Water Audit

Client XXXX– Vimannagar Pune.

Period: Dec 2015 / Jan 2016

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WATER related Infrastructure at XXXX:

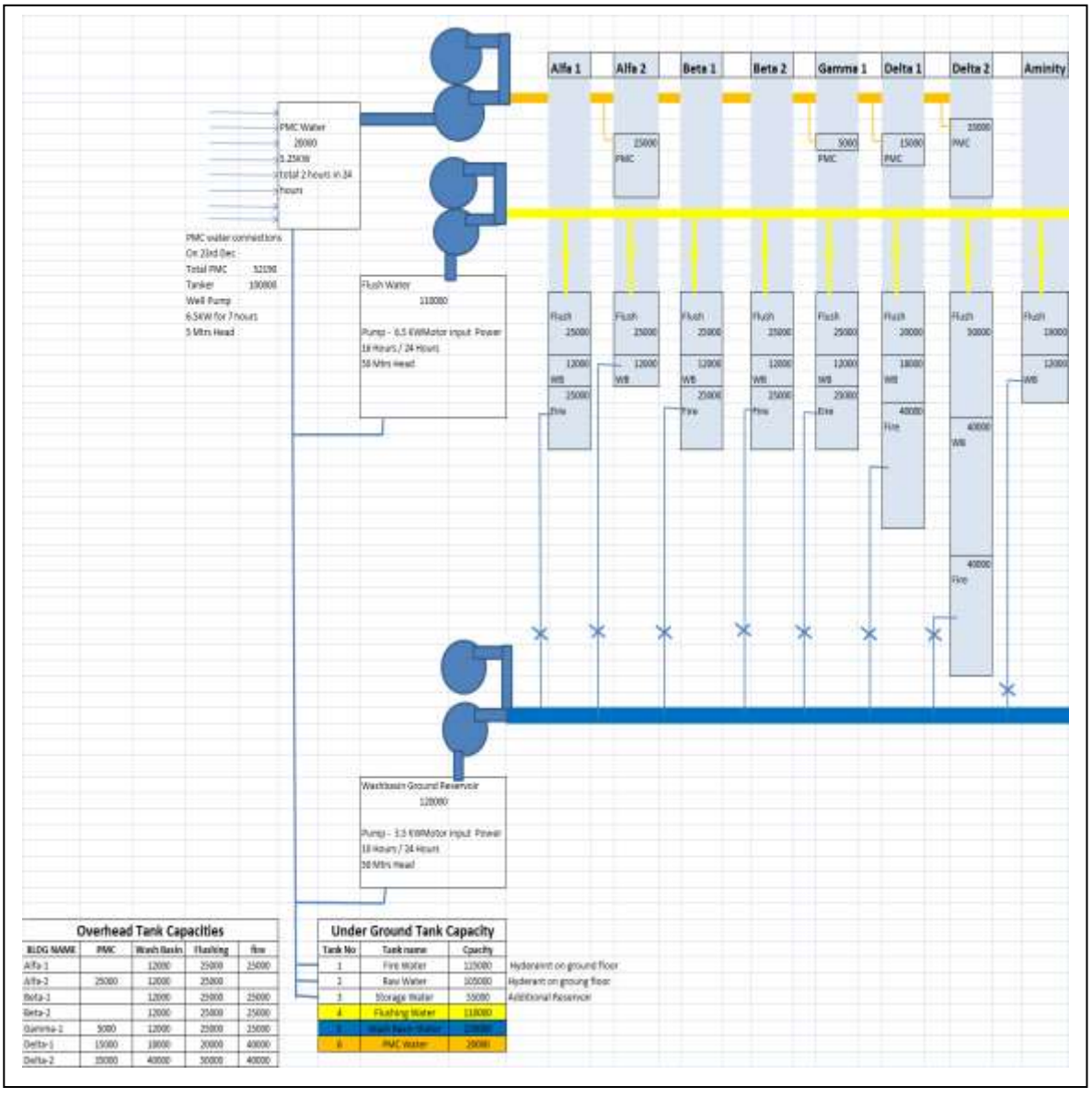
XXXX is a large setup of 7 commercial and one amenity buildings, which is about 8 years old. Most of the buildings are occupied by IT or ITES companies. Few of these companies work in one shift while others work in all three shifts.

At present there are three sources of water

a) PMC through 8 metered connections
b) Tankers
c) Well within the premises.

Major water usage heads are as follows

a) Drinking water
b) Basin water
c) Flush water
d) Stock of water for fire fighting systems at ground and terrace levels.



Problem manifestation:

- At present water is collected in different underground reservoirs which are common for all buildings but different for different type of usages.
- This water is pumped to terrace level tanks of each building by common pumps installed for each application.
- Different valves mounted on pipelines decide distribution of water to one or all the buildings.
- At present this entire system is operated manually in all three shifts and normally works satisfactorily as persons having experience in use of water by various buildings operate the same.
- The system is vulnerable to any disturbance which may arise from supply side or usage side. Whenever such disturbance occurs, the occupants suffer due to water shortage and the task of establishing normalcy becomes very tough. This happens as there is neither ONLINE indication available describing situation of any of the tanks nor any ONINE automatic control system exists, which can bring the normalcy systematically and monitor the same on continuous basis.
- In this situation management decided to appoint an independent expert agency to
  a) Study the entire system,
  b) Assess capacity and physical state of various equipment involved
  c) Confirm adequacy of the system for intended use.
  d) Design / modify new / modified system If present equipment is found inadequate / unreliable
  e) Suggest SCADA and automation to ensure adequate water supply to all buildings and for all usages.
  f) Physically inspect water bodies in the premises and suggest required repairs / rework to put them back into normal working.

Methodology used:

1) Measure all tank capacities.
2) Measure power consumption of all working pumps for 24 hours on a normal working day mainly to know working hours of pumps.
3) Measure flow of all pumps to help calculating adequacy of pumping.
4) Co relate all above information and cross check with per person daily use for commercial buildings as per IS standard.
5) Ensure equipment adequacy. If the existing system is not adequate, recommend modifications along with relevant cost easimates.
6) Study feasibility of SCADA and Automation for the entire water supply system for XXXX project. Prepare generic BOQ and cost estimation for these options.
7) Recommend repairs / modifications for water bodies in the premises along with cost estimates.
8) Present report based on above.

Audit team:

1) Mr. Narendra Duvedi – Certified energy auditor, Chartered Engineer – Electrical Expert

2) Mr. Makarand Kulkarni - Certified energy auditor – Utility expert
3) Mr. Amit Jadhav, Mr. Vijay Sonawne – Measurement Engineers.

Executive Summary:

Observations:

1) XXXX is a large commercial / IT / ITES space accommodating about 5000 persons in 8 numbers of multy storied buildings of various sizes.

2) Total estimated water requirement is about 250000 Ltrs per day including all three uses namely drinking water, basin water and flush water. Average measured water pumped to overhead tanks every day is about 268000 Ltrs.

3) Average water requirement, pumping hours, KW consumed and overall efficiency as estimated and rounded off from actual measurements under different heads is as under.

Wash basin water	= 75000 Ltrs	- 10 hrs. – 3.3KW@25% efficiency
Flush water	= 200000 Ltrs	- 16 hrs. – 6.3KW@24% efficiency
PMC water	= 20000 Ltrs.	– 1.5 hrs. – 49KW@ 33% efficiency

Above pumping hours in case of wash basin water are recorded for normal filling assuming that "Fire water Tank" is already full.

4) At Present 2 submersible pumps are installed in parallel for each of these applications. Out of these; 2 pumps are working only in case of Flush water. Where as for other two cases, only one pump is working.

- In case of flush water, if one pump fails the other will be insufficient for daily routine requirement.
- In case of other two applications, if the working pump fails there is no standby arrangement and respective application will not get water supply.

5) Details regarding pump head – Desinged Flow / pressure, motor wattage etc are not available. All these motors at present are working at power factors bellow 0.5, which suggest that they are underloaded or they have some other electrical problem. Record related to pump repairs / maintenance is also not available.

6) It is clear from above that "Wash basin water" and 'Flush water" systems are largely vulnerable and any failure will lead to shortage of water for the buildings.

Recommendations:

1) Procure a 50Mtr head and 20M3/hr Pump with suitable motor and make ready a standby pump set using these. This pump should be connected to each application outlet one by one and present pump may be removed for inspection. The actions regarding their repairs / replacement etc can be decided only after inspection.

2) As regards pump replacement, two options are available

- Centralized pumping for each application as is provided at present.
- Decentralized pumping for each application and for each building.

3) Two types of water level sensors are available in the market namely “High, Low, Critically Low Level sensors” or “Linear Level sensors”. Select any of them to suit your budget and have a SCADA designed / implemented across these to know all levels in the control room. Such SCADA can be designed to make these level signals available outside for further automation.

4) Repairs / Automation design will depend upon selection of type of sensors and on mode of pumping. Basic options are as bellow and their costs will increase in the sequence as bellow. We have also given silent features of all the options.

- Repair / Replace existing pumps to suit the requirements now measured as above and introduce only centralized display of tank levels and operate the system manually.
  Simple system, least minimum required investment, can be extended to automation if planned at design stage.
- Each building will have its own set of pumps automated based on level sensing. – with manual bypass
  Lot of plumbing changes required – which can be done without disturbing the working. Basic pump cost will increase but automation will become very simple.
- Centralised pumping for each application and solenoid valve operation based on CRITICAL – LOW – HIGH digital censors – with manual bypass.
  Complex and costly system – will operate on digital level signals – ON – OFF control may pose some problems in critical situation.
- Centralised pumping for each application and motorised valve operation based on linear level censors and deciding valve opening based on actual requirement in each tank – with manual bypass.
  Complex, most costly but full proof system – will give current water level status ONLINE and take decisions on it’s own regarding maintaining water levels or generating anticipatory alerts in case of equipment failure or shortage of water in base tanks. This option will also generate time stamped reports on Consumption and Alerts.

5) We are of the opinion that, a detail BOQ and costing for future system may be prepared after understanding above present situation among all stakeholders and deciding the budget.

Collected data:

Under Ground Tank Capacity details			
Tank No	**Tank name**	**Capacity Ltrs**	**Use**
1	Fire Water	125000	Hydrant on ground floor
2	Raw Water	105000	Hydrant on ground floor
3	Storage Water	55000	Additional Reservoir
4	Flushing Water	110000	Flushing water
5	Wash Basin Water	120000	Wash Basin Water
6	PMC Water	20000	Drinking Water

- Total water storage capacity as above is 535000 Ltrs.
- Assuming 5000 people occupy these buildings for 8 to 10 hours per day and Water requirement to be 45Ltrs / per person / day;
  Water requirement would be = 225000 / day.

  Assuming some buffer and requirements of cafeteria and landscape maintenance we can safely take requirement as 300000 Ltrs / day.

Historical data on water intake.

The chart bellow shows extract of monthly intake of water from PMC and Tankers. Apart from this the water is also take from a well at site. There is no record available as far as input from well is concerned.

Sr No	Month	Meter 1014	Meter 2438	Meter 2427	Meter 7306	Meter 2432	Total PMC Water	Tanker Qty	Total Tanker Water	Total Monthly
1	Aug-14	1297250	229250	211250	210150	212875	**2160775**	108	**1080000**	3240775
2	Sep-14	1297250	229250	211250	210150	212875	**2160775**	173	**1730000**	3890775
3	Oct-14	1297250	229250	211250	210150	212875	**2160775**	182	**1820000**	3980775
4	Nov-14	1297250	229250	211250	210150	212875	**2160775**	245	**2450000**	4610775
5	Dec-14	1232909	229250	211250	210150	212875	**2096434**	273	**2730000**	4826434
6	Jan-15	1232909	229250	211250	210150	212875	**2096434**	322	**3220000**	5316434
7	Feb-15	1232909	229250	211250	210150	212875	**2096434**	425	**4250000**	6346434
8	Mar-15	1232000	229250	211250	210150	212875	**2095525**	382	**3820000**	5915525
9	Apr-15	1236500	164000	133500	81500	77500	**1693000**	469	**4690000**	6383000
10	May-15	1236500	164000	133500	81500	77500	**1693000**	464	**4640000**	6333000
11	Jun-15	1504500	263000	187500	185000	215500	**2355500**	326	**3260000**	5615500
12	Jul-15	1504500	263000	187500	185000	215500	**2355500**	467	**4670000**	7025500
13	Aug-15	1389190	309350	82974	158014	1389190	**3328718**	390	**3900000**	7228718
14	Sep-15	1028400	231780	93631	110514	247895	**1712220**	209	**2090000**	3802220
									Total Tanker Water	**74515865**
									Assuming 300 days working in 14 months, Average per day input would be - Ltrs	**248386**

As per daily consumption estimates monthly water consumption will be between 70L to 75L litres. This is seen only in the month of July and Aug in above data.

Above average monthly intake and consumption calculated indicates that the difference must have been lifted from well whenever it was available. It was also informed to us that the well water is also used for some construction work going on in a nearby site. The data in above table is in consistent as some of the PMC meters were not working for some time and due to some other errors.

Overhead tank capacities, Pumping data collected for a day and measured flow.

Overhead Tank Capacities in ltrs and consumption				
BLDG NAME	**PMC**	**Wash Basin**	**Flushing**	**fire**
Alfa-1		12000	25000	25000
Alfa-2	25000	12000	25000	
Beta-1		12000	25000	25000
Beta-2		12000	25000	25000
Gamma-1	5000	12000	25000	25000
Delta-1	15000	18000	20000	40000
Delta-2	35000	40000	50000	40000
GS – Amenity		12000	19000	
Total Ltrs	**80000**	**130000**	**214000**	**180000**
Assume 75% consumption Ltrs	60000	97500	160500	
Flow measured in Ltrs / hr	12050	6120	11300	
Pumping hours required	5	16	14	
Actual Pumping hours on a normal day	1.33	10.25	16.25	
Actual Consumption in Ltrs	16026.5	62730	183625	

- PMC water is pumped in overhead PMC water tanks and the buildings which do not have overhead PMC water tank, receive this water from adjoining building.
- For the buildings where “fire” and “wash basin” both tanks exist, the “fire” tank is filled first and the overflow starts filling “wash basin” tank.
- Flushing tank is filled directly at present with fresh water. Once the WTP starts functioning properly, “Flushing” may receive recycled water.
- Assuming that daily pumped water = water consumed or water requirement;
  the actual water consumed at present on a normal day from above calculations is
  16026+62730+183625 = 262381 Ltrs.
  This also confirms theoretical requirement calculated on earlier page.

Details of Measurements carried out on Pumps and associated observations.

Parameter	WashBasin, PMC, Flush Pumping			Well water Pumping	
	Wash Basin	Flush Pump	PMC	Well water in flush/basin	Total well water
No of Pumps	1	2	1	1	1
Pipe Dia	2.5"	3"	1.5"	2"	2"
Flow Observed M3/hr	6.12	11.3	12.05	4.2	11
Velocity Mtr/Sec	0.51	0.6	2.69	0.59	
Head Assumed Mtrs	50	50	50	25	20
Hyd power OUT KW	0.83	1.54	1.64	0.29	0.60
Electrical Power IN KW	3.3	6.3	4.9		4.2
Pump efficiency	25.27	24.44	33.51		14.27
Running Hours/day	10.25	16.25	1.33	6.5	6.5
Total Water Ltrs Per day	**62730**	**183625**	**16026.5**	**27300**	**71500**
Grand Total	**262381.5**				
Water pumped Ltrs/ Hr	6120	11300	12050	4200	11000

- Rounding off above figures, we can assume following per day requirements:
  Wash basin water = 75000 Ltrs
  Flush water = 200000 Ltrs
  PMC water = 20000 Ltrs.

- Average Energy consumption for water pumping would be:
  (3.3KW x 10.25hrs) + (6.3KW x 16.25 hrs) + (4.9KW x 1.33hrs) + (4.2KW x 6.5hrs)
  = 170Kwh per day. Assuming tariff of Rs.10/Kwh, this translates to Rs.4 to 4.5Lacs per year.

- It is observed from above that the pumps are operating at 25%, 24%, 33%, 14% efficiency at present. (Efficiency calculated based on flow measured on visible header available outside the tank). The pumps are almost 8 years old and any record related to their capacities, servicing etc is not available. These efficiency figures are too low and for this size of pumps at least 50% efficiency can be achieved with proper pump selection.

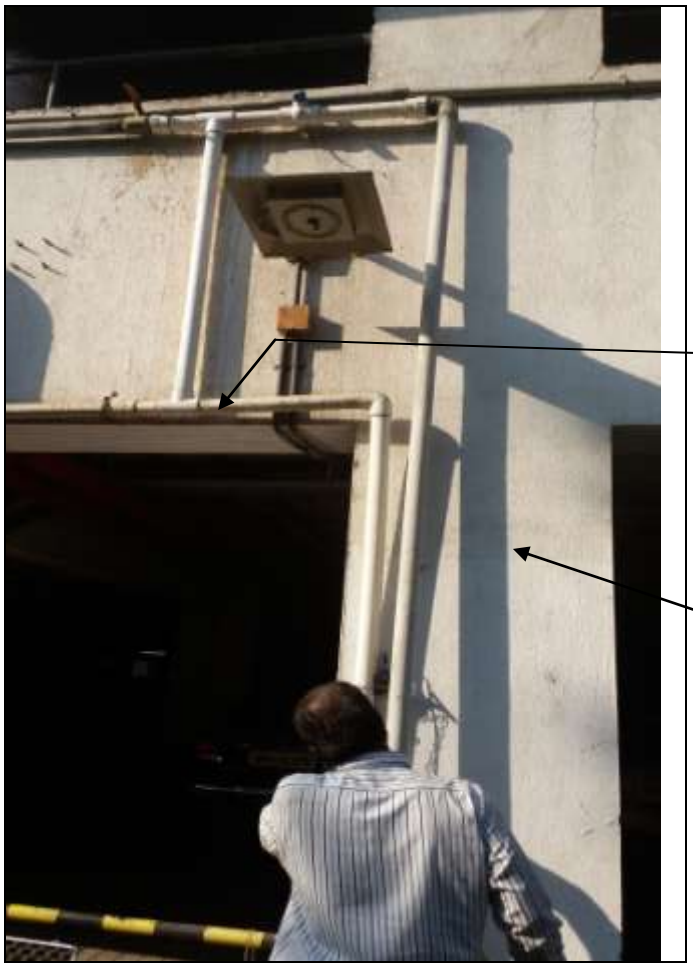
- We were informed that each application has two pumps installed which are connected in parallel to work as parallel combination or one working / one standby.

- Two pumps are working in parallel only in case of Flush Water. From above measurements, even in this case it is clear that the parallel combination is required to work for 16 hours a day to meet actual requirement.

- For rest of the pumping requirements, there is only one working pump per application and if it fails, the water will not be pumped. We were informed that second pump in these cases is not in working condition.

- All pumps are of submersible type as such physical inspection was not possible. It is quite likely that leakages must have been developed at output piping of these pumps. There is possibility of partial pump / header clogging due to dust / mud / foreign bodies etc which has created artificial resistance and due to this flow has reduced.

- Well water distribution



We did not get explanation for balance flow. The flow in pipe on RHS was negligible. The flow through LHS branch could not be measured. Although the metallic valve appears to be closed there must be leakage through this, which needs to be checked.

PMC water pumping estimates.

Measured flow of PMC water pump is 12000 Ltrs per hour. This is further diverted to four tanks. Actual consumption is 20000 Ltrs.		
BLDG NAME	**PMC tank capacity Ltrs**	**Total requirement split for each building Ltrs**
Alfa-1		
Alfa-2	25000	6250
Beta-1		
Beta-2		
Gamma-1	5000	1250
Delta-1	15000	3750
Delta-2	35000	8750
GS - Amenity		
Total	**80000**	**20000**

- Above estimate assumes that total water requirement can be split building wise in same proportion as overhead tank capacity.
- As the measured flow of this pump is 12000 Ltrs / Hr. All these tanks can be filled in any combination.
- Overall Pump efficiency is 33.51%.
- If only one tank is filled at a time, the time required for each tank would be less than 1 hour.
- At present this application has only 1 pump, we advise one standby pump to cater to any emergency.

Basin water pumping estimates.

Measured flow of Wash basin water pump is 6120 Ltrs / hour. This can not be diverted to all 8 tanks simultaniously. Delta 1, 2 requirements are more.		
BLDG NAME	**Wash Basin Tank Capacity Ltrs**	**Total requirement split for each building**
Alfa-1	12000	6923
Alfa-2	12000	6923
Beta-1	12000	6923
Beta-2	12000	6923
Gamma-1	12000	6923
Delta-1	18000	10385
Delta-2	40000	23077
GS - Amenity	12000	6923
Total	**130000**	**75000**

- Above estimate assumes that total water requirement can be split building wise in same proportion as overhead tank capacity.
- As the measured flow of this pump is only 6120 Ltrs / Hr.
- This flow is not sufficient to fill these tanks simultaneously.
- Overall Pump efficiency is 25.27%.
- Delta 1 and 2 are tanks with large capacities and daily consumption is also more.
- In some buildings, overhead basin water tanks get filled after respective Fire Tanks are filled.

Flush water pumping estimates.

Measured flow of flush water pump is 11300 Ltrs / hour. This can not be diverted to all 8 tanks simultaniously. Delta 1, 2 requirements are more.		
BLDG NAME	**Flush Tank Capacity Ltrs**	**Total requirement split for each building**
Alfa-1	25000	23364
Alfa-2	25000	23364
Beta-1	25000	23364
Beta-2	25000	23364
Gamma-1	25000	23364
Delta-1	20000	18692
Delta-2	50000	46729
GS - Amenity	19000	17757
Total	**214000**	**200000**

- Above estimate assumes that total water requirement can be split building wise in same proportion as overhead tank capacity.
- As the measured flow of this pump is only 11300 Ltrs / Hr.
- This flow is not sufficient to fill these tanks simultaneously.
- Overall Pump efficiency is 24.44%.
- Delta 1 and 2 are tanks with large capacities and daily consumption is also more.
- The pump operator shared that while two pumps working in parallel, he cannot keep more than 4 valves open at a time. If he tries this, the pump head is insufficient to take the water to top of any tank.

----------END OF REPORT----------