Laxhmi Vihar	15	0.07	1	Fan
		0.1	1	incandescent bulb
2A Nehru Nagar	19	1	1	Heater
2 B nehru Nagar	15	-	0	Nil
Sabhaghar Pump	15	-	0	nil
Nehru Nagar No 2	23	0.04	1	T-8 Tube Light
Hind Park	19	0.07	1	Fan
		0.04	1	T-8 Tube Light
MB girls College	23	0.04	1	T-8 Tube Light
		0.06	1	T-8 Tube Light
Chandrapuri	23	0.1	1	incandescent bulb
Town Hall Pump no 1	15	0.07	1	Fan
		0.04	1	T-8 Tube Light
		0.373	1	Dosing pump
DC garg Pump	7.5	0.07	1	Fan
		0.04	1	Table Fan
		0.373	1	Dosing Pump
3B nehru Nagar	19	0.373	1	Dosing Pump
Arjun Nagar	15	-	-	-
Gandhi Nagar no 6	23	0.07	1	Fan
		0.011	1	CFL
		0.373	1	Dosing Pump
Payre lal pumping station	7.5	-	-	-
Ram Nagar Teekona Park	23	0.04	1	T-8 Tube Light
		0.1	1	incandescent bulb
		0.373	1	Dosing Pump
Nand Gram C Block	19	0.1	2	incandescent bulb
Nand Gram B Block	19	-	0	Nil
C block Ramlila Garond	15	-	0	Nil
Nand Gram No 1	22.4	-	0	Nil
Nand Gram E block	15	1	1	House Load
Nand Gram F block	22.4	0.11	1	incandescent bulb
		0.373	1	Dosing Pump
Lohia Nagar Pump no 1	22.4	-	-	-
Lohia Nagar Pump no 2	22.4	0.1	1	incandescent bulb
Gandhi Park	22.4	-	0	Nil
Dina Ghari	22.4	-	0	Nil
G block Patel Nagar	22.4	-	0	Nil
Sanjay geeta Park	15	0.045	1	Fan
		0.1	1	incandescent bulb
B block market	22.4	-	0	Nil

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
Patel Nagar B block	22.4	0.04	1	Fan
		0.373	1	Dosing Pump
Patel Nagar D block Mother dairy	22.4	0.1	1	incandescent bulb
		0.373	1	Dosing Pump
Banwari Nagar	15	0.1	1	incandescent bulb
		0.07	1	Fan
		0.1	1	incandescent bulb
Shibbon Pura	15	0.373	1	Dosing Pump
L block patel nagar	15	0.1	2	incandescent bulb
Dhookna Katha	22.4	0.07	1	Fan
		0.1	1	incandescent bulb
		1	1	Heater
Dhookna Mandir	19	0.04	1	Fan
		0.1	1	incandescent bulb
Gautam Nagar	22.4			
Bhonja	22.4	0.1	1	incandescent bulb
Lohia Nagar B ablock	22.4	0.045	1	Fan
lal Quarter No 1	22.4	0.373	1	Dosing Pump
		0.07	1	Fan
		0.04	1	T-8 Tube Light
lal Quarter No 2	22.4	0.1	1	Bulb
Lal Quarter no 2 (rebore)	22.4	-	-	-
MMG Pump no -1	15	3	3	House load
		0.04	1	Fan
		0.04	1	T-8 Tube Light
MMG Pump no 2	7.5	0.373	1	dosing pump
Model Town Park No-1	7.5	0.07	1	Fan
		0.1	1	Incandescent Bulb
Model Town Pump NO 2	22.3	-	1	
Model Town Pump No 4	22.3	0.7	1	Fan
New Bus adda No 1	22.3	-	1	
New Bus Adda Tank	22.3	-	3	incandescent bulb
MB Girls Kela Kheda	22.3	-	0	nil
Tar Factory	15	-	0	nil
Chmada Patt	22.3	0.07	1	Fan
		0.1	1	Incandescent Bulb
Jassipurs	22.3	0	0	nil
Kella Masrasa	22.3	0.1	1	Incandescent Bulb
Lalten Factory	22.3	-	-	-
Sarai Nagar	22.3	0.07	1	Fan
		0.04	1	T-8 Tube Light

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
		0.373	1	dosing Pump
Kella Khada	22.3	-		
D-block No.1	22.4	0.07	5	Fan
		0.04	8	T-8 Tube Light
		0.373	1	Dosing Pump
Hathi park No.2	22.4	0.07	1	Fan
		0.06	1	Incandescent bulb
Tulsi park No.3	22.4	0.373	1	Dousing Pump
C block No No 4	-	0.746	1	Dewatering Pump
Pumping station No.14		0.373	1	Dosing Pump
Chiranjeevi vihar Tank No.1	22.4	0.014	1	CFL
		0.07	1	Fan
Shani mandir pump No.2	22.4	0.373	1	Dousing Pump
Sec-1 park Chiranjeevi vihar No.3	22.4	0.373	1	Dosing Pump
C block No.1	22.4	0.04	1	T-8 Tube Light
A block park pump No.5	22.4	0	0	nil
3A block pump No.6	22.4	0	0	nil
1D block pump No.3	22.4	0	0	nil
Govindpuram pump No.4	22.4	0	0	nil
G-block pump No.2	22.4	0	0	nil
C-block pump No.1	22.4	3	1	House load
C-block pump No.2	22.4	0	0	nil
Uttam public school No.3	22.4	0.1	1	Incandescent bulb
D-block No.5	22.4	0	0	nil
Mother Dairy No 8	-	0	0	nil
A-block pump No.4	22.4	0.1	1	Incandescent bulb
Rajnagar No.1	22.4	0.04	1	T-8 Tube Light
Ramlila Maidan No 10	-	-	-	-
Sector 11 pump no 11	22.4	0.1	1	Incandescent bulb
		0.045	1	tv
		0.07	1	Fan
GDA market No.3	22.4	1.5	1	House load
		0.373	1	dosing Pump
		0.2	1	cooler fan
Sector-8 pump No.7	22.4	0	0	0
Sector-6 pump No.2	22.4	0	0	0
Sector-9 pump No.9	22.4	2	1	House load
F block tank compound	22.4	0.07	1	Fan
		0.04	1	T-8 Tube Light
B-block No.4	18.5	0.1	1	Incandescent bulb
Near forest dept. No.2	22.4	0.04	1	T-8 Tube Light
P-block No.7	22.4	0.04	1	T-8 Tube Light
L-block No.8	22.4	0	0	nil
L-block No.10	22.4	0	0	nil
G-block tank No.6	22.4	0	0	nil

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
N-block pump No.3	22.4	0	0	nil
loha mandi pump No.12	22.4	0	0	nil
B-block park No.5	18.65	0.375	1	Dosing Pump
Ramlila maidan no.6	22.4	0	0	nil
C-block nursery No.7	18.65	0.009	1	LED Bulb
		0.373	1	Dosing Pump
I-block park No.8	18.65	0.373	1	Dosing Pump
F-block park No.9	15	0.373	1	Dosing Pump
H-block tank No.10	22.38	0.373	1	Dosing Pump
Vivekanand nagar No.11	22.38	0.04	1	T-8 Tube Light
		0.373	1	Dosing Pump
K-block No.7	18.65	0	0	nil
Bahwali colony	22.38	0	0	0
Shastri nagar No.6	22.38	0.373	1	dosing Pump
		0.1	1	Incandescent bulb
K-block No.5	15	0.373	1	Dosing Pump
RDC building	22.38	0	0	nil
Dr.Mukherjee park	15	0	0	nil
GDA market sector-7 pump No.8	22.38	0.07	1	Fan
		0.1	1	Incandescent bulb
		1.5	1	heater
P-block No.11	22.38	0.04	1	T-8 Tube Light
		0.1	1	Incandescent bulb
Guldhar	18.65	0.04	1	T-8 Tube Light
		0.373	1	Dosing Pump
Ramlila Maidan sec 9	22.4	-	1	Nil
E block sec 9	22.4	-	1	Nil
G block sec 9	22.4	-	-	-
F block sec 9	18.65	-	-	-
A block sec 9	22.4	0.1	1	Incandescent bulb
		0.07	1	Fan
C block Sec 9	22.4	0	1	Nil
Ambedkar Nagar Sec 9	22.4	-	-	-
Zonal Office	22.4	0.07	1	Fan
		0.04	1	Fan
H block sec 9	19	-	-	-
Mirza Pur No 2	19	0.373	1	Dosing pump
Mirza Pur No 3	7.5	0.04	1	Fan
F block sec 12	22.4	-	-	-
Mother dairy M block	22.4	-	-	-
H block sec 12	22.4	0.04	1	T-8 Tube Light
		0.007	1	LED bulb
N block teachers colony	22.4	-	-	-
D block sec 11	22.4	1	1	house load
B block sec 11	22.4	0	0	Nil
E block sec 11 no -2	22.4	-	-	-
E block sec 11 no -5	22.4	1.5	1	Heater
		0.07	1	Fan

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
		0.04	1	T-8 Tube Light
G block sec 11 pump No.3	22.4	1.5	1	house load
G block Sec 11 No 4	22.4	0.012	1	Incandescent bulb
F block sec 11	22.4	0.2	1	Cooler
		0.045	1	Fan
Awas Vikas Kashiram colony	22.4	1	1	house load
Sudamapuri no 1	18.65	0	0	Nil
Sudamapuri no 2	22.4	0.1	1	Incandescent bulb
		0.04	1	T-8 Tube Light
Sudamapuri no 3	22.4	1	1	house load
K block sec 9	18.7	-	-	-
H block sec 9	18.7	-	-	-
L block sec 9	22.4	0	0	nil
H block sec 9 rosevally school	22.4	0	0	Nil
Bhud bharat nagar	18.7	-	-	-
Sundar puri	22.4	-	-	-
H block Kela Khada	22.4	0	0	nil
R block sec 12	22.4	0	0	Nil
Sorvaday Nagr	22.4	0	0	Nil
A-block Sec 11	22.4	0	0	nil
Dhara school	15	0	0	nil
B block Mata Colony	22.4	0	0	nil
Tilla More No 1	22.4	0.1	2	Incandescent bulb
Tilla More No 2	15	0.1	2	Incandescent bulb
Tilla More No 3	19	0.1	2	Incandescent bulb
Tilla More No 4	15	-	-	-
Tilla More No 7	22.4	-	-	-
Tilla More No 9	15	-	-	-
Tilla More No 10	22.4	-	-	Nil
Tilla More No 11	15	-	-	Nil
Tilla More No 12	15	1	1	Heater
		0.027	1	
		0.04	1	
Tilla More No 13	15	0.1	1	Incandescent bulb
Tilla More No 14	15	0.1	1	Incandescent bulb
		0.04	1	Fan
Tilla More No 15	22.4	0.1	1	Incandescent bulb
Tilla More No 16	22.4	0.1	1	Incandescent bulb
		0.04	1	T-8 Tube Light
		0.04	1	Fan
Tilla More No 17	22.4	1	1	House Load

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
		0.1	2	Incandescent bulb
Tilla More No 18	22.4			
Tilla More No 19	18.8	1	1	House Load
Tilla More No 20	15	-	-	-
Tilla More No 21	22.4	-	-	-
Sai upwan no 1	19	0	0	Nil
Sai upwan no 2	22.4	0	0	Nil
Sai upwan no 9	22.4	0	0	Nil
Sai upwan no 6	22.4	0	0	Nil
Sai upwan no 7	22.4	0	0	Nil
Sai upwan no 3	22.4	0	0	Nil
Sai upwan no 8	15	0.25	1	Sodium Lamp
		0.1	1	Incandescent bulb
Kanha Upwan	22.4	0.1	1	Incandescent bulb
		1	1	Heater
Hindon No 1	18.7	-	-	-
Hindon No 2	18.7	-	-	-
Hindon No 4	15.0	1	1	House load
Hindon No 7	18.7	0	0	nil
Hindon No 8	18.7	-	-	-
Hindon No 9	23.0	1	1	House load
Vasundhara sec 7/1	13.1	-	-	-
Vasundhara sec 7/2	7.5	0.045	1	Fan
		0.045	1	TV
Vasundhara sec 7/3	13.1	-	-	-
Vasundhara sec 7/4	13.1	-	-	-
Vasundhara sec 9/1	7.5	1	1	House Load
		0.1	1	Incandescent Bulb
Vasundhara sec 9/2	7.5	1	1	House Load
		0.1	1	Incandescent Bulb
Vasundhara sec 11	7.5	1	1	House Load
Sec 15	11.2	0	0	Nil
Vasundhara sec 15	22.4	1	1	House Load
		0.1	4	Incandescent Bulb
Sec 19	14.9	-	-	-
Sec 13	13.1	-	-	-
Sec 2/2	7.5	-	-	-
sec 2/3	15.0	-	-	-
Vaishali sec 1	22,4	-	-	-
Vaishali sec 3 no-1	22.4	1	1	house load
Vaishali sec 3 no-2	22.4	-	-	-
Vaishali sec 3 no-3	22.4	-	-	-
Vaishali sec 5/4	22.4	-	-	-
Vaishali sec 5/5	15.0	0	0	nil
Vaishali sec 6/8	15	0.07	1	Fan
		0.1	1	Incandescent

Site Name	Rated Pump Power (kW)	Aux load rating (kW)	No. of Aux fittings	Type of Aux. load
				Bulb
		1	1	heater
Vasundhara sec 6/9	22.4	-	-	-
Ashirvad Sec 2	22.4	-	-	-
Vasundhara sec 5	23	0.04	3	T-8 Tube Light
		0.25	1	Incandescent Bulb
Total Connected load	**4,325 kW**			

4.2 Pumping Station

4.2.1 Overview of existing systems

There are presently 223 bore well pumping station operated by Ghaziabad Municipal Corporation; all pump sets are drawing water from ground water bed. All pumping stations have one pump set only. Out of 223 bore wells, 26 pumps were under maintenance during the site visit whereas 42 sites were not in use. Entire piping is underground except at the pumping station site and discharge line to the tanks that are above the ground.

All pumping stations have almost similar type of layout; generic layout for the same is shown in figure 2 below:

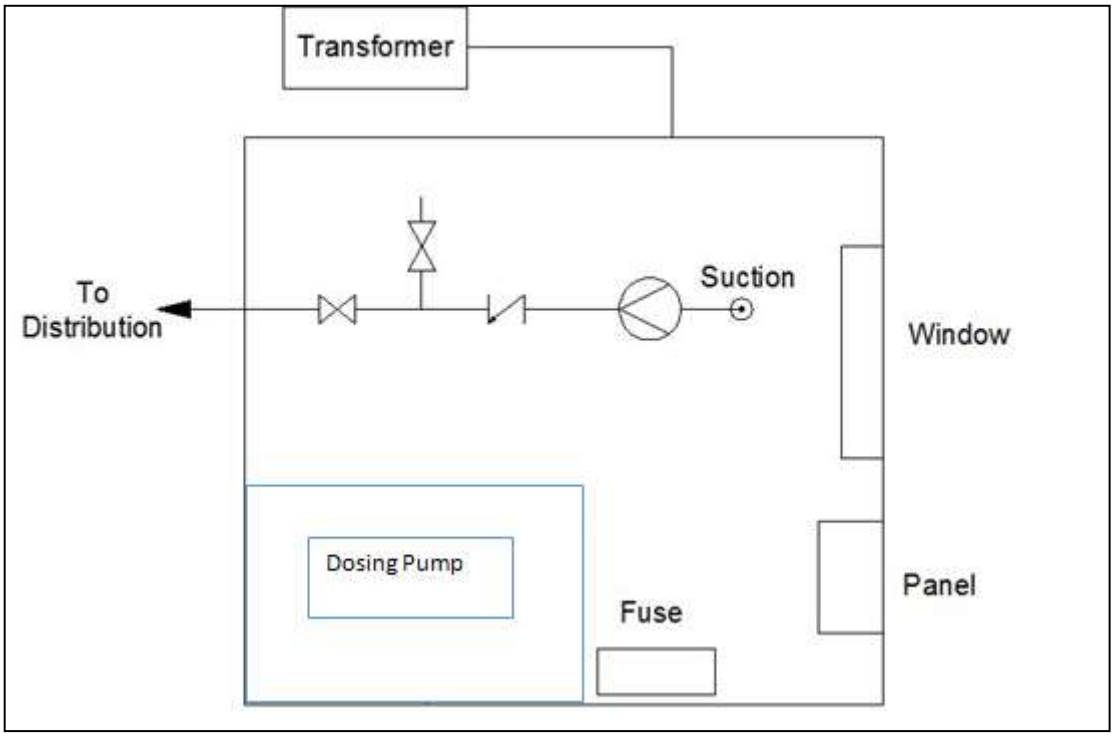

Figure 2: Plant Layout for borewell

4.2.2 Electricity supply

The only source of energy is electricity supplied from the grid, Paschimanchal Vidyut Vitran Nigam Limited (PVVNL). The HT 11 kV connection is taken from PVVNL and the power is stepped down to 433 V by a distribution transformer to supply electricity to respective pump set. Details of the transformers at each site are provided in table 8:

Table 8: Details of transformers

Site No. as on list	Name of pumping station	Transformer (kVA)
1	3rd A Pump no -6	63
2	3rd A Pump no -7	63
3	3 F nehru Nagar	NA
4	Ram lila maidan no 3	63
5	Ghanta Ghar taxi Stand	63
6	Company Bang No 5	NA
7	Company Bang No 4	NA
8	Ashok Nagar	No Separate Transformer
9	Yashoda Hospital	NA
10	Holichild Barat Ghar	No Separate Transformer
11	Gandhi Park No-5	100 KVA (No separate transformer)
12	Dayanad Nagar No 1	-
13	Dayanand Nagar N0.2	100 KVA (No separate transformer)
14	Paras Hotel Pump	100 KVA (No separate transformer)
15	Kalkaghari Pump no 1	100 KVA (No separate transformer)
16	Balupura Pump	No Separate Transformer
17	Maliwada Fire Brigade	No Separate Transformer
18	Pranghari	No Separate Transformer
19	Jai prakash	63
20	Panch Wati	NA
21	Anand Vihar	63
22	Kamla Quarter	63
23	Laxhmi Vihar	63
24	2A Nehru Nagar	63
25	2 B nehru Nagar	63
26	Sabhaghar Pump	No Separate Transformer
27	Nehru Nagar No 2	63
28	Hind Park	63
29	MB girls College	100
30	Chandrapuri	63
31	Town Hall Pump no 1	63
32	DC garg Pump	No Separate Transformer
33	3B nehru Nagar	63
34	Arjun Nagar	NA
35	Gandhi Nagar no 6	No Separate Transformer
36	Payre lal pumping station	NA
37	Ram Nagar Teekona Park	100
38	Nand Gram C Block	63
39	Nand Gram B Block	63
40	C block Ramlila Garond	63
41	Nand Gram No 1	63
42	Nand Gram E block	63
43	Nand Gram F block	63

Site No. as on list	Name of pumping station	Transformer (kVA)
44	Lohia Nagar Pump no 1	63
45	Lohia Nagar Pump no 2	63
46	Gandhi Park	63
47	Dina Ghari	63
48	G block Patel Nagar	63
49	Sanjay geeta Park	No Separate Transformer
50	B block market	No Separate Transformer
51	Patel Nagar B block	63
52	Patel Nagar D block Mother dairy	63
53	Banwari Nagar	63
54	Shibbon Pura	63
55	L block patel nagar	63
56	Dhookna Katha	63
57	Dhookna Mandir	63
58	Gautam Nagar	NA
59	Bhonja	63
60	Lohia Nagar B ablock	63
61	lal Quarter No 1	63
62	lal Quarter No 2	63
63	Lal Quarter no 2 (rebore)	NA
64	MMG Pump no -1	No separate Transformer
65	MMG Pump no 2	63
66	Model Town Park No-1	63
67	Model Town Pump NO 2	NA
68	Model Town Pump No 4	63
69	New Bus adda No 1	NA
70	New Bus Adda Tank	63
71	MB Girls Kela Kheda	63
72	Tar Factory	63
73	Chmada Patt	63
74	Jassipurs	63
75	Kella Masrasa	63
76	Lalten Factory	NA
77	Sarai Nagar	No separate Transformer
78	Kella Khada	NA
79	D-block No.1	63
80	Hathi park No.2	No separate Transformer
81	Tulsi park No.3	No separate Transformer
82	C block No No 4	NA
83	Pumping station No.14	63
84	Chiranjeevi vihar Tank No.1	63
85	Shani mandir pump No.2	100
86	Sec-1 park Chiranjeevi vihar No.3	100
87	C block No.1	63
88	A block park pump No.5	63
89	3A block pump No.6	63
90	1D block pump No.3	63
91	Govindpuram pump No.4	63
92	G-block pump No.2	63
93	C-block pump No.1	63
94	C-block pump No.2	63
95	Uttam public school No.3	63
96	D-block No.5	63

Site No. as on list	Name of pumping station	Transformer (kVA)
97	Mother Dairy No 8	63
98	A-block pump No.4	63
99	Rajnagar No.1	63
100	Ramlila Maidan No 10	63
101	Sector-11 pump No.11	63
102	GDA market No.3	63
103	Sector-8 pump No.7	63
104	Sector-6 pump No.2	63
105	Sector-9 pump No.9	63
106	F block tank compound	63
107	B-block No.4	63
108	Near forest dept. No.2	63
109	P-block No.7	63
110	L-block No.8	63
111	L-block No.10	250KVA (No separate transformer)
112	G-block tank No.6	63
113	N-block pump No.3	63
114	loha mandi pump No.12	NA
115	B-block park No.5	63
116	Ramlila maidan no.6	100
117	C-block nursery No.7	63
118	I-block park No.8	63
119	F-block park No.9	63
120	H-block tank No.10	63
121	Vivekanand nagar No.11	63
122	K-block No.7	63
123	Bahwali colony	NA
124	Shastri nagar No.6	63
125	K-block No.5	63
126	RDC building	63
127	Dr.Mukherjee park	63
128	GDA market sector-7 pump No.8	63
Not In list	P-block No.11	63
Not In list	Guldhar	63
129	Ramlila Maidan sec 9	NA
130	E block sec 9	63
131	G block sec 9	NA
132	F block sec 9	NA
133	A block sec 9	63
134	C block Sec 9	63
135	Ambedkar Nagar Sec 9	NA
136	Zonal Office	No separate Transformer
137	H block sec 9	NA
138	Mirza Pur No 2	63
139	Mirza Pur No 3	63
140	F block sec 12	NA
141	Mother dairy M block	NA
142	H block sec 12	63
143	N block teachers colony	NA
144	D block sec 11	63
145	B block sec 11	63
146	E block sec 11 no -2	NA
147	E block sec 11 no -5	63

Site No. as on list	Name of pumping station	Transformer (kVA)
148	G block sec 11 pump No.3	63
149	G block Sec 11 No 4	63
150	F block sec 11	63
151	Awas Vikas Kashiram colony	63
152	Sudamapuri no 1	63
153	Sudamapuri no 2	63
154	Sudamapuri no 3	63
155	K block sec 9	NA
156	H block sec 9	NA
157	L block sec 9	NA
158	H block sec 9 rosevally school	63
159	Bhud bharat nagar	NA
160	Sundar puri	NA
161	H block Kela Khada	63
162	R block sec 12	63
163	Sorvaday Nagr	63
164	A-block Sec 11	63
165	Dhara school	63
166	B block Mata Colony	63
167	Tilla More No 1	63
168	Tilla More No 2	63
169	Tilla More No 3	63
170	Tilla More No 4	NA
171	Tilla More No 7	63
172	Tilla More No 9	NA
173	Tilla More No 10	63
174	Tilla More No 11	63
175	Tilla More No 12	63
176	Tilla More No 13	63
177	Tilla More No 14	63
178	Tilla More No 15	63
179	Tilla More No 16	63
180	Tilla More No 17	63
181	Tilla More No 18	63
182	Tilla More No 19	63
183	Tilla More No 20	NA
184	Tilla More No 21	NA
185	Sai upwan no 1	63
186	Sai upwan no 2	63
187	Sai upwan no 9	63
188	Sai upwan no 6	63
189	Sai upwan no 7	63
190	Sai upwan no 3	63
191	Sai upwan no 8	63
192	Kanha Upwan	63
193	Hindon No 1	NA
194	Hindon No 2	NA
195	Hindon No 4	63
196	Hindon No 7	63 and 63.2 KVA DG
197	Hindon No 8	NA
198	Hindon No 9	25
199	Vasundhara sec 7/1	NA
200	Vasundhara sec 7/2	25

Site No. as on list	Name of pumping station	Transformer (kVA)
201	Vasundhara sec 7/3	No separate Transformer
202	Vasundhara sec 7/4	NA
203	Vasundhara sec 9/1	No separate Transformer
204	Vasundhara sec 9/2	No separate Transformer
205	Vasundhara sec 11	No separate Transformer
206	Sec 15	63
207	Vasundhara sec 15	No separate Transformer
208	Sec 19	63
209	Sec 13	63
210	Sec 2/2	63
211	sec 2/3	NA
212	Vaishali sec 1	NA
213	Vaishali sec 3 no-1	250KVA (No separate transformer)
214	Vaishali sec 3 no-2	
215	Vaishali sec 3 no-3	
216	Vaishali sec 5/4	63
217	Vaishali sec 5/5	63
218	Vaishali sec 6/8	63
219	Vasundhara sec 6/9	NA
220	Ashirvad Sec 2	NA
221	Vasundhara sec 5	400 kVA(No separate Transformer)

SLD of pumping station is given below in figure 3.

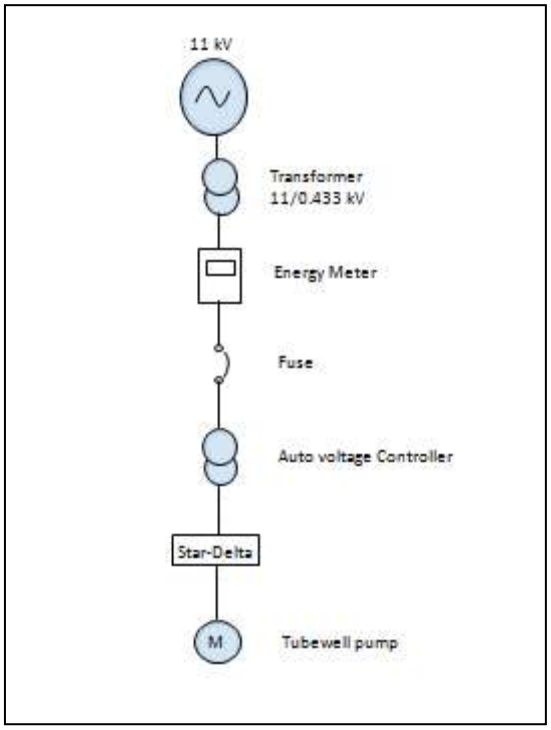

Figure 3: SLD of water pumping station

4.2.3 Tariff structure

Ghaziabad pumping stations are supplied power from PVVNL (Paschimanchal Vidyut Vitran Nigam Limited). There are energy meters installed at each pumping station and the present power tariff is INR 7.95/kWh (summery of electricity bills are attached as Annex 10). However, most of the pumping stations are billed collectively; they are billed on the fixed energy consumption on flat rate. The details in provided in Table No 9

Table 9: Tariff structure (From Bill Dec 2016, PVVNL FY 2016-17 Tariff order)

Zone	Bill No	Power Supply (kV)	Energy charges (INR/kWh)	Fixed/demand charge (per kW)
city-1	7010/000001	11	7.95	290
city-2		11	7.95	290
city-3		11	7.95	290
Kavi Nagar		11	7.95	290
Vijay Nagar		11	7.95	290
Mohan Nagar	690,567	11	7.95	290
Vasundhara		11	7.95	290

4.2.4 Electricity Bill Analysis

Bills have been collected from the Ghaziabad Municipal Corporation. Summary of same has been tabulated in table 10.

Table 10: Energy cost and energy consumption detail

Zone	Period	Unit Consumption	Total electricity consumption cost (Rs)
Vijay Nagar	Jan 2016- Dec 2016	NA	55,239,456
City 2	FY 2016-17	NA	163,384,116
	FY 2015-16		149,152,410
	FY 2014-15		133,716,810
Vashundhra	FY 2016-17	4,170,000	45323088
	FY 2015-16	4,170,000	42113919
	FY 2014-15	NA	NA
Kavi Nagar Zone	FY 2016-17	5,916,924	63,148,940
	FY 2015-16	5,916,924	58,856,884
	FY 2014-15	5,916,924	49,696,694
City 1	July 2016-March 2017	NA	76,113,915
City 3	partially in city-2 and Vijay Nagar zones	NA	NA
Mohan Nagar	FY 2016-17	6,287,638	58,217,387

Note: The details of the collective bills of pumping stations are provided in Annexure 4.
All transformers are having incoming voltage of 11 kV and same is stepped down to 433 V.
No pumping station is billed on the energy consumed and the pumping stations are billed on the fixed energy consumption at a flat rate.
City 3 zone is billed partially in city-2 and Vijay Nagar zones.

4.2.5 Pumping Station System Mapping

A PID station for all pumping stations are similar and thus sample PID is shown in following figure 4:

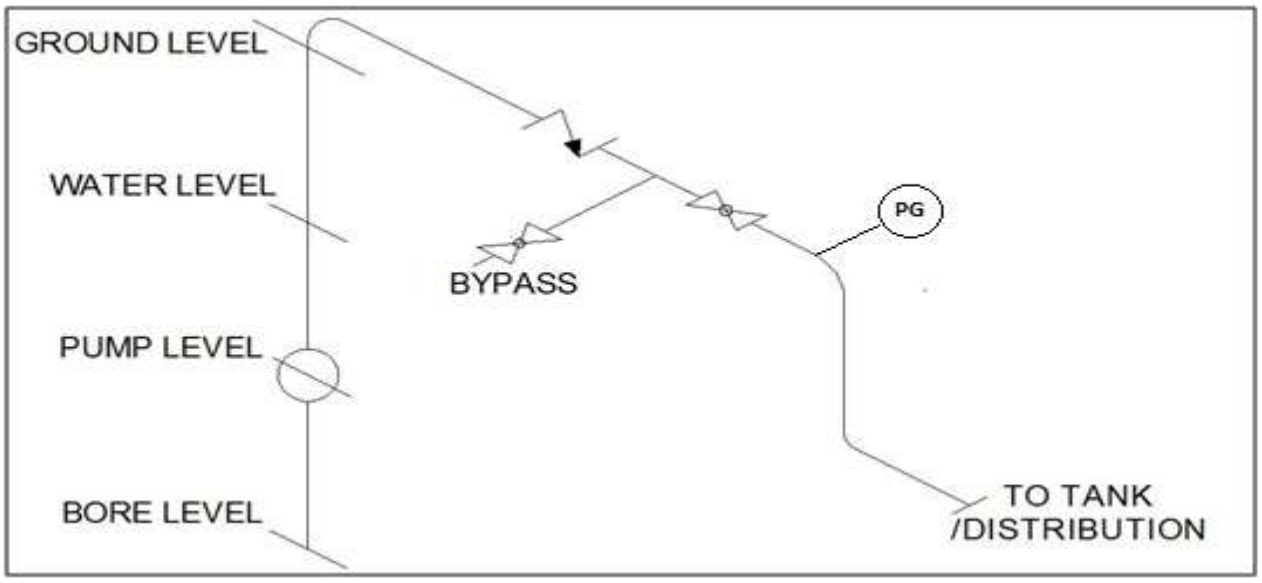

Figure 4: P&ID diagram for New Water Intake plant

4.2.6 Pumps Performance Evaluation

As per the methodology described in section - o, the team had collected detailed information from the pumping stations. Site data collection activities included the following:

- Data collection
- System mapping including collection of inventories, name plate details
- Measurements of flow, head and power input to motor
- Interaction with the site personnel on the operating practices
- Verification of Job card by the authorized representative of ULB

Detailed energy audit at Ghaziabad was conducted on 27th March to 18th April and 10th May to 16th May, 2017.The photograph is provided in table 11 below.

Table 11: Photographs captured at various pumping stations of Ghaziabad to showcase the actual situation

Bhonja Pumping station	Gandhi Park
	
	
	

There are 223 bore well pumps at Ghaziabad out of which 26 pumps were under maintenance; whereas 42 sites are not in use. The details are provided in Table no 12 below.

Table 12: Details of the operational pumps.

Sl No.	Zones	Total Pumps	Total Pumps under maintenance	Total No. of pumps not in use	Total No of pumps Audited
1	City 1	37	3	7	27
2	City 2	26	1	2	23
3	City 3	15	2	4	9
4	Kavi Nagar	52	1	3	48
5	Vijay Nagar	38	5	13	20
6	Mohan Nagar	26	6	5	15
7	Vasundhara	29	8	8	13
	Total	223	26	42	155

4.2.7 Performance efficiency evaluation.

Performance evaluations for the pumping station at Ghaziabad have been calculated and summary of same is provided in Table No 13 - 45:

Table 13: Performance Evaluation of city -1-(I) pumps

Parameters Pump Reference	UOM	3rd A Pump no -6 Site No -1	Ram lila maidan no 3 Site No -4	Ghanta Ghar taxi Stand Site No -5	Ashok Nagar Site No -8	Yashoda Hospital Site No -9
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	15	15	22	22
Parameters Measured						
Level of the water above pump (m)	m	6.10	3.10	3.05	4.60	4.60
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	39.52	39.52	42.56	42.56
Measured discharge head (C)	m	1.83	23.50	21.80	6.20	4.44
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.58	0.29	0.21	1.00	0.82
Total discharge head (E= B+C +D)	m	45.0	63.3	61.5	49.8	47.8
Total Flow	m^3/h	64	45	38	85	77
Motor input power	kW	15	14	20	21	24
Calculation						
Total head developed	m	39	60	58	45	43
Head utilization	%	62	96	93	72	69
Flow utilization	%	106	76	64	142	128
Hydraulic power developed by pump	kW	6.7	7.4	6.1	10.5	9.0
Motor input power	kW	15.4	14.1	20.2	20.8	23.8
Calculated overall efficiency	%	43.70	52.77	30.11	50	38
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	53.3	64.4	36.7	61.3	46.3
Specific power consumption	kWh/m^3	0.24	0.31	0.53	0.24	0.31
Specific energy consumption	$Wh/m^3/m$ of WC	6.23	5.16	9.04	5.41	7.17

Table 14: Performance Evaluation of city -1 – (II) pumps

Parameters Pump Reference	UOM	Holichild Barat Ghar Site No -10	Gandhi Park No-5 Site No -11	Dayanand Nagar No. 2 Site No -13	Paras Hotel Pump Site No -14	Kalkaghari Pump no 1 Site No -15
Rated flow	m^3/h	60	60	56	60	60
Rated head	m	63	63	63	63	63

Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (m)	m	4.60	4.60	4.60	4.60	4.60
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	42.56	42.56	42.56	42.56
Measured discharge head (C)	m	7.90	3.63	2.64	2.03	1.88
Frictional head from pump eye to discharge pressure gauge point (D)	m	1.08	0.27	0.58	1.39	1.02
Total discharge head (E= B+C +D)	m	51.5	46.5	45.8	46.0	45.5
Total Flow	m^3/h	89	42	64	102	86
Motor input power	kW	22	23	20	22	21
Calculation						
Total head developed	m	47	42	41	41	41
Head utilization	%	75	66	65	66	65
Flow utilization	%	148	71	114	170	144
Hydraulic power developed by pump	kW	11.4	4.8	7.2	11.5	9.6
Motor input power	kW	22.0	23.1	19.9	22.2	21.3
Calculated overall efficiency	%	52	21	36	52	45
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	63.0	25.4	43.9	63.1	55.0
Specific power consumption	kWh/m^3	0.25	0.55	0.31	0.22	0.25
Specific energy consumption	$Wh/m^3/m$ of WC	5.27	13.05	7.55	5.26	6.03

Table 15: Performance Evaluation of city -1 (III) pumps

Parameters	UOM	Balupura Pump Site No -16	Maliwada Fire Brigade Site No -17	Pranghari Site No -18	Jai prakash Site No -19	Kamla Quarter Site No -22
Rated flow	m^3/h	60	60	60	60	31
Rated head	m	63	63	63	63	45
Motor Rating	kW	22	22	15	19	19
Parameters Measured						
Level of the water above pump (m)	m	4.60	6.00	4.60	6.10	6.10
Static head up to discharge	m	42.56	42.56	42.56	42.56	42.56

Parameters	UOM	Balupura Pump Site No -16	Maliwada Fire Brigade Site No -17	Pranghari Site No -18	Jai prakash Site No -19	Kamla Quarter Site No -22
pressure gauge from pump eye (B)						
Measured discharge head (C)	m	6.10	1.65	1.47	3.33	2.45
Frictional head from pump eye to discharge pressure gauge point (D)	m	1.00	1.01	0.26	1.10	0.28
Total discharge head (E= B+C +D)	m	49.7	45.2	44.3	47.0	45.3
Total Flow	m^3/h	85	86	41	90	43
Motor input power	kW	24	22	14	18	16
Calculation						
Total head developed	m	45	39	40	41	39
Head utilization	%	72	62	63	65	87
Flow utilization	%	142	143	68	150	139
Hydraulic power developed by pump	kW	10.4	9.1	4.4	10.0	4.6
Motor input power	kW	24.0	21.6	14.3	17.6	16.2
Calculated overall efficiency	%	43	42	31	57	28
Calculated motor efficiency	%	82	82	82	82	82
pump efficiency	%	53.0	51.6	37.8	69.3	34.6
Specific power consumption	kWh/m^3	0.28	0.25	0.35	0.20	0.38
Specific energy consumption	$Wh/m^3/m$ of WC	6.26	6.43	8.79	4.79	9.59

Table 16: Performance Evaluation of city -1 (IV) pumps

Parameters	UOM	Laxhmi Vihar Site No -23	2A Nehru Nagar Site No -24	Sabhaghar Pump Site No-26	Nehru Nagar No 2 Site No-27	Hind Park Site No-28
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	19	15	23	19
Parameters Measured						
Level of the water above pump (m)	m	4.60	4.60	6.00	4.60	4.60
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	42.56	42.56	42.56	42.56
Measured discharge head (C)	m	3.07	3.80	4.10	2.34	3.29
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.35	0.46	0.27	0.77	0.63
Total discharge head (E= B+C +D)	m	46.0	46.8	46.9	45.7	46.5
Total Flow	m^3/h	49	56	42	74	67
Motor input power	kW	14	18	16	19	19

Parameters Calculation	UOM	Laxhmi Vihar Site No -23	2A Nehru Nagar Site No -24	Sabhaghar Pump Site No-26	Nehru Nagar No 2 Site No-27	Hind Park Site No-28
Total head developed	m	41	42	41	41	42
Head utilization	%	66	67	65	65	66
Flow utilization	%	81	93	70	124	111
Hydraulic power developed by pump	kW	5.5	6.4	4.7	8.3	7.6
Motor input power	kW	14.4	17.6	16.4	19.2	19.2
Calculated overall efficiency	%	38	37	29	43	40
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	46.4	44.5	34.9	52.7	48.3
Specific power consumption	kWh/m^3	0.30	0.31	0.39	0.26	0.29
Specific energy consumption	$Wh/m^3/m$ of WC	7.15	7.46	9.52	6.30	6.87

Table 17: Performance Evaluation of city -1 (V) pumps

Parameters	UOM	MB girls College Site No-29	Chandrapuri Site No-30	Town Hall Pump no 1 Site No-31	DC garg Pump Site NO-32	3B nehru Nagar Site No-33
Rated flow	m^3/h	60	56	60	31	60
Rated head	m	63	63	63	45	63
Motor Rating	kW	23	23	15	8	19
Parameters Measured						
Level of the water above pump (m)	m	4.60	4.60	4.60	7.60	4.60
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	42.56	42.56	33.44	42.56
Measured discharge head (C)	m	3.72	0.60	4.55	1.76	4.44
Frictional head from pump eye to discharge pressure gauge point (D)	m	1.68	0.14	0.53	0.02	0.42
Total discharge head (E= B+C +D)	m	48.0	43.3	47.6	35.2	47.4
Total Flow	m^3/h	113	30	61	12	54
Motor input power	kW	23	22	15	11	18
Calculation						
Total head developed	m	43	39	43	28	43
Head utilization	%	69	61	68	61	68
Flow utilization	%	188	54	101	38	89
Hydraulic power developed by pump	kW	13.3	3.2	7.1	0.9	6.2
Motor input power	kW	23.4	22.2	15.2	10.5	17.6
Calculated overall efficiency	%	57	14	47	8	36

Parameters	UOM	MB girls College Site No-29	Chandrapuri Site No-30	Town Hall Pump no 1 Site No-31	DC garg Pump Site NO-32	3B nehru Nagar Site No-33
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	69.5	17.4	57.2	10.3	43.3
Specific power consumption	kWh/m^3	0.21	0.74	0.25	0.89	0.33

Table 18: Performance Evaluation of city -1 (VI) pumps

Parameters	UOM	Gandhi Nagar no 6 Site No-35	Ram Nagar Teekona Park Site No-37
Rated flow	m^3/h	60	60
Rated head	m	63	63
Motor Rating	kW	23	23
Parameters Measured			
Level of the water above pump (m)	m	4.60	12.00
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	36.48
Measured discharge head (C)	m	2.49	1.32
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.28	0.50
Total discharge head (E= B+C +D)	m	45.3	38.3
Total Flow	m^3/h	43	64
Motor input power	kW	17	25
Calculation			
Total head developed	m	41	26
Head utilization	%	65	42
Flow utilization	%	71	107
Hydraulic power developed by pump	kW	4.7	4.6
Motor input power	kW	17.2	24.9
Calculated overall efficiency	%	28	18
Motor efficiency	%	82	82
Calculated pump efficiency	%	33.7	22.4
Specific power consumption	kWh/m^3	0.40	0.39
Specific energy consumption	Wh/m^3/m of WC	9.84	14.82

Table 19: Performance Evaluation of city -2 (I) pumps

Parameters	UOM	Nand Gram C Block Site No -38	Nand Gram B Block Site No -39	C block Ramlila Garond Site No -40	Nand Gram No 1 Site No -41	Nand Gram E block Site No -42
Rated flow	m^3/h	60	53	53	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	19	19	15	22	15
Parameters Measured						
Level of the water above pump (A)	m	6.10	6.10	6.00	9.10	9.10
Static head up to discharge pressure gauge from pump eye (B)	m	27.36	33.44	27.36	33.44	33.44
Measured discharge head (C)	m	2.34	6.70	3.20	9.12	5.22
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.77	1.23	0.55	1.23	0.16
Total discharge head (E= B+C +D)	m	30.5	41.4	31.1	43.8	38.8
Total Flow	m^3/h	94	109	78	109	37
Motor input power	kW	20	19	14	23	14
Calculation						
Total head developed	m	24.4	35.3	25.1	35	30
Head utilization	%	39	56	40	55	47
Flow utilization	%	157	205	148	181	61
Hydraulic power developed by pump	kW	6.25	10.42	5.36	10.24	2.97
Motor input power	kW	19.50	18.90	13.97	22.57	13.60
Calculated overall efficiency	%	32	55	38	45	22
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	39.1	67.2	46.8	55.4	26.6
Specific power consumption	kWh/m^3	0.21	0.17	0.18	0.21	0.37
Specific energy consumption	$Wh/m^3/m$ of WC	8.49	4.94	7.10	6.00	12.47

Table 20: Performance Evaluation of city -2(II) pumps

Parameters	UOM	Nand Gram F block Site No -43	Lohia Nagar Pump no 2 Site No -45	Gandhi Park Site No -46	Dina Ghari Site No -47	G block Patel Nagar Site No -48
Rated flow	m^3/h	60	56	53	60	56
Rated head	m	63	63	63	63	63

Parameters	UOM	Nand Gram F block Site No -43	Lohia Nagar Pump no 2 Site No -45	Gandhi Park Site No -46	Dina Ghari Site No -47	G block Patel Nagar Site No -48
Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	6.10	6.10	7.60	4.60	4.60
Static head up to discharge pressure gauge from pump eye (B)	m	21.28	39.52	39.52	42.56	36.48
Measured discharge head (C)	m	0.42	0.25	26.52	24.30	23.22
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.00	0.38	0.53	0.14	0.48
Total discharge head (E= B+C +D)	m	21.7	40.2	66.6	67.0	60.2
Total Flow	m^3/h	5	53	63	30	63
Motor input power	kW	24	19	23	17	27
Calculation						
Total head developed	m	16	34	59	62	56
Head utilization	%	25	54	94	99	88
Flow utilization	%	8	95	119	49	112
Hydraulic power developed by pump	kW	0.19	4.91	10.16	5.03	9.49
Motor input power	kW	23.50	18.70	22.90	16.60	26.50
Calculated overall efficiency	%	1	26	44	30	36
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	1.0	32.0	54.1	36.9	43.7
Specific power consumption	kWh/m^3	5.16	0.35	0.36	0.56	0.42
Specific energy consumption	Wh/m^3/m of WC	331.03	10.36	6.13	8.99	7.60

Table 21: Performance Evaluation of city -2(III) pumps.

Parameters	UOM	Sanjay geeta Park Site No -49	B block market Site No -50	Patel Nagar B block Site No -51	Patel Nagar D block Mother dairy Site No -52	Banwari Nagar Site No -53
Rated flow	m^3/h	60	56	60	60	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	22	22	22	15
Parameters Measured						
Level of the water above pump (A)	m	6.10	7.60	7.60	7.60	9.10
Static head up to discharge pressure	m	39.52	39.52	42.56	39.52	33.44

Parameters	UOM	Sanjay geeta Park Site No -49	B block market Site No -50	Patel Nagar B block Site No -51	Patel Nagar D block Mother dairy Site No -52	Banwari Nagar Site No -53
gauge from pump eye (B)						
Measured discharge head (C)	m	24.43	23.33	6.42	0.63	1.21
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.09	0.15	1.34	0.33	0.28
Total discharge head (E= B+C +D)	m	64.0	63.0	50.3	40.5	34.9
Total Flow	m^3/h	24	32	100	49	49
Motor input power	kW	14	15	24	18	16
Calculation						
Total head developed	m	58	55	43	33	26
Head utilization	%	92	88	68	52	41
Flow utilization	%	40	56	167	81	93
Hydraulic power developed by pump	kW	3.74	4.77	11.62	4.34	3.46
Motor input power	kW	14.40	14.80	23.80	18.20	16.20
Calculated overall efficiency	%	26	32	49	24	21
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	31.7	39.3	59.5	29.1	26.1
Specific power consumption	kWh/m^3	0.61	0.47	0.24	0.38	0.33
Specific energy consumption	$Wh/m^3/m$ of WC	10.49	8.45	5.58	11.41	12.74

Table 22: Performance Evaluation of city -2(IV) pumps.

Parameters	UOM	Shibbon Pura Site No -54	L block patel nagar Site No 55	Dhookna Katha Site No 56	Dhookna Mandir Site No -57	Bhonja Site No -59
Rated flow	m^3/h	60	60	56	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	15	22	19	22
Parameters Measured						
Level of the water above pump (A)	m	7.60	7.60	9.10	9.10	7.60
Static head up to discharge pressure gauge from pump eye (B)	m	39.52	39.52	33.44	33.44	39.52
Measured discharge head (C)	m	0.26	3.90	7.51	1.27	0.76
Frictional head from pump eye to discharge pressure gauge point (D)	m	2.09	0.78	1.43	0.54	0.91
Total discharge head (E= B+C +D)	m	41.9	44.2	42.4	35.3	41.2

Parameters	UOM	Shibbon Pura Site No -54	L block patel nagar Site No 55	Dhookna Katha Site No 56	Dhookna Mandir Site No -57	Bhonja Site No -59
Total Flow	m^3/h	132	78	118	70	84
Motor input power	kW	20	17	25	16	16
Calculation						
Total head developed	m	34	37	33	26	34
Head utilization	%	54	58	53	42	53
Flow utilization	%	221	129	211	117	140
Hydraulic power developed by pump	kW	12.34	7.72	10.68	4.98	7.70
Motor input power	kW	20.10	17.40	25.30	16.27	15.80
Calculated overall efficiency	%	61	44	42	31	49
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	74.9	54.1	51.5	37.3	59.4
Specific power consumption	kWh/m^3	0.15	0.22	0.21	0.23	0.19
Specific energy consumption	$Wh/m^3/m$ of WC	4.43	6.13	6.45	8.90	5.59

Table 23: Performance Evaluation of city -2(E) pumps

Parameters	UOM	Lohia Nagar B ablock Site No -60	lal Quarter No 1 Site No -61	lal Quarter No 2 Site No -62
Rated flow	m^3/h	60	56	60
Rated head	m	63	63	63
Motor Rating	kW	22	22	22
Parameters Measured				
Level of the water above pump (A)	m	6.10	7.60	7.60
Static head up to discharge pressure gauge from pump eye (B)	m	39.52	39.52	39.52
Measured discharge head (C)	m	6.53	1.77	1.56
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.60	1.32	1.12
Total discharge head (E= B+C +D)	m	46.6	42.6	42.2
Total Flow	m^3/h	67	103	94
Motor input power	kW	20	24	17
Calculation				
Total head developed	m	41	35	35
Head utilization	%	64	56	55
Flow utilization	%	112	184	157

Parameters	UOM	Lohia Nagar B ablock Site No -60	lal Quarter No 1 Site No -61	lal Quarter No 2 Site No -62
Hydraulic power developed by pump	kW	7.43	9.85	8.88
Motor input power	kW	19.90	23.70	17.00
Calculated overall efficiency	%	37	42	52
motor efficiency	%	82	82	82
Calculated pump efficiency	%	45.5	50.7	63.7
Specific power consumption	kWh/m^3	0.30	0.23	0.18
Specific energy consumption	$Wh/m^3/m$ of WC	7.29	6.55	5.21

Table 24: Performance Evaluation of city -3 (I) pumps.

Parameters	UOM	MMG Pump no -1 Site No -64	MMG Pump no 2 Site No -65	Model Town Park No-1 Site No -66	MB Girls Kela Kheda Site No -71	Tar Factory Site No -72
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	8	8	22	15
Parameters Measured						
Level of the water above pump (A)	m	9.10	6.10	6.10	6.10	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	45.60	42.56	42.56	42.56	42.56
Measured discharge head (C)	m	26.70	26.72	2.19	2.49	2.33
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.12	0.13	0.18	1.46	0.30
Total discharge head (E= B+C +D)	m	72.4	69.4	44.9	46.5	45.2
Total Flow	m^3/h	27	10	34	108	46
Motor input power	kW	16	8	8	25	14
Calculation						
Total head developed	m	63	63	39	40	39
Head utilization	%	101	100	62	64	62
Flow utilization	%	44	16	57	180	77
Hydraulic power developed by pump	kW	4.6	1.7	3.6	11.9	4.9
Motor input power	kW	15.9	7.5	8.3	24.8	14.3
Calculated overall efficiency	%	29	22	44	48	34
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	35.0	27.2	53.4	58.4	41.7
Specific power consumption	kWh/m^3	0.60	0.77	0.24	0.23	0.31

Parameters	UOM	MMG Pump no -1 Site No -64	MMG Pump no 2 Site No -65	Model Town Park No-1 Site No -66	MB Girls Kela Kheda Site No -71	Tar Factory Site No -72
Specific energy consumption	Wh/m^3/m of WC	9.48	12.21	6.21	5.68	7.95

Table 25: Performance Evaluation of city -3 (II) pumps

Parameters	UOM	Chmada Patt Site No -73	Jassipurs Site No -74	Kella Masrasa Site No -75	Sarai Nagar Site No -77
Rated flow	m^3/h	60	60	60	60
Rated head	m	63	63	63	63
Motor Rating	kW	22	23	22	22
Parameters Measured					
Level of the water above pump (A)	m	6.10	6.10	6.10	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	42.56	42.56	42.56
Measured discharge head (C)	m	1.26	0.23	0.65	3.31
Frictional head from pump eye to discharge pressure gauge point (D)	m	1.55	0.31	0.74	0.11
Total discharge head (E= B+C +D)	m	45.4	43.1	44.0	46.0
Total Flow	m^3/h	114	48	78	28
Motor input power	kW	22	11	22	17
Calculation					
Total head developed	m	39	37	38	40
Head utilization	%	62	59	60	63
Flow utilization	%	190	80	130	47
Hydraulic power developed by pump	kW	12.2	4.9	8.0	3.1
Motor input power	kW	22.1	10.8	21.6	16.5
Calculated overall efficiency	%	55	45	37	19
motor efficiency	%	82	82	82	82
Calculated pump efficiency	%	67.3	54.8	45.3	22.7
Specific power consumption	kWh/m^3	0.19	0.22	0.28	0.58
Specific energy consumption	Wh/m^3/m of WC	4.93	6.06	7.33	14.62

Table 26: Performance Evaluation of Kavi Nagar (I) pumps

Parameters	UOM	D-block No.1 Site No -79	Hathi park No.2 Site No -80	Tulsi park No.3 Site No -81	Pumping station No.14 Site No -83	Chiranjeevi vihar Tank No.1 Site No -84
Rated flow	m^3/h	60	60	60	60	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	9.10	9.10	7.60	8.50	12.10
Static head up to discharge pressure gauge from pump eye (B)	m	36.48	36.48	36.48	30.40	33.44
Measured discharge head (C)	m	18.80	17.80	15.20	16.54	27.37
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.19	0.02	0.49	0.57	0.32
Total discharge head (E= B+C +D)	m	55.5	54.3	52.2	47.5	61.1
Total Flow	m^3/h	38	12	64	78	55
Motor input power	kW	16	21	23	23	21
Calculation						
Total head developed	m	46	45	45	39	49
Head utilization	%	74	72	71	62	78
Flow utilization	%	63	20	107	130	104
Hydraulic power developed by pump	kW	4.8	1.5	7.8	8.3	7.3
Motor input power	kW	16.1	21.4	22.7	23.4	21.0
Calculated overall efficiency	%	30	7	34	35	35
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	36.1	8.4	41.9	43.1	42.6
Specific power consumption	kWh/m^3	0.43	1.78	0.35	0.30	0.38
Specific energy consumption	$Wh/m^3/m$ of WC	9.19	39.37	7.92	7.70	7.80

Table 27: Performance Evaluation of Kavi Nagar pumps (II)

Parameters	UOM	Shani mandir pump No.2 Site No -85	Sec-1 park Chiranjeevi vihar No.3 Site No -86	C block No.1 Site No -87	A block park pump No.5 Site No -88	3A block pump No.6 Site No -89
Rated flow	m^3/h	53	53	53	53	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	12.10	12.10	15.20	15.20	15.20
Static head up to discharge pressure gauge from pump eye (B)	m	33.44	36.48	30.40	30.40	30.40
Measured discharge head (C)	m	28.40	1.52	25.00	28.70	29.70
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.21	1.10	0.05	0.54	0.33
Total discharge head (E= B+C +D)	m	62.1	39.1	55.4	59.6	60.4
Total Flow	m^3/h	44	104	21	80	62
Motor input power	kW	20	21	21	21	25
Calculation						
Total head developed	m	50	27	40	44	45
Head utilization	%	79	43	64	71	72
Flow utilization	%	83	196	39	150	117
Hydraulic power developed by pump	kW	6.0	7.6	2.3	9.6	7.6
Motor input power	kW	20.0	21.2	20.6	20.5	24.6
Calculated overall efficiency	%	30	36	11	47	31
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	36.5	43.8	13.5	57.2	37.9
Specific power consumption	kWh/m^3	0.45	0.20	0.99	0.26	0.40
Specific energy consumption	$Wh/m^3/m$ of WC	9.09	7.57	24.53	5.80	8.76

Table 28: Performance Evaluation of Kavi Nagar pumps (III)

Parameters	UOM	1D block pump No.3 Site No -90	Govindpuram pump No.4 Site No -91	G-block pump No.2 Site No -92	C-block pump No.1 Site No -93	C-block pump No.2 Site No -94
Rated flow	m^3/h	53	53	60	60	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	15.20	15.20	15.20	11.00	10.70
Static head up to discharge pressure gauge from pump eye (B)	m	30.40	30.40	30.40	36.48	38.00
Measured discharge head (C)	m	29.10	28.20	31.38	28.60	28.90
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.70	0.15	0.55	0.76	0.38
Total discharge head (E= B+C +D)	m	60.2	58.8	62.3	65.8	67.3
Total Flow	m^3/h	93	41	83	91	62
Motor input power	kW	24	22	30	22	26
Calculation						
Total head developed	m	45	44	47	55	57
Head utilization	%	71	69	75	87	90
Flow utilization	%	176	77	139	151	116
Hydraulic power developed by pump	kW	11.4	4.9	10.7	13.5	9.5
Motor input power	kW	23.8	22.3	29.9	22.3	26.0
Calculated overall efficiency	%	48	22	36	61	36
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	58.5	26.6	43.7	74.0	44.4
Specific power consumption	kWh/m^3	0.26	0.54	0.36	0.25	0.42
Specific energy consumption	$Wh/m^3/m$ of WC	5.67	12.49	7.61	4.48	7.48

Table 29: Performance evaluation of Kavi Nagar pumps (IV)

Parameters	UOM	Uttam public school No.3 Site No -95	D-block No.5 Site No -96	A-block pump No.4 Site No -98	Rajnagar No.1 Site No -99	Sector-11 pump No.11 Site No -101
Rated flow	m^3/h	60	60	60	53	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	9.00	10.70	10.70	10.70	10.70
Static head up to discharge pressure gauge from pump eye (B)	m	38.00	36.48	36.48	38.00	38.00
Measured discharge head (C)	m	28.72	30.30	29.80	27.60	24.40
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.49	0.19	0.11	0.45	0.09
Total discharge head (E= B+C +D)	m	67.2	67.0	66.4	66.1	62.5
Total Flow	m^3/h	71	44	34	70	31
Motor input power	kW	31	20	21	21	24
Calculation						
Total head developed	m	58	56	56	55	52
Head utilization	%	92	89	88	88	82
Flow utilization	%	119	73	56	133	51
Hydraulic power developed by pump	kW	11.3	6.7	5.1	10.6	4.3
Motor input power	kW	30.6	20.0	21.1	21.5	24.3
Calculated overall efficiency	%	37	33	24	49	18
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	40.9	37.2	26.9	54.9	19.7
Specific power consumption	kWh/m^3	0.43	0.46	0.63	0.31	0.80
Specific energy consumption	$Wh/m^3/m$ of WC	7.40	8.13	11.22	5.51	15.37

Table 30: Performance Evaluation of Kavi Nagar pumps (V)

Parameters	UOM	GDA market No.3 Site No -102	Sector-8 pump No.7 Site No -103	Sector-6 pump No.2 Site No -104	Sector-9 pump No.9 Site No -105	F block tank compound Site No -106
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	10.70	10.70	10.70	10.70	10.70
Static head up to discharge pressure gauge from pump eye (B)	m	38.00	38.00	38.00	38.00	39.52
Measured discharge head (C)	m	25.30	23.20	24.41	22.40	24.77
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.48	0.14	0.11	0.11	0.07
Total discharge head (E= B+C +D)	m	63.8	61.3	62.5	60.5	64.4
Total Flow	m^3/h	74	39	34	34	27
Motor input power	kW	22	21	21	19	15
Calculation						
Total head developed	m	53	51	52	50	54
Head utilization	%	84	80	82	79	85
Flow utilization	%	123	64	56	56	45
Hydraulic power developed by pump	kW	10.6	5.3	4.7	4.5	3.9
Motor input power	kW	22.3	20.8	21.5	18.5	15.1
Calculated overall efficiency	%	48	26	22	25	26
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	58.0	31.2	26.9	30.0	31.5
Specific power consumption	kWh/m^3	0.30	0.54	0.64	0.55	0.57
Specific energy consumption	Wh/m^3/m of WC	5.72	10.62	12.35	11.08	10.54

Table 31: Performance Evaluation of Kavi Nagar pumps (VI)

Parameters	UOM	B-block No.4 Site No -107	Near forest dept. No.2 Site No -108	P-block No.7 Site No -109	L-block No.8 Site No -110	L-block No.10 Site No -111
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	19	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	11.00	12.10	9.10	9.10	9.10
Static head up to discharge pressure gauge from pump eye (B)	m	39.52	38.00	36.48	36.48	36.48
Measured discharge head (C)	m	27.90	27.30	31.20	27.30	25.20
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.10	0.32	0.09	0.10	0.18
Total discharge head (E= B+C +D)	m	67.5	65.6	67.8	63.9	61.9
Total Flow	m^3/h	32	62	32	35	47
Motor input power	kW	17	25	26	20	20
Calculation						
Total head developed	m	57	54	59	55	53
Head utilization	%	90	85	93	87	84
Flow utilization	%	53	104	54	58	79
Hydraulic power developed by pump	kW	4.9	9.1	5.1	5.2	6.8
Motor input power	kW	17.4	24.7	26.1	20.3	19.6
Calculated overall efficiency	%	28	37	20	26	35
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	34.5	44.8	24.0	31.2	42.3
Specific power consumption	kWh/m^3	0.54	0.40	0.81	0.58	0.41
Specific energy consumption	Wh/m^3/m of WC	9.62	7.41	13.82	10.65	7.85

Table 32: Performance Evaluation of Kavi Nagar pumps (VII)

Parameters	UOM	G-block tank No.6 Site No -112	N-block pump No.3 Site No -113	loha mandi pump No.12 Site No -114	B-block park No.5 Site No -115	Ramlila maidan no.6 Site No -116
Rated flow	m^3/h	60	60	60	56	56
Rated head	m	63	63	63	63	63

Parameters	UOM	G-block tank No.6 Site No -112	N-block pump No.3 Site No -113	loha mandi pump No.12 Site No -114	B-block park No.5 Site No -115	Ramlila maidan no.6 Site No -116
Motor Rating	kW	22	22	22	19	22
Parameters Measured						
Level of the water above pump (A)	m	9.10	12.20	10.70	7.60	9.10
Static head up to discharge pressure gauge from pump eye (B)	m	36.48	39.52	41.04	36.48	36.48
Measured discharge head (C)	m	26.95	31.10	24.70	1.87	0.42
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.16	0.16	0.29	0.27	0.51
Total discharge head (E= B+C +D)	m	63.6	70.8	66.0	38.6	37.4
Total Flow	m^3/h	45	44	59	62	88
Motor input power	kW	15	27	17	12	20
Calculation						
Total head developed	m	54	59	55	31	28
Head utilization	%	86	93	88	49	45
Flow utilization	%	75	74	99	110	157
Hydraulic power developed by pump	kW	6.7	7.1	8.9	5.2	6.8
Motor input power	kW	15.5	27.1	17.4	12.3	20.4
Calculated overall efficiency	%	43	26	51	42	33
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	52.9	31.9	62.6	51.3	40.5
Specific power consumption	kWh/m^3	0.34	0.61	0.29	0.20	0.23
Specific energy consumption	$Wh/m^3/m$ of WC	6.28	10.41	5.31	6.47	8.20

Table 33: Performance Evaluation of Kavi Nagar pumps (VIII)

Parameters	UOM	C-block nursery No.7 Site No -117	I-block park No.8 Site No -118	F-block park No.9 Site No -119	H-block tank No.10 Site No -120	Vivekanand nagar No.11 Site No -121
Rated flow	m^3/h	56	56	60	53	60

Parameters	UOM	C-block nursery No.7 Site No -117	I-block park No.8 Site No -118	F-block park No.9 Site No -119	H-block tank No.10 Site No -120	Vivekanand nagar No.11 Site No -121
Rated head	M	63	63	63	63	63
Motor Rating	kW	19	19	15	22	22
Parameters Measured						
Level of the water above pump (A)	M	9.10	9.10	9.10	9.10	9.10
Static head up to discharge pressure gauge from pump eye (B)	M	36.48	36.48	36.48	36.48	36.48
Measured discharge head (C)	M	1.20	1.80	3.44	0.90	0.90
Frictional head from pump eye to discharge pressure gauge point (D)	M	0.22	0.06	0.24	0.80	0.49
Total discharge head (E= B+C +D)	M	37.9	38.3	40.2	38.2	37.9
Total Flow	m^3/h	55	27	60	115	89
Motor input power	kW	12	20	12	22	20
Calculation						
Total head developed	M	29	29	31	29	29
Head utilization	%	46	46	49	46	46
Flow utilization	%	99	48	99	217	148
Hydraulic power developed by pump	kW	4.3	2.1	5.0	9.1	6.9
Motor input power	kW	11.8	19.6	12.2	22.3	19.8
Calculated overall efficiency	%	36.7	11.0	41.4	40.8	35.1
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	44.7	13.4	50.5	49.7	42.8
Specific power consumption	kWh/m^3	0.21	0.72	0.20	0.19	0.22
Specific energy consumption	$Wh/m^3/m$ of WC	7.42	24.78	6.58	6.68	7.76

Table 34: Performance Evaluation of Kavi Nagar pumps (IX)

Parameters	UOM	K-block No.7 Site No -122	Shastri nagar No.6 Site No -124	K-block No.5 Site No -125	RDC building Site No -126	Dr.Mukherjee park Site No -127
Rated flow	m^3/h	53	53	53	60	53
Rated head	m	63	63	63	63	56
Motor Rating	kW	19	22	15	22	15
Parameters Measured						
Level of the water above pump (A)	m	11.00	11.00	11.00	9.10	7.60
Static head up to discharge pressure gauge from pump eye (B)	m	38.00	38.00	38.00	36.48	36.48
Measured discharge head (C)	m	0.14	0.28	1.47	2.45	2.55
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.50	1.12	0.08	0.08	0.28
Total discharge head (E= B+C +D)	m	38.6	39.4	39.6	39.0	39.3
Total Flow	m^3/h	89	138	34	35	68
Motor input power	kW	18	24	14	14	13
Calculation						
Total head developed	m	28	28	29	30	32
Head utilization	%	44	45	45	47	57
Flow utilization	%	167	261	65	59	128
Hydraulic power developed by pump	kW	6.7	10.7	2.7	2.9	5.9
Motor input power	kW	18.3	23.9	13.7	14.2	12.6
Calculated overall efficiency	%	36.5	44.6	19.6	20.2	46.6
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	44.5	54.4	23.9	24.6	56.8
Specific power consumption	kWh/m^3	0.21	0.17	0.40	0.40	0.19
Specific energy consumption	$Wh/m^3/m$ of WC	7.46	6.10	13.90	13.50	5.84

Table 35: Performance evaluation of Kavi Nagar pumps (X)

Parameters	UOM	GDA market sector-7 pump No.8 Site No -128	P-block No.11 Not in list-1	Guldhar Not in list-2
Rated flow	m^3/h	60	63	60.0
Rated head	m	63	63	63.0
Motor Rating	kW	22	22	18.7
Parameters Measured				
Level of the water above pump (A)	m	10.70	12.90	7.6
Static head up to discharge pressure gauge from pump eye (B)	m	38.00	39.52	38.0
Measured discharge head (C)	m	0.50	29.20	2.8
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.77	0.22	0.2
Total discharge head (E= B+C +D)	m	39.3	68.9	41.0
Total Flow	m^3/h	116	58	58.6
Motor input power	kW	20	25	17.4
Calculation				
Total head developed	m	29	56	33.4
Head utilization	%	45	89	53.0
Flow utilization	%	193	93	97.7
Hydraulic power developed by pump	kW	9.0	8.9	5.3
Motor input power	kW	20.2	24.9	17.4
Calculated overall efficiency	%	44.5	35.8	30.7
motor efficiency	%	82	82	82
Calculated pump efficiency	%	54.3	44	37
Specific power consumption	kWh/m^3	0.17	0.43	0.3
Specific energy consumption	$Wh/m^3/m$ of WC	6.11	7.61	8.9

Table 36: Performance Evaluation of Vijay Nagar pumps (I)

Parameters	UOM	C block Sec 9 Site No -134	Zonal Office Site No -136	Mirza Pur No 2 Site No -138	Mirza Pur No 3 Site No -139	H block sec 12 Site No -142
Rated flow	m^3/h	60	60	53	60	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22.4	19.0	7.5	22.4
Parameters Measured						

Parameters	UOM	C block Sec 9 Site No -134	Zonal Office Site No -136	Mirza Pur No 2 Site No -138	Mirza Pur No 3 Site No -139	H block sec 12 Site No -142
Level of the water above pump (A)	m	6.10	9.10	3.00	6.10	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	42.56	42.56	42.56	42.56	42.56
Measured discharge head (C)	m	22.24	2.43	21.80	2.21	1.86
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.66	0.66	0.42	0.49	1.03
Total discharge head (E= B+C +D)	m	65.5	45.6	64.8	45.3	45.4
Total Flow	m^3/h	68	68	53	9	87
Motor input power	kW	22	19	21	7	23
Calculation						
Total head developed	m	59	37	62	39	39
Head utilization	%	94	58	98	62	62
Flow utilization	%	113	113	101	16	163
Hydraulic power developed by pump	kW	11.0	6.8	9.0	1.0	9.3
Motor input power	kW	22.4	19.3	20.6	7.0	22.9
Calculated overall efficiency	%	49.1	35.0	43.6	14.3	40.5
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	59.8	42.7	53.2	17.5	49.3
Specific power consumption	kWh/m^3	0.33	0.28	0.39	0.74	0.26
Specific energy consumption	$Wh/m^3/m$ of WC	5.55	7.78	6.24	19.01	6.73

Table 37: Performance Evaluation of Vijay Nagar pumps (II)

Parameters	UOM	D block sec 11 Site No -144	B block sec 11 Site No -145	E block sec 11 no -5 Site No -147	G block sec 11 pump No.3 Site No -148	F block sec 11 Site No -150
Rated flow	m^3/h	60	53	53	53	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22.4	22.4	22.4	22.4	22.4
Parameters Measured						
Level of the water above pump (A)	m	7.60	7.60	7.60	6.10	7.60
Static head up to discharge pressure gauge from pump eye (B)	m	39.52	39.52	36.48	36.48	39.52
Measured discharge head (C)	m	22.10	22.54	1.38	1.65	1.25
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.17	0.19	1.15	0.17	0.19

Parameters	UOM	D block sec 11 Site No -144	B block sec 11 Site No -145	E block sec 11 no -5 Site No -147	G block sec 11 pump No.3 Site No -148	F block sec 11 Site No -150
Total discharge head (E= B+C +D)	m	61.8	62.3	39.0	38.3	41.0
Total Flow	m^3/h	34	37	100	36	36
Motor input power	kW	18	19	28	23	20
Calculation						
Total head developed	m	54	55	31	32	33
Head utilization	%	86	87	50	51	53
Flow utilization	%	57	69	189	68	68
Hydraulic power developed by pump	kW	5.0	5.5	8.6	3.2	3.3
Motor input power	kW	17.7	18.6	28.2	23.1	20.1
Calculated overall efficiency	%	28.4	29.3	30.4	13.7	16.4
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	34.6	35.8	37.0	16.7	19.9
Specific power consumption	kWh/m^3	0.52	0.51	0.28	0.64	0.56
Specific energy consumption	$Wh/m^3/m$ of WC	9.60	9.28	8.97	19.93	16.64

Table 38: Performance evaluation of Vijay Nagar pumps (III)

Parameters	UOM	Awas Vikas Kashiram colony Site No -151	Sudamapuri no 2 Site No -153	Sudamapuri no 3 Site No -154	L block sec 9 Site No -157	H block sec 9 rosevally school Site No -158
Rated flow	m^3/h	53	53	53	53	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	22.4	22.4	22.4	22.4	22.4
Parameters Measured						
Level of the water above pump (A)	m	4.56	6.10	6.10	9.10	11.00
Static head up to discharge pressure gauge from pump eye (B)	m	33.44	27.36	27.36	36.48	39.52
Measured discharge head (C)	m	27.85	27.20	25.80	13.40	3.15
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.87	0.08	0.00	0.96	0.91
Total discharge head (E= B+C +D)	m	62.2	54.6	53.2	50.8	43.6
Total Flow	m^3/h	91	28	6	91	85
Motor input power	kW	25	17	22	24	22

Parameters	UOM	Awas Vikas Kashiram colony Site No -151	Sudamapuri no 2 Site No -153	Sudamapuri no 3 Site No -154	L block sec 9 Site No -157	H block sec 9 rosevally school Site No -158
Calculation						
Total head developed	m	58	49	47	42	33
Head utilization	%	91	77	75	66	52
Flow utilization	%	172	52	11	171	141
Hydraulic power developed by pump	kW	14.3	3.6	0.7	10.3	7.5
Motor input power	kW	24.7	17.4	22.4	23.9	21.5
Calculated overall efficiency	%	57.6	20.9	3.2	43.1	34.9
motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	70.3	25.5	4.0	52.6	42.5
Specific power consumption	kWh/m^3	0.27	0.63	3.95	0.26	0.25
Specific energy consumption	$Wh/m^3/m$ of WC	4.73	13.02	83.88	6.31	7.81

Table 39: Performance Evaluation of Vijay Nagar pumps (IV)

Parameters	UOM	H block Kela Khada Site No -161	R block sec 12 Site No -162	Sorvaday Nagr Site No -163	A-block Sec 11 Site No -164	Dhara school Site No -165
Rated flow	m^3/h	53	53	60	53	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22.4	22.4	22.4	22.4	15.0
Parameters Measured						
Level of the water above pump (A)	m	10.60	6.10	6.10	6.10	3.00
Static head up to discharge pressure gauge from pump eye (B)	m	39.52	36.48	42.56	39.52	39.52
Measured discharge head (C)	m	9.13	5.18	2.70	3.26	0.15
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.88	0.85	0.13	0.17	0.83
Total discharge head (E= B+C +D)	m	49.5	42.5	45.4	42.9	40.5
Total Flow	m^3/h	83	85	28	34	80
Motor input power	kW	22	23	20	20	15
Calculation						
Total head developed	m	39	36	39	37	38
Head utilization	%	62	58	62	58	60

Parameters	UOM	H block Kela Khada Site No -161	R block sec 12 Site No -162	Sorvaday Nagr Site No -163	A-block Sec 11 Site No -164	Dhara school Site No -165
Flow utilization	%	156	160	47	64	152
Hydraulic power developed by pump	kW	8.8	8.4	3.0	3.4	8.2
Motor input power	kW	21.8	23.2	20.2	20.4	15.0
Calculated overall efficiency	%	40.3	36.2	14.9	16.6	54.7
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	49.1	44.2	18.2	20.2	66.7
Specific power consumption	kWh/m^3	0.26	0.27	0.72	0.61	0.19
Specific energy consumption	$Wh/m^3/m$ of WC	6.76	7.51	18.23	16.43	4.98

Table 40: Performance Evaluation of Mohan Nagar pumps (I)

Parameters	UOM	Tilla More No 1 Site No -167	Tilla More No 2 Site No -168	Tilla More No 3 Site No -169	Tilla More No 11 Site No -174	Tilla More No 12 Site No -175
Rated flow	m^3/h	60	56	60	60	53
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	15	19	15	15
Parameters Measured						
Level of the water above pump (A)	m	7.60	11.00	9.40	6.10	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	33.44	39.52	39.52	33.44	39.52
Measured discharge head (C)	m	5.46	22.90	3.27	5.10	5.33
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.25	0.28	0.60	0.36	0.39
Total discharge head (E= B+C +D)	m	39.1	62.7	43.4	38.9	45.2
Total Flow	m^3/h	46	45	68	56	53
Motor input power	kW	21	12	11	15	12
Calculation						
Total head developed	m	32	52	34	33	39
Head utilization	%	50	82	54	52	62
Flow utilization	%	76	80	113	93	101
Hydraulic power developed by pump	kW	3.9	6.3	6.3	5.0	5.7
Motor input power	kW	21.2	12.4	11.1	15.4	11.7
Calculated overall efficiency	%	18.5	50.7	56.4	32.4	48.8
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	22.6	61.9	68.8	39.5	59.5

Parameters	UOM	Tilla More No 1 Site No -167	Tilla More No 2 Site No -168	Tilla More No 3 Site No -169	Tilla More No 11 Site No -174	Tilla More No 12 Site No -175
Specific power consumption	kWh/m^3	0.46	0.28	0.16	0.28	0.22
Specific energy consumption	Wh/m^3/m of WC	14.70	5.37	4.82	8.40	5.58

Table 41: Performance evaluation of Mohan Nagar pumps (II)

Parameters	UOM	Tilla More No 14 Site No -177	Tilla More No 16 Site No -179	Tilla More No 17 Site No -180	Tilla More No 19 Site No -182	Sai upwan no 1 Site No -185
Rated flow	m^3/h	60	53	53	53	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	22	22	19	19
Parameters Measured						
Level of the water above pump (A)	m	9.10	6.10	6.10	6.10	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	33.44	30.40	30.40	33.44	33.44
Measured discharge head (C)	m	6.62	7.40	5.44	5.21	10.10
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.11	0.77	1.84	0.06	0.40
Total discharge head (E= B+C +D)	m	40.2	38.6	37.7	38.7	43.9
Total Flow	m^3/h	30	89	142	20	59
Motor input power	kW	16	21	24	19	17
Calculation						
Total head developed	m	31	32	32	33	38
Head utilization	%	49	52	50	52	60
Flow utilization	%	49	168	268	38	99
Hydraulic power developed by pump	kW	2.5	7.8	12.2	1.8	6.1
Motor input power	kW	15.5	20.6	23.5	18.9	17.1
Calculated overall efficiency	%	16.2	38.1	52.1	9.5	35.8
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	19.7	46.5	63.5	11.6	43.6
Specific power consumption	kWh/m^3	0.52	0.23	0.17	0.93	0.29
Specific energy consumption	Wh/m^3/m of WC	16.85	7.14	5.23	28.55	7.61

Table 42: Performance evaluation of Mohan Nagar pumps (III)

Parameters	UOM	Sai upwan no 2 Site No -186	Sai upwan no 9 Site No -187	Sai upwan no 6 Site No -188	Sai upwan no 8 Site No -191	Kanha Upwan Site No -192
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	22	22	22	15	22
Parameters Measured						
Level of the water above pump (A)	m	6.10	6.10	6.10	6.10	7.60
Static head up to discharge pressure gauge from pump eye (B)	m	33.44	33.44	39.52	33.44	27.36
Measured discharge head (C)	m	11.90	9.33	14.50	10.42	5.18
Frictional head from pump eye to discharge pressure gauge point (D)	m	1.07	0.75	0.52	0.12	0.96
Total discharge head (E= B+C +D)	m	46.4	43.5	54.5	44.0	33.5
Total Flow	m^3/h	101	83	63	32	106
Motor input power	kW	25	21	24	14	25
Calculation						
Total head developed	m	40	37	48	38	26
Head utilization	%	64	59	77	60	41
Flow utilization	%	168	139	105	53	176
Hydraulic power developed by pump	kW	11.1	8.5	8.3	3.2	7.5
Motor input power	kW	24.9	21.3	23.6	13.8	25.4
Calculated overall efficiency	%	44.5	39.7	35.0	23.5	29.3
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	54.2	48.5	42.7	28.7	35.7
Specific power consumption	kWh/m^3	0.25	0.26	0.38	0.44	0.24
Specific energy consumption	$Wh/m^3/m$ of WC	6.12	6.85	7.77	11.56	9.29

Table 43: Performance evaluation of Vasundhara pumps (I)

Parameters	UOM	Hindon No 4 Site No -195	Hindon No 9 Site No -198	Vasundhara sec 7/2 Site No -200	Vasundhara sec 9/1 Site No -203	Vasundhara sec 9/2 Site No -204
Rated flow	m^3/h	53	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	15	23	8	8	8

Parameters	UOM	Hindon No 4 Site No -195	Hindon No 9 Site No -198	Vasundhara sec 7/2 Site No -200	Vasundhara sec 9/1 Site No -203	Vasundhara sec 9/2 Site No -204
Parameters Measured						
Level of the water above pump (A)	m	9.10	9.10	7.60	7.60	7.60
Static head up to discharge pressure gauge from pump eye (B)	m	36.48	36.48	36.48	36.48	36.48
Measured discharge head (C)	m	5.98	2.66	1.48	3.65	3.65
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.04	0.84	0.30	0.56	0.42
Total discharge head (E= B+C +D)	m	42.5	40.0	38.3	40.7	40.6
Total Flow	m^3/h	35	103	35	33	39
Motor input power	kW	15	18	10	8	8
Calculation						
Total head developed	m	33	31	31	33	33
Head utilization	%	53	49	49	53	52
Flow utilization	%	65	172	59	56	65
Hydraulic power developed by pump	kW	3.2	8.7	2.9	3.0	3.5
Motor input power	kW	15.0	17.5	10.4	7.7	8.1
Calculated overall efficiency	%	21.0	49.5	28.3	39.2	43.2
Calculated motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	25.6	60.3	34.5	47.8	52.7
Specific power consumption	kWh/m^3	0.43	0.17	0.30	0.23	0.21
Specific energy consumption	$Wh/m^3/m$ of WC	12.94	5.50	9.63	6.94	6.29

Table 44: Performance evaluation of Vasundhara pumps (II)

Parameters	UOM	Vasundhara sec 11 Site No -205	Vasundhara sec 15 Site No -207	Vaishali sec 3 no-1 Site No -213	Vaishali sec 3 no-2 Site No -213	Vaishali sec 3 no-3 Site No -213
Rated flow	m^3/h	60	60	60	60	60
Rated head	m	63	63	63	63	63
Motor Rating	kW	8	22	22	22	22
Parameters Measured						
Level of the water above pump (A)	m	7.60	4.50	6.10	6.10	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	36.48	36.48	36.48	36.48	36.48
Measured discharge head (C)	m	3.21	11.30	3.22	3.20	2.17

Parameters	UOM	Vasundhara sec 11 Site No -205	Vasundhara sec 15 Site No -207	Vaishali sec 3 no-1 Site No -213	Vaishali sec 3 no-2 Site No -213	Vaishali sec 3 no-3 Site No -213
Frictional head from pump eye to discharge pressure gauge point (D)	m	0.46	0.43	1.01	0.44	0.05
Total discharge head (E= B+C +D)	m	40.1	48.2	40.7	40.1	38.7
Total Flow	m^3/h	30	66	105	56	117
Motor input power	kW	6	14	23	19	23
Calculation						
Total head developed	m	33	44	35	34	33
Head utilization	%	52	69	55	54	52
Flow utilization	%	50	111	175	93	195
Hydraulic power developed by pump	kW	2.7	7.9	9.9	5.2	10.4
Motor input power	kW	6.4	14.3	22.6	18.7	23.4
Calculated overall efficiency	%	41.3	55.3	43.8	27.7	44.4
Motor efficiency	%	82	82	82	82	82
Calculated pump efficiency	%	50.3	67.4	53.4	33.8	54.1
Specific power consumption	kWh/m^3	0.21	0.22	0.22	0.33	0.20
Specific energy consumption	$Wh/m^3/m$ of WC	6.60	4.93	6.21	9.83	6.13

Table 45: Performance evaluation of Vasundhara pumps (III)

Parameters	UOM	Vaishali sec 5/5 Site No -215	Vaishali sec 6/8 Site No -216	Vasundhara sec 5 Site No -219
Rated flow	m^3/h	56	56	60
Rated head	m	63	63	63
Motor Rating	kW	15	15	23
Parameters Measured				
Level of the water above pump (A)	m	4.60	4.60	6.10
Static head up to discharge pressure gauge from pump eye (B)	m	36.48	36.48	36.48
Measured discharge head (C)	m	30.30	28.14	3.20
Frictional head from pump eye to discharge pressure gauge point (D)	m	1.56	0.29	0.11
Total discharge head (E= B+C +D)	m	68.3	64.9	39.8
Total Flow	m^3/h	35	62	85

Parameters	UOM	Vaishali sec 5/5 Site No -215	Vaishali sec 6/8 Site No -216	Vasundhara sec 5 Site No -219
Motor input power	kW	12	18	19
Calculation				
Total head developed	m	64	60	34
Head utilization	%	101	96	53
Flow utilization	%	63	111	141
Hydraulic power developed by pump	kW	6.1	10.2	7.8
Motor input power	kW	12.2	18.1	18.9
Calculated overall efficiency	%	49.7	56.5	41.1
Motor efficiency	%	82	82	82
Calculated pump efficiency	%	60.7	68.9	50.1
Specific power consumption	kWh/m^3	0.35	0.29	0.22
Specific energy consumption	$Wh/m^3/m$ of WC	5.47	4.82	6.63

4.2.8 Auxiliaries in Pumping Stations

During the energy audit electrical energy consuming equipment at the station other than water pumps were also studied and same is provided in table no 46.

Table 46: Auxiliary loading details

Site Name	No. of fittings	Rating (KW)	Type of load
3rd A Pump no -6	1	0.1	Fan
	1	0.373	Dosing Pump
3rd A Pump no -7		-	-
3 F nehru Nagar		-	-
Ram lila maidan no 3	1	0.07	Fan
	2	0.04	T-8 Tube Light
	1	0.373	Dosing Pump
Ghanta Ghar taxi Stand		-	-
Company Bang No 5		-	-
Company Bang No 4		-	-
Ashok Nagar	0	0	Nil
Yashoda Hospital	1	0.07	Fan
	1	0.1	incandescent bulb
	1	0.373	Dosing Pump
Holichild Barat Ghar	1	0.1	incandescent bulb
	1	0.373	Dosing Pump
Gandhi Park No-5	1	0.04	T-8 Tube Light
	1	0.07	Fan
Dayanand Nagar N0.1	-	-	-
Dayanand Nagar N0.2	1	0.07	Fan
	1	0.007	LED
Paras Hotel Pump	1	0.1	incandescent bulb
Kalkaghari Pump no 1	1	0.1	incandescent bulb
	1	0.373	Dosing Pump
Balupura Pump	0	0	Nil
Maliwada Fire Brigade	1	0.04	T-8 Tube Light
	1	0.04	Fan
	1	0.373	Dosing Pump
Pranghari	1	0.373	Dosing Pump
	1	0.04	T-8 Tube Light
Jai prakash	1	0.2	incandescent bulb
	1	0.1	incandescent bulb
Panch Wati	-	-	-
Anand Vihar	1	0.1	incandescent bulb
Kamla Quarter	1	0.1	incandescent bulb
Laxhmi Vihar	1	0.07	Fan
	1	0.1	incandescent bulb
2A Nehru Nagar	1	1	Heater
2 B nehru Nagar	0	0	Nil
Sabhaghar Pump	0	0	nil
Nehru Nagar No 2	1	0.04	T-8 Tube Light
Hind Park	1	0.07	Fan
	1	0.04	T-8 Tube Light
MB girls College	1	0.04	T-8 Tube Light
	1	0.06	T-8 Tube Light

Site Name	No. of fittings	Rating (KW)	Type of load
Chandrapuri	1	0.1	incandescent bulb
Town Hall Pump no 1	1	0.07	Fan
	1	0.04	T-8 Tube Light
	1	0.373	Dosing pump
DC garg Pump	1	0.07	Fan
	1	0.04	Table Fan
	1	0.373	Dosing Pump
3B nehru Nagar	1	0.373	Dosing Pump
Arjun Nagar	-	-	-
Gandhi Nagar no 6	1	0.07	Fan
	1	0.011	CFL
	1	0.373	Dosing Pump
Payre lal pumping station	-	-	-
Ram Nagar Teekona Park	1	0.04	T-8 Tube Light
	1	0.1	incandescent bulb
	1	0.373	Dosing Pump
Nand Gram C Block	2	0.1	incandescent bulb
Nand Gram B Block	0	0	Nil
C block Ramlila Garond	0	0	Nil
Nand Gram No 1	0	0	Nil
Nand Gram E block	1	1	House Load
Nand Gram F block	1	0.11	incandescent bulb
	1	0.373	Dosing Pump
Lohia Nagar Pump no 1	-	-	-
Lohia Nagar Pump no 2	1	0.1	incandescent bulb
Gandhi Park	0	0	Nil
Dina Ghari	0	0	Nil
G block Patel Nagar	0	0	Nil
Sanjay geeta Park	1	0.045	Fan
	1	0.1	incandescent bulb
B block market	0	0	Nil
Patel Nagar B block	1	0.04	Fan
	1	0.373	Dosing Pump
Patel Nagar D block Mother dairy	1	0.1	incandescent bulb
	1	0.373	Dosing Pump
Banwari Nagar	1	0.1	incandescent bulb
	1	0.07	Fan
	1	0.1	incandescent bulb
Shibbon Pura	1	0.373	Dosing Pump
L block patel nagar	2	0.1	incandescent bulb
Dhookna Katha	1	0.07	Fan
	1	0.1	incandescent bulb
	1	1	Heater
Dhookna Mandir	1	0.04	Fan
	1	0.1	incandescent bulb
Gautam Nagar	-	-	-
Bhonja	1	0.1	incandescent bulb
Lohia Nagar B ablock	1	0.045	Fan
lal Quarter No 1	1	0.373	Dosing Pump
	1	0.07	Fan
	1	0.04	T-8 Tube Light
lal Quarter No 2	1	0.1	Bulb
Lal Quarter no 2 (rebore)	-	-	-

Site Name	No. of fittings	Rating (KW)	Type of load
MMG Pump no -1	3	3	House load
	1	0.04	Fan
	1	0.04	T-8 Tube Light
MMG Pump no 2	1	0.373	dosing pump
Model Town Park No-1	1	0.07	Fan
	1	0.1	Incandescent Bulb
Model Town Pump NO 2	1		
Model Town Pump No 4	1	0.7	Fan
New Bus adda No 1	-	-	-
New Bus Adda Tank	3	0.1	incandescent bulb
MB Girls Kela Kheda	0	0	nil
Tar Factory	0	0	nil
Chmada Patt	1	0.07	Fan
	1	0.1	Incandescent Bulb
Jassipurs	0	0	nil
Kella Masrasa	1	0.1	Incandescent Bulb
Lalten Factory	-	-	-
Sarai Nagar	1	0.07	Fan
	1	0.04	T-8 Tube Light
	1	0.373	dosing Pump
Kella Khada	-	-	-
D-block No.1	5	0.07	Fan
	8	0.04	T-8 Tube Light
	1	0.373	Dosing Pump
Hathi park No.2	1	0.07	Fan
	1	0.06	Incandescent bulb
Tulsi park No.3	1	0.373	Dosing Pump
C block No No 4	1	0.746	Dewatering Pump
Pumping station No.14	1	0.373	Dosing Pump
Chiranjeevi vihar Tank No.1	1	0.014	CFL
	1	0.07	Fan
Shani mandir pump No.2	1	0.373	Dosing Pump
Sec-1 park Chiranjeevi vihar No.3	1	0.373	Dosing Pump
C block No.1	1	0.04	T-8 Tube Light
A block park pump No.5	0	0	nil
3A block pump No.6	0	0	nil
1D block pump No.3	0	0	nil
Govindpuram pump No.4	0	0	nil
G-block pump No.2	0	0	nil
C-block pump No.1	1	3	House load
C-block pump No.2	0	0	nil
Uttam public school No.3	1	0.1	Incandescent bulb
D-block No.5	0	0	nil
Mother Dairy No 8	0	0	nil
A-block pump No.4	1	0.1	Incandescent bulb
Rajnagar No.1	1	0.04	T-8 Tube Light
Ramlila Maidan No 10	-	-	-
Sector 11 pump no 11	1	0.1	Incandescent bulb
	1	0.045	tv
	1	0.07	Fan
GDA market No.3	1	1.5	House load
	1	0.373	dosing Pump
	1	0.2	cooler fan

Site Name	No. of fittings	Rating (KW)	Type of load
Sector-8 pump No.7	0	0	Nil
Sector-6 pump No.2	0	0	Nil
Sector-9 pump No.9	1	2	House load
	1	0.07	Fan
F block tank compound	1	0.04	T-8 Tube Light
B-block No.4	1	0.1	Incandescent bulb
Near forest dept. No.2	1	0.04	T-8 Tube Light
P-block No.7	1	0.04	T-8 Tube Light
L-block No.8	0	0	nil
L-block No.10	0	0	nil
G-block tank No.6	0	0	nil
N-block pump No.3	0	0	nil
loha mandi pump No.12	0	0	nil
B-block park No.5	1	0.375	Dosing Pump
Ramlila maidan no.6	0	0	nil
	1	0.009	LED Bulb
C-block nursery No.7	1	0.373	Dosing Pump
I-block park No.8	1	0.373	Dosing Pump
F-block park No.9	1	0.373	Dosing Pump
H-block tank No.10	1	0.373	Dosing Pump
	1	0.04	T-8 Tube Light
Vivekanand nagar No.11	1	0.373	Dosing Pump
K-block No.7	0	0	nil
Bahwali colony	0	0	nil
	1	0.373	Dosing Pump
Shastri nagar No.6	1	0.1	Incandescent bulb
K-block No.5	1	0.373	Dosing Pump
RDC building	0	0	nil
Dr.Mukherjee park	0	0	nil
	1	0.07	Fan
GDA market sector-7 pump No.8	1	0.1	Incandescent bulb
	1	1.5	heater
	1	0.04	T-8 Tube Light
P-block No.11	1	0.1	Incandescent bulb
	1	0.04	T-8 Tube Light
Guldhar	1	0.373	Dosing Pump
Ramlila Maidan sec 9	0	0	Nil
E block sec 9	0	0	Nil
G block sec 9	-	-	-
F block sec 9	-	-	-
	1	0.1	Incandescent bulb
A block sec 9	1	0.07	Fan
C block Sec 9	1	0	Nil
Ambedkar Nagar Sec 9	-	-	-
	1	0.07	Fan
Zonal Office	1	0.04	Fan
H block sec 9	-	-	-
Mirza Pur No 2	1	0.373	Dosing pump
Mirza Pur No 3	1	0.04	Fan
F block sec 12	-	-	-
Mother dairy M block	-	-	-
	1	0.04	T-8 Tube Light
H block sec 12	1	0.007	LED bulb

Site Name	No. of fittings	Rating (KW)	Type of load
N block teachers colony	-	-	-
D block sec 11	1	1	house load
B block sec 11	0	0	Nil
E block sec 11 no -2	-	-	-
E block sec 11 no -5	1	1.5	Heater
	1	0.07	Fan
	1	0.04	T-8 Tube Light
G block sec 11 pump No.3	1	1.5	house load
G block Sec 11 No 4	1	0.012	Incandescent bulb
F block sec 11	1	0.2	Cooler
	1	0.045	Fan
Awas Vikas Kashiram colony	1	1	house load
Sudamapuri no 1	0	0	Nil
Sudamapuri no 2	1	0.1	Incandescent bulb
	1	0.04	T-8 Tube Light
Sudamapuri no 3	1	1	house load
K block sec 9	-	-	-
H block sec 9	-	-	-
L block sec 9	0	0	nil
H block sec 9 rosevally school	0	0	Nil
Bhud bharat nagar	-	-	-
Sundar puri	-	-	-
H block Kela Khada	0	0	nil
R block sec 12	0	0	Nil
Sorvaday Nagr	0	0	Nil
A-block Sec 11	0	0	nil
Dhara school	0	0	nil
B block Mata Colony	0	0	nil
Tilla More No 1	2	0.1	Incandescent bulb
Tilla More No 2	2	0.1	Incandescent bulb
Tilla More No 3	2	0.1	Incandescent bulb
Tilla More No 4	0	0	Nil
Tilla More No 7	0	0	Nil
Tilla More No 9	0	0	Nil
Tilla More No 10	0	0	Nil
Tilla More No 11	0	0	Nil
Tilla More No 12	1	1	Heater
	1	0.027	TV
	1	0.04	Fan
Tilla More No 13	1	0.1	Incandescent bulb
Tilla More No 14	1	0.1	Incandescent bulb
	1	0.04	Fan
Tilla More No 15	1	0.1	Incandescent bulb
Tilla More No 16	1	0.1	Incandescent bulb
	1	0.04	T-8 Tube Light
	1	0.04	Fan
Tilla More No 17	1	1	House Load
	2	0.1	Incandescent bulb
Tilla More No 18	-	-	-
Tilla More No 19	1	1	House Load
Tilla More No 20	0	0	Nil
Tilla More No 21	0	0	Nil
Sai upwan no 1	0	0	Nil

Site Name	No. of fittings	Rating (KW)	Type of load
Sai upwan no 2	0	0	Nil
Sai upwan no 9	0	0	Nil
Sai upwan no 6	0	0	Nil
Sai upwan no 7	0	0	Nil
Sai upwan no 3	0	0	Nil
Sai upwan no 8	1	0.25	Sodium Lamp
	1	0.1	Incandescent bulb
Kanha Upwan	1	0.1	Incandescent bulb
	1	1	Heater
Hindon No 1	-	-	-
Hindon No 2	-	-	-
Hindon No 4	1	1	House load
Hindon No 7	0	0	nil
Hindon No 8	-	-	-
Hindon No 9	1	1	House load
Vasundhara sec 7/1	-	-	-
Vasundhara sec 7/2	1	0.045	Fan
	1	0.045	TV
Vasundhara sec 7/3	-	-	-
Vasundhara sec 7/4	-	-	-
Vasundhara sec 9/1	1	1	House Load
	1	0.1	Incandescent Bulb
Vasundhara sec 9/2	1	1	House Load
	1	0.1	Incandescent Bulb
Vasundhara sec 11	1	1	House Load
Sec 15	0	0	Nil
Vasundhara sec 15	1	1	House Load
	4	0.1	Incandescent Bulb
Sec 19	-	-	-
Sec 13	-	-	-
Sec 2/2	-	-	-
sec 2/3	-	-	-
Vaishali sec 1	-	-	-
Vaishali sec 3 no-1	1	1	house load
Vaishali sec 3 no-2	-	-	-
Vaishali sec 3 no-3	-	-	-
Vaishali sec 5/4	-	-	-
Vaishali sec 5/5	0	0	nil
Vaishali sec 6/8	1	0.07	Fan
	1	0.1	Incandescent Bulb
	1	1	heater
Vasundhara sec 6/9	-	-	-
Ashirvad Sec 2	-	-	-
Vasundhara sec 5	3	0.04	T-8 Tube Light
	1	0.25	Incandescent Bulb
Total		**56.18 kW**	

4.2.9 Total Energy Consumption Estimation for Pumps & Pumping Stations

The pumps are the major energy consumers at the pumping stations. During energy audit activity, the measurements on individual pumps were taken and the operating hours of the individual pumps were also

collected from the available log books at pumping station to estimate the annual energy consumption for the baseline estimation and future M&V usage. The details are provided in table no 47.

Table 47: Energy consumption for bore well pumping station

Sl. No.	Pump station name	Power consumption (kW)	Annual Operating Hours(hours/annum)	Total power consumption per year (kWh/annum)
1	3rd A Pump no -6	15.4	5,760	88,704
2	3rd A Pump no -7	-	-	-
3	3 F nehru Nagar	-	-	-
4	Ram lila maidan no 3	14.1	3,960	55,836
5	Ghanta Ghar taxi Stand	20.2	5,760	116,352
6	Company Bang No 5	-	-	-
7	Company Bang No 4	-	-	-
8	Ashok Nagar	20.8	5,760	119,808
9	Yashoda Hospital	23.8	5,760	137,088
10	Holichild Barat Ghar	22	5,760	126,720
11	Gandhi Park No-5	23.1	5,760	133,056
12	Dayanad Nagar No 1	-	-	-
13	Dayanand Nagar N0.2	19.85	5,760	114,336
14	Paras Hotel Pump	22.24	5,040	112,090
15	Kalkaghari Pump no 1	21.3	5,040	107,352
16	Balupura Pump	24	5,760	138,240
17	Maliwada Fire Brigade	21.6	5,040	108,864
18	Pranghari	14.3	5,400	77,220
19	Jai prakash	17.6	5,760	101,376
20	Panch Wati	-	-	-
21	Anand Vihar	-	-	-
22	Kamla Quarter	16.2	5,760	93,312
23	Laxhmi Vihar	14.35	5,760	82,656
24	2A Nehru Nagar	17.6	5,760	101,376
25	2 B nehru Nagar	-	-	-
26	Sabhaghar Pump	16.4	5,760	94,464
27	Nehru Nagar No 2	19.2	5,760	110,592
28	Hind Park	19.2	5,760	110,592
29	MB girls College	23.4	2,880	67,392
30	Chandrapuri	22.2	4,320	127,872
31	Town Hall Pump no 1	15.2	6,120	87,552
32	DC garg Pump	10.5	5,760	60,480
33	3B nehru Nagar	17.6	5,760	101,376
34	Arjun Nagar	-	-	-
35	Gandhi Nagar no 6	17.15	5,760	98,784
36	Payre lal pumping station	-	-	-
37	Ram Nagar Teekona Park	24.9	5,760	143,424
38	Nand Gram C Block	19.5	4,320	84,240
39	Nand Gram B Block	18.9	4,320	81,648
40	C block Ramlila Garond	14.0	8,640	120,701

Sl. No.	Pump station name	Power consumption (kW)	Annual Operating Hours(hours/annum)	Total power consumption per year (kWh/annum)
41	Nand Gram No 1	22.6	4,320	97,509
42	Nand Gram E block	13.6	3,600	48,960
43	Nand Gram F block	23.5	2,880	67,680
44	Lohia Nagar Pump no 1	-	-	-
45	Lohia Nagar Pump no 2	18.7	7,920	148,104
46	Gandhi Park	22.9	7,920	181,368
47	Dina Ghari	16.6	7,920	131,472
48	G block Patel Nagar	26.5	7,920	209,880
49	Sanjay geeta Park	14.4	7,920	114,048
50	B block market	14.8	7,200	106,560
51	Patel Nagar B block	23.8	3,600	85,680
52	Patel Nagar D block Mother dairy	18.2	3,600	65,520
53	Banwari Nagar	16.2	3,600	58,320
54	Shibbon Pura	19.9	3,600	71,640
55	L block patel nagar	17.4	4,320	75,168
56	Dhookna Katha	25.3	4,680	118,404
57	Dhookna Mandir	16.3	3,600	58,572
58	Gautam Nagar	-	-	-
59	Bhonja	15.8	4,320	68,256
60	Lohia Nagar B ablock	19.9	7,200	143,280
61	lal Quarter No 1	23.7	3,600	85,320
62	lal Quarter No 2	17.0	3,240	55,080
63	Lal Quarter no 2 (rebore)	-	-	-
64	MMG Pump no -1	15.9	7,920	125,928
65	MMG Pump no 2	7.5	7,920	59,400
66	Model Town Park No-1	8.3	6,480	53,784
67	Model Town Pump NO 2	-	-	-
68	Model Town Pump No 4	-	-	-
69	New Bus adda No 1	-	-	-
70	New Bus Adda Tank	-	-	-
71	MB Girls Kela Kheda	24.8	6,480	160,704
72	Tar Factory	14.3	3,600	51,480
73	Chmada Patt	22.1	6,480	142,884
74	Jassipurs	10.8	7,200	77,760
75	Kella Masrasa	21.6	5,400	116,843
76	Lalten Factory	-	-	-
77	Sarai Nagar	16.5	5,760	95,040
78	Kella Khada	-	-	-
79	D-block No.1	16.1	7,920	127,512
80	Hathi park No.2	21.4	7,920	169,664
81	Tulsi park No.3	22.7	7,920	179,872
82	C block No No 4	-	-	-
83	Pumping station No.14	23.4	7,920	184,932
84	Chiranjeevi vihar Tank No.1	21.0	7,920	166,267

Sl. No.	Pump station name	Power consumption (kW)	Annual Operating Hours(hours/annum)	Total power consumption per year (kWh/annum)
85	Shani mandir pump No.2	20.0	8,280	165,683
86	Sec-1 park Chiranjeevi vihar No.3	21.2	8,280	175,904
87	C block No.1	20.6	8,280	170,292
88	A block park pump No.5	20.5	8,280	170,016
89	3A block pump No.6	24.6	8,280	203,504
90	1D block pump No.3	23.8	8,280	197,340
91	Govindpuram pump No.4	22.3	8,280	184,644
92	G-block pump No.2	29.9	8,280	247,217
93	C-block pump No.1	22.3	8,280	184,644
94	C-block pump No.2	26.0	7,200	187,440
95	Uttam public school No.3	30.6	7,920	242,616
96	D-block No.5	20.0	7,920	158,400
97	Mother Dairy No 8	-	-	-
98	A-block pump No.4	21.1	7,920	166,848
99	Rajnagar No.1	21.5	7,920	170,016
100	Ramlila Maidan No 10	-	-	-
101	Sector-11 pump No.11	24.3	7,920	192,456
102	GDA market No.3	22.3	7,920	176,880
103	Sector-8 pump No.7	20.8	7,920	164,472
104	Sector-6 pump No.2	21.5	7,920	170,016
105	Sector-9 pump No.9	18.5	7,920	146,520
106	F block tank compound	15.1	7,920	119,592
107	B-block No.4	17.4	7,920	137,808
108	Near forest dept. No.2	24.7	7,920	195,624
109	P-block No.7	26.1	7,920	206,712
110	L-block No.8	20.3	7,920	160,424
111	L-block No.10	19.6	7,200	141,040
112	G-block tank No.6	15.5	7,920	122,496
113	N-block pump No.3	27.1	7,920	214,405
114	loha mandi pump No.12	17.4	2,520	43,764
115	B-block park No.5	12.3	7,920	97,768
116	Ramlila maidan no.6	20.4	7,920	161,304
117	C-block nursery No.7	11.8	7,920	93,764
118	I-block park No.8	19.6	7,920	154,880
119	F-block park No.9	12.2	7,920	96,360
120	H-block tank No.10	22.3	7,920	176,528
121	Vivekanand nagar No.11	19.8	7,920	156,816
122	K-block No.7	18.3	7,920	144,584
123	Bahwali colony	-	-	-
124	Shastri nagar No.6	23.9	7,920	189,464
125	K-block No.5	13.7	7,920	108,328
126	RDC building	14.2	2,880	40,880
127	Dr.Mukherjee park	12.6	3,240	40,806
128	GDA market sector-7 pump No.8	20.2	4,320	87,408

Sl. No.	Pump station name	Power consumption (kW)	Annual Operating Hours(hours/annum)	Total power consumption per year (kWh/annum)
129	P-block No.11	24.9	7,920	197,472
130	Guldhar	17.4	2,160	37,512
131	Ramlila Maidan sec 9	-	-	-
132	E block sec 9	-	-	-
133	G block sec 9	-	-	-
134	F block sec 9	-	-	-
135	A block sec 9	-	-	-
136	C block Sec 9	22.4	7,920	177,408
137	Ambedkar Nagar Sec 9	-	-	-
138	Zonal Office	19.3	7,920	152,856
139	H block sec 9	-	-	-
140	Mirza Pur No 2	20.6	2,880	59,328
141	Mirza Pur No 3	7.02	2,880	20,218
142	F block sec 12	-	-	-
143	Mother dairy M block	-	-	-
144	H block sec 12	22.9	2,880	65,952
145	N block teachers colony	-	-	-
146	D block sec 11	17.72	7,920	140,342
147	B block sec 11	18.6	7,920	147,312
148	E block sec 11 no -2	-	-	-
149	E block sec 11 no -5	28.2	7,920	223,344
150	G block sec 11 pump No.3	23.1	7,920	182,952
151	G block Sec 11 No 4	-	-	-
152	F block sec 11	20.1	7,920	159,192
153	Awas Vikas Kashiram colony	24.74	7,920	195,941
154	Sudamapuri no 1	-	-	-
155	Sudamapuri no 2	17.4	7,920	137,808
156	Sudamapuri no 3	22.4	7,920	177,180
157	K block sec 9	-	-	-
158	H block sec 9	-	-	-
159	L block sec 9	23.87	7,920	189,050
160	H block sec 9 rosevally school	21.53	2,880	62,006
161	Bhud bharat nagar	-	-	-
162	Sundar puri	-	-	-
163	H block Kela Khada	21.8	7,920	172,656
164	R block sec 12	23.16	7,920	183,427
165	Sorvaday Nagr	20.2	2,880	58,176
166	A-block Sec 11	20.4	7,920	161,568
167	Dhara school	15.02	7,920	118,958
168	B block Mata Colony	-	-	-
169	Tilla More No 1	21.2	7,200	152,640
170	Tilla More No 2	12.4	7,200	89,496
171	Tilla More No 3	10.5	7,200	75,600
172	Tilla More No 4	-	-	-

Sl. No.	Pump station name	Power consumption (kW)	Annual Operating Hours(hours/annum)	Total power consumption per year (kWh/annum)
173	Tilla More No 7	-	-	-
174	Tilla More No 9	-	-	-
175	Tilla More No 10	-	-	-
176	Tilla More No 11	15.4	7,920	121,968
177	Tilla More No 12	11.7	7,920	92,426
178	Tilla More No 13	-	-	-
179	Tilla More No 14	15.5	7,920	122,760
180	Tilla More No 15	-	-	-
181	Tilla More No 16	20.6	7,920	163,152
182	Tilla More No 17	23.5	7,920	186,120
183	Tilla More No 18	-	-	-
184	Tilla More No 19	18.9	7,920	149,688
185	Tilla More No 20	-	-	-
186	Tilla More No 21	-	-	-
187	Sai upwan no 1	17.1	7,200	123,120
188	Sai upwan no 2	24.9	7,200	179,280
189	Sai upwan no 9	21.3	7,200	153,360
190	Sai upwan no 6	23.6	7,200	169,920
191	Sai upwan no 7	-	-	-
192	Sai upwan no 3	-	-	-
193	Sai upwan no 8	13.8	7,200	99,360
194	Kanha Upwan	25.4	7,560	192,326
195	Hindon No 1	-	-	-
196	Hindon No 2	-	-	-
197	Hindon No 4	15.0	4,680	70,200
198	Hindon No 7	-	-	-
199	Hindon No 8	-	-	-
200	Hindon No 9	17.5	4,680	81,900
201	Vasundhara sec 7/1	-	-	-
202	Vasundhara sec 7/2	10.4	-	2,496
203	Vasundhara sec 7/3	-	-	-
204	Vasundhara sec 7/4	-	-	-
205	Vasundhara sec 9/1	7.7	7,920	60,588
206	Vasundhara sec 9/2	8.1	7,920	64,231
207	Vasundhara sec 11	6.4	7,920	51,005
208	Sec 15	-	-	-
209	Vasundhara sec 15	14.3	7,920	113,256
210	Sec 19	-	-	-
211	Sec 13	-	-	-
212	Sec 2/2	-	-	-
213	sec 2/3	-	-	-
214	Vaishali sec 1	-	-	-
215	Vaishali sec 3 no-1	22.6	2,880	65,088
216	Vaishali sec 3 no-2	18.7	2,880	53,770

Sl. No.	Pump station name	Power consumption (kW)	Annual Operating Hours(hours/annum)	Total power consumption per year (kWh/annum)
217	Vaishali sec 3 no-3	23.4	2,880	67,392
218	Vaishali sec 5/4	-	-	-
219	Vaishali sec 5/5	12.2	3,600	43,956
220	Vaishali sec 6/8	18.1	7,920	143,352
221	Vasundhara sec 6/9	-	-	-
222	Ashirvad Sec 2	-	-	-
223	Vasundhara sec 5	18.9	2,880	54,432
	Total	2958.25		19,135,598

5 Baseline Assessment

Estimation of baseline is the key element in design and development of any energy efficiency project. It play an important role in determining the savings associated with the implementation of energy efficiency measure (EEM) and determining the techno-financial feasibility of the EEM. In case of Municipal Energy Efficiency Programme (MEEP), the baseline is affected by many parameters including the changes in the system due to addition of command area, seasonal variations, increase in population which affect the required flow (Q) and the head (H).

Measurement and Verification (M&V) is the term given to the process for quantifying savings delivered by an Energy Efficiency Measure (EEM). It includes energy saving verification process involving measurements and reporting methodology. M & V methodology followed in this project includes following measurement schedule

a. Measurement of parameters pre EEM implementation (just before installation of EEPS) for all operating combinations using portable instruments

b. Measurement of parameters post EEM implementation for all operating combinations using portable instruments.

Energy savings are calculated as the difference in power drawn (in pre and post implementation scenario) multiplied by the operating hours mentioned in this report.

Baseline of this project will be estimated based on pre EEM implementation measurements, conducted just before installation of new EEPS at pumping station

5.1 Definition of possible and operating combinations

In ULBs, especially in case of pumping stations, where the pumps are connected in parallel, the pump operated in various combinations. For the purpose of this document, these combinations are defined as possible combinations. For example, for if 3 pumps are connected in parallel, there are 7 possible combinations considering three different pumps i.e.

Pump 1	Pump 1+ Pump 2	
Pump 2	Pump 2+ Pump 3	Pump 1+Pump 2+Pump 3
Pump 3	Pump 3 +Pump 1	

However, the ULB might be operating the pumps only in three combination, depending on the flow requirement, from the one discussed above. For the purpose of this document, these combinations are defined as operating combinations.

Operating Combination 1	Operating Combination 2	Operating Combination 3
Pump 1	Pump 1+ Pump 2	Pump 1+Pump 2+Pump 3

5.2 Key measurements for determining baseline or pre implementation level

To determine baseline, the following parameters would be measured during pre-implementation period (just before installation of new energy efficient pumps) for each operating combination.

i. Power Consumption, voltage, frequency (kW, Volt, hz)

Data Unit	kW, Volt, hz
Description	Voltage, frequency and power consumption of all operating combinations at site (pre and post implementation)
Source of Data	On site measurement using calibrated portable instrument (power analyzer)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable power analyzer
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

ii. Flow rate (m^3/hr)

Data Unit	M^3/h.
Description	Flow rate delivered for all operating combinations at site (pre and post implementation)
Source of Data	On site measurement using calibrated portable instruments (flow meter)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable flow meter
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

iii. Head (m)

Data Unit	meters (m)
Description	Average head delivered for all operating combinations at site (pre and post implementation)
Source of Data	On site measurement using calibrated instruments
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using pressure gauge installed at both the suction and discharge side of the pump
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

5.3 Baseline

The baselines energy consumption measurement for existing water pumping station will be established using pre implementation (just before installation of new pumps) measurements on existing pumps. Most of the electric parameters would be measured instantaneously using portable instruments, while operating hours would be provided by this report.

The baseline would be:

$$Baseline\ Energy\ Consumption\ of\ a\ pump\ (kWh) = kW1 \times hours\ of\ operation1 + kW2 \times hours\ of\ operation2 + \cdots.$$

Where, 1, 2…. represent operating combination of pump

$$Baseline\ Energy\ Consumption\ of\ a\ ULB\ (kWh) = Baseline\ of\ pump1 + Baseline\ of\ pump2 + \cdots.$$

Where 1, 2 … represent baseline energy consumption of pumps of ULB

Baseline of this project will be estimated based on pre-implementation measurements, conducted just before installation of new EEPS at pumping station. Table 48 provides estimated present energy consumption of all pumps operating at the pumping stations based on data provided in this report.

Table 48: Estimated present energy consumption for pumping stations

Name of pumping station	Pump Reference	Power consumption (kW)	Flow rate (m^3/h)	Frequency (Hz)	Head (m)	Hours baseline (hours)	Baseline Energy Consumption (kWh)
City 1							
3rd A Pump no -6	Site No -1	15.4	63.6	50	45	5,760	88,704
Ram lila maidan no 3	Site No -4	14.1	45.4	50	63.3	3,960	55,836
Ghanta Ghar taxi Stand	Site No -5	20.2	38.2	50	61.5	5,760	116,352
Ashok Nagar	Site No -8	20.8	85.1	50	49.8	5,760	119,808
Yashoda Hospital	Site No -9	23.8	76.8	50	47.8	5,760	137,088
Holichild Barat Ghar	Site No -10	22	89	50	51.5	5,760	126,720
Gandhi Park No-5	Site No -11	23.1	42.3	50	46.5	5,760	133,056
Dayanand Nagar N0.2	Site No -13	19.85	63.8	50	45.8	5,760	114,336
Paras Hotel Pump	Site No -14	22.24	102.1	50	46	5,040	112,090
Kalkaghari Pump no 1	Site No -15	21.3	86.4	50	45.5	5,040	107,352
Balupura Pump	Site No -16	24	85.1	50	49.7	5,760	138,240
Maliwada Fire Brigade	Site No -17	21.6	85.62	50	45.2	5,040	108,864
Pranghari	Site No -18	14.3	41	50	44.3	5,400	77,220
Jai prakash	Site No -19	17.6	89.9	50	47	5,760	101,376
Kamla Quarter	Site No -22	16.2	43.1	50	45.3	5,760	93,312
Laxhmi Vihar	Site No -23	14.35	48.5	50	46	5,760	82,656
2A Nehru Nagar	Site No -24	17.6	55.9	50	46.8	5,760	101,376
Sabhaghar Pump	Site No-26	16.4	42.1	50	46.9	5,760	94,464
Nehru Nagar No 2	Site No-27	19.2	74.2	50	45.7	5,760	110,592
Hind Park	Site No-28	19.2	66.7	50	46.5	5,760	110,592
MB girls College	Site No-29	23.4	112.9	50	48	2,880	67,392
Chandrapuri	Site No-30	22.2	30	50	43.3	5,760	127,872
Town Hall Pump no 1	Site No-31	15.2	60.8	50	47.6	5,760	87,552
DC garg Pump	Site NO-32	10.5	11.8	50	35.2	5,760	60,480
3B nehru Nagar	Site No-33	17.6	53.6	50	47.4	5,760	101,376
Gandhi Nagar no 6	Site No-35	17.15	42.8	50	45.3	5,760	98,784
Ram Nagar Teekona Park	Site No-37	24.9	63.9	50	38.3	5,760	143,424

Name of pumping station	Pump Reference	Power consumption (kW)	Flow rate (m^3/h)	Frequency (Hz)	Head (m)	Hours baseline (hours)	Baseline Energy Consumption (kWh)
Total (A)		**514.19**	**1,700.62**			**148,320**	**2,816,914**
City 2							
Nand Gram C Block	Site No -38	19.5	94.2	50	24.4	4,320	84,240
Nand Gram B Block	Site No -39	18.9	108.5	50	35.3	4,320	81,648
C block Ramlila Garond	Site No -40	14	78.4	50	25.1	8,640	120,701
Nand Gram No 1	Site No -41	22.6	108.5	50	34.7	4,320	97,509
Nand Gram E block	Site No -42	13.6	36.7	50	29.7	3,600	48,960
Nand Gram F block	Site No -43	23.5	4.55	50	15.6	2,880	67,680
Lohia Nagar Pump no 2	Site No -45	18.7	53	50	34.1	7,920	148,104
Gandhi Park	Site No -46	22.9	63.3	50	59	7,920	181,368
Dina Ghari	Site No -47	16.6	29.6	50	62.4	7,920	131,472
G block Patel Nagar	Site No -48	26.5	62.7	50	55.6	7,920	209,880
Sanjay geeta Park	Site No -49	14.4	23.7	50	57.9	7,920	114,048
B block market	Site No -50	14.8	31.6	50	55.4	7,200	106,560
Patel Nagar B block	Site No -51	23.8	99.9	50	42.7	3,600	85,680
Patel Nagar D block Mother dairy	Site No -52	18.2	48.5	50	32.9	3,600	65,520
Banwari Nagar	Site No -53	16.2	49.23	50	25.8	3,600	58,320
Shibbon Pura	Site No -54	19.9	132.3	50	34.3	3,600	71,640
L block patel nagar	Site No 55	17.4	77.5	50	36.6	4,320	75,168
Dhookna Katha	Site No 56	25.3	117.9	50	33.3	4,680	118,404
Dhookna Mandir	Site No -57	16.3	69.9	50	26.2	3,600	58,572
Bhonja	Site No -59	15.8	84.2	50	33.6	4,320	68,256
Lohia Nagar B ablock	Site No -60	19.9	67.3	50	40.5	7,200	143,280
lal Quarter No 1	Site No -61	23.7	103.3	50	35	3,600	85,320
lal Quarter No 2	Site No -62	17	94.3	50	34.6	3,240	55,080
Total(B)		**439.5**	**1639.08**			**120,240**	**2,277,409**
City 3							
MMG Pump no -1	Site No -64	15.9	26.5	50	63.32	7,920	125,928
MMG Pump no 2	Site No -65	7.5	9.7	50	63.31	7,920	59,400
Model Town Park No-1	Site No -66	8.3	34.4	50	38.83	6,480	53,784

Name of pumping station	Pump Reference	Power consumption (kW)	Flow rate (m^3/h)	Frequency (Hz)	Head (m)	Hours baseline (hours)	Baseline Energy Consumption (kWh)
MB Girls Kela Kheda	Site No -71	24.8	108	50	40.41	6,480	160,704
Tar Factory	Site No -72	14.3	46	50	39.09	3,600	51,480
Chmada Patt	Site No -73	22.1	113.8	50	39.27	6,480	142,884
Jassipurs	Site No -74	10.8	48.2	50	37	7,200	77,760
Kella Masrasa	Site No -75	21.6	78	50	37.85	5,400	116,843
Sarai Nagar	Site No -77	16.5	28.3	50	39.88	5,760	95,040
Total (c)		141.8	492.9			**57,240**	**883,823**
Kavi Nagar							
D-block No.1	Site No -79	16.1	37.8	50	46.4	7,920	127,512
Hathi park No.2	Site No -80	21.4	12	50	45.2	7,920	169,664
Tulsi park No.3	Site No -81	22.7	64.3	50	44.6	7,920	179,872
Pumping station No.14	Site No -83	23.4	77.7	50	39	7,920	184,932
Chiranjeevi vihar Tank No.1	Site No -84	21	54.9	50	49	7,920	166,267
Shani mandir pump No.2	Site No -85	20	44.1	50	50	8,280	165,683
Sec-1 park Chiranjeevi vihar No.3	Site No -86	21.2	103.9	50	27	8,280	175,904
C block No.1	Site No -87	20.6	20.8	50	40.2	8,280	170,292
A block park pump No.5	Site No -88	20.5	79.6	50	44.4	8,280	170,016
3A block pump No.6	Site No -89	24.6	62	50	45.2	8,280	203,504
1D block pump No.3	Site No -90	23.8	93.4	50	45	8,280	197,340
Govindpuram pump No.4	Site No -91	22.3	41	50	43.6	8,280	184,644
G-block pump No.2	Site No -92	29.9	83.3	50	47.1	8,280	247,217
C-block pump No.1	Site No -93	22.3	90.7	50	54.8	8,280	184,644
C-block pump No.2	Site No -94	26	61.5	50	56.6	7,200	187,440
Uttam public school No.3	Site No -95	30.6	71.1	50	58.2	7,920	242,616
D-block No.5	Site No -96	20	43.7	50	56.3	7,920	158,400
A-block pump No.4	Site No -98	21.1	33.7	50	55.7	7,920	166,848
Rajnagar No.1	Site No -99	21.5	70.3	50	55.4	7,920	170,016
Sector-11 pump No.11	Site No -101	24.3	30.5	50	51.8	7,920	192,456
GDA market No.3	Site No -102	22.3	73.5	50	53.1	7,920	176,880
Sector-8 pump No.7	Site No -103	20.8	38.6	50	50.6	7,920	164,472

Name of pumping station	Pump Reference	Power consumption (kW)	Flow rate (m^3/h)	Frequency (Hz)	Head (m)	Hours baseline (hours)	Baseline Energy Consumption (kWh)
Sector-6 pump No.2	Site No -104	21.5	33.5	50	51.8	7,920	170,016
Sector-9 pump No.9	Site No -105	18.5	33.5	50	49.8	7,920	146,520
F block tank compound	Site No -106	15.1	26.7	50	53.7	7,920	119,592
B-block No.4	Site No -107	17.4	32	50	56.5	7,920	137,808
Near forest dept. No.2	Site No -108	24.7	62.3	50	53.5	7,920	195,624
P-block No.7	Site No -109	26.1	32.2	50	58.7	7,920	206,712
L-block No.8	Site No -110	20.3	34.7	50	54.8	7,920	160,424
L-block No.10	Site No -111	19.6	47.3	50	52.8	7,200	141,040
G-block tank No.6	Site No -112	15.5	45.2	50	54.5	7,920	122,496
N-block pump No.3	Site No -113	27.1	44.4	50	58.6	7,920	214,406
loha mandi pump No.12	Site No -114	17.4	59.2	50	55.3	2,520	43,764
B-block park No.5	Site No -115	12.3	61.6	50	31	7,920	97,768
Ramlila maidan no.6	Site No -116	20.4	87.7	50	28.3	7,920	161,304
C-block nursery No.7	Site No -117	11.8	55.4	50	28.8	7,920	93,764
I-block park No.8	Site No -118	19.6	27	50	29.2	7,920	154,880
F-block park No.9	Site No -119	12.2	59.5	50	31.1	7,920	96,360
H-block tank No.10	Site No -120	22.3	114.8	50	29.1	7,920	176,528
Vivekanand nagar No.11	Site No -121	19.8	88.7	50	28.8	7,920	156,816
K-block No.7	Site No -122	18.3	88.5	50	27.6	7,920	144,584
Shastri nagar No.6	Site No -124	23.9	138.1	50	28.4	7,920	189,464
K-block No.5	Site No -125	13.7	34.5	50	28.6	7,920	108,328
RDC building	Site No -126	14.2	35.2	50	29.9	2,880	40,880
Dr.Mukherjee park	Site No -127	12.6	68	50	31.7	3,240	40,806
GDA market sector-7 pump No.8	Site No -128	20.2	115.9	50	28.6	4,320	87,408
P-block No.11	Not in list-1	24.9	58.4	50	56	7,920	197,472
Guldhar	Not in list-2	17.4	58.6	50	33.4	2,160	37,512
Total(D)		**983.2**	**2831.3**			**357,480**	**7,428,895**
Vijay Nagar							
C block Sec 9	Site No -134	22.4	68	50	59.4	7,920	177,408
Zonal Office	Site No -136	19.3	67.9	50	36.5	7,920	152,856

Name of pumping station	Pump Reference	Power consumption (kW)	Flow rate (m^3/h)	Frequency (Hz)	Head (m)	Hours baseline (hours)	Baseline Energy Consumption (kWh)
Mirza Pur No 2	Site No -138	20.6	53.4	50	61.8	2,880	59,328
Mirza Pur No 3	Site No -139	7.02	9.43	50	39.2	2,880	20,218
H block sec 12	Site No -142	22.9	86.5	50	39.3	2,880	65,952
D block sec 11	Site No -144	17.72	34.06	50	54.2	7,920	140,342
B block sec 11	Site No -145	18.6	36.67	50	54.7	7,920	147,312
E block sec 11 no -5	Site No -147	28.2	100.1	50	31.4	7,920	223,344
G block sec 11 pump No.3	Site No -148	23.1	36	50	32.2	7,920	182,952
F block sec 11	Site No -150	20.1	36.2	50	33.4	7,920	159,192
Awas Vikas Kashiram colony	Site No -151	24.74	90.9	50	57.6	7,920	195,941
Sudamapuri no 2	Site No -153	17.4	27.53	50	48.5	7,920	137,808
Sudamapuri no 3	Site No -154	22.37125	5.6	50	47.1	7,920	177,180
L block sec 9	Site No -157	23.87	90.6	50	41.7	7,920	189,050
H block sec 9 rosevally school	Site No -158	21.53	84.6	50	32.6	2,880	62,006
H block Kela Khada	Site No -161	21.8	82.9	50	38.9	7,920	172,656
R block sec 12	Site No -162	23.16	84.7	50	36.4	7,920	183,427
Sorvaday Nagr	Site No -163	20.2	28.2	50	39.3	2,880	58,176
A-block Sec 11	Site No -164	20.4	33.7	50	36.8	7,920	161,568
Dhara school	Site No -165	15.02	80.43	50	37.5	7,920	118,958
Total(E)		**410.43**	**1137.42**			**133,200**	**2,785,676**
Mohan Nagar							
Tilla More No 1	Site No -167	21.2	45.7	50	31.5	7,200	152,640
Tilla More No 2	Site No -168	12.43	44.8	50	51.7	7,200	89,496
Tilla More No 3	Site No -169	10.5	67.7	50	34	7,200	75,600
Tilla More No 11	Site No -174	15.4	55.9	50	32.8	7,920	121,968
Tilla More No 12	Site No -175	11.67	53.4	50	39.1	7,920	92,426
Tilla More No 14	Site No -177	15.5	29.6	50	31.1	7,920	122,760
Tilla More No 16	Site No -179	20.6	88.8	50	32.5	7,920	163,152
Tilla More No 17	Site No -180	23.5	142.3	50	31.6	7,920	186,120
Tilla More No 19	Site No -182	18.9	20.3	50	32.6	7,920	149,688
Sai upwan no 1	Site No -185	17.1	59.4	50	37.8	7,200	123,120

Name of pumping station	Pump Reference	Power consumption (kW)	Flow rate (m^3/h)	Frequency (Hz)	Head (m)	Hours baseline (hours)	Baseline Energy Consumption (kWh)
Sai upwan no 2	Site No -186	24.9	100.9	50	40.3	7,200	179,280
Sai upwan no 9	Site No -187	21.3	83.1	50	37.4	7,200	153,360
Sai upwan no 6	Site No -188	23.6	62.7	50	48.4	7,200	169,920
Sai upwan no 8	Site No -191	13.8	31.5	50	37.9	7,200	99,360
Kanha Upwan	Site No -192	25.44	105.7	50	25.9	7,560	192,326
Total(F)		**275.84**	**991.8**			**112,680**	**2,071,217**
Vasundhara							
Hindon No 4	Site No -195	15	34.7	50	33.4	70,200	70,200
Hindon No 9	Site No -198	17.5	103	50	30.88	81,900	81,900
Vasundhara sec 9/1	Site No -203	7.65	33.3	50	33.09	60,588	60,588
Vasundhara sec 9/2	Site No -204	8.11	39.1	50	32.95	64,231	64,231
Vasundhara sec 11	Site No -205	6.44	30	50	32.55	51,005	51,005
Vasundhara sec 15	Site No -207	14.3	66.4	50	43.71	113,256	113,256
Vaishali sec 3 no-1	Site No -213	22.6	105.1	50	34.61	65,088	65,088
Vaishali sec 3 no-2	Site No -213	18.67	55.8	50	34.02	53,770	53,770
Vaishali sec 3 no-3	Site No -213	23.4	117	50	32.6	67,392	67,392
Vaishali sec 5/5	Site No -215	12.21	35	50	63.74	43,956	43,956
Vaishali s**ec 6/8**	Site No -216	18.1	62.3	50	60.31	143,352	143,352
Vasundhara sec 5	Site No -219	18.9	84.67	50	33.69	54,432	54,432
Total(G)		**182.88**	**766.37**			**869,169.6**	**869,169.6**
Total (A+B+C+D+E+F+G)		**2947.84**					**19,135,598**

6 Energy Efficiency Measures

6.1 Summary of Energy Efficiency Measures

A summary of the proposed energy efficiency measures at Ghaziabad Pumping Station is provided in Table 49.

Table 49: Summary of energy efficiency measures for water pumping stations

Site No	Name of the station	EEM Measure	Present Energy consumption (kWh/y)	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings (Rs. Lakhs)	Payback Period (months)	Percentage of Energy saving
Site No -1	3rd A Pump no -6	Replacement with energy Efficient pumps	88,704	24,072.5	1.48	1.91	9	27.14
Site No -5	Ghanta Ghar taxi Stand		116,352	54,875.0	1.48	4.36	4	47.16
Site No -8	Ashok Nagar		119,808	20,992.0	1.55	1.67	11	17.52
Site No -9	Yashoda Hospital		137,088	50,303.1	1.52	4.00	5	36.69
Site No -11	Gandhi Park No-5		133,056	84,324.2	1.36	6.70	2	63.37
Site No -13	Dayanand Nagar N0.2		114,336	45,642.6	1.48	3.63	5	39.92
Site No -15	Kalkaghari Pump no 1		107,352	26,586.4	1.52	2.11	9	24.77
Site No -16	Balupura Pump		138,240	39,642.9	1.55	3.15	6	28.68
Site No -17	Maliwada Fire Brigade		108,864	32,053.5	1.52	2.55	7	29.44
Site No -18	Pranghari		77,220	35,239.0	1.36	2.80	6	45.63
Site No -22	Kamla Quarter		93,312	46,825.9	1.36	3.72	4	50.18
Site No -23	Laxhmi Vihar		82,656	28,376.3	1.47	2.26	8	34.33
Site No -24	2A Nehru Nagar		101,376	38,632.8	1.48	3.07	6	38.11
Site No-26	Sabhaghar Pump		94,464	47,042.9	1.36	3.74	4	49.80
Site No-27	Nehru Nagar No 2		110,592	30,917.5	1.52	2.46	7	27.96
Site No-28	Hind Park		110,592	37,555.4	1.48	2.99	6	33.96
Site No-30	Chandrapuri		127,872	94,756.0	1.21	7.53	2	74.10
Site No-31	Town Hall Pump no 1		87,552	19,131.9	1.48	1.52	12	21.85
Site NO-32	DC garg Pump		60,480	49,829.1	0.87	3.96	3	82.39
Site No-33	3B nehru Nagar		101,376	40,351.1	1.46	3.21	6	39.80

Site No	Name of the station	EEM Measure	Present Energy consumption (kWh/y)	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings (Rs. Lakhs)	Payback Period (months)	Percentage of Energy saving
Site No-35	Gandhi Nagar no 6	Replacement with energy Efficient pumps	98,784	51,639.0	1.47	4.11	4	52.27
Site No-37	Ram Nagar Teekona Park		143,424	97,171.9	1.36	7.73	2	67.75
Site No -38	Nand Gram C Block		84,240	38,460.1	1.48	3.06	5	45.66
Site No -40	C block Ramlila Garond		120,701	40,839.0	1.47	3.25	5	33.83
Site No -41	Nand Gram No 1		97,509	23,715.4	1.55	1.89	9	24.32
Site No -42	Nand Gram E block		48,960	29,514.4	1.21	2.35	6	60.28
Site No -43	Nand Gram F block		67,680	66,442.7	0.85	5.28	2	98.17
Site No -45	Lohia Nagar Pump no 2		148,104	80,985.2	1.47	6.44	3	54.68
Site No -46	Gandhi Park		181,368	47,172.8	1.55	3.75	5	26.01
Site No -47	Dina Ghari		131,472	62,784.7	1.47	4.99	3	47.76
Site No -48	G block Patel Nagar		209,880	84,597.0	1.52	6.73	3	40.31
Site No -49	Sanjay geeta Park		114,048	62,090.4	1.36	4.94	3	54.44
Site No -50	B block market		106,560	47,379.4	1.47	3.77	4	44.46
Site No -51	Patel Nagar B block		85,680	17,090.2	1.55	1.36	13	19.95
Site No -52	Patel Nagar D block Mother dairy		65,520	38,094.9	1.36	3.03	5	58.14
Site No -53	Banwari Nagar		58,320	35,649.8	1.21	2.83	5	61.13
Site No 55	L block patel nagar		75,168	19,554.8	1.48	1.55	11	26.01
Site No 56	Dhookna Katha		118,404	36,423.1	1.5	2.90	6	30.76
Site No -57	Dhookna Mandir		58,572	27,671.0	1.4	2.20	8	47.24
Site No -59	Bhonja		68,256	12,806.0	1.48	1.02	17	18.76
Site No -60	Lohia Nagar B ablock		143,280	54,100.1	1.48	4.30	4	37.76
Site No -61	lal Quarter No 1		85,320	27,189.9	1.52	2.16	8	31.87

Site No	Name of the station	EEM Measure	Present Energy consumption (kWh/y)	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings (Rs. Lakhs)	Payback Period (months)	Percentage of Energy saving
Site No -64	MMG Pump no -1		125,928	62,430.9	1.36	4.96	3	49.58
Site No -65	MMG Pump no 2		59,400	32,910.8	1	2.62	4	55.41
Site No -66	Model Town Park No-1		53,784	10,926.9	1.21	0.87	16	20.32
Site No -71	MB Girls Kela Kheda		160,704	34,444.8	1.55	2.74	6	21.43
Site No -72	Tar Factory		51,480	21,089.3	1.47	1.68	10	40.97
Site No -74	Jassipurs		77,760	17,469.2	1.47	1.39	12	22.47
Site No -75	Kella Masrasa	Replacement with energy Efficent pumps	116,843	44,477.6	1.45	3.54	8	38.07
Site No -77	Sarai Nagar		95,040	62,850.4	1.21	5.00	3	66.13
Site No -79	D-block No.1		127,512	61,228.7	1.47	4.87	3	48.02
Site No -80	Hathi park No.2		169,664	146,193.6	1	11.62	1	86.17
Site No -81	Tulsi park No.3		179,872	76,816.8	1.48	6.11	3	42.71
Site No -83	Pumping station No.14		184,932	75,941.6	1.52	6.04	3	41.06
Site No -84	Chiranjeevi vihar Tank No.1		166,267	69,472.6	1.48	5.52	3	41.78
Site No -85	Shani mandir pump No.2		165,683	81,558.2	1.48	6.48	3	49.23
Site No -86	Sec-1 park Chiranjeevi vihar No.3		175,904	70,467.7	1.48	5.60	3	40.06
Site No -87	C block No.1		170,292	133,933.5	1.07	10.65	1	78.65
Site No -88	A block park pump No.5		170,016	37,071.3	1.52	2.95	6	21.80
Site No -89	3A block pump No.6		203,504	98,047.5	1.48	7.79	2	48.18
Site No -90	1D block pump No.3		197,340	41,967.8	1.55	3.34	5	21.27
Site No -91	Govindpuram pump No.4		184,644	115,226.0	1.47	9.16	2	62.40
Site No -92	G-block pump No.2		247,217	102,098.5	1.55	8.12	2	41.30
Site No -94	C-block pump		187,440	73,730.4	1.52	5.86	3	39.34

Site No	Name of the station	EEM Measure	Present Energy consumption (kWh/y)	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings (Rs. Lakhs)	Payback Period (months)	Percentage of Energy saving
	No.2							
Site No -95	Uttam public school No.3		242,616	93,778.7	1.55	7.46	2	38.65
Site No -96	D-block No.5	Replacement with energy Efficent pumps	158,400	68,512.6	1.48	5.45	3	43.25
Site No -98	A-block pump No.4		166,848	97,052.7	1.47	7.72	2	58.17
Site No -99	Rajnagar No.1		170,016	30,066.4	1.55	2.39	7	17.68
Site No -101	Sector-11 pump No.11		192,456	132,613.5	1.36	10.54	1	68.91
Site No -102	GDA market No.3		176,880	38,945.1	1.55	3.10	6	22.02
Site No -103	Sector-8 pump No.7		164,472	91,779.0	1.47	7.30	2	55.80
Site No -104	Sector-6 pump No.2		170,016	105,398.7	1.44	8.38	2	61.99
Site No -105	Sector-9 pump No.9		146,520	83,321.6	1.36	6.62	2	56.87
Site No -106	F block tank compound		119,592	65,377.1	1.36	5.20	3	54.67
Site No -107	B-block No.4		137,808	70,552.0	1.47	5.61	3	51.20
Site No -108	Near forest dept. No.2		195,624	75,766.8	1.52	6.02	3	38.73
Site No -109	P-block No.7		206,712	136,460.3	1.47	10.85	2	66.01
Site No -110	L-block No.8		160,424	89,667.3	1.47	7.13	2	55.89
Site No -111	L-block No.10		141,040	59,493.1	1.48	4.73	4	42.18
Site No -112	G-block tank No.6		122,496	33,960.3	1.48	2.70	8	27.72
Site No -113	N-block pump No.3		214,406	120,964.3	1.48	9.62	2	56.42
Site No -115	B-block park No.5		97,768	26,764.1	1.47	2.13	8	27.38
Site No -116	Ramlila maidan no.6		161,304	72,033.8	1.48	5.73	3	44.66
Site No -117	C-block nursery No.7		93,764	33,425.2	1.36	2.66	6	35.65
Site No -118	I-block park No.8		154,880	122,146.3	1.07	9.71	1	78.87
Site No -119	F-block park No.9		96,360	27,598.2	1.47	2.19	8	28.64
Site No -120	H-block tank		176,528	56,535.7	1.52	4.49	4	32.03

Site No	Name of the station	EEM Measure	Present Energy consumption (kWh/y)	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings (Rs. Lakhs)	Payback Period (months)	Percentage of Energy saving
	No.10	Replacement with energy Efficent pumps						
Site No -121	Vivekanand nagar No.11		156,816	65,086.7	1.48	5.17	3	41.51
Site No -122	K-block No.7		144,584	56,656.0	1.48	4.50	4	39.19
Site No -124	Shastri nagar No.6		189,464	50,747.1	1.55	4.03	4	26.78
Site No -125	K-block No.5		108,328	69,019.5	1.21	5.49	2	63.71
Site No -126	RDC building		40,880	25,885.6	1.21	2.06	7	63.32
Site No -127	Dr.Mukherjee park		40,806	8,560.3	1.48	0.68	25	20.98
Site No -128	GDA market sector-7 pump No.8		87,408	22,486.2	1.52	1.79	10	25.73
Not in list	P-block No.11		197,472	79,753.9	1.52	6.34	3	40.39
Not in list	Guldhar		37,512	17,648.9	1.47	1.40	12	47.05
Site No -134	C block Sec 9		177,408	34,692.0	1.55	2.76	6	19.55
Site No -136	Zonal Office		152,856	63,654.9	1.48	5.06	3	41.64
Site No -138	Mirza Pur No 2		59,328	16,203.3	1.52	1.29	13	27.31
Site No -139	Mirza Pur No 3		20,218	14,182.9	1	1.13	9	70.15
Site No -142	H block sec 12		65,952	21,463.0	1.52	1.71	10	32.54
Site No -144	D block sec 11		140,342	71,706.0	1.47	5.70	3	51.09
Site No -145	B block sec 11		147,312	72,782.2	1.47	5.79	3	49.41
Site No -147	E block sec 11 no -5		223,344	102,344.0	1.52	8.32	2	45.82
Site No -148	G block sec 11 pump No.3		182,952	137,488.4	1.21	10.93	1	75.15
Site No -150	F block sec 11		159,192	111,834.2	1.21	8.89	2	70.25
Site No -153	Sudamapuri no 2		137,808	86,340.6	1.21	6.86	2	62.65
Site No -154	Sudamapuri no 3		177,180	164,941.4	1	13.11	1	93.09
Site No -157	L block sec 9		189,050	55,344.2	1.52	4.40	4	29.27
Site No -158	H block sec 9 rosevally school		62,006	25,972.2	1.48	2.06	8	41.89
Site No -161	H block Kela Khada		172,656	56,655.9	1.52	4.50	4	32.81
Site No -162	R block sec 12		183,427	74,397.6	1.52	5.91	3	40.56
Site No -163	Sorvaday Nagr		58,176	42,376.5	1.21	3.37	4	72.84
Site No -164	A-block Sec 11		161,568	112,873.2	1.21	8.97	2	69.86

Site No	Name of the station	EEM Measure	Present Energy consumption (kWh/y)	Saving (kWh/y)	Investment Cost (Rs. Lakhs)	Monetary Cost savings (Rs. Lakhs)	Payback Period (months)	Percentage of Energy saving
Site No -167	Tilla More No 1		152,640.0	102,003.6	1.31	8.14	2	66.83
Site No -174	Tilla More No 11		121,968.0	53,245.9	1.43	4.24	4	43.66
Site No -175	Tilla More No 12		92,426.4	13,463.3	1.44	1.14	15	14.57
Site No -177	Tilla More No 14		122,760.0	85,112.9	1.16	6.81	2	69.33
Site No -179	Tilla More No 16	Replacement with energy Efficent pumps	163,152.0	57,573.6	1.44	4.60	4	35.29
Site No -182	Tilla More No 19		149,688.0	120,380.0	1	9.65	1	80.42
Site No -185	Sai upwan no 1		123,120.0	47,347.3	1.44	3.82	4	38.46
Site No -186	Sai upwan no 2		179,280.0	48,318.6	1.51	3.85	4	26.95
Site No -187	Sai upwan no 9		153,360.0	50,756.3	1.48	4.47	4	33.10
Site No -188	Sai upwan no 6		169,920.0	70,691.5	1.52	5.66	3	41.60
Site No -191	Sai upwan no 8		99,360.0	56,008.8	1.21	4.51	3	56.37
Site No -192	Kanha Upwan		192,326.4	97,757.8	1.41	7.79	2	50.83
Site No -195	Hindon No 4		70,200	43,245.0	1.61	3.44	4	61.60
Site No -198	Hindon No 9		81,900	13,517.4	1.48	1.07	16	16.50
Site No -203	Vasundhara sec 9/1		60,588	16,695.9	1.16	1.33	10	27.56
Site No -204	Vasundhara sec 9/2		64,231	13,050.7	1.16	1.04	13	20.32
Site No -205	Vasundhara sec 11		51,005	12,203.5	1.21	0.97	14	23.93
Site No -213	Vaishali sec 3 no-1		65,088	17,979.1	1.52	1.43	12	27.62
Site No -213	Vaishali sec 3 no-2		53,770	28,136.8	1.55	2.24	13	52.33
Site No -213	Vaishali sec 3 no-3		67,392	16,938.9	1.51	1.35	1.12	25.13
Site No -215	Vaishali sec 5/5		43,956	7,697.1	1.48	0.61	27	17.51
Site No -219	Vasundhara sec 5		54,432	16,330.4	1.52	1.30	13	30.00
Total			**17,167,306**	**7,700,640**	**192.27**	**612.2**	**4**	

6.2 Detailed Energy Efficiency Measures at Ghaziabad Municipal Corporation

Opportunities of energy saving identified at Ghaziabad are provided in Table No 50 -78

Table 50: Cost benefit analysis for replacement of pumps city 1 pumps (I)

Rated Parameters	UOM	Site No -1 3rd A Pump no -6	Site No -5 Ghanta Ghar taxi Stand	Site No -8 Ashok Nagar	Site No -9 Yashoda Hospital	Site No -11 Gandhi Park No-5
Flow of the pump	m^3/h	60	60	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	15	15	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	63.6	38	85	77	42
Head of the pump	m	38.9	58.5	45.2	43.2	41.9
Power of the motor	kW	15.4	20	21	24	23
Calculated efficiency of pump set	%	43.7	30.1	50.3	38.0	20.9
Proposed Parameters[3]						
Flow of the pump	m^3/h	63.60	38.20	85.10	76.80	42.30
Head of the pump	m	38.87	58.48	45.16	43.22	41.86
Power of the motor on exiting duty point	kW	11.22	10.67	17.16	15.07	8.46
Proposed Efficiency of pump set on exiting duty point	%	0.60	0.57	0.61	0.60	0.57
Operating hours of the pump	h/y	5760.00	5760.00	5760.00	5760.00	5760.00
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Annual energy saving	kWh/y	24072.54	54874.95	20992.02	50303.13	84324.21
Annual cost saving	Rs. Lakh	1.91	4.36	1.67	4.00	6.70
Investment of new pump set (with Installation)	Rs. Lakh	1.00	1.00	1.07	1.05	0.89
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.48	1.48	1.55	1.52	1.36

[3] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 51: Cost benefit analysis for replacement of city -1 pumps-(II)

Rated Parameters	UOM	Site No -13 Dayanand Nagar N0.2	Site No -15 Kalkaghari Pump no 1	Site No -16 Balupura Pump	Site No -17 Maliwada Fire Brigade	Site No -18 Pranghari
Flow of the pump	m^3/h	56	60	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	15
Measured Parameters						
Flow of the pump	m^3/h	64	86	85	86	41
Head of the pump	m	41.2	40.9	45.1	39.2	39.7
Power of the motor	kW	20	21	24	22	14
Present Specific Power Consumption	kWh/m^3	0.31	0.25	0.28	0.25	0.35
Calculated efficiency of pump set	%	36.0	45.1	43.5	42.3	31.0
Proposed Parameters[4]						
Flow of the pump	m^3/h	63.80	86.40	85.10	85.62	41.00
Head of the pump	m	41.18	40.86	45.06	39.22	39.69
Power of the motor on exiting duty point	kW	11.93	16.02	17.12	15.24	7.77
Proposed Efficiency of pump set on exiting duty point	%	0.60	0.60	0.61	0.60	0.57
Proposed Specific energy consumption	kWh/m^3	0.19	0.19	0.20	0.18	0.19
Operating hours of the pump	h/y	5760.00	5040.00	5760.00	5040.00	5400.00
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Annual energy saving	kWh/y	45642.63	26586.44	39642.86	32053.53	35239.04
Annual cost saving	Rs. Lakh	3.63	2.11	3.15	2.55	2.80
Investment of new pump set (with Installation)	Rs. Lakh	1.00	1.05	1.07	1.05	0.89
Investment of NRV replacement	Rs. Lakh	0.18	0.17	0.17	0.17	0.17
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.48	1.52	1.55	1.52	1.36

[4] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 52: Cost benefit analysis for replacement of city -1 pumps – (III)

Rated Parameters	UOM	Site No -22 Kamla Quarter	Site No -23 Laxhmi Vihar	Site No -24 2A Nehru Nagar	Site No-26 Sabhaghar Pump	Site No-27 Nehru Nagar No 2
Flow of the pump	m^3/h	31	60	60	60	60
Head of the pump	m	45	63	63	63	63
Power of the motor	kW	19	15	19	15	23
Measured Parameters						
Flow of the pump	m^3/h	43	49	56	42	74
Head of the pump	m	39.2	41.4	42.2	40.9	41.1
Power of the motor	kW	16	14	18	16	19
Present Specific Power Consumption	kWh/m^3	0.38	0.30	0.31	0.39	0.26
Calculated efficiency of pump set	%	28.4	38.1	36.5	28.6	43.2
Proposed Parameters[5]						
Flow of the pump	m^3/h	43.10	48.50	55.90	42.10	74.20
Head of the pump	m	39.19	41.38	42.22	40.93	41.07
Power of the motor on exiting duty point	kW	8.07	9.42	10.89	8.23	13.83
Proposed Efficiency of pump set on exiting duty point	%	0.57	0.58	0.59	0.57	0.60
Proposed Specific energy consumption	kWh/m^3	0.19	0.19	0.19	0.20	0.19
Operating hours of the pump	h/y	5760.00	5760.00	5760.00	5760.00	5760.00
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Annual energy saving	kWh/y	46825.90	28376.28	38632.81	47042.86	30917.53
Annual cost saving	Rs. Lakh	3.72	2.26	3.07	3.74	2.46
Investment of new pump set (with Installation)	Rs. Lakh	0.89	0.99	1.00	0.89	1.05
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.36	1.47	1.48	1.36	1.52

[5] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 53: Cost benefit analysis for replacement of city- 1 pumps – IV

Rated Parameters		Site No-28 Hind Park	Site No-30 Chandrapuri	Site No-31 Town Hall Pump no 1	Site NO-32 DC garg Pump	Site No-33 3B nehru Nagar
Flow of the pump	m^3/h	60	56	60	31	60
Head of the pump	m	63	63	63	45	63
Power of the motor	kW	19	23	15	8	19
Measured Parameters						
Flow of the pump	m^3/h	67	30	61	12	54
Head of the pump	m	41.9	38.7	43.0	27.6	42.8
Power of the motor	kW	19	22	15	11	18
Present Specific Power Consumption	kWh/m^3	0.29	0.74	0.25	0.89	0.33
Calculated efficiency of pump set	%	39.6	14.2	46.9	8.4	35.5
Proposed Parameters[6]						
Flow of the pump	m^3/h	66.70	30.00	60.80	11.80	53.60
Head of the pump	m	41.88	38.70	43.04	27.62	42.82
Power of the motor on exiting duty point	kW	12.68	5.75	11.88	1.85	10.59
Proposed Efficiency of pump set on exiting duty point	%	0.60	0.55	0.60	0.48	0.59
Proposed Specific energy consumption	kWh/m^3	0.19	0.19	0.20	0.16	0.20
Operating hours of the pump	h/y	5760.00	5760.00	5760.00	5760.00	5760.00
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Annual energy saving	kWh/y	37555.40	94756.01	19131.88	49829.10	40351.08
Annual cost saving	Rs. Lakh	2.99	7.53	1.52	3.96	3.21
Investment of new pump set (with Installation)	Rs. Lakh	1.00	0.74	1.00	0.40	1.00
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.48	1.21	1.48	0.87	1.48

[6] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 54: Cost benefit analysis for replacement of city- 1 pumps – V

Rated Parameters		Site No-35 Gandhi Nagar no 6	Site No-37 Ram Nagar Teekona Park
Flow of the pump	m^3/h	60	60
Head of the pump	m	63	63
Power of the motor	kW	23	23
Measured Parameters			
Flow of the pump	m^3/h	43	64
Head of the pump	m	40.7	26.3
Power of the motor	kW	17	25
Present Specific Power Consumption	kWh/m^3	0.40	0.39
Calculated efficiency of pump set	%	27.7	18.4
Proposed Parameters[7]			
Flow of the pump	m^3/h	42.80	63.90
Head of the pump	m	40.73	26.30
Power of the motor on exiting duty point	kW	8.18	8.03
Proposed Efficiency of pump set on exiting duty point	%	58%	57%
Proposed Specific energy consumption	kWh/m^3	0.19	0.13
Operating hours of the pump	h/y	5760	5760
Electricity Tariff	Rs./kWh	7.95	7.95
Annual energy saving	kWh/y	51638.97	97171.95
Annual cost saving	Rs. Lakh	4.11	7.73
Investment of new pump set (with Installation)	Rs. Lakh	0.99	0.89
Investment of NRV replacement	Rs. Lakh	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22
Total Investment	Rs. Lakh	1.47	1.36

[7] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 55: Cost benefit analysis for replacement of city- 2 pumps – (I)

Rated Parameters	UOM	Site No -38 Nand Gram C Block	Site No -40 C block Ramlila Garond	Site No -41 Nand Gram No 1	Site No -42 Nand Gram E block	Site No -43 Nand Gram F block
Flow of the pump	m^3/h	60	53	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	19	15	22	15	22
Measured Parameters						
Flow of the pump	m^3/h	94	78	109	37	5
Head of the pump	m	24.4	25.1	34.7	29.7	15.6
Power of the motor	kW	20	14	23	14	24
Present Specific Power Consumption	kWh/m^3	0.21	0.18	0.21	0.37	5.16
Calculated efficiency of pump set	%	32.1	38.4	45.4	21.8	0.8
Proposed Parameters[8]						
Flow of the pump	m^3/h	94	78	109	37	5
Head of the pump	m	24.4	25.1	34.7	29.7	15.6
Power of the motor on exiting duty point	kW	10.6	9.2	17.1	5.4	0.4
Proposed Efficiency of pump set on exiting duty point	%	59.00%	58.00%	60.00%	55.00%	45.00%
Proposed Specific energy consumption	kWh/m^3	0.112	0.118	0.157	0.147	0.094
Operating hours of the pump	h/y	4,320.0	8,640.0	4,320.0	3,600.0	2,880.0
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	38,460.11	40,838.96	23,715.41	29,514.43	66,442.70
Total Monetary Savings	Rs. Lakh	3.06	3.25	1.89	2.35	5.28
Investment of new pump set (with Installation)	Rs. Lakh	1.00	0.99	1.07	0.74	0.37
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve	Rs. Lakh	0.22	0.22	0.22	0.22	0.22

[8] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -38 Nand Gram C Block	Site No -40 C block Ramlila Garond	Site No -41 Nand Gram No 1	Site No -42 Nand Gram E block	Site No -43 Nand Gram F block
replacement						
Total Investment	Rs. Lakh	1.48	1.47	1.55	1.21	0.85

Table 56: Cost benefit analysis for replacement of city- 2 pumps – (II)

Rated Parameters	UOM	Site No -45 Lohia Nagar Pump no 2	Site No -46 Gandhi Park	Site No -47 Dina Ghari	Site No -48 G block Patel Nagar	Site No -49 Sanjay geeta Park
Flow of the pump	m^3/h	56	53	60	56	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	15
Measured Parameters						
Flow of the pump	m^3/h	53	63	30	63	24
Head of the pump	m	34.1	59.0	62.4	55.6	57.9
Power of the motor	kW	19	23	17	27	14
Present Specific Power Consumption	kWh/m^3	0.35	0.36	0.56	0.42	0.61
Calculated efficiency of pump set	%	26.3	44.4	30.3	35.8	26.0
Proposed Parameters[9]						
Flow of the pump	m^3/h	53	63	30	63	24
Head of the pump	m	34.1	59.0	62.4	55.6	57.9
Power of the motor on exiting duty point	kW	8.5	16.9	8.7	15.8	6.6
Proposed Efficiency of pump set on exiting duty point	%	58.00%	60.00%	58.00%	60.00%	57.00%
Proposed Specific energy consumption	kWh/m^3	0.160	0.268	0.293	0.252	0.277
Operating hours of the pump	h/y	7,920.0	7,920.0	7,920.0	7,920.0	7,920.0
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	80,985.17	47,172.82	62,784.74	84,596.96	62,090.41

[9] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -45 Lohia Nagar Pump no 2	Site No -46 Gandhi Park	Site No -47 Dina Ghari	Site No -48 G block Patel Nagar	Site No -49 Sanjay geeta Park
Total Monetary Savings	Rs. Lakh	6.44	3.75	4.99	6.73	4.94
Investment of new pump set (with Installation)	Rs. Lakh	0.99	1.07	0.99	1.05	0.89
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.47	1.55	1.47	1.52	1.36

Table 57: Cost Benefit analysis for replacement of city- 2 pumps – (III)

Rated Parameters	UOM	Site No -50 B block market	Site No -51 Patel Nagar B block	Site No -52 Patel Nagar D block Mother dairy	Site No -53 Banwari Nagar	Site No 55 L block patel nagar
Flow of the pump	m^3/h	56	60	60	53	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	15	15
Measured Parameters						
Flow of the pump	m^3/h	32	100	49	49	78
Head of the pump	m	55.4	42.7	32.9	25.8	36.6
Power of the motor	kW	15	24	18	16	17
Present Specific Power Consumption	kWh/m^3	0.47	0.24	0.38	0.33	0.22
Calculated efficiency of pump set	%	32.2	48.8	23.8	21.4	44.4
Proposed Parameters[10]						
Flow of the pump	m^3/h	32	100	49	49	78
Head of the pump	m	55.4	42.7	32.9	25.8	36.6
Power of the motor on exiting duty point	kW	8.2	19.1	7.6	6.3	12.9
Proposed Efficiency of pump set on exiting duty point	%	58.00%	61.00%	57.00%	55.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.260	0.191	0.157	0.128	0.166

[10] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -50 B block market	Site No -51 Patel Nagar B block	Site No -52 Patel Nagar D block Mother dairy	Site No -53 Banwari Nagar	Site No 55 L block patel nagar
Operating hours of the pump	h/y	7,200.0	3,600.0	3,600.0	3,600.0	4,320.0
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	47,379.40	17,090.22	38,094.89	35,649.84	19,554.76
Total Monetary Savings	Rs. Lakh	3.77	1.36	3.03	2.83	1.55
Investment of new pump set (with Installation)	Rs. Lakh	0.99	1.07	0.89	0.74	1.00
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.43	1.51	1.33	1.19	1.44

Table 58: Cost benefit analysis for replacement of city- 2 pumps – (IV)

Rated Parameters	UOM	Site No 56 Dhookna Katha	Site No -57 Dhookna Mandir	Site No -59 Bhonja	Site No -60 Lohia Nagar B ablock	Site No -61 lal Quarter No 1
Flow of the pump	m^3/h	56	60	60	60	56
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	19	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	118	70	84	67	103
Head of the pump	m	33.3	26.2	33.6	40.5	35.0
Power of the motor	kW	25	16	16	20	24
Present Specific Power Consumption	kWh/m^3	0.21	0.23	0.19	0.30	0.23
Calculated efficiency of pump set	%	42.2	30.6	48.7	37.3	41.5
Proposed Parameters[11]						
Flow of the pump	m^3/h	118	70	84	67	103
Head of the pump	m	33.3	26.2	33.6	40.5	35.0
Power of the motor on exiting	kW	17.5	8.6	12.8	12.4	16.1

[11] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No 56 Dhookna Katha	Site No -57 Dhookna Mandir	Site No -59 Bhonja	Site No -60 Lohia Nagar B ablock	Site No -61 lal Quarter No 1
duty point						
Proposed Efficiency of pump set on exiting duty point	%	61.00%	58.00%	60.00%	60.00%	61.00%
Proposed Specific energy consumption	kWh/m^3	0.149	0.123	0.152	0.184	0.156
Operating hours of the pump	h/y	4,680.0	3,600.0	4,320.0	7,200.0	3,600.0
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	36,423.13	27,670.98	12,806.03	54,100.07	27,189.87
Total Monetary Savings	Rs. Lakh	2.90	2.20	1.02	4.30	2.16
Investment of new pump set (with Installation)	Rs. Lakh	1.07	0.99	1.00	1.00	1.05
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.55	1.47	1.48	1.48	1.52

Table 59: Cost Benefit analysis for replacement of city- 3 pumps – I

Rated Parameters	UOM	Site No -64 MMG Pump no -1	Site No -65 MMG Pump no 2	Site No -66 Model Town Park No-1	Site No -71 MB Girls Kela Kheda	Site No -72 Tar Factory
Flow of the pump	m^3/h	60	60	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	15	8	8	22	15
Measured Parameters						
Flow of the pump	m^3/h	27	10	34	108	46
Head of the pump	m	63.3	63.3	38.8	40.4	39.1
Power of the motor	kW	16	8	8	25	14
Present Specific Power Consumption	kWh/m^3	0.60	0.77	0.24	0.23	0.31
Calculated efficiency of pump set	%	28.7	22.3	43.8	47.9	34.2
Proposed Parameters[12]						
Flow of the pump	m^3/h	26.5	9.7	34.4	108	46
Head of the pump	m	63.3	63.3	38.8	40.4	39.1
Power of the motor on exiting duty point	kW	8.0	3.3	6.6	19.5	8.4
Proposed Efficiency of pump set on exiting duty point	%	57.00%	50.00%	55.00%	61.00%	58.00%
Proposed Specific energy consumption	kWh/m^3	0.303	0.345	0.192	0.180	0.184
Operating hours of the pump	h/y	7,920	7,920	6,480	6,480	3,600
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of SEC	kWh/y	62,431	32,911	10,927	34,445	21,089
Energy saving in terms of reduction of power consumption	kWh/y	62,431	32,911	10,927	34,445	21,089
Total Monetary Savings	Rs. Lakh	5.0	2.6	0.9	2.7	1.7
Investment of new pump set	Rs. Lakh	0.89	0.52	0.74	1.07	0.99
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve	Rs. Lakh	0.22	0.22	0.22	0.22	0.22

[12] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -64 MMG Pump no -1	Site No -65 MMG Pump no 2	Site No -66 Model Town Park No-1	Site No -71 MB Girls Kela Kheda	Site No -72 Tar Factory
replacement						
Total Investment	Rs. Lakh	1.36	0.99	1.2	1.5	1.5

Table 60: Cost benefit analysis for replacement of city- 3 pumps (II)

Rated Parameters	UOM	Site No -74 Jassipurs	Site No -75 Kella Masrasa	Site No -77 Sarai Nagar
Flow of the pump	m^3/h	60	60	60
Head of the pump	m	63	63	63
Power of the motor	kW	23	22	22
Measured Parameters				
Flow of the pump	m^3/h	48	78	28
Head of the pump	m	37.0	37.9	39.9
Power of the motor	kW	11	22	17
Present Specific Power Consumption	kWh/m^3	0.22	0.28	0.58
Calculated efficiency of pump set	%	45.0	37.1	18.6
Proposed Parameters[13]				
Flow of the pump	m^3/h	48.2	78	28.3
Head of the pump	m	37.0	37.9	39.9
Power of the motor on exiting duty point	kW	8.4	13.4	5.6
Proposed Efficiency of pump set on exiting duty point	%	58.00%	60.00%	55.00%
Proposed Specific energy consumption	kWh/m^3	0.174	0.172	0.197
Operating hours of the pump	h/y	7,200	5,400	5,760
Electricity Tariff	Rs./kWh	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	17,469	44,478	62,850
Total Monetary Savings	Rs. Lakh	1.4	3.5	5.0
Investment of new pump set	Rs. Lakh	0.99	1.00	0.74
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.47	1.48	1.21

[13] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 61: Cost benefit analysis for replacement of Kavi nagar pumps – I

Rated Parameters	UOM	Site No -79 D-block No.1	Site No -80 Hathi park No.2	Site No -81 Tulsi park No.3	Site No -83 Pumping station No.14	Site No -84 Chiranjeevi vihar Tank No.1
Flow of the pump	m^3/h	60	60	60	60	53
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	38	12	64	78	55
Head of the pump	m	46.4	45.2	44.6	39.0	49.0
Power of the motor	kW	16	21	23	23	21
Present Specific Power Consumption	kWh/m^3	0.43	1.78	0.35	0.30	0.38
Calculated efficiency of pump set	%	29.6	6.9	34.4	35.3	34.9
Proposed Parameters[14]						
Flow of the pump	m^3/h	37.8	12.0	64.3	77.7	54.9
Head of the pump	m	46.4	45.2	44.6	39.0	49.0
Power of the motor on exiting duty point	kW	8.4	3.0	13.0	13.8	12.2
Proposed Efficiency of pump set on exiting duty point	%	57.00%	50.00%	60.00%	60.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.22	0.25	0.20	0.18	0.22
Operating hours of the pump	h/y	7,920	7,920	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	61,229	146,194	76,817	75,942	69,473
Total Monetary Savings	Rs. Lakh	4.9	11.6	6.1	6.0	5.5
Investment of new pump set	Rs. Lakh	0.99	0.52	1.00	1.05	1.00
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.47	1.00	1.48	1.52	1.48

[14] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 62: Cost benefit analysis for replacement of Kavi nagar pumps – II

Rated Parameters	UOM	Site No -85 Shani mandir pump No.2	Site No -86 Sec-1 park Chiranjeevi vihar No.3	Site No -87 C block No.1	Site No -88 A block park pump No.5	Site No -89 3A block pump No.6
Flow of the pump	m^3/h	53	53	53	53	53
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	44	104	21	80	62
Head of the pump	m	50.0	27.0	40.2	44.4	45.2
Power of the motor	kW	20	21	21	21	25
Present Specific Power Consumption	kWh/m^3	0.45	0.20	0.99	0.26	0.40
Calculated efficiency of pump set	%	29.9	35.9	11.1	46.9	31.1
Proposed Parameters[15]						
Flow of the pump	m^3/h	44.1	103.9	20.8	79.6	62.0
Head of the pump	m	50.0	27.0	40.2	44.4	45.2
Power of the motor on exiting duty point	kW	10.2	12.7	4.4	16.1	12.7
Proposed Efficiency of pump set on exiting duty point	%	59.00%	60.00%	52.00%	60.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.23	0.12	0.21	0.20	0.21
Operating hours of the pump	h/y	8,280	8,280	8,280	8,280	8,280
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	81,558	70,468	133,934	37,071	98,047
Total Monetary Savings	Rs. Lakh	6.5	5.6	10.6	2.9	7.8
Investment of new pump set	Rs. Lakh	1.00	1.00	0.61	1.05	1.00
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.48	1.48	1.09	1.52	1.48

[15] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 63: Cost Benefit analysis for replacement of Kavi nagar pumps –III

Rated Parameters	UOM	Site No -90 1D block pump No.3	Site No -91 Govindpuram pump No.4	Site No -92 G-block pump No.2	Site No -94 C-block pump No.2	Site No -95 Uttam public school No.3
Flow of the pump	m^3/h	53	53	60	53	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	93	41	83	62	71
Head of the pump	m	45.0	43.6	47.1	56.6	58.2
Power of the motor	kW	24	22	30	26	31
Present Specific Power Consumption	kWh/m^3	0.26	0.54	0.36	0.42	0.43
Calculated efficiency of pump set	%	48.0	21.8	35.8	36.4	36.8
Proposed Parameters[16]						
Flow of the pump	m^3/h	93.4	41.0	83.3	61.5	71.1
Head of the pump	m	45.0	43.6	47.1	56.6	58.2
Power of the motor on exiting duty point	kW	18.8	8.4	17.5	15.8	18.8
Proposed Efficiency of pump set on exiting duty point	%	61.00%	58.00%	61.00%	60.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.20	0.20	0.21	0.26	0.26
Operating hours of the pump	h/y	8,280	8,280	8,280	7,200	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	41,968	115,226	102,098	73,730	93,779
Total Monetary Savings	Rs. Lakh	3.3	9.2	8.1	5.9	7.5
Investment of new pump set	Rs. Lakh	1.07	0.99	1.07	1.05	1.07
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.55	1.47	1.55	1.52	1.55

[16] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 64: Cost benefit analysis for replacement of Kavi nagar pumps –IV

Rated Parameters	UOM	Site No -96 D-block No.5	Site No -98 A-block pump No.4	Site No -99 Rajnagar No.1	Site No -101 Sector-11 pump No.11	Site No -102 GDA market No.3
Flow of the pump	m^3/h	60	60	53	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Status of the pump Set	Operation	Operation	Operation	Operation	Operation	Operation
Measured Parameters						
Flow of the pump	m^3/h	44	34	70	31	74
Head of the pump	m	56.3	55.7	55.4	51.8	53.1
Power of the motor	kW	20	21	21	24	22
Present Specific Power Consumption	kWh/m^3	0.46	0.63	0.31	0.80	0.30
Calculated efficiency of pump set	%	33.5	24.3	49.4	17.7	47.6
Proposed Parameters[17]						
Flow of the pump	m^3/h	43.7	33.7	70.3	30.5	73.5
Head of the pump	m	56.3	55.7	55.4	51.8	53.1
Power of the motor on exiting duty point	kW	11.3	8.8	17.7	7.6	17.4
Proposed Efficiency of pump set on exiting duty point	%	59.00%	58.00%	60.00%	57.00%	61.00%
Proposed Specific energy consumption	kWh/m^3	0.26	0.26	0.25	0.25	0.24
Operating hours of the pump	h/y	7,920	7,920	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	68,513	97,053	30,066	132,614	38,945
Total Monetary Savings	Rs. Lakh	5.4	7.7	2.4	10.5	3.1
Investment of new pump set	Rs. Lakh	1.00	0.99	1.07	0.89	1.07
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08

[17] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -96 D-block No.5	Site No -98 A-block pump No.4	Site No -99 Rajnagar No.1	Site No -101 Sector-11 pump No.11	Site No -102 GDA market No.3
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.48	1.47	1.55	1.36	1.55

Table 65: Cost Benefit analysis for replacement of Kavi nagar pumps –V

Rated Parameters	UOM	Site No -103 Sector-8 pump No.7	Site No -104 Sector-6 pump No.2	Site No -105 Sector-9 pump No.9	Site No -106 F block tank compound	Site No -107 B-block No.4
Flow of the pump	m^3/h	60	60	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	19
Measured Parameters						
Flow of the pump	m^3/h	39	34	34	27	32
Head of the pump	m	50.6	51.8	49.8	53.7	56.5
Power of the motor	kW	21	21	19	15	17
Present Specific Power Consumption	kWh/m^3	0.54	0.64	0.55	0.57	0.54
Calculated efficiency of pump set	%	25.6	22.0	24.6	25.8	28.3
Proposed Parameters[18]						
Flow of the pump	m^3/h	38.6	33.5	33.5	26.7	32.0
Head of the pump	m	50.6	51.8	49.8	53.7	56.5
Power of the motor on exiting duty point	kW	9.2	8.2	8.0	6.8	8.5
Proposed Efficiency of pump set on exiting duty point	%	58.00%	58.00%	57.00%	57.00%	58.00%
Proposed Specific energy consumption	kWh/m^3	0.24	0.24	0.24	0.26	0.27
Operating hours of the pump	h/y	7,920	7,920	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	91,779	105,399	83,322	65,377	70,552

[18] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -103 Sector-8 pump No.7	Site No -104 Sector-6 pump No.2	Site No -105 Sector-9 pump No.9	Site No -106 F block tank compound	Site No -107 B-block No.4
Total Monetary Savings	Rs. Lakh	7.3	8.4	6.6	5.2	5.6
Investment of new pump set	Rs. Lakh	0.99	0.99	0.89	0.89	0.99
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.47	1.47	1.36	1.36	1.47

Table 66: Cost benefit analysis for replacement of Kavi nagar pumps –VI

Rated Parameters	UOM	Site No -108 Near forest dept. No.2	Site No -109 P-block No.7	Site No -110 L-block No.8	Site No -111 L-block No.10	Site No -112 G-block tank No.6
Flow of the pump	m^3/h	60	60	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	62	32	35	47	45
Head of the pump	m	53.5	58.7	54.8	52.8	54.5
Power of the motor	kW	25	26	20	20	15
Present Specific Power Consumption	kWh/m^3	0.40	0.81	0.58	0.41	0.34
Calculated efficiency of pump set	%	36.7	19.7	25.6	34.7	43.3
Proposed Parameters[19]						
Flow of the pump	m^3/h	62.3	32.2	34.7	47.3	45.2
Head of the pump	m	53.5	58.7	54.8	52.8	54.5
Power of the motor on exiting duty point	kW	15.1	8.9	8.9	11.3	11.2

[19] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -108 Near forest dept. No.2	Site No -109 P-block No.7	Site No -110 L-block No.8	Site No -111 L-block No.10	Site No -112 G-block tank No.6
Proposed Efficiency of pump set on exiting duty point	%	60.00%	58.00%	58.00%	60.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.24	0.28	0.26	0.24	0.25
Operating hours of the pump	h/y	7,920	7,920	7,920	7,200	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	75,767	136,460	89,667	59,493	33,960
Total Monetary Savings	Rs. Lakh	6.0	10.8	7.1	4.7	2.7
Investment of new pump set	Rs. Lakh	1.05	0.99	0.99	1.00	1.00
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.52	1.47	1.47	1.48	1.48

Table 67: Cost Benefit analysis for replacement of Kavi nagar pumps –VII

Rated Parameters	UOM	Site No -113 N-block pump No.3	Site No -115 B-block park No.5	Site No -116 Ramlila maidan no.6	Site No -117 C-block nursery No.7	Site No -118 I-block park No.8
Flow of the pump	m^3/h	60	56	56	56	56
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	19	22	19	19
Measured Parameters						
Flow of the pump	m^3/h	44	62	88	55	27
Head of the pump	m	58.6	31.0	28.3	28.8	29.2
Power of the motor	kW	27	12	20	12	20
Present Specific Power Consumption	kWh/m^3	0.61	0.20	0.23	0.21	0.72
Calculated efficiency of pump set	%	26.1	42.1	33.2	36.7	11.0

Rated Parameters Proposed Parameters[20]	UOM	Site No -113 N-block pump No.3	Site No -115 B-block park No.5	Site No -116 Ramlila maidan no.6	Site No -117 C-block nursery No.7	Site No -118 I-block park No.8
Flow of the pump	m^3/h	44.4	61.6	87.7	55.4	27.0
Head of the pump	m	58.6	31.0	28.3	28.8	29.2
Power of the motor on exiting duty point	kW	11.8	9.0	11.3	7.6	4.1
Proposed Efficiency of pump set on exiting duty point	%	60.00%	58.00%	60.00%	57.00%	52.00%
Proposed Specific energy consumption	kWh/m^3	0.27	0.15	0.129	0.138	0.153
Operating hours of the pump	h/y	7,920	7,920	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	120,964	26,764	72,034	33,425	122,146
Total Monetary Savings	Rs. Lakh	9.6	2.1	6	3	10
Investment of new pump set	Rs. Lakh	1.00	0.99	1.00	0.89	0.61
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.48	1.47	1.48	1.36	1.09

Table 68: Cost Benefit analysis for replacement of Kavi nagar pumps –VIII

Rated Parameters	UOM	Site No -119 F-block park No.9	Site No -120 H-block tank No.10	Site No -121 Vivekanand nagar No.11	Site No -122 K-block No.7	Site No -124 Shastri nagar No.6
Flow of the pump	m^3/h	60	53	60	53	53
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	15	22	22	19	22
Measured Parameters						
Flow of the pump	m^3/h	60	115	89	89	138
Head of the pump	m	31.1	29.1	28.8	27.6	28.4
Power of the motor	kW	12	22	20	18	24

[20] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -119 F-block park No.9	Site No -120 H-block tank No.10	Site No -121 Vivekanand nagar No.11	Site No -122 K-block No.7	Site No -124 Shastri nagar No.6
Present Specific Power Consumption	kWh/m^3	0.20	0.19	0.22	0.21	0.17
Calculated efficiency of pump set	%	41.4	40.8	35.1	36.5	44.6
Proposed Parameters[21]						
Flow of the pump	m^3/h	59.5	114.8	88.7	88.5	138.1
Head of the pump	m	31.1	29.1	28.8	27.6	28.4
Power of the motor on exiting duty point	kW	8.7	15.2	11.6	11.1	17.5
Proposed Efficiency of pump set on exiting duty point	%	58.00%	60.00%	60.00%	60.00%	61.00%
Proposed Specific energy consumption	kWh/m^3	0.146	0.132	0.131	0.125	0.127
Operating hours of the pump	h/y	7,920	7,920	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	27,598	56,536	65,087	56,656	50,747
Total Monetary Savings	Rs. Lakh	2	4	5	5	4
Investment of new pump set	Rs. Lakh	0.99	1.05	1.00	1.00	1.07
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.47	1.52	1.48	1.48	1.55

Table 69: Cost Benefit analysis for replacement of Kavi nagar pumps –IX

Rated Parameters	UOM	Site No -125 K-block No.5	Site No -126 RDC building	Site No -127 Dr.Mukherjee park	Site No -128 GDA market sector-7 pump No.8	Not in list P-block No.11	Not in list Guldhar
Flow of the pump	m^3/h	53	60	53	60	63	60
Head of the pump	m	63	63	56	63	63	63
Power of the motor	kW	15	22	15	22	22	19
Measured Parameters							
Flow of the pump	m^3/h	34	35	68	116	58	59

[21] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -125 K-block No.5	Site No -126 RDC building	Site No -127 Dr.Mukherjee park	Site No -128 GDA market sector-7 pump No.8	Not in list P-block No.11	Not in list Guldhar
Head of the pump	m	28.6	29.9	31.7	28.6	56.0	33.4
Power of the motor	kW	14	14	13	20	25	17
Present Specific Power Consumption	kWh/m^3	0.40	0.40	0.19	0.17	0.43	0.30
Calculated efficiency of pump set	%	19.6	20.2	46.6	44.5	35.8	30.7
Proposed Parameters[22]							
Flow of the pump	m^3/h	34.5	35.2	68.0	115.9	58.4	58.6
Head of the pump	m	28.6	29.9	31.7	28.6	56.0	33.4
Power of the motor on exiting duty point	kW	5.0	5.2	10.0	15.0	14.9	9.2
Proposed Efficiency of pump set on exiting duty point	%	54.00%	55.00%	59.00%	60.00%	60.00%	58.00%
Proposed Specific energy consumption	kWh/m^3	0.144	0.148	0.146	0.130	0.254	0.157
Operating hours of the pump	h/y	7,920	2,880	3,240	4,320	7,920	2,160
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	69,019	25,886	8,560	22,486	79,754	17,649
Total Monetary Savings	Rs. Lakh	5	2	1	2	6	1
Investment of new pump set	Rs. Lakh	0.74	0.74	1.00	1.05	1.05	0.99
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18	0.18
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08	0.08
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22	0.22
Total Investment	Rs. Lakh	1.21	1.21	1.48	1.52	1.52	1.47

Table 70: Cost Benefit analysis for replacement of Vijay nagar pumps –I

Rated Parameters	UOM	Site No -134 C block Sec 9	Site No -136 Zonal Office	Site No -138 Mirza Pur No 2	Site No -139 Mirza Pur No 3	Site No -142 H block sec 12

[22] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -134 C block Sec 9	Site No -136 Zonal Office	Site No -138 Mirza Pur No 2	Site No -139 Mirza Pur No 3	Site No -142 H block sec 12
Flow of the pump	m^3/h	60	60	53	60	53
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	19	8	22
Measured Parameters						
Flow of the pump	m^3/h	68	68	53	9	87
Head of the pump	m	59.4	36.5	61.8	39.2	39.3
Power of the motor	kW	22	19	21	7	23
Present Specific Power Consumption	kWh/m^3	0.33	0.28	0.39	0.74	0.26
Calculated efficiency of pump set	%	49.1	35.0	43.6	14.3	40.5
Proposed Parameters[23]						
Flow of the pump	m^3/h	68	68	53	9	87
Head of the pump	m	59.4	36.5	61.8	39.2	39.3
Power of the motor on exiting duty point	kW	18.0	11.3	15.0	2.1	15.4
Proposed Efficiency of pump set on exiting duty point	%	61.00%	60.00%	60.00%	48.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.26	0.17	0.28	0.22	0.18
Operating hours of the pump	h/y	7,920	7,920	2,880	2,880	2,880
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	34,692	63,655	16,203	14,183	21,463
Total Monetary Savings	Rs. Lakh	2.8	5.1	1.3	1.1	1.7
Investment of new pump set	Rs. Lakh	1.07	1.00	1.05	0.42	1.05
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Total Investment	Rs. Lakh	1.55	1.48	1.52	0.90	1.52

[23] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Table 71: Cost Benefit analysis for replacement of Vijay nagar pumps –II

Rated Parameters	UOM	Site No -144 D block sec 11	Site No -145 B block sec 11	Site No -147 E block sec 11 no -5	Site No -148 G block sec 11 pump No.3	Site No -150 F block sec 11
Flow of the pump	m^3/h	60	53	53	53	53
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	34	37	100	36	36
Head of the pump	m	54.2	54.7	31.4	32.2	33.4
Power of the motor	kW	18	19	28	23	20
Present Specific Power Consumption	kWh/m^3	0.52	0.51	0.28	0.64	0.56
Calculated efficiency of pump set	%	28.4	29.3	30.4	13.7	16.4
Proposed Parameters[24]						
Flow of the pump	m^3/h	34	37	102	36	36
Head of the pump	m	54.2	54.7	33.0	32.2	33.4
Power of the motor on exiting duty point	kW	8.7	9.4	15.3	5.7	6.0
Proposed Efficiency of pump set on exiting duty point	%	58.00%	58.00%	60.00%	55.00%	55.00%
Proposed Specific energy consumption	kWh/m^3	0.25	0.26	0.15	0.16	0.17
Operating hours of the pump	h/y	7,920	7,920	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	71,706	72,782	102,344	137,488	111,834
Total Monetary Savings	Rs. Lakh	5.7	5.8	8.3	10.9	8.9
Investment of new pump set	Rs. Lakh	0.99	0.99	1.05	0.74	0.74
Investment of NRV /replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment towards apparatus of	Rs. Lakh	0.08	0.08	0.08	0.08	0.08

[24] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -144 D block sec 11	Site No -145 B block sec 11	Site No -147 E block sec 11 no -5	Site No -148 G block sec 11 pump No.3	Site No -150 F block sec 11
web based dashboard						
Total Investment	Rs. Lakh	1.47	1.47	1.52	1.21	1.21

Table 72: Cost benefit analysis for replacement of Vijay Nagar pumps –III

Rated Parameters	UOM	Site No -153 Sudamapuri no 2	Site No -154 Sudamapuri no 3	Site No -157 L block sec 9	Site No -158 H block sec 9 rosevally school	Site No -161 H block Kela Khada
Flow of the pump	m^3/h	53	53	53	60	53
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	22	22	22	22
Measured Parameters						
Flow of the pump	m^3/h	28	6	91	85	83
Head of the pump	m	48.5	47.1	41.7	32.6	38.9
Power of the motor	kW	17	22	24	22	22
Present Specific Power	kWh/m^3	0.63	3.95	0.26	0.25	0.26
Calculated efficiency of pump set	%	20.9	3.2	43.1	34.9	40.3
Proposed Parameters[25]						
Flow of the pump	m^3/h	28	6	91	85	83
Head of the pump	m	48.5	47.1	41.7	32.6	38.9
Power of the motor on exiting duty point	kW	6.5	1.5	16.9	12.5	14.6
Proposed Efficiency of pump set on exiting duty point	%	56.00%	47.00%	61.00%	60.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.24	0.27	0.19	0.15	0.18
Operating hours of the pump	h/y	7,920	7,920	7,920	2,880	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	86,341	164,941	55,344	25,972	56,656
Total Monetary Savings	Rs. Lakh	6.9	13.1	4.4	2.1	4.5

[25] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -153 Sudamapuri no 2	Site No -154 Sudamapuri no 3	Site No -157 L block sec 9	Site No -158 H block sec 9 rosevally school	Site No -161 H block Kela Khada
Investment of new pump set	Rs. Lakh	0.74	0.40	1.05	1.00	1.05
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08	0.08	0.08
Total Investment	Rs. Lakh	1.21	0.87	1.52	1.48	1.52

Table 73: Cost benefit analysis for replacement of Vijay nagar pumps –IV

Rated Parameters	UOM	Site No -162 R block sec 12	Site No -163 Sorvaday Nagr	Site No -164 A-block Sec 11
Flow of the pump	m^3/h	53	60	53
Head of the pump	m	63	63	63
Power of the motor	kW	22	22	22
Measured Parameters				
Flow of the pump	m^3/h	85	28	34
Head of the pump	m	36.4	39.3	36.8
Power of the motor	kW	23	20	20
Present Specific Power Consumption	kWh/m^3	0.27	0.72	0.61
Calculated efficiency of pump set	%	36.2	14.9	16.6
Proposed Parameters[26]				
Flow of the pump	m^3/h	85	28	34
Head of the pump	m	36.4	39.3	36.8
Power of the motor on exiting duty point	kW	13.8	5.5	6.1
Proposed Efficiency of pump set on exiting duty point	%	61.00%	55.00%	55.00%
Proposed Specific energy consumption	kWh/m^3	0.16	0.19	0.18
Operating hours of the pump	h/y	7,920	2,880	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	74,398	42,376	112,873
Total Monetary Savings	Rs. Lakh	5.9	3.4	9.0
Investment of new pump set	Rs. Lakh	1.05	0.74	0.74

[26] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -162 R block sec 12	Site No -163 Sorvaday Nagr	Site No -164 A-block Sec 11
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08
Total Investment	Rs. Lakh	1.52	1.21	1.21

Table 74: Cost Benefit analysis for replacement of Mohan Nagar pumps –I

Rated Parameters	UOM	Site No - 167 Tilla More No 1	Site No -168 Tilla More No 2	Site No -174 Tilla More No 11	Site No -175 Tilla More No 12	Site No -177 Tilla More No 14
Flow of the pump	m^3/h	60	56	60	53	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	15	15	15	15
Measured Parameters						
Flow of the pump	m^3/h	46	45	56	53	30
Head of the pump	m	31.5	51.7	32.8	39.1	31.1
Power of the motor	kW	21	12	15	12	16
Present Specific Power Consumption	kWh/m^3	0.46	0.28	0.28	0.22	0.52
Calculated efficiency of pump set	%	18.5	50.7	32.4	48.8	16.2
Proposed Parameters[27]						
Flow of the pump	m^3/h	46	45	56	54	30
Head of the pump	m	32.0	52.0	33.0	40.0	32.0
Power of the motor on exiting duty point	kW	7.0	10.6	8.7	10.0	4.8
Proposed Efficiency of pump set on exiting duty point	%	57.00%	60.00%	58.00%	59.00%	55.00%
Proposed Specific energy consumption	kWh/m^3	0.15	0.24	0.15	0.18	0.16
Operating hours of the pump	h/y	7,200	7,200	7,920	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	102,004	13,025	53,246	13,463	85,113
Total Monetary Savings	Rs. Lakh	8.1	1.1	4.2	1.1	6.8
Investment of new pump set	Rs. Lakh	0.89	1.00	0.99	1.00	0.74

[27] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No - 167 Tilla More No 1	Site No -168 Tilla More No 2	Site No -174 Tilla More No 11	Site No -175 Tilla More No 12	Site No -177 Tilla More No 14
Investment of NRV replacement	Rs. Lakh	0.17	0.17	0.17	0.17	0.17
Investment of gate valve replacement	Rs. Lakh	0.19	0.19	0.19	0.19	0.19
Investment towards apparatus of web based dashboard	Rs. Lakh	0.07	0.07	0.07	0.07	0.07
Total Investment	Rs. Lakh	1.31	1.43	1.42	1.43	1.16

Table 75: Cost Benefit analysis for replacement of Mohan Nagar pumps –II

Rated Parameters	UOM	Site No -179 Tilla More No 16	Site No -182 Tilla More No 19	Site No -185 Sai upwan no 1	Site No -186 Sai upwan no 2	Site No -187 Sai upwan no 9
Flow of the pump	m^3/h	53	53	60	60	60
Head of the pump	m	63	63	63	63	63
Power of the motor	kW	22	19	19	22	22
Measured Parameters						
Flow of the pump	m^3/h	89	20	59	101	83
Head of the pump	m	32.5	32.6	37.8	40.3	37.4
Power of the motor	kW	21	19	17	25	21
Present Specific Power Consumption	kWh/m^3	0.23	0.93	0.29	0.25	0.26
Calculated efficiency of pump set	%	38.1	9.5	35.8	44.5	39.7
Proposed Parameters[28]						
Flow of the pump	m^3/h	89	21	60	101	84
Head of the pump	m	33.0	33.0	38.0	41.0	38.0
Power of the motor on exiting duty point	kW	13.3	3.7	10.5	18.2	14.3
Proposed Efficiency of pump set on exiting duty point	%	60.00%	51.00%	59.00%	62.00%	61.00%
Proposed Specific energy consumption	kWh/m^3	0.15	0.18	0.18	0.18	0.17
Operating hours of the pump	h/y	7,920	7,920	7,200	7,200	7,200
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	57,574	120,380	47,347	48,319	50,756

[28] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -179 Tilla More No 16	Site No -182 Tilla More No 19	Site No -185 Sai upwan no 1	Site No -186 Sai upwan no 2	Site No -187 Sai upwan no 9
Total Monetary Savings	Rs. Lakh	4.6	9.6	3.8	3.9	4.1
Investment of new pump set	Rs. Lakh	1.00	0.57	1.00	1.07	1.05
Investment of NRV replacement	Rs. Lakh	0.17	0.17	0.17	0.17	0.17
Investment of gate valve replacement	Rs. Lakh	0.19	0.19	0.19	0.19	0.19
Investment towards apparatus of web based dashboard	Rs. Lakh	0.07	0.07	0.07	0.07	0.07
Total Investment	Rs. Lakh	1.43	0.99	1.43	1.50	1.47

Table 76: Cost benefit analysis for replacement of Mohan Nagar pumps –III

Rated Parameters	UOM	Site No -188 Sai upwan no 6	Site No -191 Sai upwan no 8	Site No -192 Kanha Upwan
Flow of the pump	m^3/h	60	60	60
Head of the pump	m	63	63	63
Power of the motor	kW	22	15	22
Measured Parameters				
Flow of the pump	m^3/h	63	32	106
Head of the pump	m	48.4	37.9	25.9
Power of the motor	kW	24	14	25
Present Specific Power Consumption	kWh/m^3	0.38	0.44	0.24
Calculated efficiency of pump set	%	35.0	23.5	29.3
Proposed Parameters[29]				
Flow of the pump	m^3/h	63	32	106
Head of the pump	m	49.0	38.0	26.0
Power of the motor on exiting duty point	kW	13.8	6.0	12.5
Proposed Efficiency of pump set on exiting duty point	%	61.00%	55.00%	60.00%
Proposed Specific energy consumption	kWh/m^3	0.22	0.19	0.12
Operating hours of the pump	h/y	7,200	7,200	7,560
Electricity Tariff	Rs./kWh	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	70,691	56,009	97,758
Total Monetary Savings	Rs. Lakh	5.7	4.5	7.8
Investment of new pump set	Rs. Lakh	1.05	0.74	1.00

[29] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -188 Sai upwan no 6	Site No -191 Sai upwan no 8	Site No -192 Kanha Upwan
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22
Investment towards apparatus of web based dashboard	Rs. Lakh	0.08	0.08	0.08
Total Investment	Rs. Lakh	1.52	1.21	1.48

Table 77: Cost benefit analysis for replacement of Vasundhara pumps –I

Rated Parameters	UOM	Site No -195 Hindon No 4	Site No -198 Hindon No 9	Site No -203 Vasundhara sec 9/1	Site No -204 Vasundhara sec 9/2
Flow of the pump	m^3/h	53	60	60	60
Head of the pump	m	63	63	63	63
Power of the motor	kW	15	23	8	8
Measured Parameters					
Flow of the pump	m^3/h	35	103	33	39
Head of the pump	m	33.4	30.9	33.1	33.0
Power of the motor	kW	15	18	8	8
Present Specific Power Consumption	kWh/m^3	0.43	0.17	0.23	0.21
Calculated efficiency of pump set	%	21.0	49.5	39.2	43.2
Proposed Parameters[30]					
Flow of the pump	m^3/h	34.7	103	33.3	39.1
Head of the pump	m	33.5	31.3	33.6	34.0
Power of the motor on exiting duty point	kW	5.8	14.6	5.5	6.5
Proposed Efficiency of pump set on exiting duty point	%	55.00%	60.00%	55.00%	56.00%
Proposed Specific energy consumption	kWh/m^3	0.17	0.14	0.17	0.17
Operating hours of the pump	h/y	4,680	4,680	7,920	7,920
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	43,245	13,517	16,696	13,051
Total Monetary Savings	Rs. Lakh	3.4	1.1	1.3	1.0
Investment of new pump set	Rs. Lakh	0.74	1.05	0.74	0.74
Investment of NRV replacement	Rs. Lakh	0.17	0.17	0.17	0.17

[30] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -195 Hindon No 4	Site No -198 Hindon No 9	Site No -203 Vasundhara sec 9/1	Site No -204 Vasundhara sec 9/2
Investment of gate valve replacement	Rs. Lakh	0.19	0.19	0.19	0.19
Investment towards apparatus of web based dashboard	Rs. Lakh	0.07	0.07	0.07	0.07
Total Investment	Rs. Lakh	1.16	1.47	1.16	1.16

Table 78: Cost Benefit analysis for replacement of Vasundhara pumps –II

Rated Parameters	UOM	Site No -205 Vasundhara sec 11	Site No -213 Vaishali sec 3 no-1	Site No -213 Vaishali sec 3 no-2	Site No -213 Vaishali sec 3 no-3	Site No - 215 Vaishali sec 5/5	Site No -219 Vasundhara sec 5
Flow of the pump	m^3/h	60	60	60	60	56	60
Head of the pump	m	63	63	63	63	63	63
Power of the motor	kW	8	22	22	22	15	23
Measured Parameters							
Flow of the pump	m^3/h	30	105	56	117	35	85
Head of the pump	m	32.5	34.6	34.0	32.6	63.7	33.7
Power of the motor	kW	6	23	19	23	12	19
Present Specific Power Consumption	kWh/m^3	0.21	0.22	0.33	0.20	0.35	0.22
Calculated efficiency of pump set	%	41.3	43.8	27.7	44.4	49.7	41.1
Proposed Parameters[31]							
Flow of the pump	m^3/h	30	105.1	55.8	117	35	84.67
Head of the pump	m	33.0	34.9	34.0	34.1	62.3	34.4
Power of the motor on exiting duty point	kW	4.9	16.4	8.9	17.5	10.1	13.2
Proposed Efficiency of pump set on exiting duty point	%	55.00%	61.00%	58.00%	62.00%	59.00%	60.00%

[31] The selection of pump has been based on measured parameter and also considers the percentage variation of 10% in water table.

Rated Parameters	UOM	Site No -205 Vasundhara sec 11	Site No -213 Vaishali sec 3 no-1	Site No -213 Vaishali sec 3 no-2	Site No -213 Vaishali sec 3 no-3	Site No - 215 Vaishali sec 5/5	Site No -219 Vasundhara sec 5
Proposed Specific energy consumption	kWh/m^3	0.16	0.16	0.16	0.15	0.29	0.16
Operating hours of the pump	h/y	7,920	2,880	2,880	2,880	3,600	2,880
Electricity Tariff	Rs./kWh	7.95	7.95	7.95	7.95	7.95	7.95
Energy saving in terms of reduction of power consumption	kWh/y	12,204	17,979	28,137	16,939	7,697	16,330
Total Monetary Savings	Rs. Lakh	1.0	1.4	2.2	1.3	0.6	1.3
Investment of new pump set	Rs. Lakh	0.74	1.05	0.99	1.07	1.00	1.05
Investment of NRV replacement	Rs. Lakh	0.18	0.18	0.18	0.18	0.18	0.18
Investment of gate valve replacement	Rs. Lakh	0.22	0.22	0.22	0.22	0.22	0.22
Investment towards apparatus of web based dashboard		0.08	0.08	0.08	0.08	0.08	0.08
Total Investment	Rs. Lakh	1.21	1.52	1.47	1.55	1.48	1.52

Existing operating conditions: There are 223 submersible pumps are installed at Ghaziabad Municipality to pump the water from ground reservoir to direct distribution or to the OHT. In general practice, one pumps are operated to meet the water demand. The measurement was taken on 155 number of pump during energy audit to estimate the pump efficiency during normal operation.

Recommendations: The average efficiency of the pumps was calculated for the operational duty point. The efficiency can be enhanced by changing the existing 136 number of pump and motor with new energy efficient pump and motor.

Cost benefit analysis: Expected savings from replacement of pump is about 7,700,640 kWh per year, which would result in a cost benefit of about Rs 612.2 Lakh per year. Estimated investment for implementation of this measure is about Rs. 192.27 Lakh, which basically includes cost of pump set, installation cost, cost of NRV, gate valve and cost of Web based dashboard.

7 Repair &Maintenance Measures

7.1 Present R&M and O&M expenses

Pump sets requires periodic repair and maintenance to keep them in running condition and each R & M activity has a cost associated with it. During energy audit, it was observed that need of repair and maintenance arises generally for replacement of consumables and for addressing wear and tears of components of pump set. During energy audit, data regarding repair and maintenance cost was collected for last three financial years along with other cost related with operation of pumping station. Details of R & M and other cost associated with Ghaziabad Municipal Corporation.

The various data collected for R&M and O&M from Ghaziabad Municipal Corporation is given in Table 79.

Table 79: R&M and O&M expenses for Ghaziabad Municipal Corporation

Financial Data	Units	Values
Cost of Repair & Maintenance in FY2014 - 2015	Rs. Lakh	95.7
Cost of Repair & Maintenance in FY2015 - 2016	Rs. Lakh	82.68
Cost of Repair & Maintenance in FY2016- 2017	Rs. Lakh	257.2
Cost of Operation in FY2014 -2015	Rs. Lakh	311.2
Cost of Operation in FY2015-2016	Rs. Lakh	360.3
Cost of Operation in FY2016-2017	Rs. Lakh	595.7
Cost of Purchase of new pump/motors/accessories in FY2014-2015	Rs. Lakh	80.09
Cost of Purchase of new pump/motors/accessories in FY2015- 2016	Rs. Lakh	16.65
Cost of Purchase of new pump/motors/accessories in FY2016 -2017	Rs. Lakh	55.85

The above table depicts the cost of operation which includes cost associated with the contract persons involved in terms of their salaries and the chemicals used during repair and maintenance of pump sets.

Due to implementation of energy efficiency interventions provided in this report, the repair and maintenance cost for the pumps will reduce drastically due to replacement of existing pumps with new pumps and also the repair and maintenance will be done by EESL selected manufacturer during the contract period.

8 Project Financials and Business model

An IGEA report is the process of conducting an energy audit to identify efficiency improvement opportunities, and translating the technical findings into financial terms to present it as a bankable project capable of securing a loan. Therefore it is important to conduct a detailed financial analysis for the project to ascertain the financial viability of the project.

This project would be implemented in Annuity Mode. In this mode, EESL will invest all the capital investment required for implementation of the Energy Efficiency Project. **EESL will assure a minimum energy savings of approx. 20% as compared to the existing energy consumption. Payments would not be affected if savings are higher than 20%.** Further EESL would provide Repair & Maintenance (R&M) for the replaced pump sets during the project period. The repayment to EESL (in the form of annuity) would be determined on cost plus ROE basis. Schematic of business model of this project is provided in figure 45.

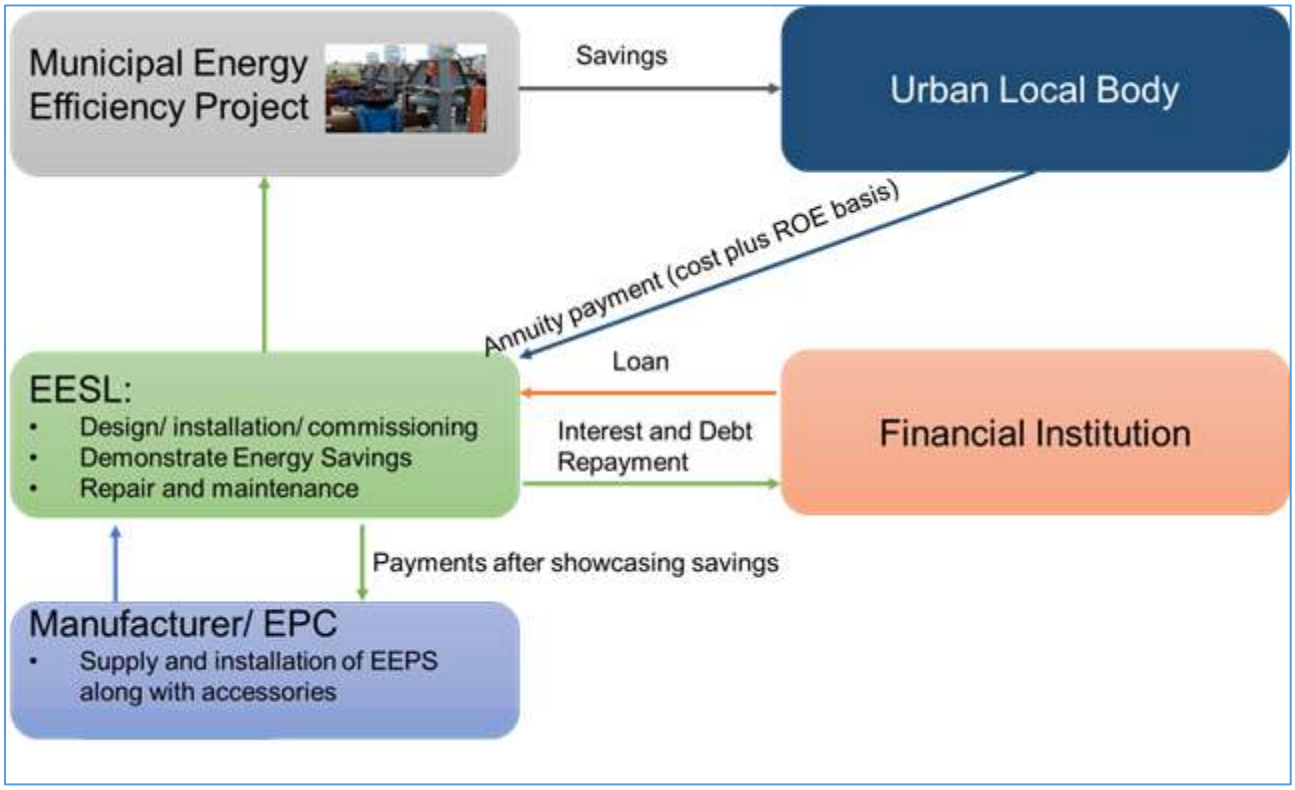

Figure 5: Schematic of business model of the project

8.1 Total Project cost (CAPEX)

The following are the key components considered while arriving at the total project cost:

i. Cost of pump, motor and other accessories (like NRV and gate valve), discovered through a transparent bidding process;

ii. Cost of dismantling, installation and commissioning, discovered through a transparent bidding process;

iii. Project Establishment and Supervision charges of EESL at 5 % of total cost of equipment including installation;
iv. Cost of preparation of IGEA, as per actual tendered cost, plus EESL's service charge at 15%;
v. All applicable taxes and duties as on actual basis; and
vi. Capitalized interest during the Project Implementation Period.

Details of project capital cost are provided in Table 80.

Table 80: Project capital cost

Capital Cost Related assumption	Unit	Value
Number of Pumps	No.	136.00
Total Cost of Equipment including accessories	INR lakhs	192.27
Cost of pump	INR lakhs	117.37
Cost of NRV	INR lakhs	24.07
Cost of Gate valve	INR lakhs	30.49
Cost of monitoring and supervision equipment	INR lakhs	10.44
Installation and Commission Cost	INR lakhs	9.89
EESL's administrative and establishment charge	%	5.0%
Cost of preparation of DPR	INR lakhs	4.21
Total Project cost w/o Capitalized sheet	INR lakhs	206.09
Commissioning Details		
Total Months for Commissioning	Month	9
Capitalized interest	INR lakhs	11.55
Total Project Cost	INR lakhs	217.64

8.2 Operating Costs (OPEX)

The following are the key components considered while arriving at the operating cost for the project:

i. Project Establishment and Supervision charges of EESL at 4% of total project cost; and

ii. Actual incurred Repair & Maintenance charges, discovered through a transparent bidding process.

Details of operating cost are provided in table 81.

Table 81: Project operating cost

Operational Details	Unit	Value
EESL's administrative and establishment charges	%	4%

8.3 Financing Terms and other tax related assumptions

The following are the key financial assumptions used in developing the model. Details of financing terms and tax related assumptions are provided in the table no 82.

Table 82: Financing terms and tax related assumptions

Financing Details		
Debt Percentage	%	70%
Cost of Debt	%	11%
Equity Percentage	%	30%
Cost of Equity (post- tax)	%	16%
Tax Details		
Income Tax Rate	%	34.6%
Income Tax Rate	%	30.0%
Surcharge	%	12.0%
Education Cess	%	3.0%
Goods and service tax	%	18.0%

8.4 Output - Annuity Payment to EESL

Based on the cost parameters and assumptions mentioned above, the annuity payment to EESL was computed. Details of annuity payment to EESL are provided in the table no 83.

Table 83: Annuity payment.

Year Calculations of annuity payment		1	2	3	4	5	6	7	Total
Total Debt to be repaid	INR lakh	37.6	35.2	32.8	30.4	28.0	25.7	23.3	213.1
Principal Repayment	INR lakh	21.8	21.8	21.8	21.8	21.8	21.8	21.8	152.3
Interest	INR lakh	15.9	13.5	11.1	8.7	6.3	3.9	1.5	60.7
Total Equity Repayments	INR lakh	24.4	22.2	19.9	17.6	15.3	13.0	10.8	123.2
Recovery of equity investment	INR lakh	9.3	9.3	9.3	9.3	9.3	9.3	9.3	65.3
Return on equity	INR lakh	15.1	12.8	10.6	8.3	6.0	3.7	1.4	57.9
R&M Charges	INR lakh	0.0	2.9	8.6	10.9	13.2	17.1	20.6	73.2
EESL's administrative and establishment charge	INR lakh	8.7	9.1	9.6	10.1	10.6	11.1	11.7	70.9
Annuity Payment to EESL	INR lakh	70.8	69.4	70.9	69.0	67.1	66.9	66.3	480.4
Service Tax on annuity payment	INR lakh	12.7	12.5	12.8	12.4	12.1	12.1	11.9	86.5
Annuity Payment to EESL incl. Goods and Service Tax	INR lakh	83.5	81.9	83.7	81.4	79.2	79.0	78.2	566.8
Total Savings	INR lakh	612.20	626.68	640.74	654.26	667.14	679.24	690.44	4570.71
Profit to ULB	INR lakh	528.68	544.80	557.09	572.87	587.95	600.25	612.26	4003.89
% of savings with ULBs	%								87.60

8.5 Sensitivity analysis

The sensitivity analysis was conducted to determine the impact of change in capital cost and change in savings on the percentage of monetary share of accrued savings retained by the ULB. Details of the project sensitivity analysis are provided in the Table no 84.

Table 84: Sensitivity analysis

Change in Capital Cost	% of savings retained by the utility
-10%	88.65%
-5%	88.12%
0%	87.60%
5%	87.07%
10%	86.55%
Change in Interest(ROE, Interest, D/E ratio)	% of savings retained by the utility
-10%	86.22%
-5%	87.95%
0%	87.60%
5%	88.19%
10%	88.73%

8.6 Payment Security Mechanism

Payment default by the borrower is perceived as one of the most important risks. For projects based on ESCO model, wherein ESCO or financial institution pays the upfront capital for project implementation, the regular payment to the ESCO/financial institution is crucial to maintain a positive cash flow. There are difficulties associated with measuring energy performance accurately and equitably, and therefore the actual energy savings may be disputable, especially in circumstances where the energy baseline and stipulated factors are not well established at the pre-project stage. Apart from possible dispute on actual savings, host's bankruptcy and dismissal of a management body could also be possible reasons for non-payment. Payment security mechanism is necessary to ensure confidence of investors in an ESCO projects. The mechanism should be structured in a way which would be acceptable to ESCO/financial institution. The payment security mechanism maybe in form of irrevocable bank guarantees or letter of credit (LOC) furnished by the ESCO/financial institution.

8.6.1 Letter of credit

Letter of credit (LC) is the obligation taken by the bank to make the payment once certain criteria are met. Whereas, bank guarantee (BG) is a promise made by a bank that the liabilities of the debtor will be met in event the energy user fails to make the payment. The major difference between bank guarantee (BG) and letter of credit (LC) is that BG reduces the loss in the transaction if transaction doesn't go as planned while letter of credit ensures that transaction proceeds as planned. As the ultimate objective of the program is to improve the energy efficiency in water supply and sewage system and ensuring the success of the project, letter of credit would be preferred payment security mechanism.

Letter of credits processes payment on receipt of required documents from the service provider. Major challenges associated with letter of credit are enlisted below:

- Letter of credits are usually irrevocable agreement and hence any changes in terms of contract will be difficult to address in letter of credit.

- Getting letter of credit is difficult considering the stringent qualification criteria. Letter of credit is usually issued to companies and organization that have cash flow, asset and good credit score.

- Usually line of credit are issued with terms for paying it back, herein energy user will be using the line of credit to pay the service provider for its services. In case of energy savings line of credit could be used as an guarantee in case of default by the government entity

In the case of the AMRUT program, the state government plays a critical role in implementation of the project would sign the tri partite agreement for implementation of the project. The state government shall provide an unconditional, revolving and irrevocable Letter of Credit from a scheduled and nationalized bank (other than co-operative banks) at its own cost for the entire contract period. The amount of letter of credit shall be equivalent to 2 times the quarterly invoice. The LC may then be drawn upon by EESL for recovery of the eligible payments, in case of defaults.

9 Key Observations and Suggestions

The installed pumps are old due to which the performances of the pumps have already deteriorated. The overall efficiency for individual pumps is in the range of 16%- 66%.

Water Pumping Station

- It was observed that the pumps installed at bore well pumping sites are dedicated to pump water to the nearest overhead tanks or distribution network.
- The head utilization and flow utilization could not be calculated because of the absence of detailed name plate details. The poor efficiency may be on account of variation in the duty point. However, this could be a reason for poor performance as the sites are quite old.
- The overall efficiency of all the pumps is in range of 16% to 66% for the operational duty point. The efficiency can be enhanced by changing the existing pump sets with new energy efficient pump sets
- There is no monitoring of water level and discharge pressure throughout the system.
- Most of the sites have soft starter at kavi nagar zone and star delta starter at rest of the zones.
- Most of the sites have over heating of cable near the fuse.
- Most of the pumps are rewind many times.
- At Vijay Nagar, Sudamapuri-No 3(Site No-154), pump is supplying water to OHT. The generated head is less than requires head so water is not reaching up to the tank height.
- At Kavi Nagar, N blocks Pump No-3 (Site No-113). Heating near the terminals.

10 Measurement and Verification (M&V)

Measurement and Verification (M&V) is the term given to the process for quantifying savings delivered by an Energy Efficiency Measure (EEM). It includes energy saving verification process involving measurements and reporting methodology. M & V methodology followed in this project includes following measurement schedule

a. Measurement of parameters pre EEM implementation (just before installation of EEPS) for all operating combinations using portable instruments

b. Measurement of parameters post EEM implementation for all operating combinations using portable instruments.

Energy savings are calculated as the difference in power drawn (in pre and post implementation scenario) multiplied by the operating hours mentioned in IGEA.

These energy savings shall be verified in accordance with M&V plan presented in the final report by EESL and as agreed upon by the ULB. The energy savings will be determined and signed by EESL, Pump Supplier and the ULB. EESL shall submit a report as per the reporting template attached to this agreement verifying the savings mentioned in the agreement.

The report shall be submitted by EESL to all the ULB within 15 days of the completion of the verification.

10.1 Definition of possible and operating combinations

In ULBs, especially in case of pumping stations, where the pumps are connected in parallel, the pump operated in various combinations. For the purpose of this document, these combinations are defined as possible combinations. For example, for if 3 pumps are connected in parallel, there are 7 possible combinations considering three different pumps i.e.

Pump 1	Pump 1+ Pump 2	
Pump 2	Pump 2+ Pump 3	Pump 1+Pump 2+Pump 3
Pump 3	Pump 3 +Pump 1	

However, the ULB might be operating the pumps only in three combination, depending on the flow requirement, from the one discussed above. For the purpose of this document, these combinations are defined as operating combinations.

Operating Combination 1	Operating Combination 2	Operating Combination 3
Pump 1	Pump 1+ Pump 2	Pump 1+Pump 2+Pump 3

10.2 Flow of activities under M & V process

- First, measurements of old pump would be carried out by the supplier when new pump is ready to be installed at ULB.
- Instantaneous measurement of parameters like flow, head (both at suction and discharge) and power of old pump would be carried out for all operating combinations after stabilisation using portable meters. These parameters will be called pre implementation parameters

- Pre implementation parameters will be verified by EESL, ULB and Supplier.
- Then, old pump will be replaced by new pump and instantaneous measurements of parameters mentioned above will be carried out on new pump after stabilisation for same operating combinations. These parameters will be called post implementation parameters.
- Energy savings of a pump for each combination would be determined by multiplying the difference in instantaneous power consumption in pre and post EEM implementation scenario with corresponding operating hours mentioned in IGEA. Total savings of a pump will be the summation of energy savings in each operating combination (i.e. weighted average savings of a pump would be estimated)
- The flow and head of new pump i.e. post implementation parameters should match pre implementation parameters.
- Post implementation parameters will be verified by EESL, ULB and supplier.
- Penalty would be imposed on pump supplier if energy savings, at ULB level, are less than 20% of existing energy consumption

10.3 Pre and post implementation assessment

To determine savings, the following parameters would be measured during pre and post implementation for each operating combination:

i. Power Consumption, voltage, frequency (kW, Volt, hz)

Data Unit	kW, Volt, hz
Description	Voltage, frequency and power consumption of all operating combinations (pre and post implementation)
Source of Data	On site measurement using calibrated portable instrument (power analyzer)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable power analyzer
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

ii. Flow rate (m3/hr)

Data Unit	m^3/hr
Description	Flow rate delivered for all operating combinations (pre and post implementation)
Source of Data	On site measurement using calibrated portable instruments (flow meter)
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using portable flow meter
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

iii. Head (m)

Data Unit	meters (m)
Description	Average head delivered for all operating combinations (pre and post implementation)
Source of Data	On site measurement using calibrated instruments
Description of measurement methods and procedures to be applied	Instantaneous onsite measurement using pressure gauge installed at both the suction and discharge side of the pump
QA/QC procedures to be applied	Calibrated instrument from a NABL accredited laboratory

10.4 Correction Factors and adjustments

In case of deviation in frequency and voltage at the time of post implementation parameter measurements, following correction factors would be applied on parameters of new pump to determine actual. Adjustments factors to be used during M&V are provided in table 85.

Table 85: Adjustment factors to be used during M & V

Factors affecting	Rationale for adjustment	Adjustment to be made
Variation in supply frequency	As per pump affinity law	$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$ $\frac{P_1}{P_2} = (\frac{N_1}{N_2})^3$ Where, Q is the flow of the meter N is the speed of the shaft P is the power drawn
Voltage Variation	As per BEE guidelines	If the post implementation voltage is 10% higher than pre implementation voltage, power consumption will increases by 0.75% If the post implementation voltage is 10% lower than pre implementation voltage, power

Factors affecting	Rationale for adjustment	Adjustment to be made
		consumption will increase by 2%

10.5 Determination of Savings

- Based on this data, the energy savings would be calculated as given below:

$$\%\ savings\ (s1) = \frac{\left((kWpre1\ -kWpost1)\ X\ h1\right) + \left((kWpre2\ -kWpost2)\ X\ h2\right) + \ \ldots\ldots.}{\left(kWpre1\ X\ h1\right) + \left(kWpre2\ X\ h2\right) + \cdots \ldots}$$

  - Where, 1, 2…. represents parameter for different operating combinations of a pump
  - h1, h2 represents annual operating hours of a pump in different combinations
  - kW_{pre} – Instantaneous power consumption of old pump in a particular combination
  - kW_{post} – Instantaneous power consumption of new pump in a particular combination
  - s1 represents percentage savings of a pump

- Further, aggregate savings at a ULB level would be determined based on weighted average savings of all pumps:

  The aggregate percentage savings at ULB would be

$$aggregate\ \%\ savings\ at\ ULB = \frac{s_1 \times e_1 + \ s_2 \times e_2 + \ s_3 \times e_3 \ldots\ldots\ldots.}{e_1 + \ e_2 + \ e_3 \ldots\ldots}$$

  - Where, e represents energy consumption of one pump in all combination

$$e1 = kWpre1\ X\ hour1 + kWpre2\ X\ hour2 + \cdots \ldots\ldots\ldots$$

  - s1, s2, s3, s4, s5..... are percentage savings for individual pumps replaced at ULB
  - e1, e2, e3, e4, e5..... are annual energy consumption of each pump

11 Risk Responsibility Matrix & Risk Mitigation

To develop an effective business model, it is necessary to identify clear roles and responsibilities and the risks associated with the project development. This is useful to develop appropriate structure and plan for project financing and risk mitigation mechanism for ring fencing the risks of project investors. Some of the major risks and their mitigation mechanisms are discussed below.As established in the previous sections, the preferred mode for implementation of this project is annuity mode. Therefore, the responsibility matrix has been prepared considering the preferred implementing mode. Details of financial risk and associated mitigation measures Table 86.

Table 86: Financial risk analysis and mitigation

Risk	Key Incidence of risk	Description	Mitigation Measure
Operational Risk: Usage risks are usually a direct consequence of use of equipment by the end users. These risks are usually beyond the control of the ESCO			
Inaccurate Baseline	ULB	Baseline for any ESCO based project is usually defined in terms of energy consumption and the performance level of the equipment. In case of pumping stations, when pumps are connected in parallel, few pumps might not be operational during baseline determination. Also, an increase or decrease in operating hours can show up as corresponding increase or decrease in "savings" unless adequate adjustments are applied	The design of the M&V protocol would include sufficient measures in form of engineering formula for baseline correction to sufficiently mitigate this risk
Operational change in the facility	ULB	Operational changes can be in terms of change in usage hours. Further in case of pumping system, the operational changes can be a result of use of higher size of pumps, increase in number of pumps connected in a parallel system, increase in required flow among others.	
Market Risk: Market risks arise due to uncertainty of market conditions. These risks can be attributed to various stakeholders and factors including suppliers of technology, maturity of technology and consumers among others.			
Availability of suppliers	EESL	Availability of suppliers and the technology are keys to development of any ESCO project. Competition in market leads to market forces optimizing the cost. This also leads to new technology innovations and product differentiation. Dependence on a single supplier also increase the project risk, where the project is dependent on capability of single	EESL is mitigating the risk by ensuring the involvement of manufacturers and suppliers throughout the project lifecycle including taking inputs during IGEA preparation. Further pumping is a matured industry with many suppliers

Risk	Key Incidence of risk	Description	Mitigation Measure
		vendor to supply quality products in required quantity in a pre-determined time frame. Ineffective competition may lead to installation of inferior quality product and also cause delay in implementation.	
Age of the technology	EESL	Mature technologies are by nature stable and more dependable than new technology. The performance standards for mature technologies are also well defined. There are many inherent risks associated with new technology; these include price fluctuations, rapid technology improvements (which could lead to project being more effective later i.e. early adopters curse[32]), lesser awareness about technology shortcomings and effects.	Pumping is a matured technology with key technical parameters and fundamentals remaining relatively constant during the past century.
Financial Risk: The financial risk mainly deals with the cost escalations associated with the project. These risks if not mitigated properly affect the profitability and feasibility of the project			
Equipment Cost Escalation	ULB	The increase in equipment cost could be due to various factors including increase in cost of raw materials, changed policies and regulations. The escalated cost could result in reducing the project profitability and in worst scenarios making the project unviable.	In the annuity mode, the equipment cost considered is the cost discovered in competitive bidding. This will ensure the best possible cost for the ULB. Further, manufacturer's budgetary quotations are taken while developing the IGEA.
Installation and annual maintenance cost Escalation	ULB (before bidding) Technology supplier (post bidding)	Installation cost is the function of manpower cost, cost of carrying inventory and material required for installation. For a project with longer execution cycle, managing installation and annual maintenance cost can be key to success of the project. In addition to factor affecting increase in manpower cost (change in labor laws etc.), the reasons for installation and annual maintenance cost are similar to	For the ULB the mitigation measures are same above

[32] The new technology turns old very quickly. Also rapid improvements lead to reduction in cost in near future. For example early adopters of solar technology had to pay a higher feed in tariff as compared to later adopters

Risk	Key Incidence of risk	Description	Mitigation Measure
		equipment cost escalation. As the selected technology supplier is contractually responsible for installation and annual maintenance at the rate mentioned in its bids. The risk is transferred to the technology provider post bidder selection.	
M&V Costs	EESL	M&V costs tend to vary significantly depending on the extent of measurements, involvement of technical manpower, and automation required in the M&V methods and protocols adopted	M&V mechanism will be clearly defined, agreed and incorporated into project financials prior to project implementation
Time and Budget Overruns	EESL	Failure to implement a viable project in a timely manner can add costs	To be addressed by closely monitoring progress with unit
Design and construction risk: Improper design and delays in constructions are a significant risk to ESCO project.			
Delays in procurement, installation and commissioning	All stakeholders	Delay in procurement, installation and commissioning could drive up project cost. Longer project durations could also increase the probability of other regulatory and policy related risks. It is important to plan the project efficiently to minimize these risks. Projects undertaken by EESL usually require procurement of large quantity of a single product	Standardization of bidding and other contractual documents is key to minimize this risk. Additionally all the stakeholders including ULBs, state government, manufacturers and energy auditors need to be engaged since project inception
Improper selection of energy efficiency solution and integration of energy efficient solution	All stakeholders	The aim of an ESCO project is reduce energy consumption while maintaining or improving performance of the equipment. Proper selection of solution is important to achieve these objectives. Improper selection of solution could lead to non-achievement of savings as estimated. It could also lead to not meeting the performance parameters from the baseline scenario	The manufacturers and technology suppliers are engaged since the project inception including overseeing energy audit activities and selection of technology. Further the manufacturers should be encouraged to visit the facility before bidding for the project.
Performance risks: related to performance of energy efficient equipment post implementation. Poor performance could lead to reduced savings from the ESCO project. This may result in poor financial returns for the project			
Equipment performance depreciation	EESL /Technology Supplier	In many conditions the equipment performance deteriorates over the life of	Derating of equipment has been appropriately modelled in the financial

Risk	Key Incidence of risk	Description	Mitigation Measure
		the project. The derating of the equipment needs to be properly modelled in the business model for the project. Incorrect assumptions could lead to severe financial implication of the project. There are two key reasons for the equipment performance depreciation. • **Quality of equipment:** Equipment installed as a part of the project does not conform to quality standards set. It is also possible that the vendor supplies equipment which do not meet the technical specification set out in the bidding document. • **External conditions:** These conditions include various external parameters including power quality and operating condition (flow output and pump submergence) deviating from the design parameters	model. The values of derating have been finalized after consultation with manufacturers. Proper quality control action plan needs to be developed as part of the bidding documents and contract. Capacity building of pump operators in proper operations of the new pumps installed
Repair/maintenance and warranty risks	EESL /Technology Supplier	Repair/maintenance and warranty risks relate to faulty equipment risks. The risk also arises due to different agencies being responsible for operations and repair/maintenance. In case of this project, operation would be managed by urban utility, whereas EESL and in turn technology supplier would be responsible for the repair and maintenance. A dispute also might arise related to deviation from warranty conditions which are also not under EESL/technology supplier control. EESL offers extended warranty up to the life of the project under most of its projects. The payment to EESL is also linked to satisfactory replacement of faulty equipment and timely repairs.	Capacity building of pump operators will be taken up to facilitate proper operations and routine preventive maintenance of the new pumps installed EESL will define Comprehensive repair and maintenance requirements including spares and components inventory, as well as appropriate systems (e.g. for registering complaints and turn-around times) and will make the equipment suppliers contractually responsible for preventive maintenance requirements.

Risk	Key Incidence of risk	Description	Mitigation Measure
Environmental and Legal Risk			
Reduction of water level	ULB, state government and general population	In areas where ground water is supplied through submersible pumps, another important risk is reduction of water level due to over drawl of water by the farmers because of more efficient high discharge new pumps. This could result in many short and long term environmental effects. If the water table is not recharged consistently if might result in other long term effects including desertification.	Change in operation guidelines, i.e. reduction if water supply hours if the flow is increased
Utilization of old inventory in other areas	ULB and EESL	If the collected inefficient pumps are not destroyed they could be used again. This would defeat the purpose of the project and lead to over-estimation of environmental benefits associated with the project.	Proper destruction of old inventory
Health, Safety and Social risk			
Health Safety and Social risk	ULB and EESL	As principal employer EESL is responsible for these risks including: • Nonpayment of minimum wages • Child labor • Insurance for workers • Emergency preparedness, fire & electrical safety • Safety of tools and equipment used	EESL should contractually make the technology supplier and contractor adequately responsible for this risk. As principal employer of all the people working under this project, EESL should collect proper documentation.

12 Project Implementation Schedule

12.1 Execution Strategy

EESL and other stakeholders need to pay attention to project execution in order to deliver impactful projects. The efforts and money on a project that is poorly executed do not produce results on the expected lines.

Following are the project execution strategies to keep projects running efficiently and on schedule:

Define specific and measurable objectives: The well-executed project is seen as one that achieves its desired results. Those specifics should include:

- The timeline for the project- Identify milestones and deadlines that are needed to accomplish incremental progress.
- The staff and infrastructure resources necessary to complete the project. This would include full-time employees, outside contractors, part-time staff or specialized freelance support to properly execute the project.
- The cost of the project- Be sure to take into account human resources and material costs, including hardware and software or consulting fees, travel or other incremental expenses.

Plan for the unexpected: The project managers should take into account that not everything will go as planned. Being prepared for changes also means standing behind a project's goals on a broad level. As the project is being executed, project leaders should be able to explain and support what has happened in the project to date, along with: current status, what the results thus far mean to the project and its objectives, and what specific impact these results will have on the project in terms of cost reduction, broader opportunities, etc.

Measure progress through project waypoints: The process to improvement must invariably include measurement; and not just on a one-and-done basis. The different stakeholders need to measure progress along the way to see an updated view of the project so that they can respond immediately if (and when) project parameters need to be re-calibrated or changed. Measurement should be happening organically so that project leaders have visibility into the time commitment of project participants and the cost of materials and infrastructure.

12.2 Proposed schedule

The total implementation period of the EEM's as per the schedule provided by the pumping station is given in table 87.

Table 87: Project implementation schedule

T0: Date of signing of MoU between State Government and EESL

Sl. No	Activity	T0	T0 + 30 days	T0 + 90 days	T0 + 105 days	T0 + 135 days
1	Signing of MoU between State Government and EESL					
2	Inviting tenders for hiring of agency to prepare IGEA Report					
3	Preparation of IGEA and submission to ULB					
4	Submission of IGEA to SLTC by ULB					
5	SLTC approval on IGEA					

T1: Date of signing tripartite agreement between State Government, ULB and EESL, known as effective date.

Sl. No	Activity	T1	T1 + 30 days	T1 + 90 days	T1 + 255 days	T1 + 270 days
1	Signing of tripartite agreement between State Government, ULB and EESL					
2	Inviting tenders for selection of pump supplier					
3	Selection of pump supplier					
4	Installation of energy efficient pump sets at ULB					
5	Submission of M & V report to ULB by EESL					

Since the ULB has water supplying priorities; the implementation is proposed to be carried out in such a way that the operation of pumping station is not impacted.

Annexures

The Annexures have been compiled as a separate document.

Annexure-1: CEA Certificate.
Annexure-2: Verified Job Cards.
Annexure-3: Calibration certificates of instruments
Annexure-4: Electricity bills
Annexure-5: Vendor quotes
Annexure-6: Completion letter and running hours.
Annexure-7: Other supported documents