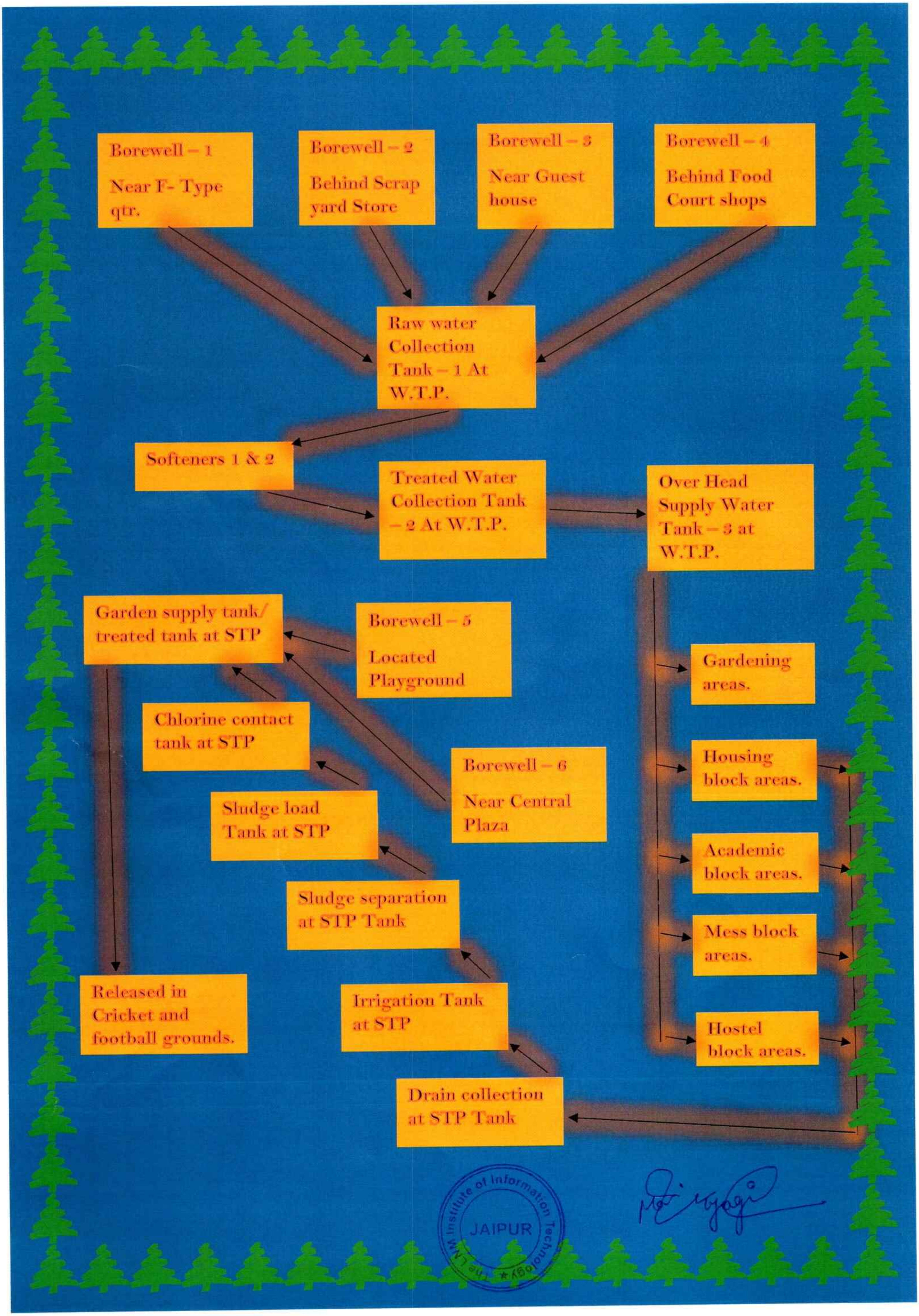
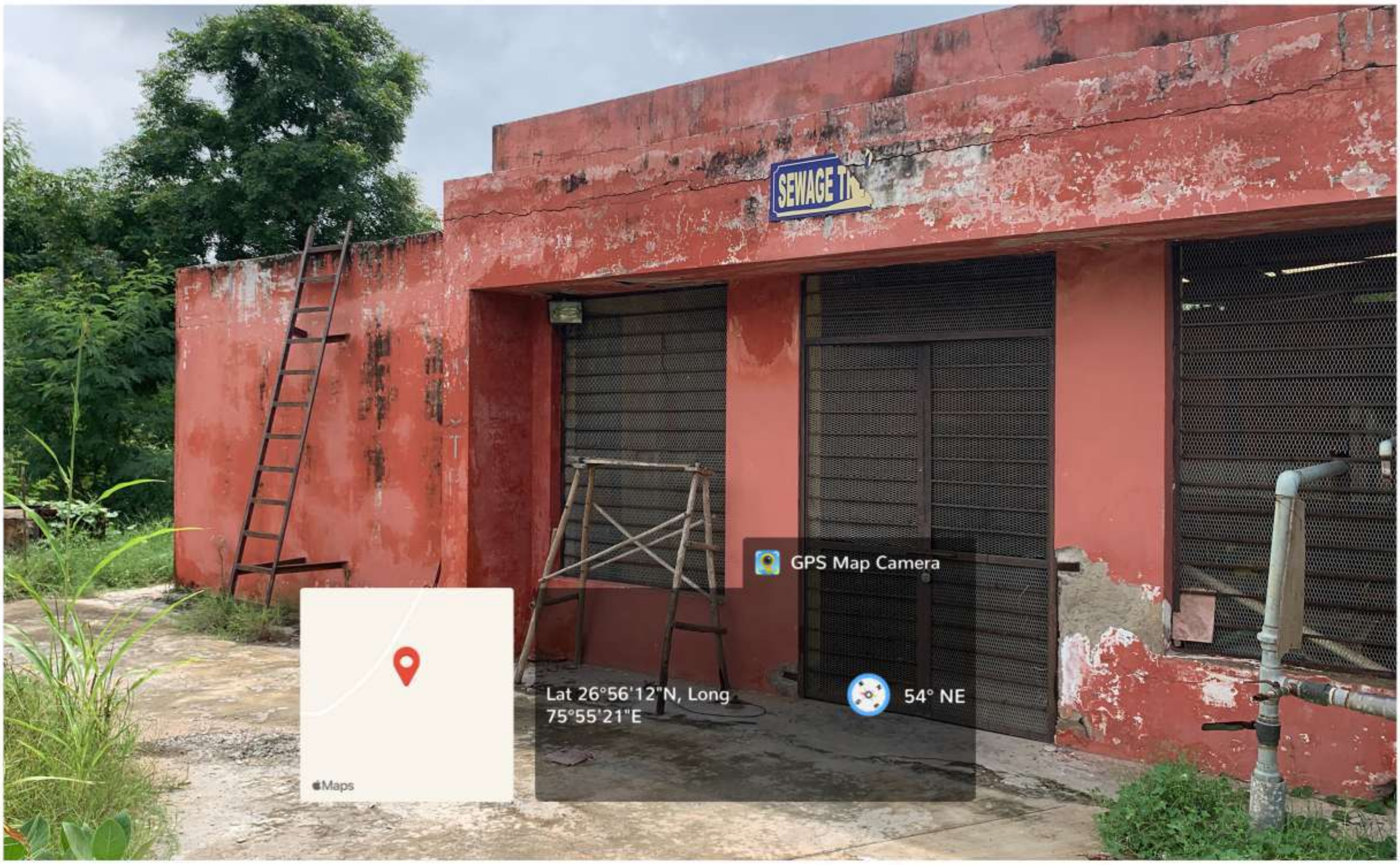
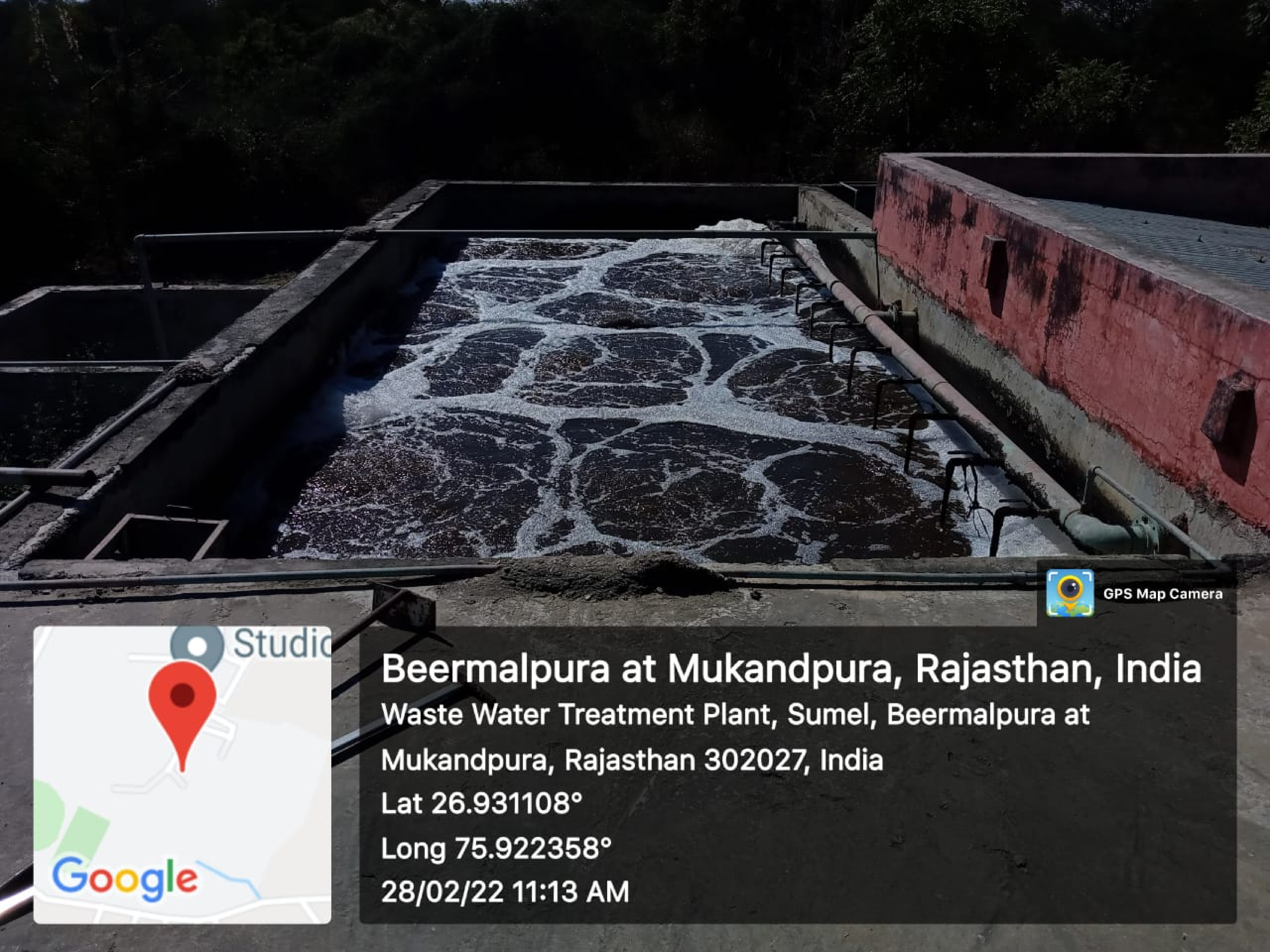
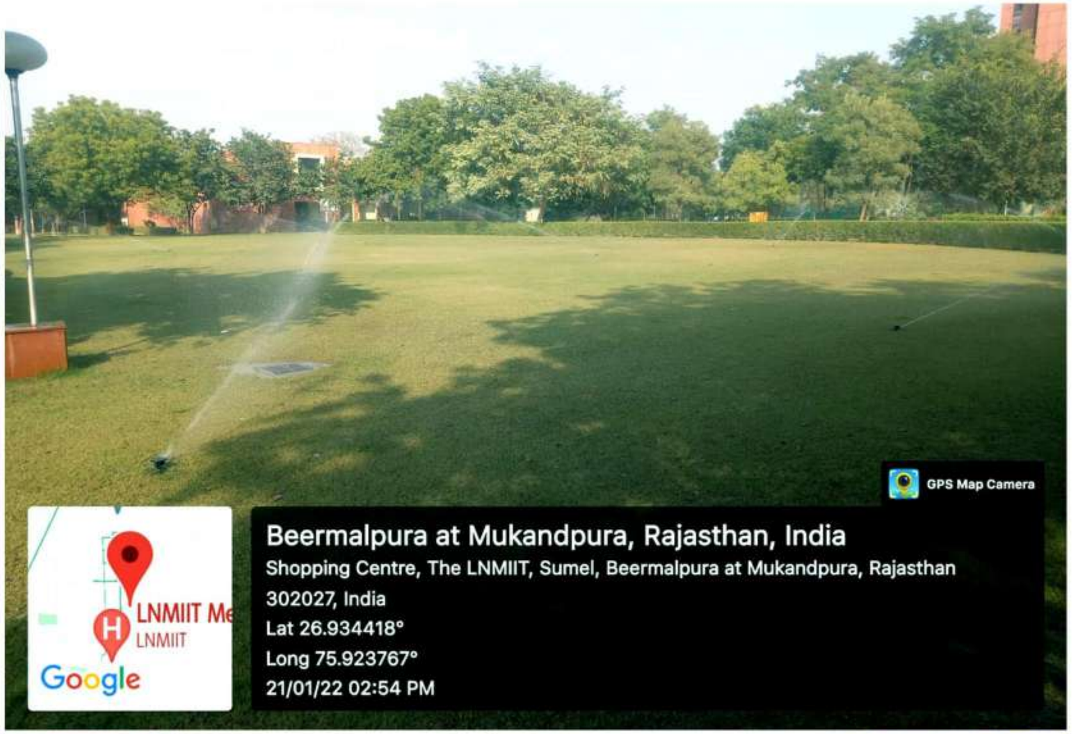

Borewell – 1
Near F- Type qtr.
Borewell – 2
Behind Scrap yard Store
Borewell – 3
Near Guest house
Borewell – 4
Behind Food Court shops
Raw water Collection Tank – 1 At W.T.P.
Softeners 1 & 2
Treated Water Collection Tank – 2 At W.T.P.
Over Head Supply Water Tank – 3 at W.T.P.
Garden supply tank/ treated tank at STP
Borewell – 5
Located Playground
Gardening areas.
Chlorine contact tank at STP
Borewell – 6
Near Central Plaza
Housing block areas.
Sludge load Tank at STP
Academic block areas.
Sludge separation at STP Tank
Mess block areas.
Released in Cricket and football grounds.
Irrigation Tank at STP
Hostel block areas.
Drain collection at STP Tank
The LNM Institute of Information Technology
JAIPUR

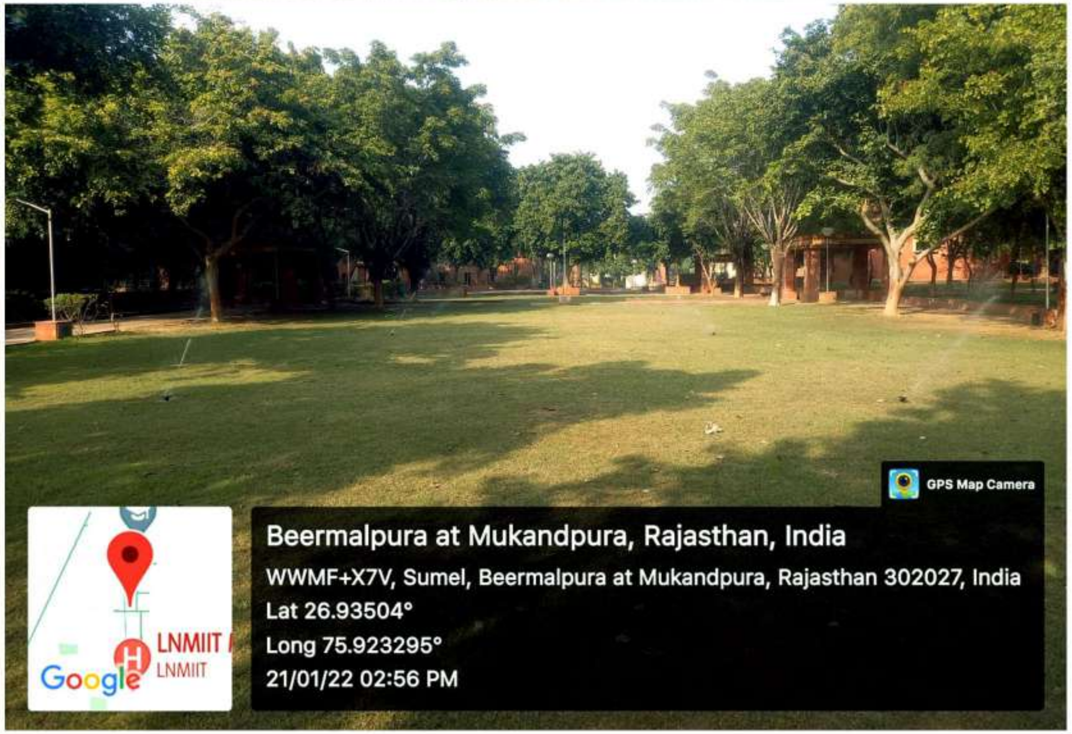
Sewage Treatment Plant




GPS Map Camera
Beermalpura at Mukandpura, Rajasthan, India
Waste Water Treatment Plant, Sumel, Beermalpura at
Mukandpura, Rajasthan 302027, India
Lat 26.931108°
Long 75.922358°
28/02/22 11:13 AM
Google

Sprinkler System in Campus Gardens





WEECON
Water ▪ Energy ▪ Environment
▪ Consultants
▪ Auditors
▪ Project Work & Industrial Services

1/240, SFS, Agarwal Farm,
Mansarovar, Jaipur-302 020
Cell: 98285 69939

Ref:WO/EA/2017/LNMIIT/03
June 20, 2017

Certificate of completion of Energy/Water Audit and preparation of Master Plan for LNMIIT Green Campus

This is to certify that an Energy Audit/Water audit was conducted at LNMIIT institute, Rupa ki Nangal, via-Jamdoli, Jaipur 302031 with full co-operation of concerned faculty and staff during the period 27th April 2017 to 5th June 2017. The validation Energy audit covered illumination, air conditioning, utilities, and common facilities to ascertain the status of utilization of energy and to summarize the possible opportunities for energy savings .The water audit included water quality analysis for different applications, water balancing and enlisting conservation and recycling opportunities. The audit findings were duly shared with the Institute management. This certificate and the energy/water audit report and DPR for master plan for green campus are attached as per the requirements of LNMIIT (Work order PO/LNMIIT/2017-18/04-2018 Dt April 24,2017).

This certificate /audit report is a proprietary document of LNMIIT University and accordingly can be used for up gradation of infrastructure or any other institutional requirements.

(Lalit Kumar Joshi)
Certified Energy Auditor (BEE- EA-3296)

WEECON JAIPUR

LNMIIT
Rupa Ki Nangal, via Jamdoli
Jaipur -302031

Green Campus Initiative

Master Plan
(2017-2022)

The LNM Institute of Information Technology

Note: This report is a propriety document solely prepared for research grant /inhouse use of LNMIIT Jaipur. No part of the report is to be reproduced or published or shared without the prior permission of LNMIIT,Jaipur.

Team members:

Dr. Kamal Kishore Khatri (LNMIIT, Jaipur)
Dr. Abhishek Sharma (LNMIIT,Jaipur)
Mr. Ashok Saraf (LNMIIT,Jaipur)
Mr. Lalit Kumar Joshi (WEECON Consultants, Jaipur) , lkjoshiweecon@hotmail.com
Mr.KamleshJagratwal (WEECON Consultants, Jaipur)

Contents

List of Figures

List of Tables

1.0 Introduction

The LNM Institute of Information Technology (LNMIIT), a deemed to be university, is a public–private partnership university jointly set-up by the Government of Rajasthan and the Lakshmi Usha Mittal Foundation in 2003. The institute spread in a an area of 100 acres is a fully residential instate that offers five branches at undergraduate level and three branches at post graduate level. It was rated as 'A' grade of NAAC by UGC. It ranks at "5th in terms of employability in India' including IIT's, NIIT's etc by EDU-RAND in 2016 and MHRD national ranking stands at position 85th in 2016.The institute has a 97% placement record.

Though not far from Jaipur, and with all amenities the institute is located in a pollution free semi urban settings with a green sprawling campus. The architecture of the institute is distinctively exquisite and blends excellently well with the requirements of a technical institute.Some pictures of the institute are as under for a visual appreciation.

Fig 1: LNMIT Campus, Jaipur

2.0 Objectives of the report

The LNMIT being a premier technical higher education institute is committed to sustainable development and being progressive it has inclination and means to implement processes which further reinforces its sustainability commitments. The respect for nature and sustainability are therefore well embedded in its education stream. This report has been prepared to comprehensively enlist the options which may act as a roadmap for improved energy efficiency, improved resources utilisation, minimising and recycle of identified wastes, renewable integration and increasing the green cover for its continuous improvement plan of green campus initiative. The report thus summarises the following

A) Energy use analysis and its reduction.
B) Water use analysis and its optimal use
C) Renewable integration
D) Identification of waste streams and plan for reduction
E) Progressively increasing of green cover
F) Conservation of other resources especially fossil fuel based.

The overall purpose of this report is to optimize resources in a defined manner for their progressive reduction so as to reduce their consumption by minimum 20% by the year 2022.

3.0 Methodology

The methodology comprises of the following sub – components which synergise to meet the above objectives

A) Assessment of the current energy use

An energy audit was conducted by the Bureau of Energy efficiency Certified auditors to revalidate the energy audit report which was prepared by the institute in the preceding year. This was done to assess the current energy use pattern and to suggest various options which can further optimize the institute energy use.

B) Assessment of other energy resources

   A comprehensive study was conducted to ascertain the pattern of usage of water, LPG, Petrol/diesel etc so as to enlist pathways for their reduction.

C) Identification of waste streams and suggestions for their reduction/safe disposal.
D) Assessment of green coverage of the institute.

E) Detailed study for the possibility of deployment of renewable technologies for reduction in dependence on commercial energy.

Further, this being a technical institute an underlying requirement of participation of the students in meeting the desired objectives of sustainability has been kept in mind while preparing the detailed project reports covering the above mentioned areas of intervention.

The baseline year has been ascertained which shall act as a reference year for progressive improvement to meet the objective targets of energy use reduction, waste minimisation, resource optimisation etc. by year 2022.

After completion of the above studiesthe Detailed Project Report (s) have been prepared in two tier

Tier 1: Identified opportunities which can be implemented to meet the objectives.

Tier 2: This is for exclusive participation by the students who in consultation with their mentors shall progressively evolve in small groups, the projects which can further improve upon the sustainability criteria performances. This shall enable students to evolve in house means, methods and the technology which can help to over achieve the specified goals.

This master plan thus covers Tier 1 detailed project reports only.

The key performance indicators (KPI) have been evolved which shall help LNMIT in periodic internal assessment.

4.0 Base line year

The following criteria has been used to ascertain the base year for a reference point

a) Beginning of a calendar year (1^{st} Jan)/ new financial year (1^{st} April) Or
b) Beginning of new term of the institute. Or
c) Point of initiation of committed sustainability drive by institute. Or
d) Starting of MNRE project for green campus initiative.Or
e) A representative year from immediate preceding years for peak values of energy consumption

From the above selection criteria the beginning of new financial year 2016-17 has been taken as the reference year. To elaborate further the energy consumption, resource consumption as on 1^{st} April 2016 has been taken as the reference point. The reasons are as under –

a) Monthly assessment of consumption pattern maintains the pace of initiatives rather than averaging of complete year. The yearly summary shall definitely be improved if monthly incremental improvement is evident.
b) The year 2016 -17 marked the beginning of initiatives under which a proposal was also submitted to MNRE for green campus initiatives.
c) Yearly expenditure on resources are also summarised at the end of any financial year.

The details of the institute for referencing are thus as under. These enlisted parameters shall work as the baseline data to record changes which may occur due to change in conditioned area, addition of any new facility or any use patterns

Institute building details : There are three boys hostels, two girls hostel, one academic area, one administrative area and supporting infrastructures like library, computer labs, sports complex, institute hospital, temple etc in LNMIIT Jaipur campus.The total connected load of the institute is 2800 kW. Presently, they have two DG (Diesel Generator) sets for emergency power back–up with capacities of 380 kVA and 125 kVA (sparingly used).

Total build–up area of the institute is 27231 Square meter. Out of this 3430 Square meter and 10575 Square meter is air conditioned and air cooled respectively. Total connected equipment load in the Institute is 1632.58 kW.
The building details are summarised in Table 1 below.

<table>
<tr><th>S.N</th><th colspan="2">Item</th><th>Units</th></tr>
<tr><td>1</td><td colspan="2">Connected Load (kW)</td><td>2800</td></tr>
<tr><td>2</td><td colspan="2">Installed capacity: DG Sets (kVA or kW)</td><td>380</td></tr>
<tr><td rowspan="3">3</td><td colspan="2">a) Annual Electricity Consumption, purchased from Utilities (kWh)</td><td>1809585</td></tr>
<tr><td colspan="2">b) Annual Electricity Consumption, through DG Set (kWh)</td><td>45479</td></tr>
<tr><td colspan="2">c) Total Annual Electricity Consumption, Utilities + DG Sets (kWh)</td><td>1855064</td></tr>
<tr><td rowspan="3">4</td><td colspan="2">a) Annual Cost of Electricity, purchased from Utilities (Rs.)</td><td>11036083</td></tr>
<tr><td colspan="2">b) Annual Cost of Electricity generated through DG Sets (Rs.)</td><td>513607</td></tr>
<tr><td colspan="2">c) Total Annual Electricity Cost, Utilities + DG Sets (Rs.)</td><td>11549690</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Area of the building (exclude parking, lawn, roads, etc.)</td><td>Built Up Area (sq.m.)</td><td>27231</td></tr>
<tr><td>Air Conditioned Area (sq.m)</td><td>3430</td></tr>
<tr><td>Air Cooled Area (sq.m)</td><td>10575</td></tr>
<tr><td rowspan="10">6</td><td rowspan="10">Buildings with Carpet Area</td><td>Academic Area (sq.m)</td><td>9360</td></tr>
<tr><td>Lecture Area (sq.m)</td><td>3698</td></tr>
<tr><td>Hostel Area (sq.m)</td><td>31010</td></tr>
<tr><td>Sports Area (sq.m)</td><td>2448</td></tr>
<tr><td>Library (sq.m)</td><td>1225</td></tr>
<tr><td>Mess Area (sq.m)</td><td>1160</td></tr>
<tr><td>Guest House Area (sq.m)</td><td>2624</td></tr>
<tr><td>Faculty accommodation Area(sq.m)</td><td>5395</td></tr>
<tr><td>Miscellaneous Area (Guard room, ATM, Exchange, Substation WTP, Food court) (sq.m)</td><td>1201</td></tr>
<tr><td>Total Area (sq.m)</td><td>58121</td></tr>
<tr><td>7</td><td colspan="2">Working hours (e.g. day working /24 hour working)</td><td>9</td></tr>
<tr><td>8</td><td colspan="2">Working days/week (e.g. 5/6/7 days per week)</td><td>6</td></tr>
<tr><td>9</td><td colspan="2">Installed capacity of Duct-able Air Conditioning System (kW)</td><td>159</td></tr>
<tr><td>10</td><td colspan="2">Installed capacity of Room Air Conditioning System (kW)</td><td>311</td></tr>
<tr><td>11</td><td colspan="2">Installed capacity of Air Cooling System (kW)</td><td>455</td></tr>
<tr><td>12</td><td colspan="2">Installed lighting load (kW)</td><td>183</td></tr>
<tr><td>13</td><td colspan="2">Installed Fanning load(kW)</td><td>133</td></tr>
<tr><td>14</td><td colspan="2">Installed Computer, Printer etc load (kW)</td><td>60</td></tr>
<tr><td>15</td><td colspan="2">Installed Pumping Load (kW)</td><td>66</td></tr>
<tr><td>16</td><td colspan="2">Installed Street Lighting Load (kW)</td><td>26</td></tr>
<tr><td>17</td><td colspan="2">Installed Heating Load (kW)</td><td>162</td></tr>
<tr><td>18</td><td colspan="2">Installed Extra Load (Water Cooler ,Electrical Cattle ,Freeze ,TV etc) (kW)</td><td>79</td></tr>
<tr><td></td><td colspan="2">Total Electrical load (kW)</td><td>1633</td></tr>
</table>

Table 1: Building details for baseline reference (Ref: Energy Audit Report)

5.0 Key Performance Indicators (KPI)

LNMIT is a technical institute where varieties of programs (conferences, events etc) take place every year , beside this there is a progressive additions/alterations in buildings, lab facilities , additions of new courses etc. Thus the energy /resource use pattern may vary due to these factors. The factors which can contribute to the energy use variance are also to be identified and properly apportioned while comparing the resource use pattern with the baseline year. The following Key performance indicators are recommended to be used for evaluating the progress of green campus initiative .

A) Electrical Energy : kWh/sq.meter (for identified non conditioned area)

kWh/sq. Mtr (for identified conditioned area)

Occupancy in assessment year/ occupancy in baseline year . this factor can appropriately be used for energy use comparisons.

Apportioning of energy use for conferences, seminars, events to be done in comparison to similar events in base line year and energy use to be discounted by the factor as per the merit. The methodology can thus crease out any spikes in energy use pattern.

B) Renewable Energy use : Baseline year – Nil

Assessment year – percentage contribution in total energy use.

C) Water use – litres/person/day basis for comparison of assessment year with baseline year .

D) Green Cover : No of trees in assessment year to no. of trees in baseline year and its percentage increase.

6.0 Energy use analysis (Electricity)

The Energy consumption pattern during the base line year and in the current year is as per Table 2

	EnergyConsumption (units)		ElectricityBill (Rupees)		ElectricityRate (Rs/Units)	
	Year15-16	Year16-17	Year15-16	Year16-17	Year15-16	Year16-17
April	183850	120670	667462.9	1028146	7.45	7.45
May	251540	277840	1751794	1104501	7.45	7.45
June	123490	239730	2017782	1979314	7.45	7.45
July	205280	211930	1715453	1738058	7.45	7.45
August	218320	166220	1819799	1410110	7.45	7.45
September	245957	236010	2064271	1646799	7.45	7.45
October	210350	260310	2020906	2043446	7.45	7.45
November	179130	196690	2167089	1808207	7.45	8.35
December	130310	107430	1108520	1081405	7.45	8.35
January	116700	89670	997116	1220392	7.45	8.35
February	165480	137550	1364865	1342995	7.45	8.35
March	133530	102490	1168947	1005099	7.45	8.35
Average	180328	178878	1572000.4	1450706		

Table 2: Energy Consumption pattern (Ref: Energy Audit Report)

The connected load of LNMIT is of mixed nature with loads such as air-conditioning/cooling, illumination, pumping, lab instruments etc. The details of the connected load based on different building blocks are as per Fig 2.

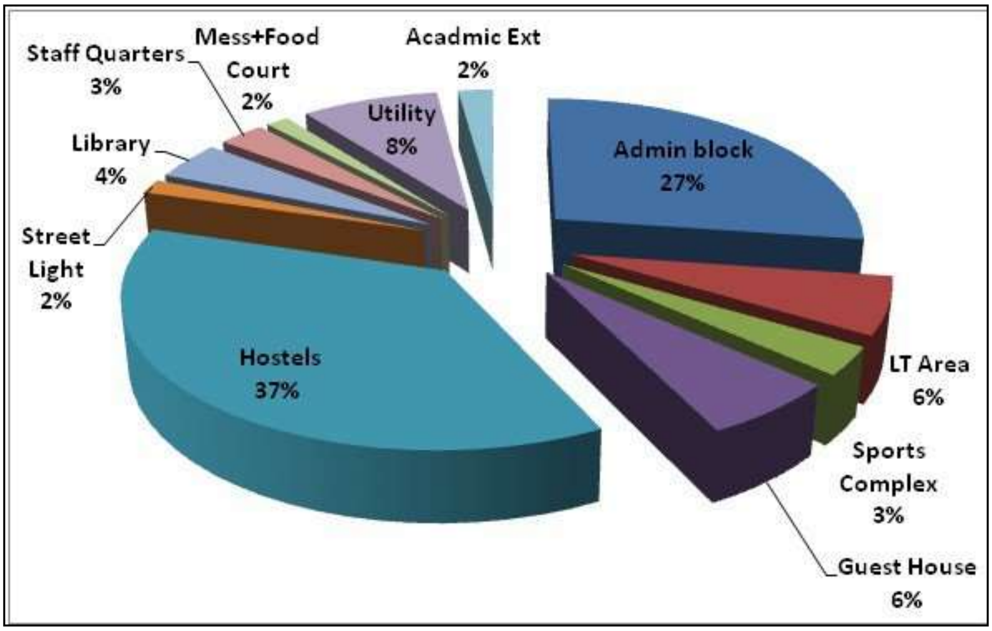


Fig 2: Building wise connected load. (Ref: Energy Audit Report)

The load details as per energy use application are as per Fig 3 below. Space cooling / conditioning both contribute nearly 57% to the connected load and consumption.

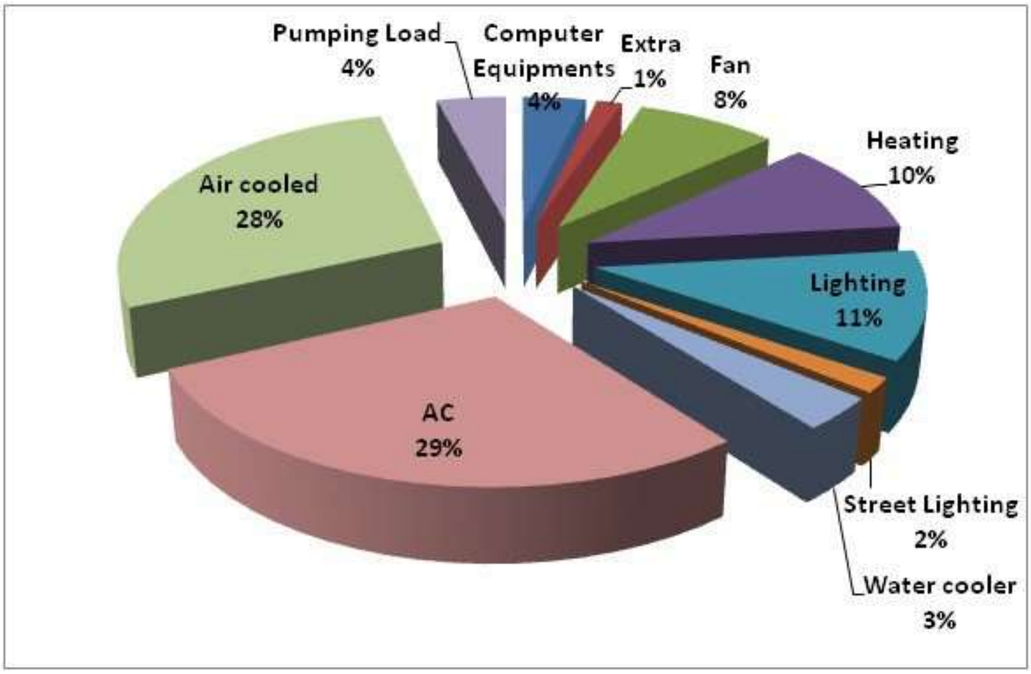


Fig 3: Application wise load details. (Ref: Energy Audit Report)

The equipment wise connected load is as per Fig 4. This covers the entire mapped load/consumption points at LNMIIT.

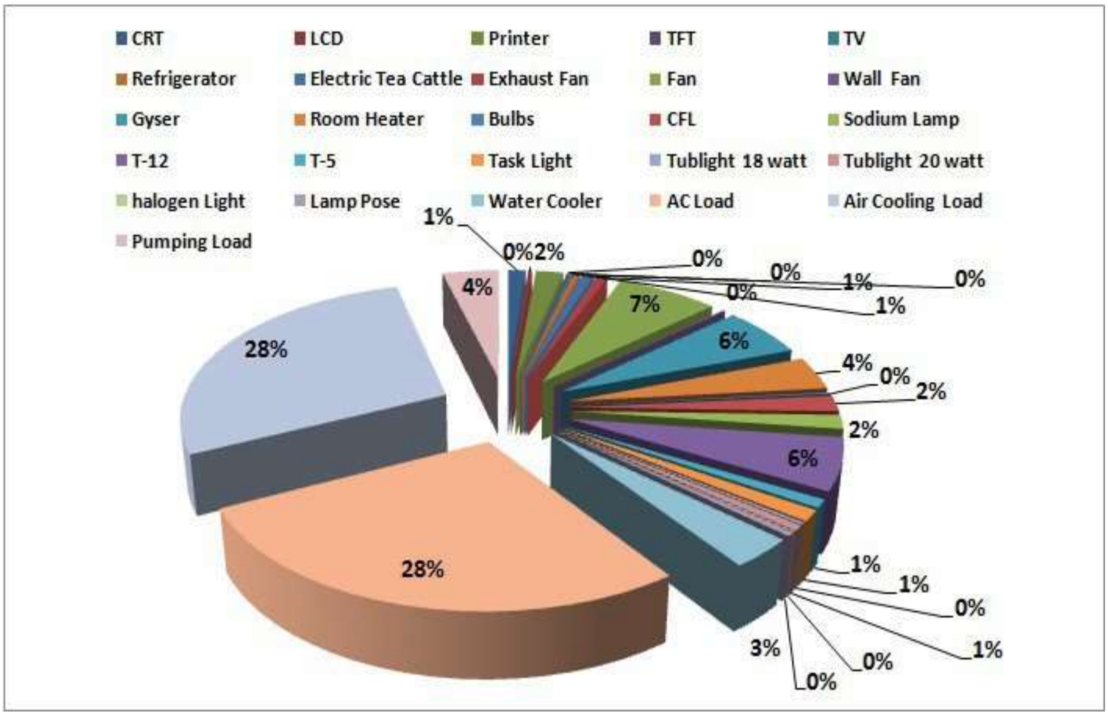


Fig 4: Equipment wise load details. (Ref: Energy Audit Report)

7.0 Water Use Analysis

The institute is not within the supply network of PHED water supply and has to meet its entire requirement from the ground water extraction. The water is hard and therefore two softener plants of capacity 450 KL and 80 KL are respectively used for piped water supply within the premises. The source of water supply is from the captive 06 no's of bore wells. The measured flow rate of the bore wells is as under

Water flow measurements

1. Bore-well no 1: .0027 m3/s (162 LPM)
2. Bore-well no 2: .0026 m3/s (156 LPM)
3. Bore-well no 3: Not working at the time of measurement
4. Bore-well no 4: .0018 m3/s (108 LPM)
5. Bore-well no 5: .0033 m3/s (198 LPM)
6. Bore-well no 6 : .0036 m3/s (216 LPM) operated by Solar PV system

Out of the above two of the bore wells are dedicatedly used for the softener applications while one bore well is used for the purpose of gardening. The presence of hardness renders the raw water use for limited applications as it results in clogging of the supply pipes. The water supply map of the institute is as per Fig 5 below

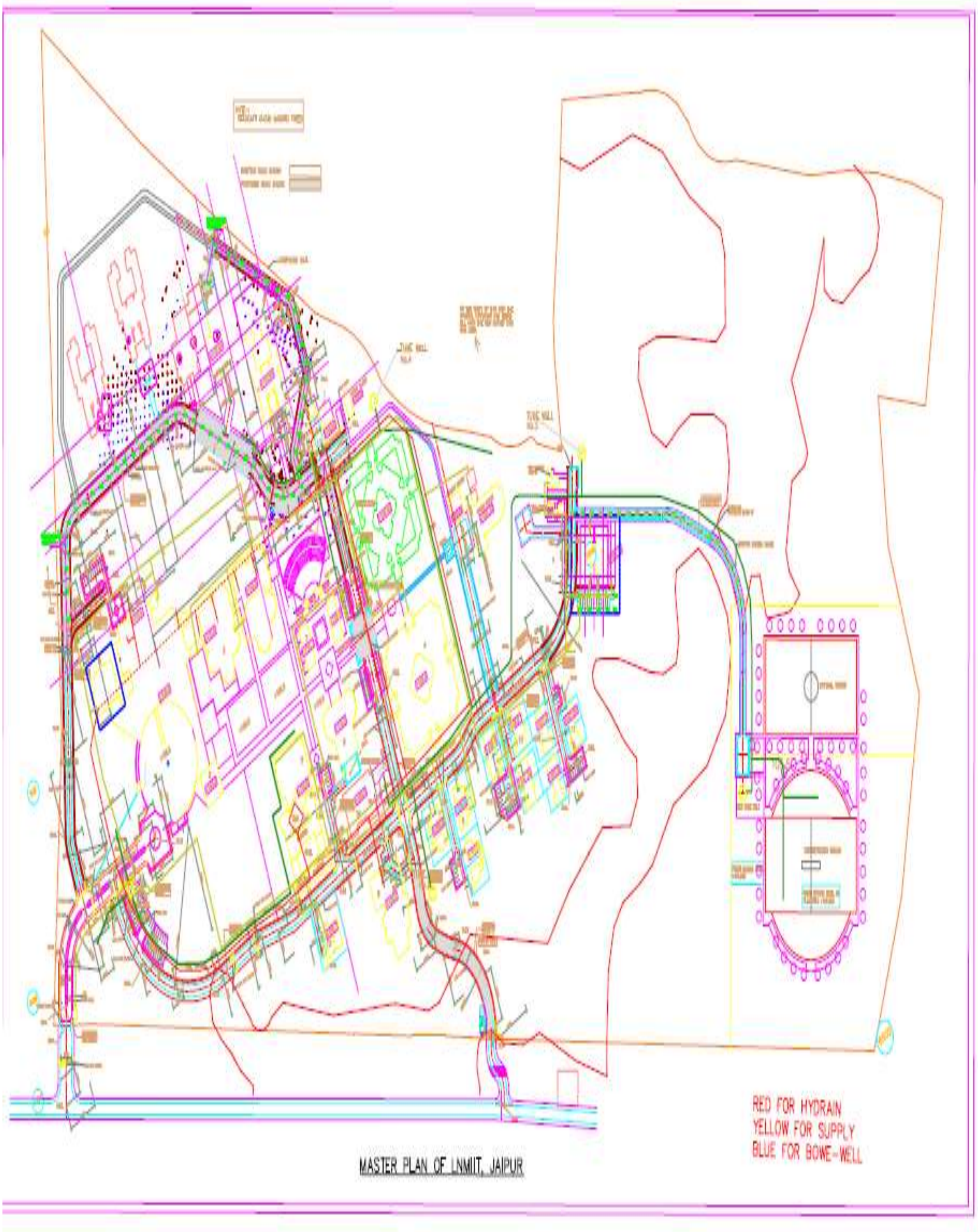


Fig 5: Water Supply Map of LNMIT

Water Quality:

The extracted ground water has high level of hardness which makes the use of softener essential. Secondly the regeneration of softener entails regeneration and backwash which is categorised as waste water as it cannot be directly used for other purposes. It clogs even the PVC pipes severely hence cannot be used for flushing purposes in restrooms even.

the water quality is assessed periodically and the soft water is tested on a daily basis for hardness. The typical values of the raw water are as per Table 3 below

WATER TESTING REPORT (MAY 2016)

Particulars	Requirement (Acceptable Limit) as per IS 10500 : 2012	Observed Value (Playfield)	Observed Value (F Quarter)	Observed Value (Sub-Station)	Observed Value (Food court)	Observed Value (Guest House)	Observed Value (Center Plaza)	Observed Value (Raw water WTP)	Observed Value (Softner 1 inside WTP)	Observed Value (Softner 2 Outside WTP)	[illegible] Apartment
Color (Hazen)	5.00	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5
Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
Turbidity (NTU)	1	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)
pH	6.50 - 8.50	7.16	7.58	7.61	7.24	7.21	7.37	7.78	7.71	7.69	7.34
Hardness (Total) (mg/l)	200.00	464	350	550	[illegible]	300	420	[illegible]	392	415	[illegible]
Iron (mg/l)	0.3	BDL(<0.01)	0.06	BDL(<0.01)	0.03	0.05	0.11	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)
Chloride (mg/l)	250.00	266.72	353.72	451.06	474.54	304.10	779.05	555.54	608.94	712.55	304.02
Total Dissolved Solid (mg/l)	500.00	1009	1241	2217	2095	1169	2401	1888	1898	1913	1266
Calcium (mg/l)	75.00										
Sulphate (mg/l)	200.00										
Fluoride (mg/l)	1.00	0.43	0.60	0.67	0.78	0.63	0.9	0.68	0.82	0.75	0.55
Arsenic (mg/l)	0.01										
Free Residual Chlorine (mg/l)	0.20	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)	BDL(<0.1)
Alkalinity - t (mg/l)	200.00	332	320	500	404	368	508	412	440	424	392
E-Coli (mpn/100ml)	Shall not be detectable in 100ml sample	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Total Coliform (mpn/100ml)	Shall not be detectable in 100ml sample	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected

Table 3: Water Quality report (Ref: Water Testing Report)

Water Consumption:

The water consumption pattern for the year 2017 is as per Table 4 below. The average consumption on per day basis works out to be 487.14 KL /day

Sl.no	Month	Avg. Water consumption/day KL
1	January 2017	463.81
2	February 2017	381.21
3	March 2017	485.21
4	April 2017	585.76
5	May 2017	524.61
6	June 2017	511.03
7	July 2017	406.51
8	August 2017	566.03
9	Sept. 2017	460.09
	Average	487.14

Table 4: Soft water consumption at LNMIT (LNMIIT Data Record)

Considering an average presence of 2000 persons/day the soft water consumption comes to 243.57 litres/ person/day. (Including staff quarters, mess , halls of residence etc).

Zero Discharge Institute

The water usage cycle at the institute is per Fig 6 below. The total wastewater generated is treated at the captive sewage treatment plant and the treated water is used back in gardening. LNMIT, thus is a zero discharge institute.(red line is for waste water and blue is for soft water respectively)

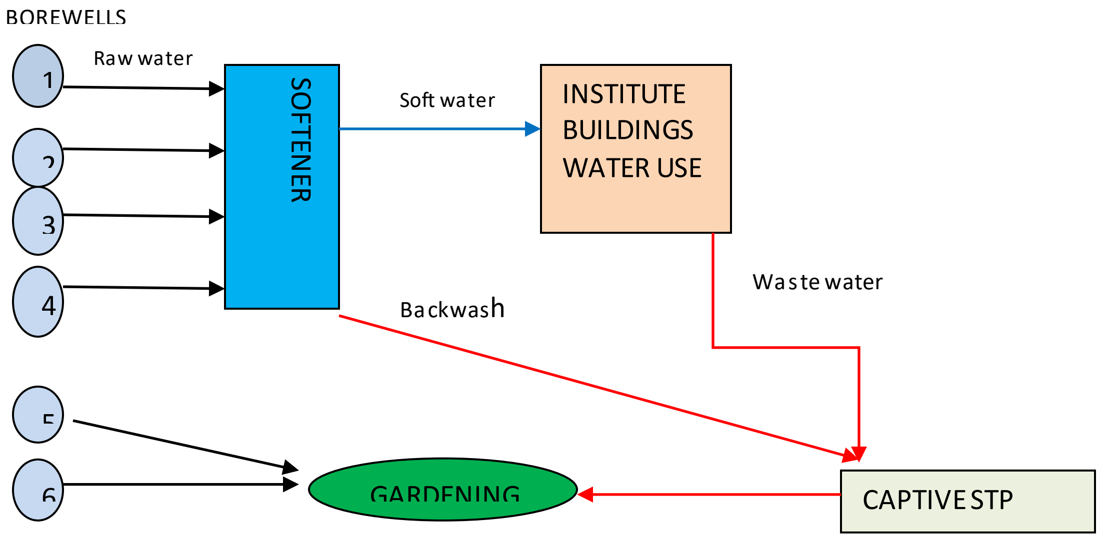


Fig 6: Zero water discharge

Rain Water recharge

The entire building blocks at LNMIT has rain water harvesting arrangement . The roof top rain water collection and all the storm water drains and connected to the rain water harvest pit at the institute.

8.0 Other Energy Resources

The following are the other fossil fuel energy resources being utilised at the institute

A) LPG consumption in hostel mess
B) Diesel consumption for Diesel Generator sets
C) Transportation fuel for commuting

The LPG consumption at the institute is as under

Sl.no	Month	Commercial LPG cylinders 19 kg.
1	October 2016	103
2	November ‘16	115
3	December ‘16	71
4	January 2017	122
5	February 2017	101
6	March 2017	96
7	April 2017	95
8	May 2017	54
9	June 2017	96
10	July 2017	118
11	August 2017	127
12	Sept. 2017	96
	Average	99.5 or 100 no’s

Table 5: LPG Consumption at the institute (Ref: LNMIIT Data Record)

The DG sets are for standby applications. The electrical energy (units) are already covered in the preceding sections.

As LNMIT is a fully residential institute and no internal transport arrangement is used by the students. Hence the consumption for transport is marginal and has not been quantified. A bus only makes a round/day for staff which as well provides a facility to students for market visit.

9.0 Waste minimisation

The institute is in the process of minimizing its waste. This shall be taken up as a student's participation project covering the following

A) Identification of all waste produced at the institute
B) Quantification of waste
C) Reusability of waste
D) Waste minimization strategies

The institute is committed to systematically eliminate /minimize & recycle all types of waste. Student's participation shall help to achieve the objectives in a participative way.

10.0 Green Coverage

The institute has more than 5000 trees at its 100 acres campus. The aerial view is as per Fig 7 below.

Fig 7: Aerial view of the institute

Tree plantation during visit of dignitaries and events is a regular feature at the institute. The institute also plants trees on an annual basis during the rainy season.

11.0 Time Lines and Proposed Initiatives

In order to progressively address to the identified objectives of energy use optimisation, other resources utilisation, waste minimisation, promoting and blending the use of renewable energy systems (RES) in existing energy usage , water use reduction, increase of green coverage etc. the incremental targets of reducing from baseline line year by 5 % has been considered. With this there shall be a major reduction of around 25% by the end of year 2022. The major thrust is expected to come from renewable integration as after the base line period the institute has deployed rooftop grid connected SPV system of 205 kWp and proposals are underway to further enhance it. Further after the base line year the institute has also commissioned its biogas plant for use of alternate fuel to mess kitchens. Being a technical institute the project was developed in-house. Projects are underway with student's participation to use internet of things (IOT) for developing products for energy monitoring and optimisation. The following projects have been identified which are proposed to be undertaken based of available grants to meet the objectives

DPR for Renewable Integration (Report attached)

Solar energy is increasingly being recognized as the alternative energy source of the future as it is non-polluting and helps to decrease the greenhouse effect of fossil fuels on global climate. Solar energy's principal advantage is that it's a free source of energy, found in abundance. The LNM Institute of Information Technology (LNMIIT) can utilize solar energy in two ways:

- Photovoltaic (PV) solar power to generate electricity
- Thermal solar power to provide a steam cooking system

Electricity

The LNMIIT has sufficient rooftop space to install the required amount of PV modules to provide the necessary capacity. The cost of a PV system has decreased in recent years, and the estimated payback period is now about four years if the system is integrated with the grid (with net metering). The LNMIIT installed a 205 kWp (kilowatt peak) solar power plant using its CapEx model in March 2016, generating 312,438 kWh (kilowatt hours) of electricity. The total recommended solar plant capacity is 1,000 kWp (including the already-installed 205 kWp).

The recommended financial model is the Renewable Energy Service Company (RESCO), in which capital expenditures (capital, installation, operational, and maintenance costs) are covered by a third party. The differential cost between the current utility's (Jaipur Vidyut Vitran Nigam Ltd., or JVVNL) tariff and the power purchase agreement (PPA) authorizing a prospective project implementer is the recurring savings for the Institute. The expected annual power generation is approximately 1,250,000 kWh which is about 60% of the Institute's annual consumption.

Steam Cooking

As it is compulsory for students to stay in hostels, approximately 1,500 people dine in mess halls. So, a concentrated solar steam cooking system may be a suitable option. Solar steam cooking technology is mature and can provide the facility to prepare boilable food (rice, rasam, daal, vegetables, idli sambar, and eggs, etc.) and hot water for cleaning. The technology involves focusing solar radiation on a receiver, which exchanges the heat with a thermal medium. The proposed financial model for this is, again, a RESCO. In case of this model, the service provider would cover all expenditure (installation, operations, and maintenance costs). The profit (energy savings) would be distributed between the service provider and Institute, according to the contract established before installation. The estimated payback period for a solar cooking system is approximately five years. However, at present, no subsidies are available for these systems.

<u>DPR for energy efficient lights (Report attached)</u>

The lighting load used to power electric lights is about 13% of the Institute's total energy load. Most of the installed lights are inefficient conventional lighting with no energy-efficient LED lighting. LED lights with the price advantage can be used to replace conventional lighting can maintain the same light (lux) level.

The majority of lights are in administrative and classroom areas, which use 2,224 FTL-12 bulbs, each consuming 40 Watts. Replacing these with 15-Watt LED lights would maintain the same lux level. The expected payback period for replacing bulbs is approximately 10.5 months (.89 years).

In hostel corridors, which use 225 FTL-12 conventional bulbs consuming 36 Watts each, which provide a lux level greater than required. The recommended LED replacement bulb is an 8-Watt model, and the expected payback period is approximately four months (.35 years).

In hostel rooms, there are currently 1,140 task lights, each consuming 18 Watts. The recommended LED replacement is 8 Watts and the expected payback period is approximately twenty six months (2.21 years).

For street lighting and the indoor sports area, 165 sodium lamps are consuming 150 Watts each. The recommended LED replacement is 60 Watt. Also in the street, there are currently five halogen bulbs, three consuming 400 Watts each, and two consuming 150 Watts each. The recommended LED replacement is 56 Watts. The capital cost recovery time for replacing sodium and halogen lamps on the campus is approximately 1.25 years.

Library and toilet areas have the potential to save energy by use of automated tools such as motion sensors and occupancy sensors to switch on lighting when the area has an occupant, and switch off when it is unused. This can significantly reduce power consumption as these places have long periods of not being used when, at present, lights are still burning. Using sensors, the Institute can save up to 60% of its lighting energy in toilet areas and up to 50% of its lighting energy in the library. The payback period for replacement of conventional lighting in these areas and replacement with energy-efficient LED lighting, and the utilization of motion sensors in toilet areas and the library is less than one year (.9 years).

<u>DPR for Hybrid waste water treatment plant with embedded intelligent controls (Report attached)</u>

Most of the waste water treatment plants (WWTPs) in India are conventional in nature. These are mostly kept in unhygienic conditions, without smart controls and consume an external source of energy which are generally operated manually hence demanding the manpower. The proposed system is to utilize the waste water obtained from the source to first separate the primary sludge through some suitable technique and then treated through biological method for the treatment. Alternately the secondary treatment may be through the conventional DAF and secondary settler method. The existing WWTP would be modified to generate the biogas from the waste Primary sludge in an Anaerobic Digester (AD) which will be utilized in a biogas operated engine generator. The biogas produced from AD would be enriched to produce pure CNG like gas by compressing and purifying it in biogas purification plant or through any other suitable modified methods developed as a part of the overall research. This modified system would have combined heating and power (CHP) or cogeneration facility based on the biogas operated engine to generate heating and electrical power and energy in general in addition to treating the waste water of the WWTPs.

The biogas-diesel dual fuel engine generator would produce the electrical power and heating from the single source of fuel which is a waste sludge obtained from the WWTP itself. The proposed set-up would produce simultaneous heating and power, part of which would be utilized to fulfil the energy requirement of the WWTP and remaining for supplying to another process or grid. A generator/alternator will be coupled to the dual fuel engine to develop electrical power. The dual fuel engine can work on Biogas or diesel/biodiesel or both fuels combined in dual fuel mode. The remaining waste water after separation of the primary sludge is processed by the suitable biological methods. The processed water can be reused in gardening, agriculture and support marine life.

The proposed plant is proposed to be fully automated and shall have smart monitoring systems with the help of IoT (Internet of Things). After collecting sufficient amount of information the CPU or the master controller shall process the information with the help of an algorithm like Petri-nets or Prediction (HMM, KPN, KNN, feed forward etc.) to generate the human readable information. In the proposed project petri-nets will be helpful to implement N schemes based model of the plant to understand the discrete-continuous process of the system. Thus the proposed set up shall have smart embedded controls for information and controls.

<u>DPR for Energy Efficiency in HVAC (Report attached)</u>

The HVAC load is 1053 kW or 64.5% of LNMIIT's total electric load. The Institute's lecture halls, labs, hostel room, and faculty rooms are air-conditioned and air-cooled. The HVAC load covers both, as well as fan and exhaust fan loads.

At present, there are 61no's installed split/window air-conditioners that are not rated or operating at inefficient energy levels. Proposed energy-efficient replacement air-conditioners are BEE-rated five stars. Their expected payback period is approximately 22 months (1.85 years).

The current air cooling system has no provision to control the speed of blower to maintain room temperature. The cost of fitting 58 VFDs is approximately 9.5LAC, with expected payback in approximately 15 months (1.23 years). The water pump in the current air-cooling system is oversized. Its present capacity is .5 HP, while the recommended capacity of the BEE-rated pump is .25 HP. The expected payback period associated with replacing current pumps with BEE-rated pumps is approximately seven months (0.56 years).

The 1,476 installed wall-mounted fans and 172 exhaust fans are all non-rated, energy-inefficient models. The estimated payback period for replacing the wall-mounted fans with BEE-rated energy-efficient models is approximately 42 months (3.73 years), while the payback period for replacing the exhaust fans with BEE-rated energy-efficient models is about 15 months (1.27 years).

For replacement of all HVAC elements, the average overall payback period is approximately 23 months (1.86 years)

DPR for Water Use Reduction

The LNMIIT has to meet its entire water requirement from groundwater extraction using six bore wells. Groundwater is hard, so softeners are required to make the water usable.

Further , the Institute uses a total of 340 reverse osmosis (RO) units of different capacities to produce drinking water throughout the campus. The measured overall efficiency of these ROs is 25% . This implies that for every litre of potable water produced, three litres is converted into wastewater. The proposed solution includes centralizing a large, multi-stage RO plant in place of hundreds of discreet RO units. This shall also result in energy savings. The centralized RO systems have large membranes which can be subjected to periodic cleaning and thus the life is also more. The DPR also proposes use of multi stage RO system where in the reject of the first membrane in fed to the second membrane for treatment of reject water and the outlet streams are combined for singular output. This arrangement has overall 70-75 % yield efficiency and can result in enormous water savings for the institute.

A Leakage test was also conducted in a few building complexes of the institute and the results demonstrated that approximately 3%-3.5% of water is lost due to leakages in variety of discharge points.

Now a days proven and low cost attachments are available in Indian market and these have the capability of reducing water discharges by nearly 30-40% and are termed as Low-discharge fittings. Sensor-based urinals can as well save up to 40% of water use compared to other available systems. These systems can be integrated in the existing fittings of the institute.