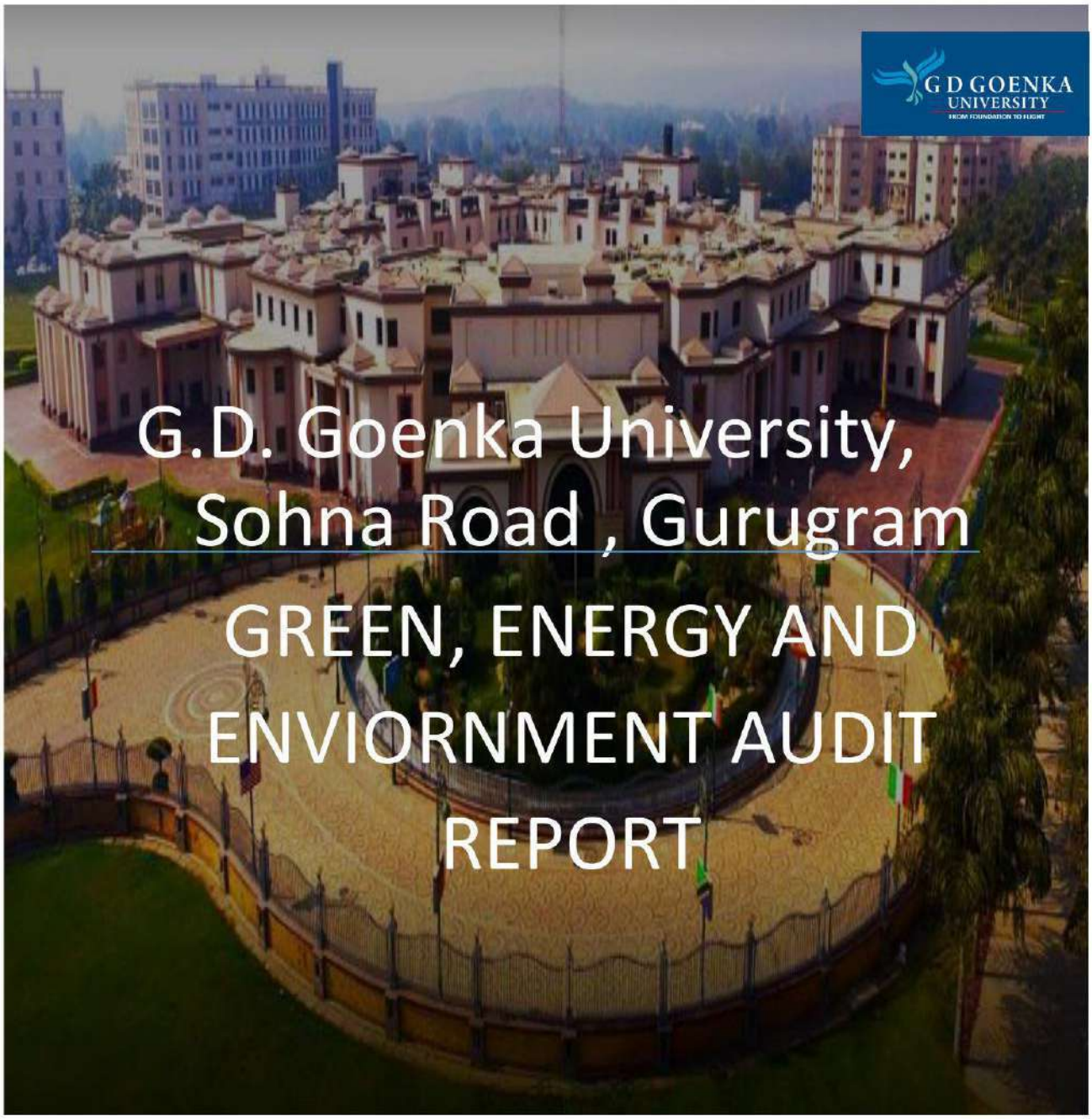

G.D. Goenka University, Sohna Road , Gurugram

GREEN, ENERGY AND ENVIORNMENT AUDIT REPORT

Report

On

Green, Energy & Environment Audit

For

G D Goenka University
Sohna 122 103

Prepared

By

Senergy Consultants Pvt. Ltd.
Mumbai 400 088

December 2023

Helping You to Conserve Energy

Contents

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I

Introduction

Green, Energy & Environment Audit was undertaken at G D Goenka University (Sohna Gurgaon Road Sohna 122103) during the month of December 2023.

The university is very keen to promote green culture wherever possible, as a commitment towards better environment and conservation of energy. A lot of efforts have already been put up to bring down the carbon footprint. To further optimize consumption and identify saving opportunities, M/s Senergy Consultants was assigned to carry out Green, Energy & Environment Audit of the premises.

This Audit Report presents the analysis of the data collected, observations made at the facility and is governed by the objectives, scope of work, methodology etc. discussed in the ensuing paragraphs.

Team:

The team members of the audit study.

- Mr Ravindra Datar
- Nitesh Kharche
- Pranav Shinde

Acknowledgment:

We would like to extend our sincere gratitude to Dr. Manvi Arora and Mr. Vipul Pandey for generously providing us with the opportunity to conduct this audit and for their unwavering support throughout the process.

A special acknowledgement goes to Prof. B. S. Satyanarayana, Vice Chancellor, GD Goenka University, and Prof. (Dr.) Anuradha Tiwary, Registrar, GD Goenka University, whose instrumental guidance and encouragement were invaluable during every stage of the audit.

Our heartfelt thanks are also extended to Dr. Arpita Sharma, Prof. (Dr.) Naresh Sharma, and Major Kartikey Sharma for their essential assistance and cooperation, which significantly contributed to the success of the audit.

Lastly, we express our appreciation to all those who, whether directly or indirectly, played a role in the successful completion of this audit.

Thank you all for being an integral part of this audit.

II
Executive Summary

The premises were evaluated against the various criterions laid down by the various Ranking and Accreditation agency. The major observations are:

Renewable Energy:

- The Roof-top Solar Photovoltaic System with grid synchronization is installed on most of the roofs.
- The hostels are installed with heat pumps for generating hot water, while Roof-top Solar Photovoltaic System with grid synchronization is installed on the roofs. This is more efficient and effective methods for energy optimization.
- The possibility of installing biogas plant from canteen waste is being assessed and planned during the next semester. This could reduce LPG consumption in the canteen, while generating organic manure. The University has already installed compost pit, while remaining food waste is handed over to an agency for composting. The agency provides organic manure for gardening and plantation.

Green Campus Initiative:

- The movement of vehicle inside the campus is restricted and limited to cater to very few and specific requirements.
- Pedestrian friendly pathways have been constructed for easy movement inside the campus.
- The electrical vehicles, bicycles are available for in-campus movement.
- There is a ban on plastic usage inside the campus.
- The campus is surrounded with a lot of greenery, trees, and proper landscaping.
- The campus has sewage treatment plants to treat the entire sewage is treated; which is then used for gardening. There is no discharge of treated water outside campus.
- The rain water in the entire campus (rooftop as well as open areas) is systematically collected and fed back in to the soil for ground water recharge. There is marked improvement in the water table over a period time after incorporating this path breaking rain water harvesting technique.

Environment & Energy Initiative:

- There are multiple activities and initiatives taken for conservation of energy and environment.

Air Quality & Ventilation:

- The entire space is air conditioned and properly ventilated to ensure proper air quality.
- The fans are appropriately installed to ensure proper air circulation and minimize load on the air conditioning.
- The outdoor plants have also been provided to improve the environment.

Lighting System:

- The usage of natural light is optimized through well designed structure and windows.
- Almost all the light fitting are provided with high efficiency LED lamps.
- The lighting in washrooms and common area is being automated with sensor based control.

Water Quality & Conservation:

- The ground water drawn through a set of three bore wells and further treated depending on the usage.

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- The drinking water is filtered and purified with RO (Reverse Osmosis Members) Mechanism to maintain requisite quality and eliminate usage of bottled water.
- The cooking water is filtered and softened to meet the quality requirements.
- The quality of water is checked at regular interval.
- Water coolers are provided at appropriate and convenient locations.
- The distribution network and piping are more or less satisfactory and adequate.
- The toilets are provided with water efficient (low usage) fittings
- The rain water in the entire campus (rooftop as well as open areas) is systematically collected and fed back in to the soil for ground water recharge. There is marked improvement in the water table over a period time after incorporating this path breaking rain water harvesting technique.

Waste Management:

- The campus has sewage treatment plants and the entire sewage is treated and used for gardening. There is no discharge of treated water outside campus.
- The organic waste is segregated and fed in the composting pit, while remaining food waste is handed to an agency for composting. The agency provides organic manure which is used for gardening and plantation. Separate dustbins have installed for collection of dry and wet solid waste at various locations.
- There is no hazardous or medical waste generated in the University.
- The electronic gadgets mostly slightly obsolete computers are donated to nearby schools.
- The waste paper is handed over to the Agency for recycling / reprocessing; a part of which is reused in the campus.

Air Conditioning System:

- The entire campus is air conditioned with centralized Chilled Water Systems and Variable Refrigerant Volume (VRV) based air conditioning units. The operation is automated to optimize the consumption.
- All the windows are provided with Double Walled Glass (DWG) windows to ensure minimal heat gain / loss.
- The outer glass pane of the windows is tinted / glazed to minimize heat gain due direct solar rays and radiations.
- The centralized chilled water air conditioning poses challenges as segregation of empty / vacant spaces is difficult. This is being progressively replaced with VRV based system.
- The room temperature is maintained at 24 to 25 °C, which is well within the recommended values.
- The Air Conditioners are serviced regularly and properly maintained.
- The performance of the centralized chiller is monitored and appears to be satisfactory.
- The VRV and other Air Conditioners units are energy efficient.
- The air conditioned space is properly sealed to prevent air ingress / cold air loss.

Infrastructure usage:

- The construction of lifts for faculty members is currently underway, with the additional aim of addressing the needs of differently abled individuals.
- Ramps are provided at requite locations to address the needs of differently able persons.
- The on-campus movement is distributed with multiple entrances as well as staircases.
- The university campus is equipped with hostels and centralized dining hall for boarding over 1000 students.

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- The campus houses a resident medical doctor and nurses to address medical needs of the residents. The university has tie up with hospitals for quick medical treatment. An ambulance is stationed on campus for medical emergencies.
- The campus has well equipped gymnasium with indoor swimming pool and shooting range as well as play grounds for various outdoor games.
- The campus has a fire tender to address any fire incident. Fire training ground is also available for regular trainings of students, faculties and housekeeping staffs.
- The main building is provided with pressurized water system as a firefighting measure. The fire hydrants are provided at strategic locations for immediate mitigation of any fire incidence.
- The fire extinguishers, fire alarm and fire sprinkler are provided at key areas.
- The draining system for washrooms is efficient and effective.
- There were no seepages observed in the building premises.

Green IT culture:

- The Energy efficient computers and laptops have been procured.
- The electronic communication is encouraged to minimize usage of papers.
- Most of the papers are reused for doubled sided printing to further minimize usage of paper.

Suggestions:

- The performance of Roof-top Solar Photovoltaic System may be monitored for further optimization.
- The difference between KVAH and KWH consumption may be minimized with more effective power factor management to minimize power cost.
- Around 1,25,000 KWH (Rs 7,50,000/-) could not be carried forward by end of March 23 and was lost. The possibility of switching over the PV generation to the World School connection may be assessed to eliminate the losses.
- The sewage treatment plants may be operated more effectively and efficiently.
- The sensor based control for lighting extended to cover classrooms and other common facilities.
- The water drawn through the bore wells may be metered and monitored for better control over water consumption.

Energy Performance Index:

Description	Unit	Value
University	M^2	102028.6
Total Area	M^2	102028.6
Annual Consumption	KWH	6047773.9
Energy Performance Index	$KWH/M^2/Year$	59.28

The energy performance index is quite decent considering almost all the space is air conditioned.

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BEE table for Star Rating of Office Buildings

6. STAR RATING TABLE:

The Star Rating Band is formed by straight line equations is in the form y=(a*b) +c, where 'b' denotes the percentage of AC area out of total built-up area.

Table for Star Rating of the Office Building

Climatic Zone	Building Category	1 Star	2 Star	3 Star	4 Star	5 Star
Composite	Large Office	y = 0.95x + 60	y = 0.9x + 50	y = 0.85x + 40	y = 0.8x + 30	y = 0.75x + 20
	Medium Office	y = 1.1x + 60	y = 1.05x + 50	y = x + 40	y = 0.95x + 30	y = 0.9x + 20
	Small Office	y = 0.65x + 60	y = 0.6x + 50	y = 0.55x + 40	y = 0.5x + 30	y = 0.45x + 20
Warm & Humid	Large Office	y = 0.9x + 65	y = 0.85x + 55	y = 0.8x + 45	y = 0.75x + 35	y = 0.7x + 25
	Medium Office	y = 0.9x + 65	y = 0.85x + 55	y = 0.8x + 45	y = 0.75x + 35	y = 0.7x + 25
	Small Office	y = 0.7x + 65	y = 0.65x + 55	y = 0.6x + 45	y = 0.55x + 35	y = 0.5x + 25
Hot & Dry	Large Office	y = 1.1x + 55	y = 1.05x + 45	y = x + 35	y = 0.95x + 25	y = 0.9x + 15
	Medium Office	y = 1.25x + 55	y = 1.2x + 45	y = 1.15x + 35	y = 1.1x + 25	y = 1.05x + 15
	Small Office	y= 0.75x + 55	y = 0.7x + 45	y = 0.65x + 35	y = 0.6x + 25	y = 0.55x + 15

Sample Calculation:

The equations provide the upper limit of the corresponding Star Rating. Lower limit will be the value obtained by the equation of next higher rating.

For Example: Any Large Office Building in Composite climatic zone, having 75% AC area

Highest EPI value for 1-Star should be less than: 0.95*75 + 60 = 131.25 kwh/sqm.

Lower limit for 1-star building will be: 0.9*75 + 50 = 117.5 kwh/sqm.

III
Electrical System

Lamps:

The lamps have been replaced with high efficiency LED lamps in almost all the areas, including offices, class rooms and street lights. The lighting in washrooms and common area is being automated with sensor based control.

The details of light fittings is as under.

Location	LED Lamps	
	36 W	10 W
Phase 2 Hostel	418	216
Dining	300	240
Fitness	180	50
Hercules	130	50
Guest house	40	28
Sophia hostel	104	84
Academic building	900	114
Lab building	548	30

Figure 1-Sensor based control for washrooms

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Fans:

The fans are with conventional motors and with electronic regulators. As all the area is air conditioned, the fans are operated at lower speed to facilitate better air circulation; which could effectively save on the power conditioning area. The details of fans is as under.

Location	Ceiling fan
Phase 2 Hostel	158
Dining	140
Fitness	50
Hercules	120
Guest house	15
Sophia hostel	84
Academic building	480
Lab building	175

The possibility of replacing conventional fans with energy efficient fans with BLDC motors may be assess, especially while new procurements.

Air Conditioning Units:

The present system consists of centralized chilled water system along with some VRV Unis, split AC units and precision AC in UPS and server rooms. The chilled water system primarily consists of 2 Water cooled centrifugal chillers (550 TR X 2 nos.), Primary chilled water pumps (18.5kW X 2 nos.), VFD driven Secondary Chilled Water Pumps (37kW), Condenser Pumps (45kW X 2 nos.) and Cooling Towers (300 TR x 4 nos.). There are over 500 Air Handling Units catering to the need of entire campus. As all the area is air conditioned, the fans are operated at lower speed to facilitate better air circulation; which could effectively save on the power conditioning area.

The system details are as under.

Location	VRV	Chiller
	HP	TR
Phase 2 Hostel	-	1600
	-	
	-	
Fitness	-	
Hercules	-	
Dining	94	-
Guest house	27	-
Sophia hostel	100	-
Academic building	1125	-
Lab building	375	-

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Figure 2-VRV Systems – Outdoor Units

Figure 3-Double Walled Glass (DWG) with tint / glaze to minimize heat ingress

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Figure 4-Controls for VRV Units (remote switching and monitoring)

Computers:

All the computers are with energy efficient LCD / LED monitors. The details are as under

Sr No	Location	Type	Quantity
1	Lab-120	Desktop	30
2	Faculty	Laptop	96
3	Call Center	Camera	9
4	Lab	DESKTOP	22
5	Dining Hall	Fire Alarm	1
6	Outdoor Location	Camera	36
7	Outdoor Location	Accessories. (IO,PowerSupply,FacePlate,RG-6)	22
8	Faculty	Printer	1
9	LIBRARY	Desktop	1
10	Student	Desktop	48
11	Outdoor Location	Camera/NVR	14
12	Hostel	Camera	3
13	D Block	Projector/Screen	12
14	D Block	Accs	8
15	All Desktop & Laptop	Antivirus	400
16	DEAN KIM MINZ	Laptop	1
17	Hostel	D-link	28
18	All Desktop & Laptop	Antivirus	400
19	Maintenance University	Smoke Detector	35
20	Ph-1 Girls Side	Camera/NVR	14
21	Ph-1 Girls Side	D-Link Cable	47
22	Hostel	Camera	6
23	SOFD DEAN	Laptop	1
24	Faculty	ADAPTER	1
25	SOC Lab	Desktop	2
26	MS. PARAMJEET	Desktop	1
27	SOHT Block	Interactive panel	48
28	Hostel	TV	14
29	Guest House	TV	14

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Sr No	Location	Type	Quantity
30	SOHT Block	TV	42
31	Eng. Lab Block	Wi-Fi AP	7
32	VC SIR	Printer	1
33	VC SIR	Laptop	1
34	ADMISSION	Printer	1
35	A1,B,C block & Hostel	WIFI, Switch	277
36	IT Room	Switch L2/L3	1
37	IT Room	Switch	17
38	IT Room	SFP	13
40	Buses	Camera	47
41	SOHT Block	Wall Mounted Huter	1
42	SOHT Block	Fire Detector	63
43	C Block	D-link cable	56
44	C Block	Camera/Fire	181
45	C Block	D-Link Cable	5
46	C Block	Projector/Screen	16
47	B Block	Projector/Screen	22
48	proctor/Staff	Printer	1
49	Eng. Lab Block	Hikvision	13
50	D Block	Printer	1
51	Admin Block	Hikvision	30
52	Dining Hall	Hikvision	24
53	SOHT Block	Hikvision	50
54	EXAM OFFICE/Staff	Printer	1
55	SOE DEAN	Printer	1
56	Staff	Printer	3
57	B Block	Wireless mic	2
58	Hostel	TV	42
59	V C SIR	Laptop	1
60	ADMISSION	Laptop	1
61	MARKETING DIRECTOR	Laptop	1
62	Staff	Printer with Laptop	3
63	SOHT	Epson, HP	4
64	Registrar, Dean Fire	LAPTOP	2
65	A1 Block	Camera	146
66	Hostel	Switch, NVR	13
67	DR UGUR OFFICE.	Printer	2
68	SOE (labs)	Desktop	100
69	DEAN SOM	Laptop	1
70	Staff	Laptop	5
71	IT Room	Fire Detector	25
72	Sophiya Hostel	Accessories. Cat-6 Cable x9, power supply x13	18
73	Sophiya Hostel	Camera	31
74	Ph-3 Girls Hostel	DVR	36
75	SOHT	Biometric Machine	1
76	Guest House	Camera, NVR	10
77	Faculty & Computer Lab	Anti-Virus	400
78	Sophiya Hostel	Access Point/switch	14

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Computer Lab

Miscellaneous Appliance:

These include office equipments like printers, photocopiers, refrigerators, water cooler, laboratory equipments as well as kitchen equipments like cold storage, oven. The appliances are well maintained and operated based on the requirements.

Roof-top Solar Photovoltaic System:

The details of the installed capacity and actual power generation is as under.

Sr No	Location	Invertors	Panels
1	DG room	60	68.25
2	Dining hall	60	74.75
3	A block university	120	140.225
4	B block university	120	134.225
5	C block university	50	61.75
6	Parking	200	234
7	Basement	80	87.75
	Overall	690	800.95

The details of power generation are provided in the subsequent sections.

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Electricity Consumption:

The details of power consumption from total as well as from the grid along with solar power generation is as under.

Month	University		
	DHBVN	Solar	Total
	KWH	KWH	KWH
Dec-22	133453	12921	146374
Jan-23	125574	10160	135734
Feb-23	141387	14474	155861
Mar-23	292012	14661	306674
Apr-23	467452	15563	483015
May-23	592330	15445	607775
Jun-23	526222	13934	540156
Jul-23	520391	12324	532715
Aug-23	700276	13991	714267
Sep-23	732612	12571	745184
Oct-23	512874	14805	527679
Nov-23	230780	9106	239886
Total	**4975364**	**159956**	**5135320**

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V
Environmental System

Ventilation & Air Quality:

The entire space is air conditioned and properly ventilated to ensure proper air quality. The fans are appropriately installed to ensure proper air circulation and minimize load on the air conditioning. The outdoor plants have also been provided to improve the environment.

Figure 5-Windows for Adequate Ventilation

Figure 6- Classrooms with adequate lighting and ventilation

Green campus Initiative:

The entire campus as a large green cover with variety of plants and trees. The details of major plants is as under. The campus is plastic free with. The details of major plants are as under.

Sr No	Description	Quantity	Remarks
1	SNEH PLANT	2500	Drought and Low water required plant
2	TIKOMA	1000	
3	HAMELIYA	2400	
4	GALFENIA	60	
5	ALMUNDA	40	
6	BUGGM BELL	120	
7	LAMUNIA	150	
8	INDOSIA	60	
9	SANOF INDIA	120	
10	AEROKERIA	40	
11	PHYCUS LUDA	15	Drought and Low water required plant
12	PLUMBOO	140	
13	GLLDEN RAISINA	130	
14	CHANDNI	80	
15	MOTIA MOGRA	30	
16	HAAR SINGAAR	6	
17	DRUNDA BAROLIO	250	
18	GOLDEN DRUNDA	5000	
19	ANARMI	6000	
20	AQLIFA	3000	
21	HIBISCUS	2500	Drought and Low water required plant
22	PHYCUS PANDA	4500	
23	CHIKOO	20	
24	ANAAR	15	Drought and Low water required plant
25	GUAVA	25	Drought and Low water required plant
26	LIME	10	Drought and Low water required plant
27	EPIJANA	6	
28	AMLA	10	Drought and Low water required plant
29	MEHENDI	8	Drought and Low water required plant
30	CURDSULA	10	Drought and Low water required plant
31	RED GUIMOHAR	1	
32	PLUMERIA	25	
33	RED PUFF PLANT	8	
34	SNAKE PLANT	15	
35	ARECA PLAM	15	Drought Plant
36	FISH TAIL PALM	25	Drought Plant
37	IXORA	5	
38	ARAUCARIA	10	
39	ALMANDA	2	
40	CANNA	25	
41	CYPRESS	7	
42	MADHUMALTHI	1	
43	CITRUS (Orange)	2	
44	ALOEVERA	15	Drought Plant
45	PAPAYA	5	

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Sr No	Description	Quantity	Remarks
46	TULSI	20	
47	PATTARCHATTA	25	Drought Plant
48	SADABHAR	15	
49	ATIBALA	10	
50	APAMARGA	10	
51	PILKHAN	67	
52	ALOSTONIA	80	
53	KAJRINA	30	
54	ISPOTHODIYA	12	
55	SILVER ROCK	155	
56	PAPDI	75	
57	ASHOKA	235	Drought and Low water required plant
58	KACHNAR	20	
59	AICESHIYA AIRAKULI	6	
60	MOLSIRI	45	
61	CHUKRASIA	190	
62	KADAMB	20	
63	AMALTAS	6	
64	KUSUM	45	
65	JACKRANDA	30	
66	SEESHAM	4	Drought and Low water required plant
67	IMLI	1	
68	JAMUN	6	Drought and Low water required plant
69	NEEM	15	Drought and Low water required plant
70	PIPAL	7	Drought and Low water required plant
71	AAM (MANGO)	6	
72	KATHA	4	
73	PUNJANJIA	150	
74	KAJLIYA PINATA	45	
75	PINE	2	
76	BOTTLE BRUSH	15	Drought and Low water required plant
77	PHONIX PALM	80	
78	SAGU PALM	8	
79	SAICUS PALM	20	
80	PHYCUS SISNOL	90	
81	PHYCUS BENJUMINA	400	
82	PHYCUS BLACK	60	
83	BOTTLE PALM	55	Drought and Low water required plant
84	PISTOL PALM	250	Drought and Low water required plant
85	JAMIYA PALM	5	Drought and Low water required plant
86	POSTAL PALM	25	Drought and Low water required plant
87	TUKA PALM	10	Drought and Low water required plant
88	JUNIPERS	30	
89	CHAMMPA RUBRA	100	
90	KADI PATTA	10	Drought and Low water required plant
91	BELPATRA	6	
92	JATRUPA	60	Drought and Low water required plant
93	GOLDEN BRUSH	20	
	TOTAL NO. OF PLANTS	30986	

Figure -Plantation, Landscaping & Biodiversity

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V
Water Management

Water Supply:

The main water sources in the University are three bore wells. The University caters to around 5881 students and around 594 staff. The average consumption of water is around 450 KLD. Metering of water is done at both the supply points and monitored on a daily basis. The water is stored in two underground water tanks of a capacity of 2,00,000 L & 1,00,000 L. Apart from these storage tanks buildings have additional overhead storage tanks on their rooftops.

The water is pumped through two pumps with a capacity of 33HP each. The water supply system is fully automated. The water quality is tested on a regular basis (Detection of MPN) and the samples are taken on a rotational basis from different locations.

The University has installed RO plants in a main hostel and food court and water filters are provided at various locations in the University to provide clean and safe drinking water.

The micro-irrigation techniques like sprinklers, drip, and canal irrigation systems are used in the garden and agricultural farms to improve water use efficiency. The irrigation works are taken up either in the early morning or late evening for better efficiency. Monitoring of water tanks is done on a regular basis and thorough cleaning of tanks is taken up at least once a year.

Construction of tanks and bunds

The campus is well equipped with a Main overhead water tank with a capacityof four lakh liters. Water drawn from 2 bore wells is routed to this tank at regular intervals to cater to the requirement of the 3 lakh liters of water on campus. The process is automated using sensors, hence reducing efforts of manual monitoring, and chances of overflow of water. Every building is provided with enough overhead water tanks, based on the footfall of the building. These tanks get automatically filled (sensor-based) from the Main Overhead Tank. We also have the luxury of 2 underground water tanks with capacities of 2 lakhs (UG Tank No. 1 at crop cafeteria) and 1 lakh liter (UG Tank No.2 at crop cafeteria) each. These are dual-purpose tanks that would cater to fire tanks as well as for use in routine water requirements. The overhead water tank is cleaned annually. The water pipeline layout is attached.

Water Filtration – RO System:

The drinking water is filtered and purified with RO (Reverse Osmosis Members) Mechanism to maintain requisite quality and eliminate usage of bottled water.

The details of the RO Systems with water quality report is asunder.

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Figure 7- Water Filtration – RO System

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Water Distribution System:

The distribution network and piping are more or less satisfactory and adequate. The toilets are provided with water efficient (low usage) fittings. There are no leakages in the distribution system.

Water Usage:

The major water consumption / usage is as under

- Cooling Towers for the Chillers for the Centralized Air-conditioning System
- Domestic consumption including drinking, cooking, bathing, washing and flushing
- Gardening

Sewage Collection & Treatment:

The campus has sewage treatment plants and the entire sewage is treated and used for gardening. There is no discharge of treated water outside campus.

Recycle of Treated Water:

The Treated Water is utilized for

a) Watering of grounds & plant
b) Nursery as well as in Canal technology
c) Flushing purposes (dual plumbing)

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The treated water is shared with villagers based on their request

There is no discharge of treated water outside campus.

Rain Water Harvesting:

The rain water in the entire campus (rooftop as well as open areas) is systematically collected and fed back in to the soil for ground water recharge. There is marked improvement in the water table over a period time after incorporating this path breaking rain water harvesting technique.

Figure 8-Rain Water Harvesting

Water Conservation Measures:

High-tech Plumbing in Buildings
GD Goenka University has established a state-of-art Plumbing area to reduce the use of water and recycle treated water from waste water through double plumbing techniques in the construction of new buildings and blocks. The treated water is being utilized to flush the toilets through double plumbing techniques.

Use of Faucets in Plumbing
All the faucets in the residential hostel rooms, washrooms, and toilets are low-flow types that conserve water. In new construction areas such as hostels and academic buildings, faucets have flow rates of 0.5 gallons per minute in the bathrooms and 2.0 gallons per minute in thekitchen. The rest of the residential area has water-saving flow rates of 1.5 gallons per minute.

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Shower Heads

All shower heads on campus ensure water is being conserved each day. The new construction areas on campus have shower heads with a flow rate ofonly 1.5 -2.0 gallons per minute.

Washers

The University has outsourced the Laundry facilities for its hostel students which are equipped with Commercial High-Efficiency Front-Load Washers and are great at conserving water. These washers sense the amount of clothing inside and dispense onlythe required amount of water in order to complete the wash cycle. This saves at least 50 percent more water than traditional washers. The high efficiency of these washers alsoallows for less detergent to be used by students while washing their clothes.

Sprinkler for Agricultural fields & Gardening

We are using recycled water in the agricultural fields- Crop cafeteria, Organic farm, fruit orchard, and horticultural garden. Sprinkler irrigation is a method of applying irrigation water that is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping and to save water. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall all around the ground.

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Picture of Sprinkler System

Sensor-BasedUrinal Flushing System

The sensor-based system is very helpful for water conservation, GD Goenka University strongly believes to save water to save the future. To achieve that goal, we planned the latest and modern technologies like automatic flushes. At pressing times like this when we are environmentally conscious, wasting so much water would not be a great choice. The use of a sensor toilet flush and wash basin helps to wastage is minimal as the flush strictly regulates the amount of water used to flush, and it automatically stops every time after it is used.

Figure 9-Water Conservation Measures

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VI
Waste Generation & Management

Solid Waste:

The University is a 20 acres beautiful, landscaped campus at the base of the Aravalli range. The green cover is 67% (13.4 acres) of the total land and 33% (6.6 acres) of land is built-up area. It has a boarding campus of around 1100 students and staff. A clean and healthy atmosphere is necessary for the students and staff to have a majestic study and work environment. The University believes to follow healthy practices to cause great admiration. This is important to adopt REUSE, RECYCLE, REDUCE and REFUSE at GD Goenka University towards sustainability. While the overall emphasis is to reduce waste generation and segregation of waste at the source, strategies/systems are in place for reusing and recycling the waste. Students are also encouraged to use parts of old equipment and infrastructure for their projects. Recently, the GD Goenka University, UID School of Design conducted a workshop on making artistic pieces from the junkyard wastes.

The waste generation is around 11760 Kg (196 kg/per acre) waste; which includes

Metal waste:-10%
Plastic, glass, used papers: - 35%
Organic food waste: - 43%
Sewer water waste: - 20,000 liter per day
Dry leaves/ Dead plant waste
Electronic Waste

General solid waste is collected in dustbins placed in various classrooms / offices / pantries /hostel rooms and open areas. The solid waste is collected from more than 1200 waste bins placed in building blocks and in the open area of the campus. It is then segregated into biodegradable, non-biodegradable and recyclable waste.

The University has tied up with Green-o-Bin and Farm Pallet for recycling/reuse of solid waste. Green-o-Bin collects the paper waste from the University for recycling. While Farm pallet collects all the kitchen waste twice a day which is segregated into dry and wet waste. The waste is used by Farm Pallet as animal feed and for composting. In return the University gets chemical free manure and compost which is used for the field. The university has banned the use of polyethene bags which create hindrances during the waste segregation and sewage treatment. The waste from all these dumpsters is deposited at the main waste yard for sorting by a contractor.

The non-degradable waste is collected by the contractor, for depositing it in the government dump yard. The degradable waste is dumped into a waste pit on campus. Food waste is used for preparing manure through vermicomposting. Some food waste is contracted for disposal to a swine farm. Incinerators are provided in the girls' hostels and an academic building, for disposal of sanitary waste. An incinerator is also centrally placed at the main waste yard. Paper waste is recycled, and sludge from STP is used as manure. A dedicated scrap disposal committee handles the solid scrap material disposal process. Old lab equipment, broken fixtures and fittings, student projects and other materials are segregated before putting them in designated bins in the junkyard.

The electronic gadgets which comprises mostly of obsolete computers are donated to nearby schools.

The campus has been designed and maintained as a green cover with lots of trees and a fully landscaped campus. To ensure natural regeneration of these areas, falling leaves are being collected at one point. It provides home and food for native fauna and breaks down with time to enrich the soil. From the campus's academic block, hostel, and dining hall, falling leaves are collected to make vermicomposting. After 60 to 70 days, around 100 kg vermicomposting is harvested which is applied to various fields and gardens.

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Figure -Vermicompost Unit at Crop Cafeteria

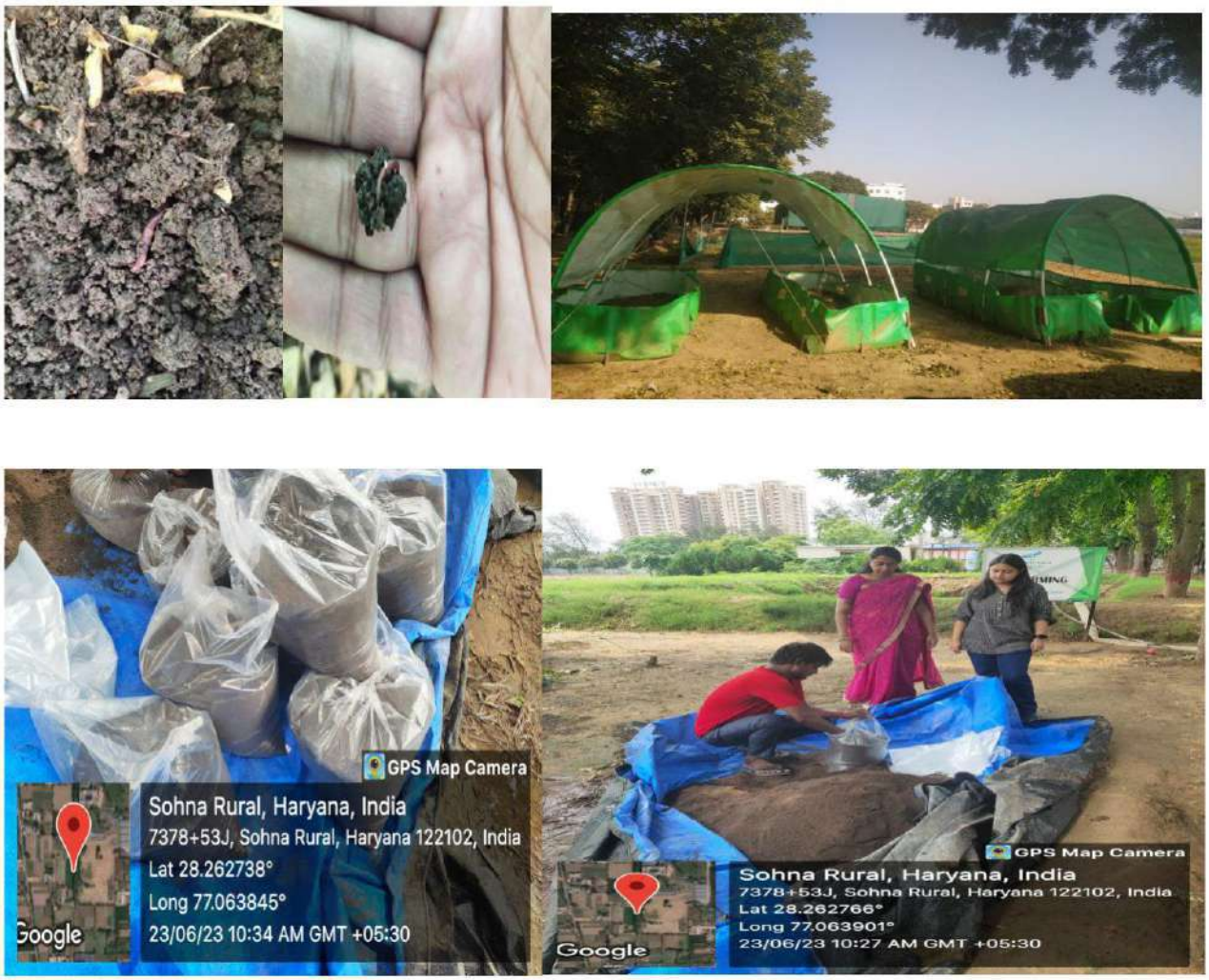

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Figure -Waste Segregation

Figure -Composting Pit

Oil Disposal:

Used oil is disposed to authorized vendors as per laid pollution norms. Specific measures have been taken to reduce used-oil generation in electric generators. All the oil (lubricating oil) generated from lab is disposed through M/S Sunrise Industries.

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Sewage & Wastewater:

The campus has sewage treatment plants and the entire sewage is treated and used for agricultural fields, gardening, landscaping and fruit orchard. There is no discharge of treated water outside campus.

There are two STPs of capacity 125 KLD and 150 KLD to treat sewage. The treated water is used for irrigation for agriculture/horticulture and landscaping purposes and is supplied to villages also for use. Treated water is being used for maintenance and inspection of water supply systems and any leakages are attended promptly for repairs to reduce water loss. Flushing purposes in some buildings by way of dual piping and being taken up in a phased manner in the earlier-constructed buildings. Water-efficient flush cisterns are used for lesser consumption. There is dedicated staff for maintenance and inspection of water supply systems and any leakages are attended promptly for repairs to reduce water loss.

Figure 10-Sewage Treatment Plant

VII
Infrastructure & Safety

Students and Faculty strength:

Description	Students	Staff	Hostel Occupancy
G D Goenka University	5881	594	1070
Total	**5881**	**594**	**1070**

Entrances & Security:

There are two main entrances Gate 2 and Gate 3 for the university. The gates are provided with round the clock security.

The entire campus is fenced with wall and barbed wires.

The entire campus is under Close Circuit Television (CCTV) to ensure complete security residents.

Main Entrance

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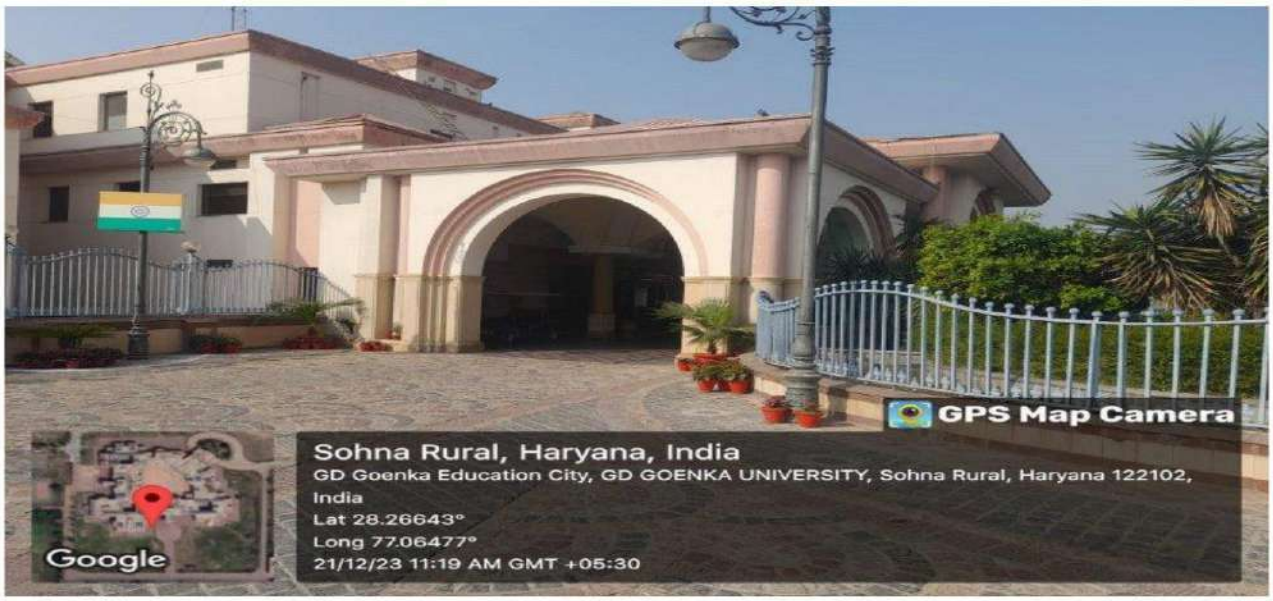

Main Office:

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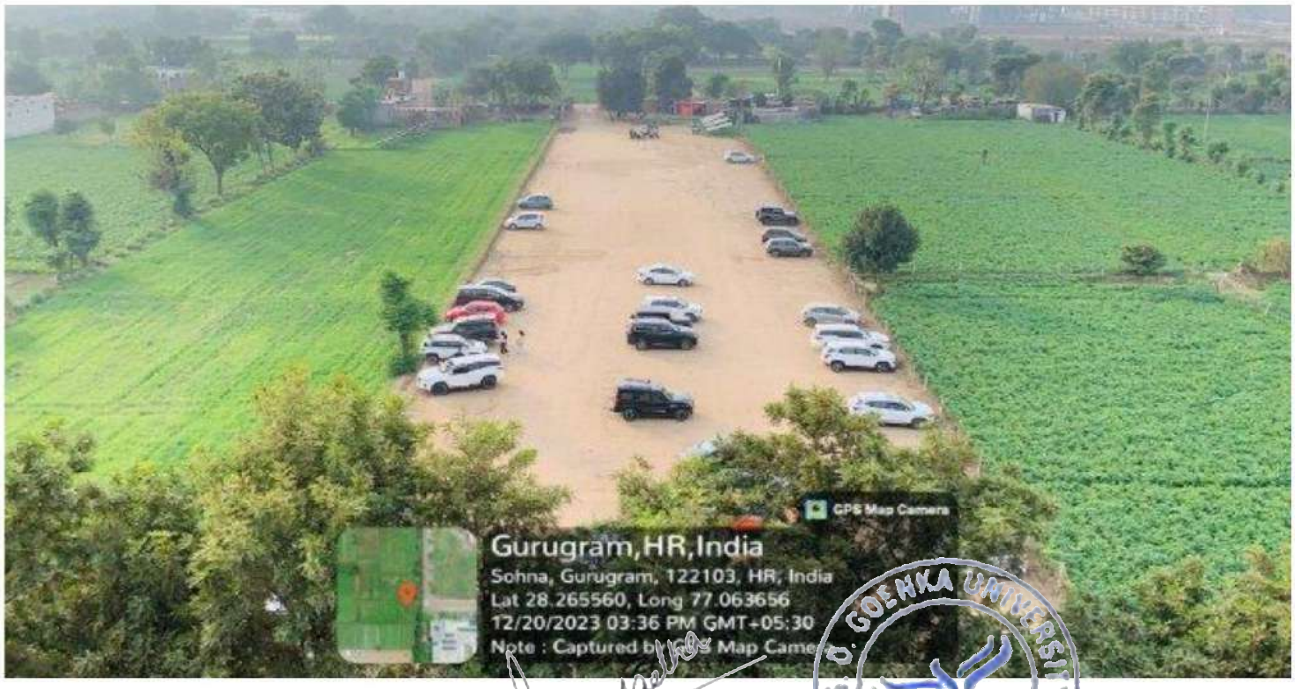
Maintenance Block

Parking Spaces:

There is adequate parking space for faculty, staff as well as students. The university also provides bus services for the students; which is availed by most of the students.



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On campus movement:

The movement of vehicle inside the campus is restricted and limited to cater to very few and specific requirements. There are pedestrian friendly pathways across the campus for easy movement. A few cycles and electrical vehicles are available for in-campus movement. There are few bicycles for resident students, however, most of the students prefer to walk down.

Pathways:

Cycles for on campus movement

Electrical Vehicles:

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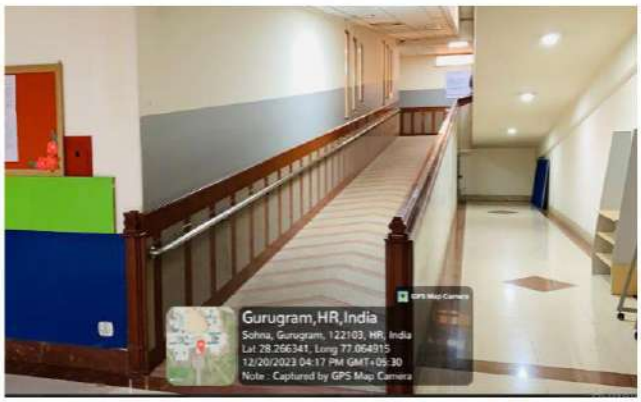
Ramp & Elevators:

The ramps are provided at key entrances for ease movement of vehicle inside the campus is restricted and limited to cater to very few and specific requirements. There are pedestrian friendly pathways across the campus for easy movement.



Laboratory

Classrooms

Greenery & Water Bodies:

The campus is surrounded with a lot of greenery, trees, and proper landscaping. A water body is maintained for fish farming.

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Fish Pond

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Green cover and landscaping

Kitchen and Dining:

A central well-equipped kitchen caters to the requirements of entire campus. While the senior students avail this facility; small dining areas are provided for primary students in the respective hostels.

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Cooking Area – Efficient burners and exhaust ducts

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Ovens

Exhaust Hoods

Dining Area

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Hostels:

There are five hostels accommodating over 1100 students; with all the rooms are centrally air conditioned. The individual hostels are provided with heat pump to supply hot waters for bathing. The lighting is with energy efficient LED lamps.

Hostel rooms

Medical Facilities:

The campus houses a resident medical doctor and nurses to address medical needs of the residents. The university has tie up with hospitals for quick medical treatment. An ambulance is stationed on campus for medical emergencies.

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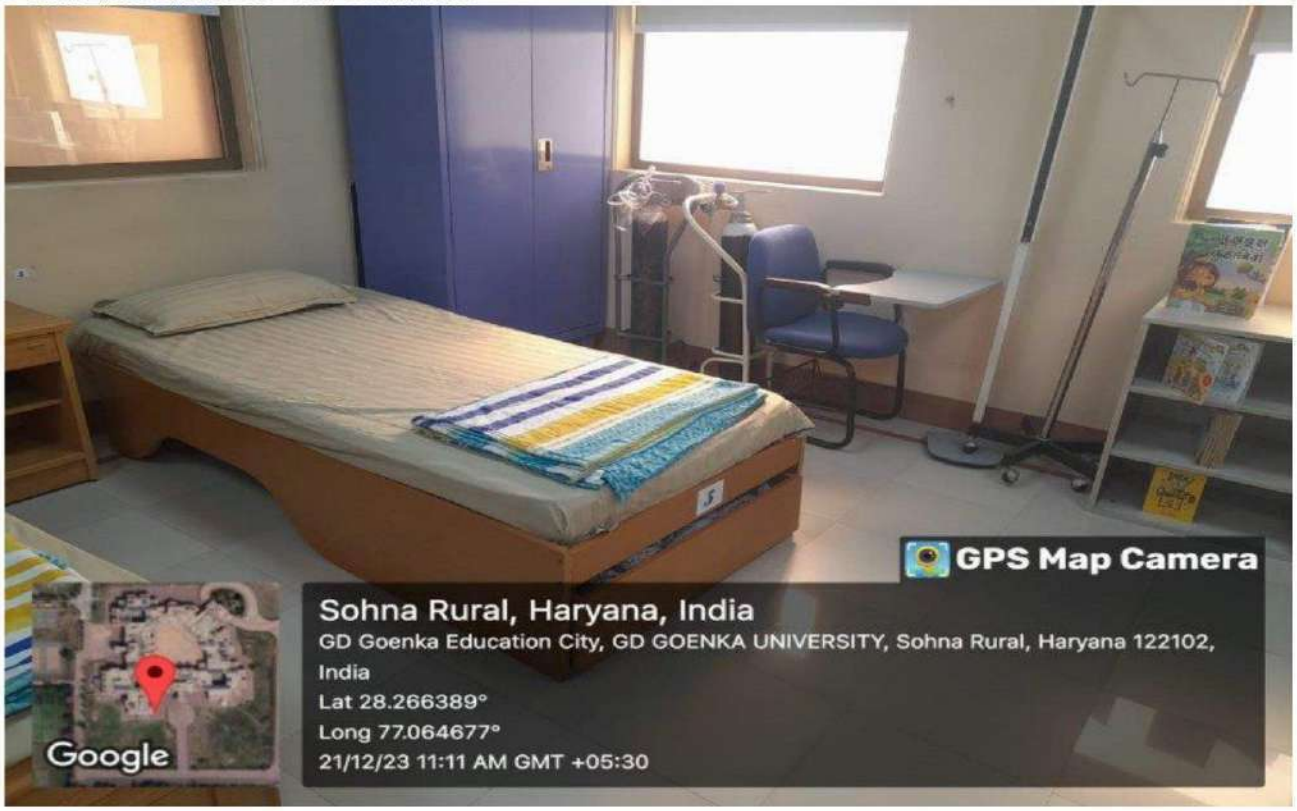
Doctor with Nurse for 24 x 7 Attention



Beds for the patients

Ambulance for medical emergencies

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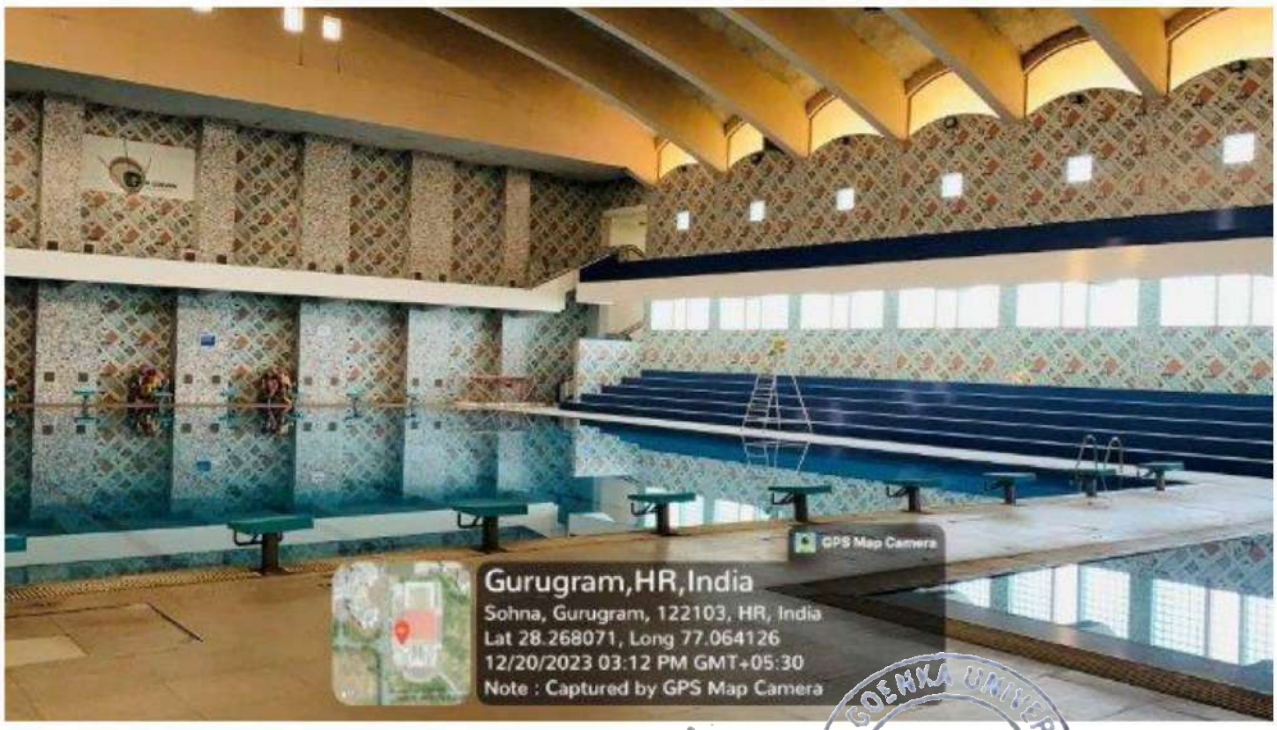
Sports & Games:

The campus has well equipped gymnasium with indoor swimming pool and shooting range as well as play grounds for various outdoor sports activities.

Gymnasium



Indoor Swimming pool

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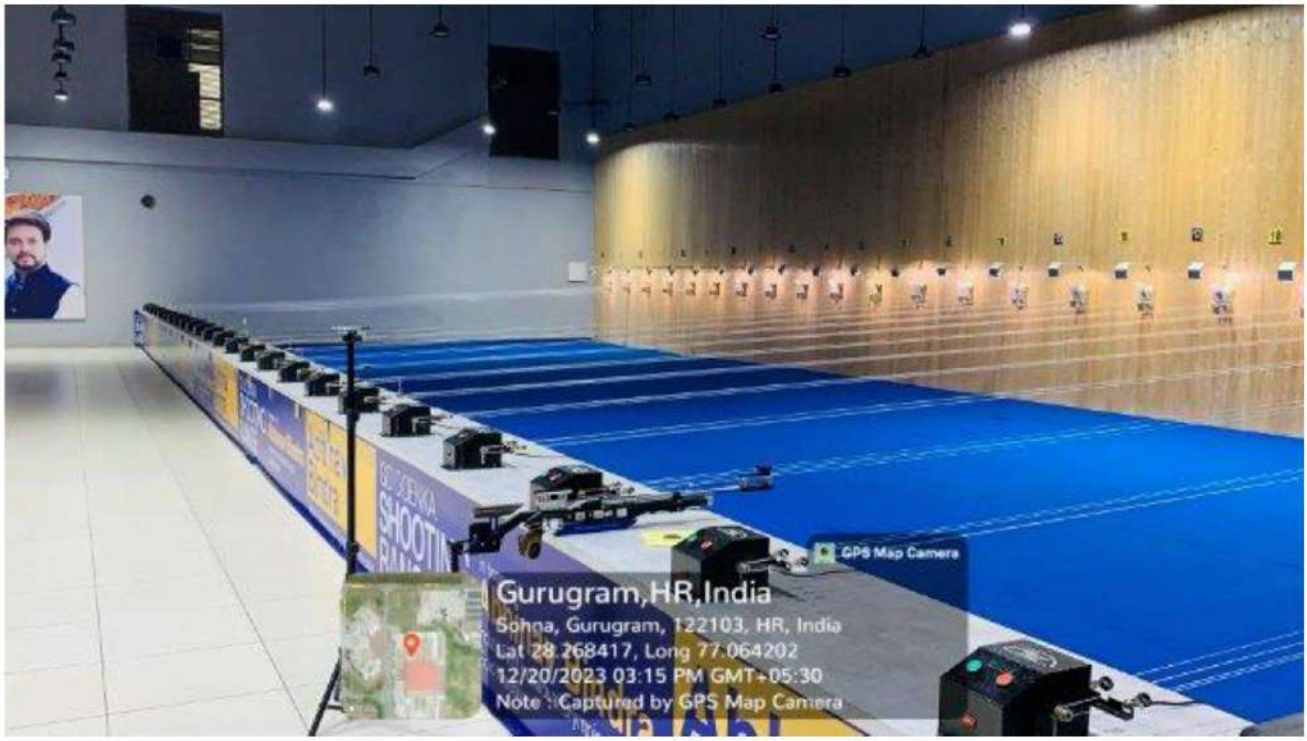

Shooting range

Table Tennis

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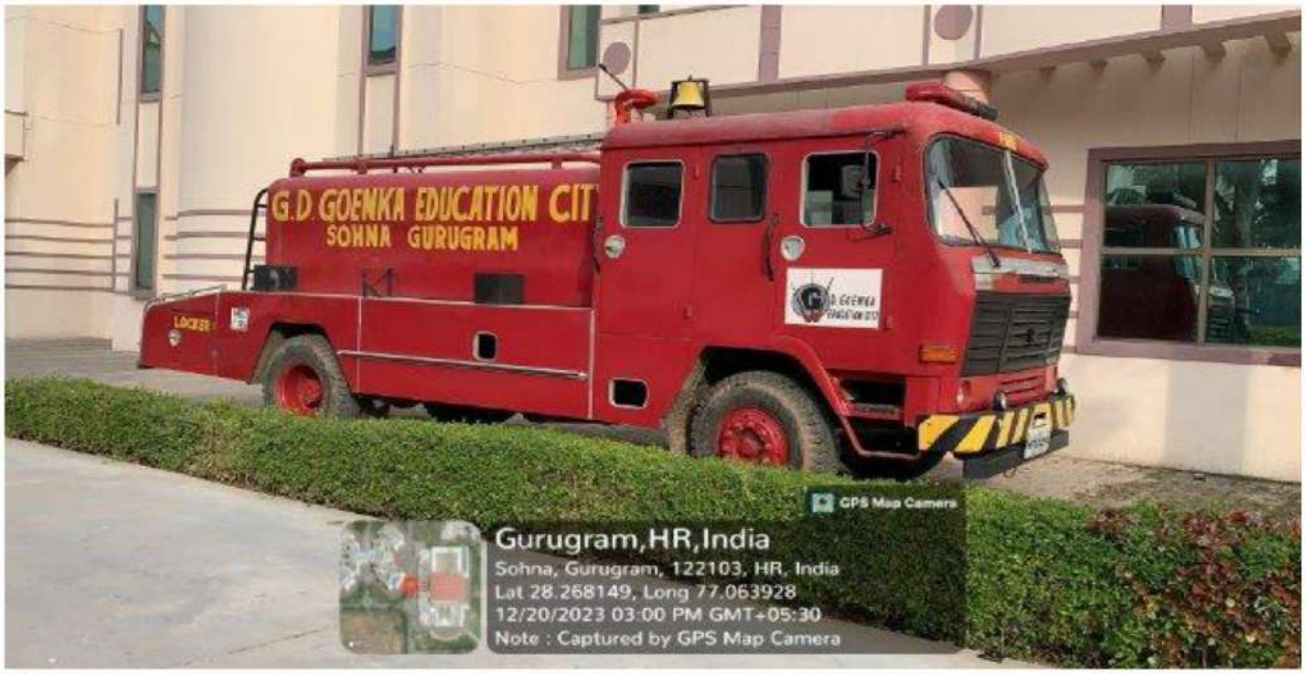
Fitness equipment

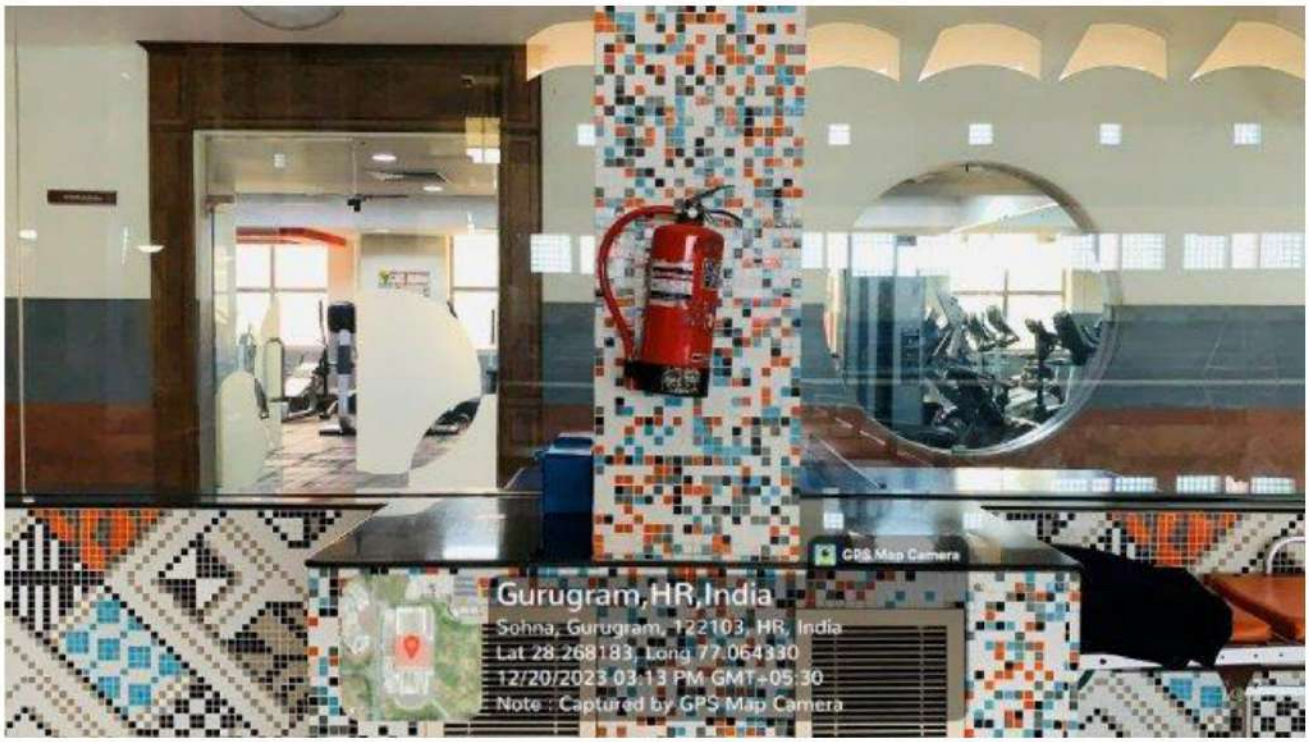
Firefighting & Fire Escape System:

The campus has a firefighting engine to address any fire incident. The main building is provided with pressurized water system as a firefighting measure. The fire hydrants are provided at strategic locations for immediate mitigation of any fire incidence. The fire extinguishers are provided at key areas.

ALL FIRE EQUIPMENT LIST WITH BUILDING											
Sr No	LOCATION	F H C	HOSE PIPE	HOSE REEL	BRANCH	FIREMAN X	EXTING UISHER	DETECTOR	PUMP	WATER TANK	PANEL
1	PHASE 1	16	27	11	16	N/A	20	320	1	1	2
2	PHASE 2	16	32	16	16	16	16	386	1	1	1
3	PHASE 3	8	16	9	8	8	9	247	1	1	2
4	HERCULES	3	N/A	3	N/A	N/A	3	87	1	1	1
5	Academic Block	18	36	18	18	N/A	27	437	1	1	4
6	Academic Block	5	N/A	5	N/A	N/A		N/A	1	1	N/A
7	Academic Block	15	8	15	6+6	N/A	15	243	1	1	1
8	Academic Block	10	9	10	4	N/A	14	138	1	1	1
9	BUS	N/A	N/A	N/A	N/A	N/A	60	N/A	N/A	N/A	N/A
10	RESIDENCE	N/A	N/A	N/A	N/A	N/A	4	N/A	N/A	N/A	N/A
11	FITNES CENTER	4	8	4	4	N/A	4	N/A	1	1	N/A
12	OTHER SIDE	8	7	N/A	N/A	N/A	20	N/A	N/A	N/A	N/A
13	SOPHIA	2	N/A	2	N/A	N/A	2	55	1	1	1
14	LCB	2	N/A	2	N/A	N/A	6	30	1	1	
15	**TOTAL**	**107**	**135**	**90**	**74**	**24**	**200**	**1943**	**13**	**11**	**13**



Fire engine



Fire Extinguisher

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Hose

Fire Escape

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Overhead Water tank with pumping

Smoke Detector


GPS Map Camera
Gurugram,HR,India
Sohna, Gurugram, 122103, HR, India
Lat 28.267006, Long 77.065056
12/20/2023 04:13 PM GMT+05:30
Note : Captured by GPS Map Camera

Sprinkler


GPS Map Camera
Sohna Rural, Haryana, India
G D Goenka University, Sohna - Gurgaon Rd, Sohna Rural, Haryana 122102, India
Lat 28.266845°
Long 77.065725°
26/12/23 03:30 PM GMT +05:30
Google
GPS Map Camera
Sohna Rural, Haryana, India
Lat 28.266822°
Long 77.06575°
26/12/23 03:30 PM GMT +05:30
Google

VIII
Green Culture

Computers:

LED Computers

- The LED / LCD monitors & Laptops has been procured, which are energy efficient. These monitors are not only energy efficient but also generate minimal heat and cut down on air conditioning load.

The following steps may be initiated to further enhance efficiency of the systems.

1. An efficient power management system may be incorporated to
   a. Switch off the display if not in use.
   b. Put the computer in Sleep mode / switching off the machines, if not used for prolonged period.

2. Optimize brightness of the screen.

3. Discourage use of screen savers, which has similar power consumption.

Communication:

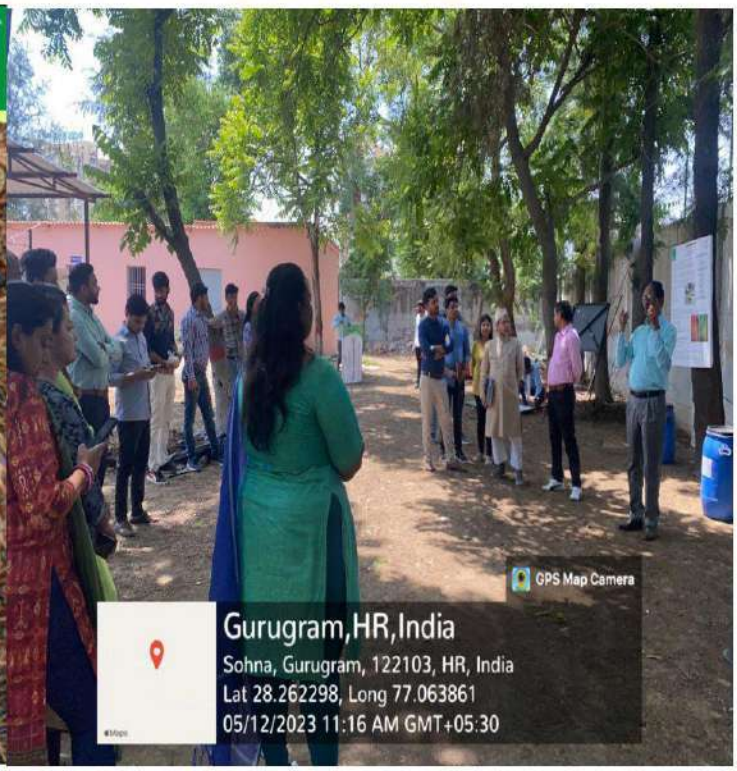
The major internal as well as external communication is through electronic medium.

Usage of Paper:

It was observed that two side printing / printing on the back side of used paper in more than 80% of the cases.

Other Activities:

The university initiated the waste decomposition unit at B- Block farm, for maximum utilization of technology to manage waste for sustainable development. The team has conducted awareness programs during International Composting Awareness Week 7th-13th May 2023 as well as hands on training programs in this field.



Training programs

International Composting Awareness Week 7th-13th May 2023

Hands-on Training for Organic Waste Decomposer

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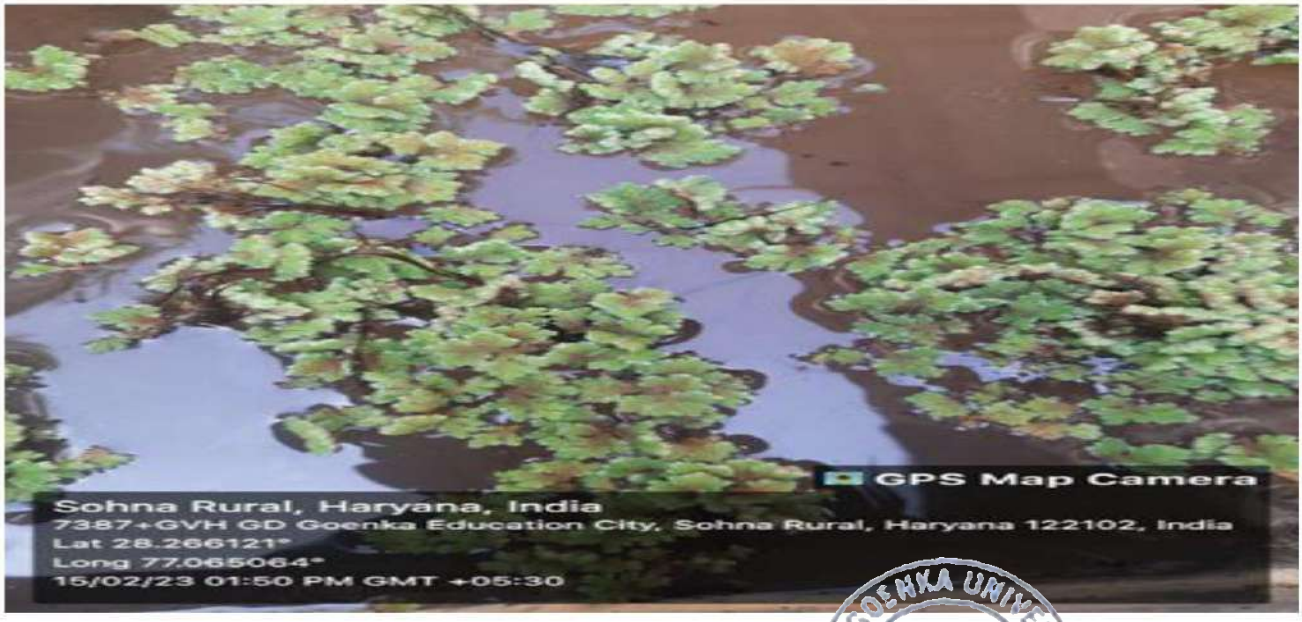
Azolla Culture:

Azolla is a floating pteridophyte known as water fern that contains the nitrogen-fixing cyanobacterium Anabaena-azolla (Nostocaceae family) as an endosymbiont. Widely cultivated in the Asian regions, Azolla is either incorporated into the soil before rice transplanting or grown as a dual crop along with rice. Azolla is a nature's gift for rice cultivation and has tremendous other agricultural uses. It is one of the most nutritive animal feeds and also a source of green manure. Moreover, it is also an excellent biofertilizer too. Azolla has several times higher levels of crude protein than other forage crops and is also rich in mineral nutrients. School of Agricultural Sciences, GD Goenka University promotes azolla culture in the pond.



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Awards & Recognition:

The university has won many awards and recognitions in the field of sustainability and water conservation.

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REGISTRAR

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IX
Renewable Energy

Rooftop Solar Photovoltaic:

The Roof-top Solar Photovoltaic System with grid synchronization is installed on most of the roofs. The details of the system are as under.

Sr No	Location	Invertors	Panels
1	DG room	60	68.25
2	Dining hall	60	74.75
3	Academic Block	120	139.75
4	Academic Block	120	134.225
5	Academic Block	50	61.75
6	Carport	200	234
7	Basement	80	87.75
	Overall	690	800.475

The actual power generation is as under.

Month	DG room	Dining hall	Academic Block	Academic Block	Academic Block	Carport	Basement	Total
Invertors	60	60	120	120	50	200	80	690
Panel Rating	68	75	140	134	62	234	88	800
Dec-22	7140	7980	15600	12950	5880	19280	9280	78133
Jan-23	5790	7020	12600	8900	5250	17544	7776	64899
Feb-23	8580	9330	17800	15350	7440	25856	11104	95490
Mar-23	8250	9120	17800	16400	7710	26616	10944	96868
Apr-23	12240	12900	24800	23100	10350	40016	14944	138391
May-23	7050	7470	14700	13350	6150	24128	8032	80903
Jun-23	9540	10110	19350	18000	8190	34248	10272	109742
Jul-23	6390	6810	13300	12350	5670	18928	10592	74061
Aug-23	8790	9300	17300	16400	7380	28712	10048	97958
Sep-23	6090	8550	16500	15050	6960	25072	10208	88456
Oct-23	9180	9870	18500	17200	7530	26856	11424	100589
Nov-23	5430	5880	11150	10500	4650	16096	6944	60668
Total	94470	104340	199400	179550	83160	303352	121568	1085866

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Solar Panels

Solar Thermal:

The hostels are provided with heat pumps for generating hot water, while Roof-top Solar Photovoltaic System with grid synchronization is installed on the roofs. This is more efficient and effective methods for energy optimization.

Heat Pump

Recommendations:

- **Biogas Plant:** The possibility of installing biogas plant from canteen waste is being assessed and planned during the next semester. This could reduce LPG consumption in the canteen, while generating organic manure. The University has already installed compost pit, while remaining food waste is handed over to an agency for composting. The agency provides organic manure for gardening and plantation.

For Senergy Consultants Pvt. Ltd.
Director

SENERGY CONSULTANTS PVT. LTD. MUMBAI

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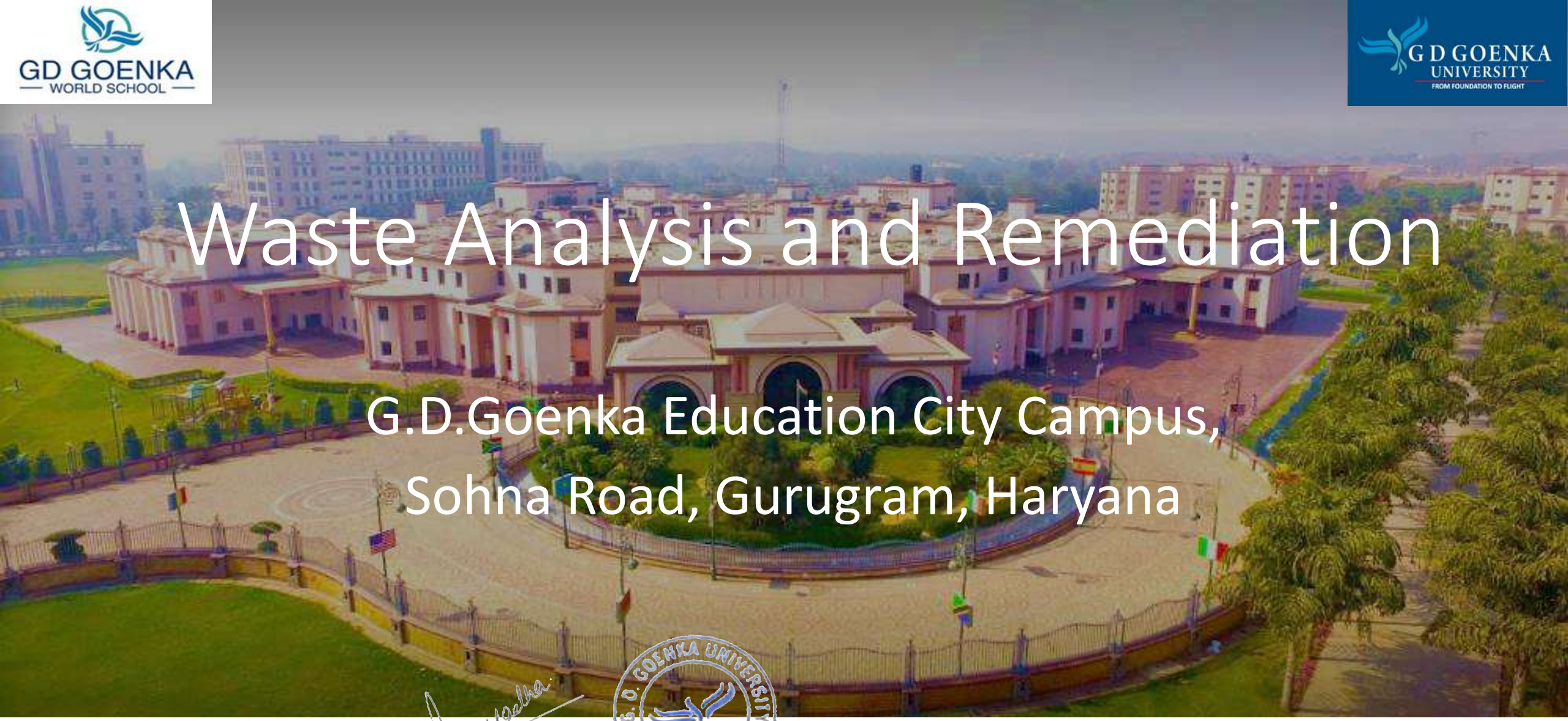
Helping You to Conserve Energy

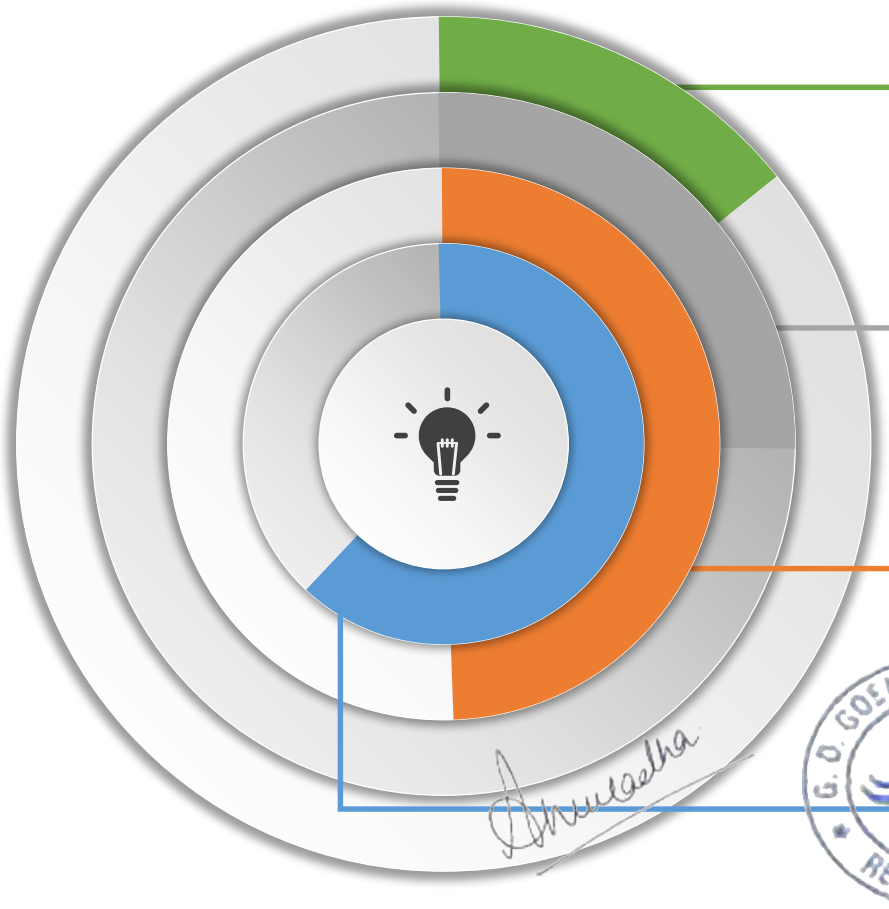
Waste Analysis and Remediation

G.D.Goenka Education City Campus,
Sohna Road, Gurugram, Haryana



Prepared by
DESIGN2OCCUPANCY SERVICES LLP

AGENDA



Award Applications and Current Position

Status of currently applied awards and future nominations

Sustainability Certification

Discussion on Feasibility Study and Go-Ahead planning

Waste Analysis

Outcome of the Waste Analysis

Management Solutions and Future Scope

- Waste Management Strategies
- Metering Solution
- Future Scope

TIMELINE PLANNING

23 – 26 Nov
- GEM Certification Data Requirement preparation and Feasibility Study.

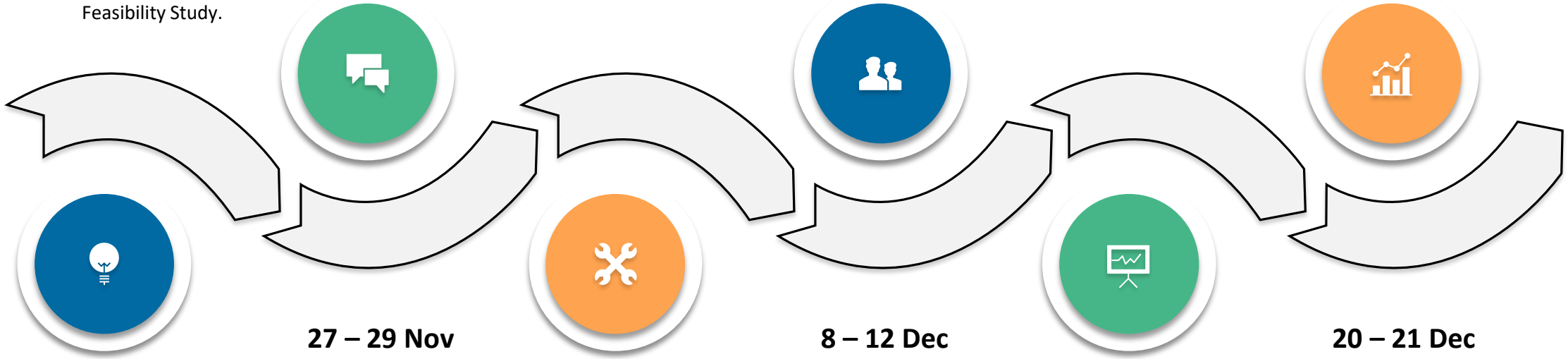
27 – 29 Nov
- Nomination for ET Innovation Award.
- Documentation for FIST Award.

2 Dec – 6 Dec
- Waste Audit Conduction

8 – 12 Dec
- Result Analysis and Calculation
- Waste Remediation methods

12 – 18 Dec
- Preparation of Presentation

20 – 21 Dec
- Final Presentation



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Principles	Description	Achievable Points	May Be	Maximum Points
Principle-1	Government Approved Plans	E	E	E
Principle-2	Parking for Building Occupants	2	0	2
Principle-3	Landscape Best Practices	3	1	4
Principle-4	Preserve and Plant Trees Onsite	2	0	2
Principle-5	High Albedo Materials - Roof and Non-roof	2	4	6
Principle-6	Rainwater Harvesting – Recharge and/ or Reuse	1	3	4
Principle-7	Install Low Flow Water Fixtures	4	3	7
Principle-8	On-site Treatment of Grey & Black Water & Reuse for Flushing	4	2	6
Principle-9	Irrigation Best Practices	2	1	3
Principle-10	Measurement of Energy and Water Consumption	6	0	6
Principle-11	Post-occupancy Waste Management	4	0	4
Principle-12	Onsite Conversion of Organic Waste		4	4
Principle-13	Amenities for fundamental needs and daily commute	6	0	6
Principle-14	Best Practices for Universal Building Design	2	3	5
Principle-15	Reduced Exposure to VOC		3	3
Principle-16	No Use of Halogenated Hydrocarbons		2	2
Principle-17	Sustainable Development of Construction Engineering	6	6	12
Principle-18	Local Sourcing of Construction Materials	4	2	6
Principle-19	Judicious use of hard wood and soft wood	4	0	4
Principle-20	Energy Management Best Practices		12	12
Principle-21	Efficient Electric Equipment and Building Operations	2	3	5
Principle-22	Use of Imperishable Energy Resources	4	2	6
Principle-23	Optimal Use of Natural Light	4	2	6
Principle-24	Healthy Indoor Air Quality		6	6
Principle-25	Training and Capacity Building of Project Team	2	0	2
Principle-26	Activities for Corporate Social Responsibility	2	0	2
Principle-27	Going the Extra Miles	5	0	5
	TOTAL POINTS	**71**	**59**	**130**

Awards

FIST Award 2020 by FSAI

ET Innovation Awards*

Thank you for your submission- The Economic Times Innovation Awards 2019-20

ET Innovation Awards <noreply@etinnovationawards.com>
to me

Dear Sai Balaji

Thank you for submitting your application for the category Innovation to Drive Sustainability.

You can log out or submit other innovations that your company has done.

Best Regards
The Economic Times

* Need to be discussed

Previously Nominated Awards

Mon 11/4/2019 4:37 PM
bee neca <bee.neca2019@gmail.com>
NECA 2019 Application Acknowledgement
To sushant@design2occupancy.com
You forwarded this message on 11/6/2019 12:53 PM.

Dear Sir/Madam,

Thank you very much for your participation in National Energy Conservation Award - 2019. This is to acknowledge that we have received your application and the same is under consideration.

You will be contacted by our team if there is any query / clarification required.

Regards

NECA Team

NECA 2018-2019

STATE LEVEL ENERGY CONSERVATION AWARD
"Award for Excellence in Energy Conservation and Management"

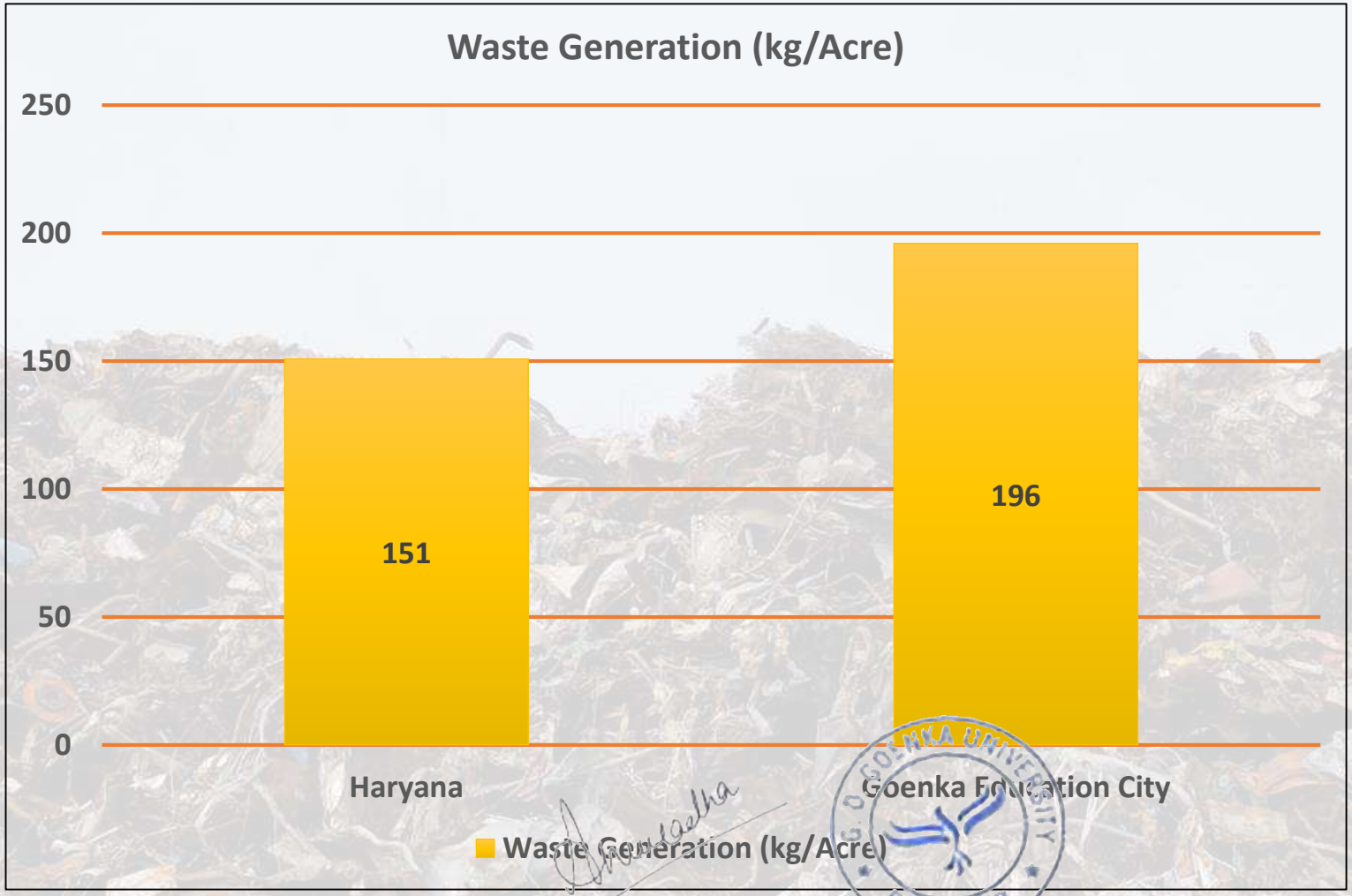
State Standards

GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

1. State/UT-wise Status of Solid Waste Generated and Processed up to November 2018

Sl. No.	State/ UT	Total Waste Generation (MTPA)	Total Waste Processing (%)
1.	Andhra Pradesh	2,330,160	29%
2.	Andaman & Nicobar Islands	36,500	52%
3.	Arunachal Pradesh	66,065	20%
4.	Assam	413,910	35%
5.	Bihar	828,915	43%
6.	Chandigarh UT	172,280	85%
7.	Chhattisgarh	601,885	84%
8.	Daman & Diu	11,680	65%
9.	Dadra & Nagar Haveli	12,775	0%
10.	NCT of Delhi	3,832,500	55%
11.	Goa	[illegible]	65%
12.	Gujarat	[illegible]	57%
13.	Haryana	[illegible]	17%
14.	Himachal Pradesh	[illegible]	40%
15	Jammu & Kashmir	501,510	8%
16.	Jharkhand	[illegible]	42%
17.	Karnataka	3,650,000	32%
18.	Kerala	227,760	60%
19.	Madhya Pradesh	2,344,760	65%

Where we stand !!



Area of Haryana (Acre)	Area of GD Goenka Education City (Acre)
1,09,25,023	60

http://www.indiaenvironmentportal.org.in
https://en.wikipedia.org/wiki/Haryana

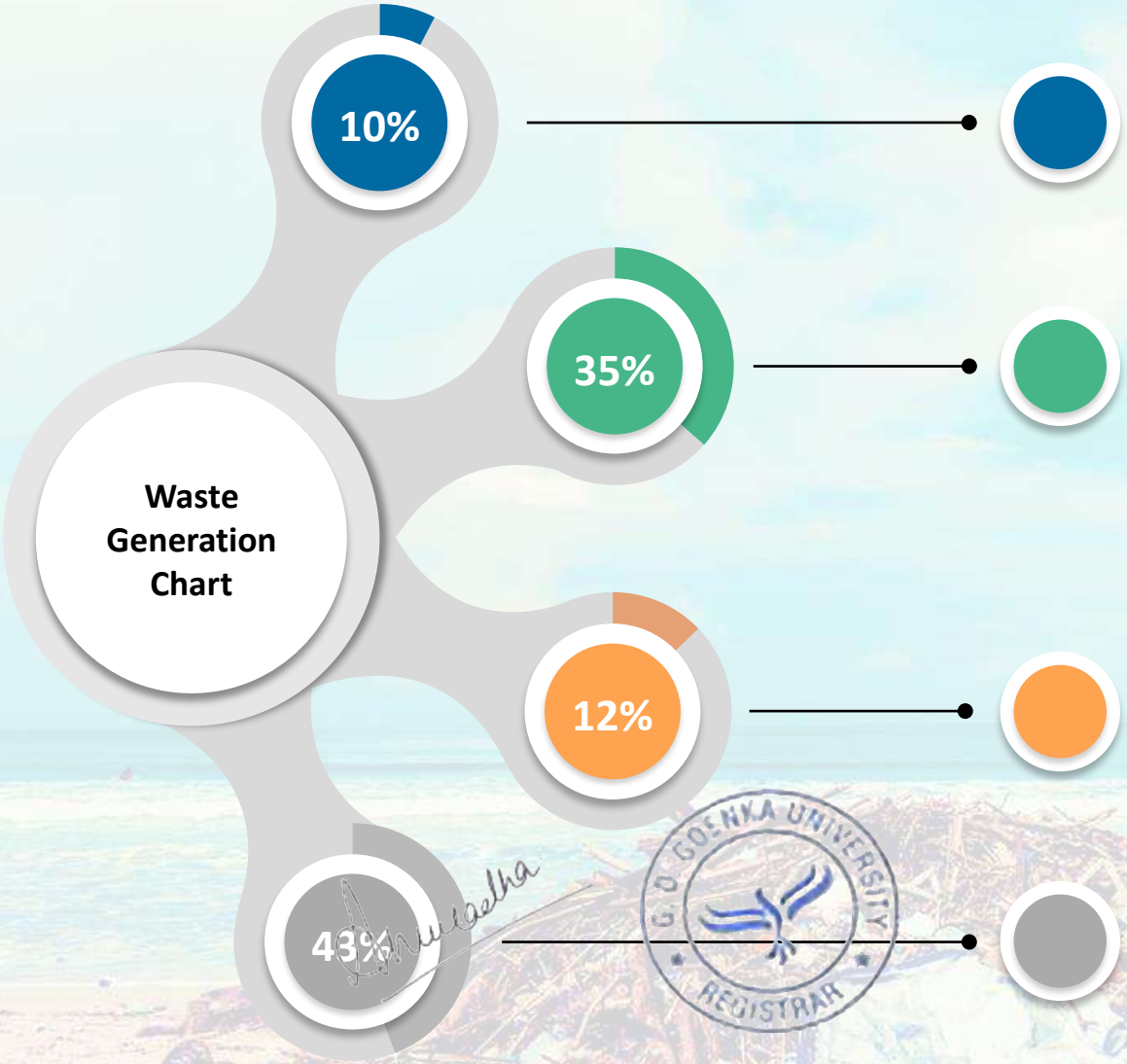
Waste Collection Process

Collection from Buildings
Designated room wise dustbins are emptied daily by the waste management team.

Packaged in disposal bags and carried to Dumping areas
Since the waste is not segregated it is carried to dumping areas present behind the Kitchen and then Dry waste and Wet waste are segregated there.

Further Tackle
Since the facility has made contract only to manage Paper and Food waste. Rest of the waste is not looked upon and hence 20% of the total generated waste is dumped to land fills

Waste Categories



Metal Waste
Mostly generated in Labs and Service Block

Plastic/Glass/Wrappers (Product Related Waste)
Mostly generated from consumables bought from stores.

Paper and Cardboard (Partly Logged)
Generation Groups –

- Students and Teachers
- Kitchen and Canteen Staff

Organic Food Waste (Logged)
Generated from Kitchen and Canteens. This waste is logged and maintained by the Kitchen Staff.

The above segregation may vary as the logged data is only available for Recycled Paper and Organic Food Waste

Corrections Required

Lack of Cleanliness

Waste dumping location at the University, is inappropriately used as public toilet. Which can support prevailing of hazardous diseases in the surrounding environment.

Improper Handling of Waste

Spilled food and waste materials was observed at the dumping area around the Kitchen in the School Campus.

Lack of Dustbins as per contract

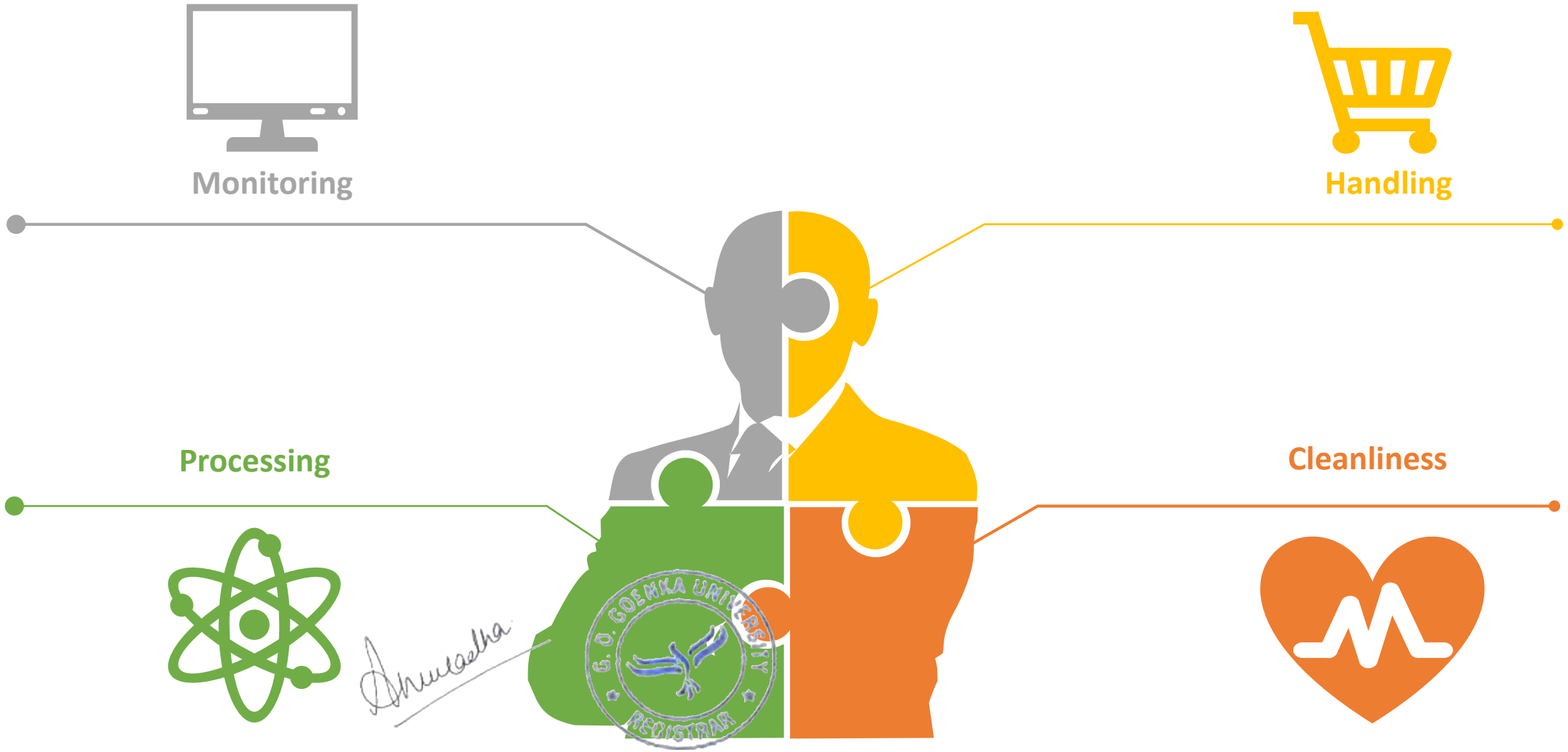
As per the contract 15 Dustbins of 220 Ltr. were required to be placed however, only 9 DB were present in the School and 3 DB were present in University.

Unhygienic Waste Management

Canteen area resides near the University Dumping place, these places were not cleaned periodically and hence, presence of Rodents were deducted.

Waste Diversion Methods

Where we lack ?

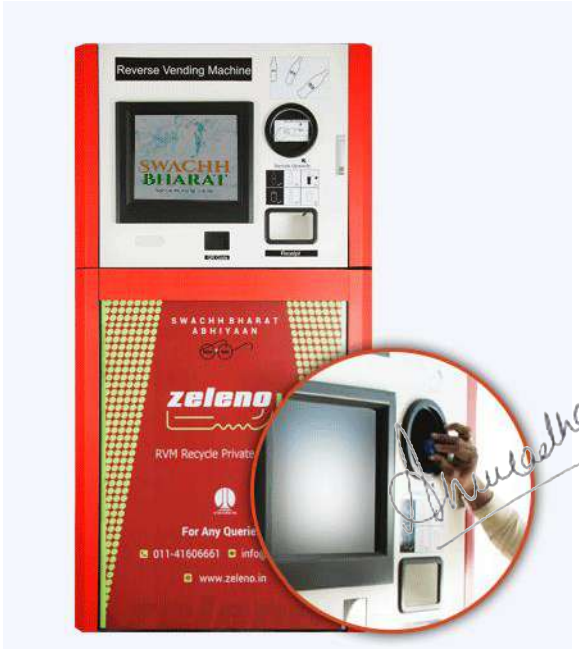


01

BIOGAS Plant

Cost (1000 Kg) : INR 30,00,000/-*
LPG Generation: 70 kg/ day
Energy Consumption : 40 kWh/day

☑ Producing biogas gives many advantages for the environment, companies and people involved. The advantages are: Biogas is a green energy source in form of electricity and heat for the local grid. Considerable environmental advantages - less emission of the greenhouse gasses methane, CO2 and nitrous oxide



02

Plastic Waste Convertor

Cost -- INR 4,95,600 /-

☑ **ZELENO- reverse vending machine** allows you to easily dispose of your plastic PET bottles and Aluminum/steel cans of different sizes. The machine automatically accepts the trash and crushes them to be recycled later.

☑ **ZELENO-RVM** generates an instant reward for the trash disposed and creates a receipt, which can be redeemed at the chosen outlets.

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* Might vary based on actual requirement

Do you want to dispose your e-waste?

If you have more than 10kgs of e-waste to dispose then write to us **e-waste pickup request form** or call us at **7349737586** between 9:30am and 6pm (Monday to Saturday) else drop it at our e-waste collection centres : List of **e-waste drop boxes**

03

Association with Recycling/ Feed the Need Organizations

☑ Formed to facilitate recycling of all kinds of packaging waste and thus contribute towards cleaner and greener environment. We specialize in collection and aggregation of all packaging waste in a professional and organized manner backed by technology and we offer Pan India services.

04

Waste Segregation

☑ **Waste segregation** is included because it is much easier to recycle. Effective segregation of wastes means that less waste goes to landfill which makes it cheaper and better for people and the environment. It is also important to segregate for public health.

05

Composting

☑ Organic waste converter which helps convert your segregated organic waste to good quality compost. It can be smart, compact, efficient and aesthetically appealing. Its robust, functional and user-friendly design.

06

Placement of additional bins (10 DB)

Cost (INR) : 1000-1500/ DB

☑ This will reduce the waste spilling which was observed in Football ground, landscapes and near canteen areas.

In the Pipeline !!

Jan 2020

First Sustainability Certification

Completion of GEM Certification for both GD Goenka University and GD Goenka World School

Feb 2020

Metered Water Baseline

Installation and Baseline Creation of Watering in the GD Goenka Education City.

Feb 2020

Metered Exterior Lighting Baseline

Energy Meter will be installed for exterior lighting and a baseline for the same will be created.

2020 March

Enrolling Into LEED ARC

Since any existing building is eligible for obtaining LEED ARC performance score. Once all the metering is installed properly, the ARC Platform can be utilized properly for benchmarking.

Intellectual Activities

LEED Lab is a multidisciplinary course by USGBC that educate and prepare students to become green building leaders and sustainability-focused citizens.

Sustainability Cell

Formation of **Sustainability Cell** with students and stakeholders to continuous monitoring and implementation of Energy, Water and Waste Management Policies.


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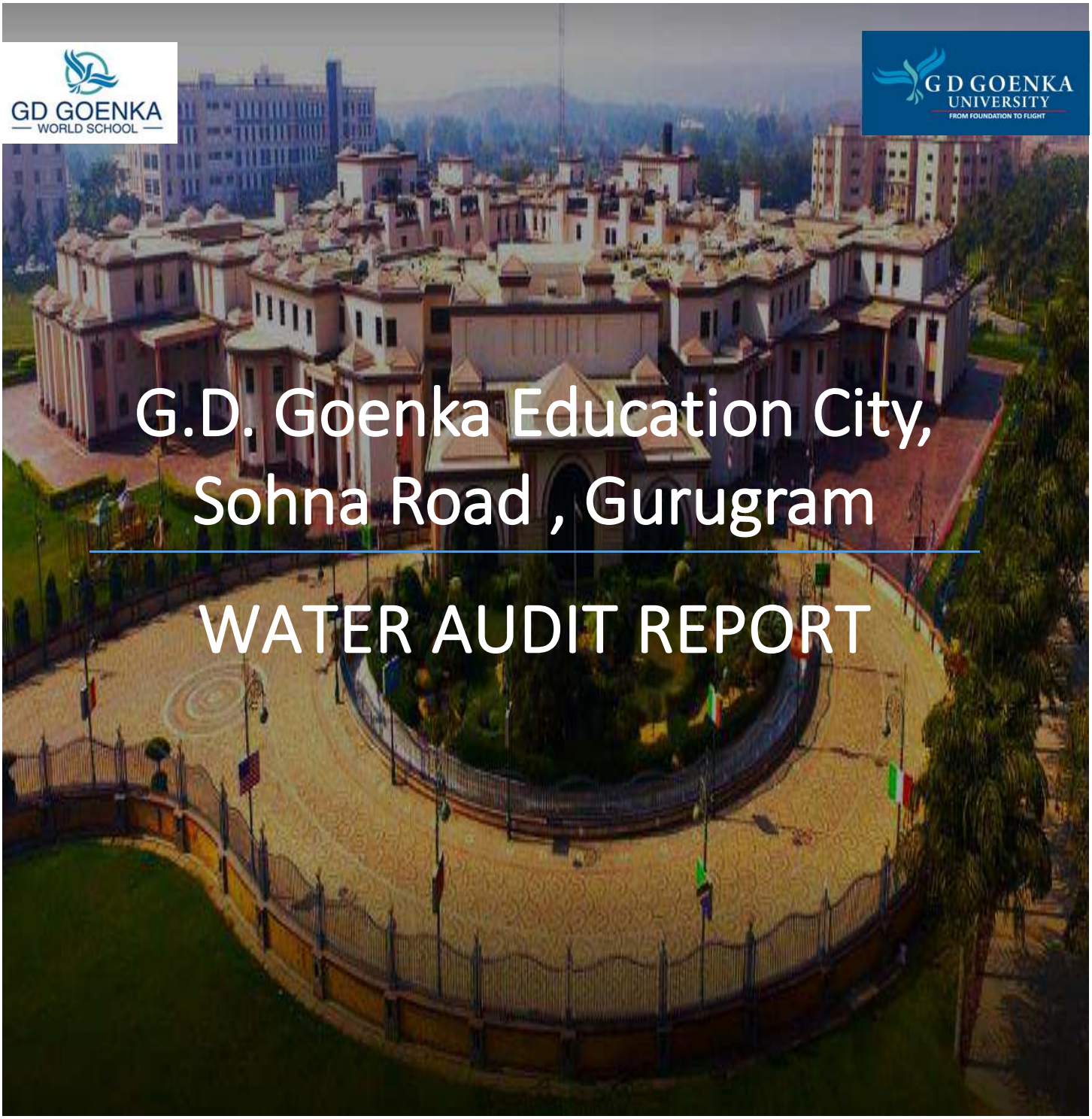


G.D. Goenka Education City, Sohna Road , Gurugram

WATER AUDIT REPORT

Prepared by-

DESIGN2OCCUPANCY SERVICES LLP, JAIPUR
Jaipur, Rajasthan

I. Introduction

Water is a precious natural resource with almost fixed quantum of availability. With continuous growth in country's population, per capita availability of utilizable water is going down, whereas with ever-rising standard of living of people, all around rapid industrialization and urbanization, demand of fresh water is going up continuously. In spite of the fact that fresh water is rapidly becoming scarce, it is continued to be used wastefully.

The old saying, "you can't manage what you can't measure" holds true with water use in the campus premises. It is important to understand how much water the campus is consuming and how it is divided among various uses such as in the building indoor, landscape, processes etc. Water audit helps in understanding the above and is an effective management tool for minimizing losses, optimizing various uses and thus enabling considerable conservation of water use in every usage type.

II. Executive Summary

G. D. Goenka Education City campus located on Sohna Road, Gurugram, is spread over an area of 60 Acres. The education city comprises of world school and university campus. The group work towards providing an environment and curriculum where children can explore and develop every facet of themselves, enabling them to realize their true potential.

The G.D. Goenka world school campus consists:

a. *Administration Block & School Building*
b. *3 Boys Hostel (Zeus, Hercules & Centaurus)*
c. *2 Girls Hostel (Athena & Andromeda)*
d. *Fitness Centre*
e. *Dining Area*
f. *Service Block*
g. *Principal & Guest House*

Whereas, the GD Goenka University campus consists:

a. *Block-B & Block-C*
b. *Administration Building (Not in Operation now)*
c. *Basement*
d. *Workshops*

1. Area Bifurcation

The whole campus is divided into school campus and university campus which is majorly divided into building footprint, hardscape and landscape area of the respective campus. The bifurcation of the area is done according to the provided drawings which is as follows:

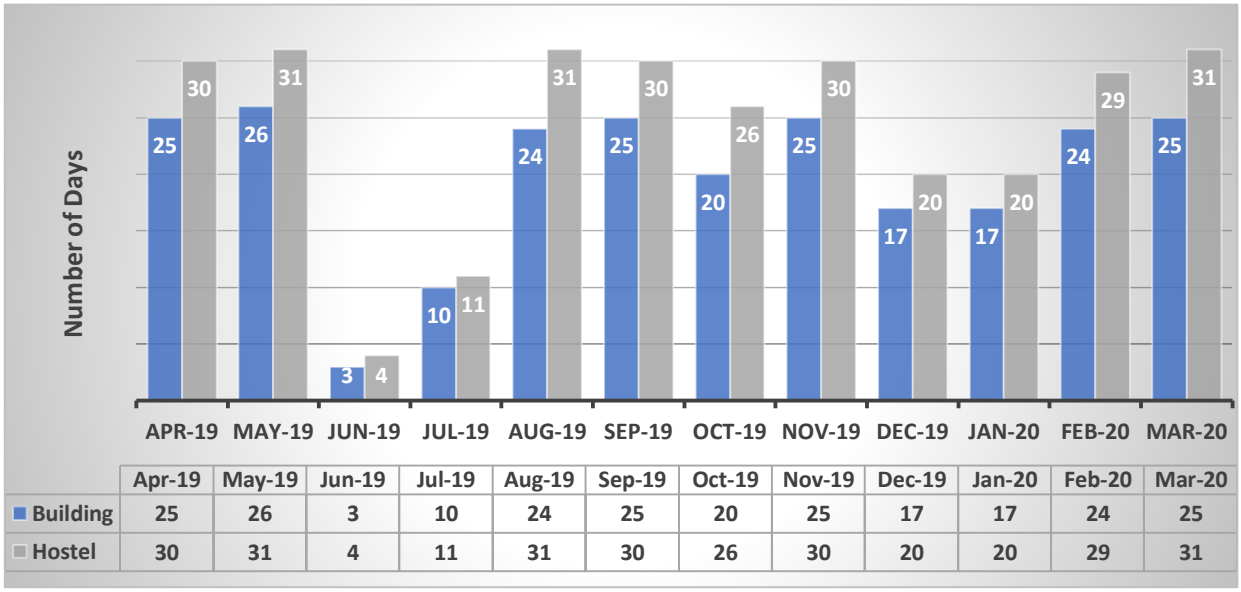
Table 1: Campus Area Bifurcation

Area Type	School Campus	University Campus
Building Footprint (sq.ft.)	3,78,896	1,93,212
Landscape Area (sq.ft.)	10,32,284	4,44,715
Hardscape Area (sq.ft.)	4,39,580	1,24,913
Total (sq.ft.)	18,50,760	7,62,840

2. Building Occupancy Schedule

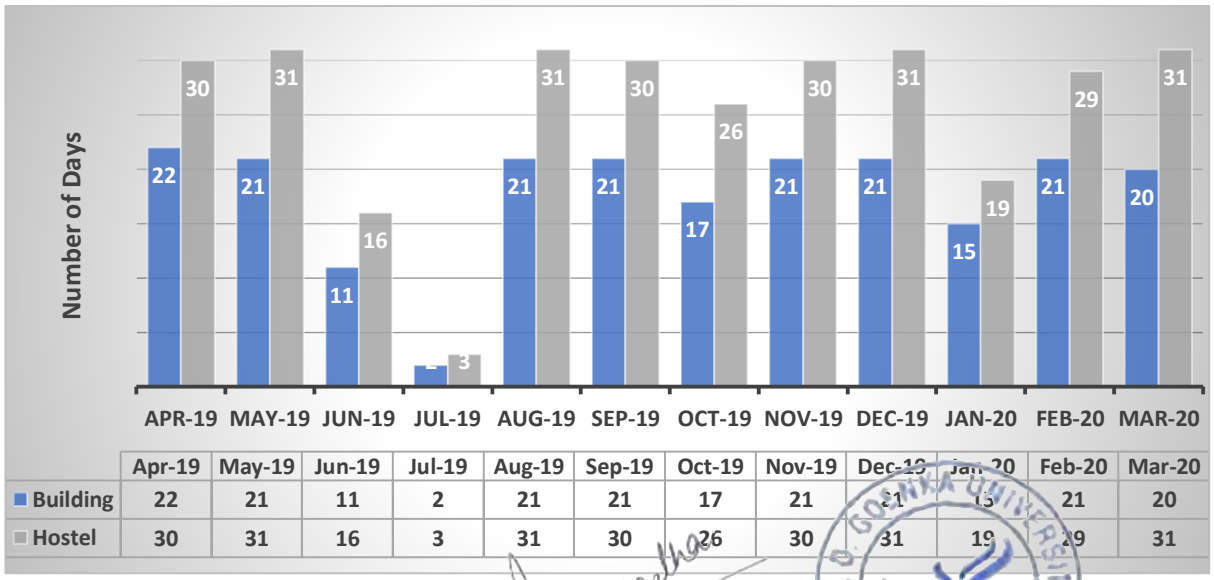
The occupancy schedule of the building varies with the number of days it remain occupant. Similarly, the water usage of the buildings within the premises are studied according to their respective occupancy schedule.

Hence, school, university, hostel buildings occupancy is considered as per the holidays within the year and their relative calendar for the year 2019-20. The schedule of the buildings is shown in figure 1 & 2 below.



	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Building	25	26	3	10	24	25	20	25	17	17	24	25
Hostel	30	31	4	11	31	30	26	30	20	20	29	31

Figure 1 School Building & Hostel Occupancy Schedule



	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Building	22	21	11	2	21	21	17	21	21	15	21	20
Hostel	30	31	16	3	31	30	26	30	31	19	29	31

Figure 2 University Building & Hostel Occupancy Schedule

3. Occupancy Details

The number of occupants is also important to define the amount of water used in the building, therefore, the following details of the occupants has been considered during the calculation and report preparation.

Table 2: School Occupancy Details

Occupant Type	Number of Occupant
School Building	
Students	675
Faculty	85
Sup. Staff	56
Total	**816**
School Hostel	
Boys	102
Girls	48
Total	**150**

Table 3: University Occupancy Details

Occupant Type	Number of Occupant
University Building	
Overall	3200
University Hostel	
Boys	403
Girls	274
Total	**677**

Table 4: Campus Staff Occupancy Details

Campus Staff	
Occupant Type	**Number of Occupant**
Warden	5
Horticulture	17
Plumbers	9
Driving Staff	72
Housekeeping	72
Catering	82
Security	54
Laundry	11
Total	**322**

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Hence, it is observed that the total occupancy of the campus is **5,165.**

4. Audit Brief

The water audit was conducted by D2O team from 16th Sept 19 to 18th Sept. 19, at the G. D. Goenka Education City premises to study the existing practices of water consumption and seek possible ways to conserve water. The facility was introduced by, **Mr. Surinder Jeet.** Concluding meeting was held on daily basis with **Major Karttikeya Sharma** during 3-day audit in which D2O team explained the observations and plan of upcoming day.

The existing fixtures and systems in the campus uses additional water of **108,359 kilo litres per annum**. Also, the analysis indicated that the campus usage **35%** more water than required.

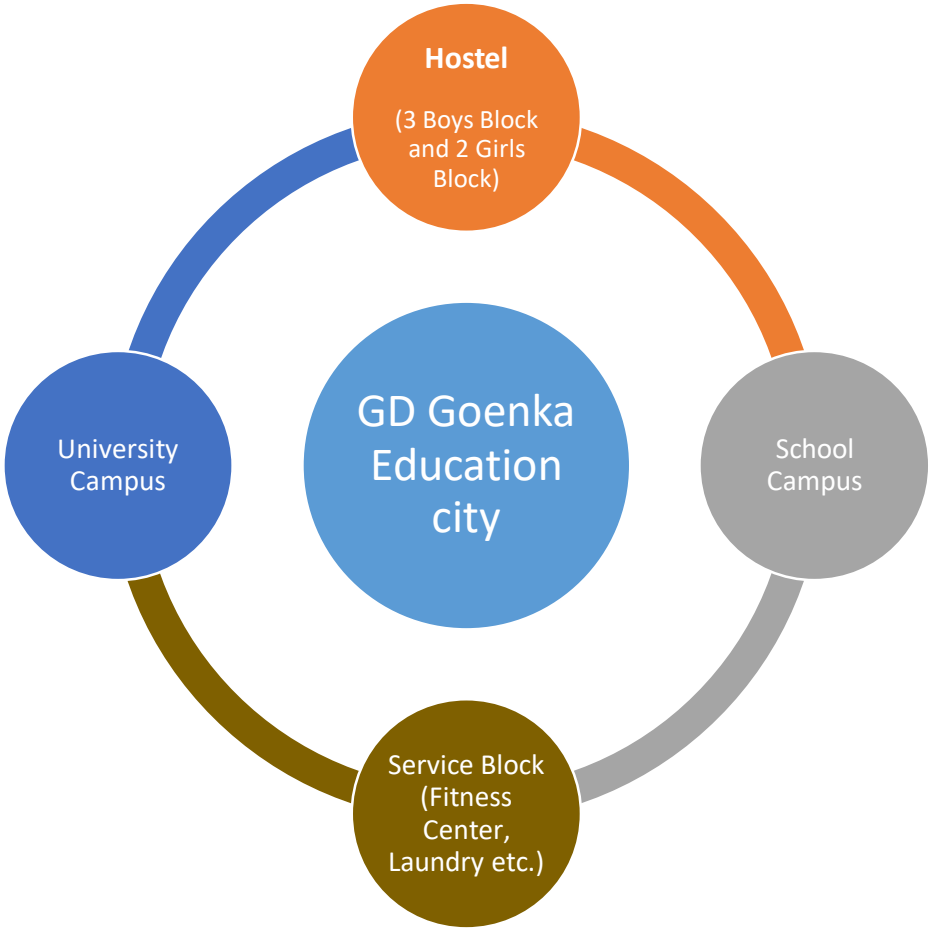

Figure 3 Assessed areas during water audit

III. Geology of Sohna, Gurugram

The study of geological space is mandatory before doing water audit, to understand the thermal, physical & properties of the place. Sohna is a tehsil in Gurugram district of Haryana. This is located around National Highway-248A in between Gurugram, Haryana to Alwar, Rajasthan. The tehsil area have Sohna municipal committee & Bhondsi census town, along with 61 villages. The total population of the tehsil is 1,65,629 as per census 2011. The geological information of the Sohna is discussed below.

1. Climate

The climate of the Sohna tehsil is classified as tropical steppe, semi-arid and hot. Because, the major part of the year, the air remains extreme dry. However, during the monsoon season, the dryness reduces due to rainfall presence in the area. Annual temperature & daylight hours at Sohna is as follows:

Mean Maximum Temperature (May)	40°C
Mean Minimum Temperature (January)	8°C

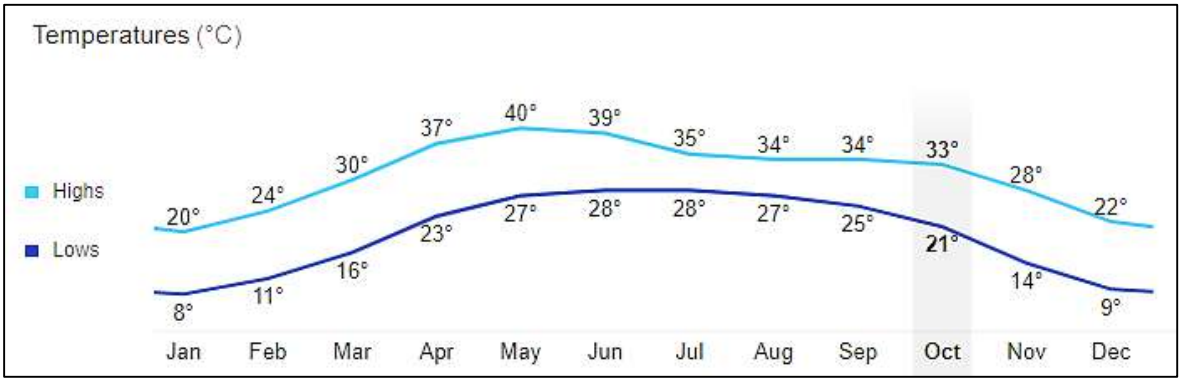

Figure 4 Annual Temperature Variation (Monthly Mean) Source-NOAA

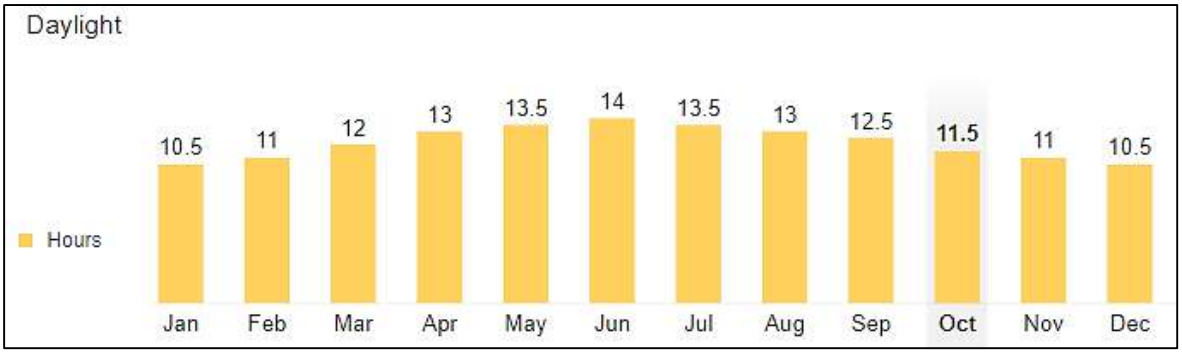

Figure 5 Annual Daylight Hours (Monthly Mean) Source-NOAA

2. Seasons

The seasonal variation is also observed in the tehsil zone in a period of 3 to 4 months. The Monsoon season starts in the last week of June and remains active until end of September, this causes the penetration of moisture into the environment and results in high humidity, cloudiness and rainfall. After the departure of monsoon, October to December constitutes post monsoon season. Followed by the winter season from January to the first half of March. At last, the summer wind prevails in the zone and remains up to the last week of June.

3. Rainfall

The major rainfall in the Sohna tehsil can be experienced in the month of July & August. The normal annual rainfall noted in the tehsil area is 587 mm. Moreover, the normal rain days remains 28 days or more. The five year data of the district has been given in Table 2.

Table 5: Five Year Rainfall Data (Source: Indian Metrological Department)

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2014	0.0	-100	13.0	11	40.8	483	16.0	150	46.2	232	11.3	-70	112.6	-33	11.8	-94	38.3	-52	4.3	-66	0.0	-100	2.7	-37
2015	10.9	7	0.0	-100	49.8	612	17.5	173	6.9	-51	31.5	-17	180.3	7	139.2	-25	30.6	-62	0.0	-100	0.0	-100	0.0	-100
2016	0.0	-100	0.0	-100	16.2	131	0.5	-92	17.6	27	38.8	2	186.8	11	138.0	-25	35.7	-55	15.4	21	0.0	-100	0.0	-100
2017	28.8	182	0.0	-100	2.4	-66	2.8	-56	15.8	14	97.3	156	61.2	-64	33.4	-82	65.0	-19	0.0	-100	0.0	-100	1.3	-69
2018	1.6	-84	0.0	-100	0.0	-100	4.8	-26	3.4	-76	64.9	71	118.3	-30	116.0	-37	112.2	40	0.0	-100	4.3	-21	0.3	-94

Note:

a. *District rainfall in mm (R/F) shown above are the arithmetic averages.*
b. *%DEP are the departures of rainfall from the long period averages of rainfall for the district.*

4. Topography-

The area is conspicuously flat topography, however, in the north-eastern part small isolated hillocks of Precambrian rocks are exposed. The alluvial plain is formed by the Sahibi river which is tributary of river Yamuna and flows around the district. Soils are classified as tropical and brown soils, existing in the north western extreme, northern and north eastern parts and water logged and salt affected soils in the southern parts. The soils are medium textured, loamy sand is the average texture in Sohna. The percolation rate of the sandy loam soil is 1.2 cm/hr.

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IV. Water Audit Definition & Procedure

1. Definition

Water auditing is a method of quantifying water flows and quality in simple or complex systems, with a view to reducing water usage and often saving money on otherwise unnecessary water use. It provides the deviation existing in the actual water supply to the minimum required water in the respective premises. Also, water auditing is a mechanism for conserving water, which will grow in significance in the future as demand for water increases.

2. Objective of the Audit

The objective of water audit is to assess the following:

a) Water Required (in accordance with National and/or State Bye Laws)
b) Water Used (as per the Existing Fixtures & Equipment)
c) Physical & Non-physical Losses
d) To identify and priorities areas which need immediate attention for control

3. Procedure

The different stages of the water audit has been depicted in form of flow chart in Figure 4. The whole procedure is divided into five phase starting from the site inspection to review of the implemented measures.

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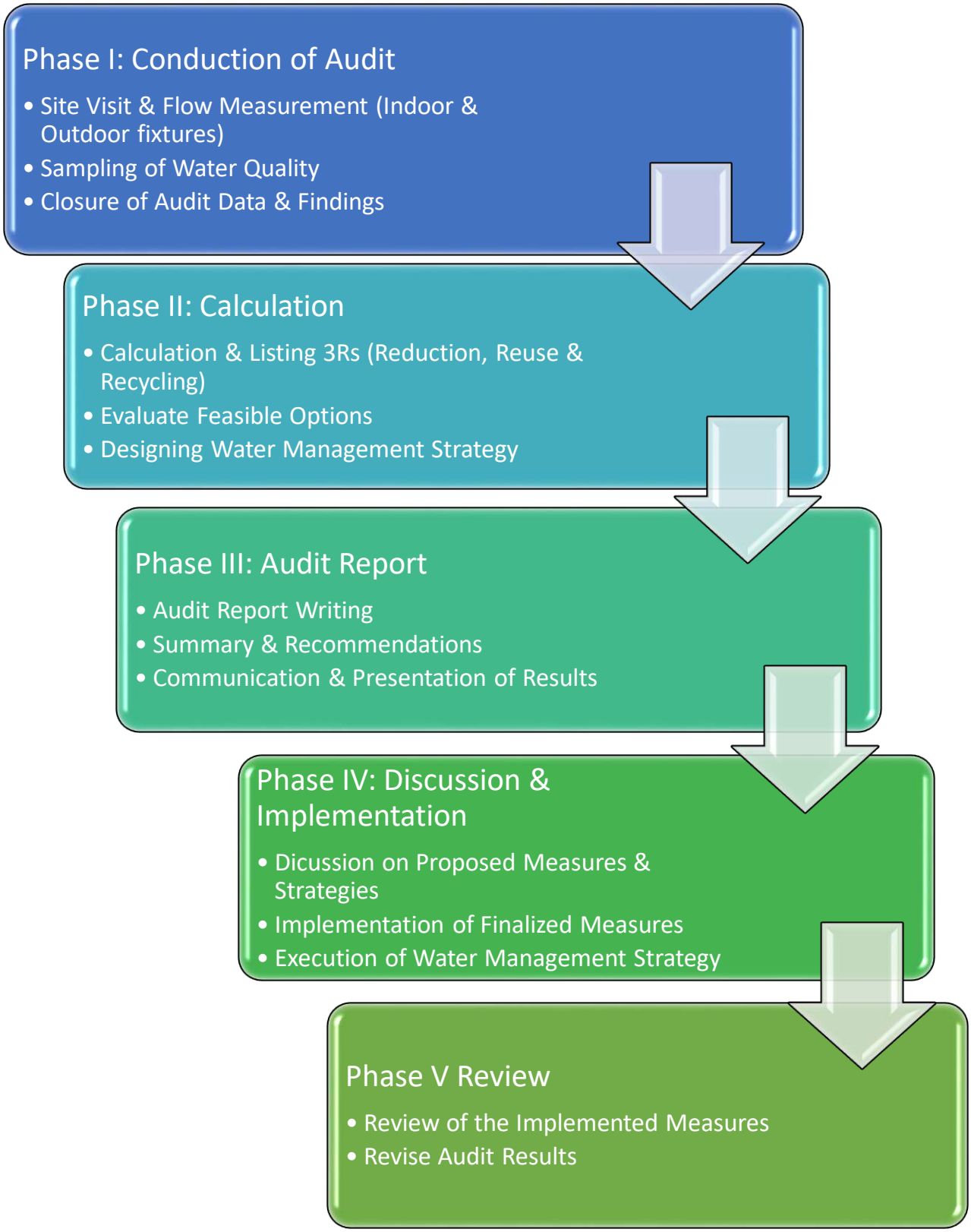

Figure 6 Audit Procedure

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Phase I: Conduction of Audit

At the beginning of water audit, it is must to observe the supply, storing & consuming facilities are provided on the site. The water audit team commits to:

a) Conduct site visit to locate the water points & Map them
b) Locate the water usage areas
c) Take samples at various location to define water quality
d) Mark storage tanks
e) Compile the findings during visit
f) Notice conditions of fixtures (dirty, stuck, leaking etc.)

Phase II: Calculation

After completion of site visit, the audit team performed calculation to analyse the acquired data with reference to local bye laws (in India: NBC 2016) as base line. This enables to determine whether the premise is consuming surplus water or not. The results will helps to calculate the amount of water wasted or misused. Following goals are kept in mind during the calculation;

a) Estimating water use from different areas and activities of a building.
b) Estimate rate of flow of water from different outlets and inlets.
c) Determine the rate of flow of water for faucets and shower head.
d) Estimating shortage or surplus with reference to NBC 2016.

Based on the calculation, the water management strategies have to be define and implement in the respective premises.

Phase III: Audit Report

The team prepares detailed report based on procedure mentioned above. The audit report consists:

a) Observations done during audit
b) All the measurements, calculations
c) Overview of the current working of water supply system
d) Summary and conclusions based on the calculations

Phase IV: Discussion & Implementation

After formation of audit report, the audit team will hold meeting with the respective project team to discuss the current and future scenario towards the water management. The key discussion points are:

a) Possible water conservation measures & their implementation

b) Areas where water can be conserved & wastage of water can be minimized

Later, the project team will implement the measure that are finalized in accordance to the discussion and meetings held with audit team.

Phase V Review

After the implementation of measures, the review and maintenance of the same is much needed. Because, the continuous monitoring of the measures can only justify and revise the water savings occurring in the premises.

The formation of **"Sustainable Cell"** in the premises will help in proper & continuous execution of the measures. This cell is also responsible to educate the occupants regarding effects of water management along with the finding and installing any new techniques at the project site.

V. Methodology

Audit team visited the site to observe the water supply and end usage. During the campus visit, the team made following observations:

1. Supply System

a) Bore well

The whole facility depends on ground water as their primary source to cater water demand of occupants, landscape and process systems. The water is extracted from a total of 9 bore wells. The bore wells have capacity, location and operational hours has been shown in Table 6 below. The details are based on the communication held during site visit.

Table 6: Water intake from Bore wells in School Premises

Location	Power (HP)	Discharge Rate (LPM)	Operational Hours (Hours)
Transformer	7.5	200	20
4-quarter	6	150	20
ATM front	5	120	21
Phase-I	7.5	200	14
At front	10	250	8
At RW Pit	3	80	4
Basement	7.5	200	4
STP	3	80	4
Near Entry Gate	5	120	14

b) Water Cans

Moreover, the **drinking water** demand for campus occupants is done by purchased water cans on daily basis. It was informed that, an average of total **250 water campers** is required to cater the drinking water requirement of the whole premises.

$$Drinking\ Water\ Supply = Number\ of\ drinking\ cans\ \times Capacity\ of\ each\ can\ (Litres)$$

$$\boldsymbol{Daily\ Drinking\ Water\ Supply\ = 250\ \times 20 = 5000\ LPD\ or\ 5\ KLPD}$$

c) Treated Water (Sewage Treatment Plant)

The building is equipped with two sewage treatment plants. One STP plant of 150 KLPD capacity is installed in the school campus whereas, the other plant of 125 KLPD capacity is located in the university campus. Both the plant treat the water of their respective campus buildings. The appropriate efficiency of a STP plant is around 80%, the same has been considered in our calculation.

STP of capacity 150 KLPD receives an amount of 200 kilo litres of waste water out of which 120 kilo litres is treated and supplied to the irrigation whereas the remaining water is left in the collection tank and extracted when reaches higher amount. Moreover, the STP plant of 125 KLPD receives only 50 KLPD and have an output of 40 KLPD with an efficiency of 80%.

The treated water of both the systems is provided to the landscape, hence, the total landscape demand is reduce from the measured baseline and actual system. However, during the site visit, it was observed that the STP located under school campus is **UNDERSIZE** and the plant located in university is **OVERSIZE**.

2. End Usage

The campus water usage is calculated on the basis of National Building Code - 2016 (NBC 2016) to define the baseline case and the actual water usage is calculated on the basis of performance data provided and observed during the site visit.

a) Building Usage

National building code, 2016 is followed to define the base case to compare with actual as per the national guidelines. The following table followed in the daily water usage in base case:

Table 7: Occupants Daily Water Usage (as per NBC 2016)

	School			Hostel		
Occupant	Student + Teaching & Non-Teaching Staff			Number of Beds + Warden Residence + Staff		
Water Usage (Per Occupant)	Domestic Usage 25 Litres	Flushing Usage 20 Litres	Total Usage 45 Litres	Domestic Usage 90 Litres	Flushing Usage 45 Litres	Total Usage 135 Litres

However, the actual water usage is calculated as per the site visit. Table 8 defines the observed flow rate of different type of water fixture in the campus.

Table 8: Flow Rates of Existing Water Fixture

Fixture Type	Flow Rate
Dual flushing WC	3/6 LPF
Sensor-based Urinals	3 LPF
Lavatory, faucet (Private)	9 LPM
Sink, Faucet	12 LPM
Health Faucet/Hand Spray	12 LPM
Shower Head	12 LPM

b) Process Equipment Water Usage

- *Laundry*

The washing and drying of the clothes is performed by means of 3 clothes washer and 2 drying machines. The equipment works continuously from 8 AM to 5 PM on daily basis. The cycle time of the equipment is 30 minutes, hence, all the machines operate 18 times on daily basis.

Table 9: Water Usage in Laundry

Usage	Capacity	Model	Water Demand per cycle (Litres)	Daily Consumption (Litres)
Staff	7.5 KG	IFB Senator Aqua SX	7.5	135
Students	30 KG	STEFAB AX 30	30	540
Students	60 KG	STEFAB AX 60	60	1,080
Total				**1,755**

- *Cooling Tower*

The campus is equipped with 4 cooling towers which operates 23 hours on daily basis. Efficiency of the system remained 0.71% under standard conditions. However, during the

preliminary meeting it was conveyed that the make-up water is higher (approx 1.2 lakh litres) in actual. Hence, the losses in the actual case of cooling tower is considered as 1%.

Table 10: Water Usage in Cooling Tower

Case	No. of Cooling Tower	Consumption (Litres)	Evaporation & Drift Losses	Make Up Water (LPM)	Operation (Hours)	Make-up Water (Litres)	Total Usage (Litres)
Standard	4 (600 each)	9,085	0.71%	65	23	89,015	**392,399**
Actual	4 (600 each)	9,085	1%	65	23	123,373	**537,832**

Note: LPM= Litres per minute,

- *Kitchen*

In the kitchen premises, the water used for food processing and dishwashing is done with the open pipe of ½ inch. The kitchen spaces is under operation for more than 6 hours from preparing to cleaning process on daily basis. Therefore, the actual total water consumption of the kitchen space comes out to be 86 kilo litres per day.

"""

However, the baseline case considered the kitchen water usage in the per capita supply as defined in Table 7.

- *Vehicle Washing*

Campus have 30 vehicles which are washed on daily basis by means of bucket system. The washing is done before and after the trip and daily trips are two i.e. one while picking everybody and other is dropping.

Table 11: Water Usage in Vehicle Washing

No. of Vehicles	Method	Daily Consumption (Litres)
30	Bucket/Manual	**900**

c) Landscape Use

The baseline landscape consumption is calculated as 4.8 Litres/m^2/day. Whereas, the actual landscape requirement is done as per the plantation species/trees/turf grass. Also, during the actual calculation the annual impending rainwater is also considered.

However, as the part of landscape demand is catered with the treated water from STP. Hence, the treated water is reduced from the total landscape demand for more feasible solution.

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Table 12: Landscape Area and Irrigation Method

Plantation	Irrigation Method	Area (sq.ft.)
Turf Grass	**Manual**	10,92,312
Shrubs	**Manual**	59,080
Mature Trees	**Manual**	1,18,160
Turf Grass	**Sprinkler**	2,07,447
Total Area		**14,76,999**

The total landscape area in the campus premises is more than 56% of the total site area i.e. 14,76,999 sq.ft or 33.6 Acres.

Table 13: Landscape Watering Schedule

Month	No. of Days	Remarks
Apr-19	15	Alternate Days
May-19	16	
Jun-19	15	
Jul-19	6	Once in a week
Aug-19	6	
Sep-19	10	Twice in a week
Oct-19	10	
Nov-19	10	
Dec-19	10	
Jan-20	10	
Feb-20	10	
Mar-20	15	Alternate Days

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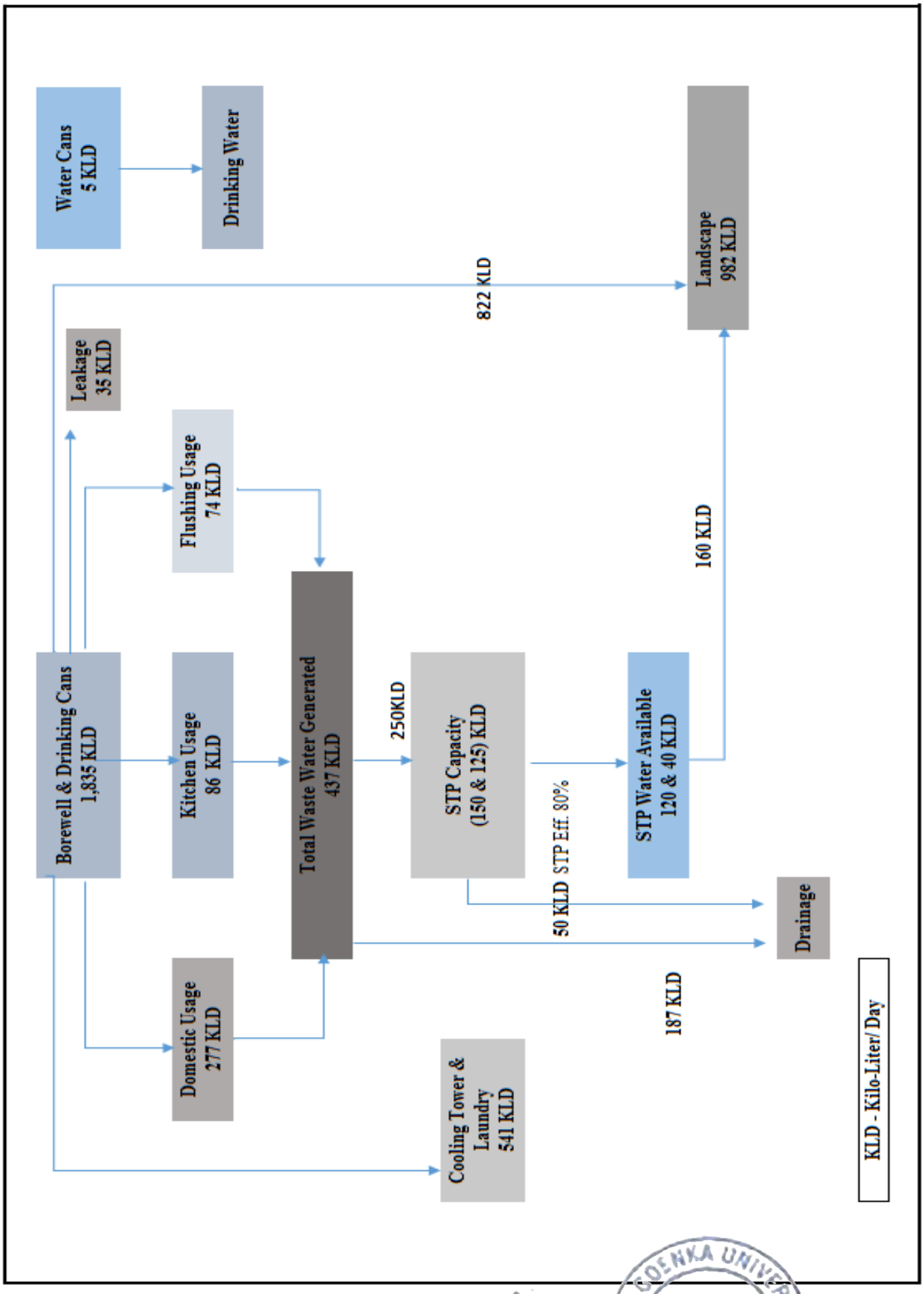

Figure 7 Water Balance Chart - Daily

VI. Water Usage Calculation

1. Daily Water Usage

Table 14: Daily Water Usage in the Campus Premises

End Use	Baseline Usage (kilo Litres)	Actual Usage (kilo Litres)	Surplus Usage (kilo Litres)	Surplus Usage (Percentage)
Landscape Usage	663	822	159	24%
Building Usage	326	356	30	9%
Process Water	395	627	232	59%
Total	**1,384**	**1840***	**456#**	**30%**

*Note: *Observed Leakages results addition of 35 kilo litres water use in the campus & drinking water of 5KLD.*

 # Surplus supply with leakages

As per Table 12, a difference of 581 kilo litres in the existing water usage and possible water usage in baseline is observed. This means the facility is using 42% more water than the best possible.

2. Annual Water Usage

Table 15: Annual Water Usage in the Campus Premises

End Use	Baseline Usage (kilo Litres)	Actual Usage (kilo Litres)	Surplus Usage (kilo Litres)	Surplus Usage (Percentage)
Landscape Usage	88,209	109,388	21,180	24%
Building Usage	81,938	97,417	15,479	19%
Process Water	140,915	199,841	58,925	42%
Total	**311,062**	**419,421***	**129,639#**	**35%**

*Note: *Observed Leakages results addition of 12,775 kilo litres water use in the campus*

 # Surplus supply with leakages

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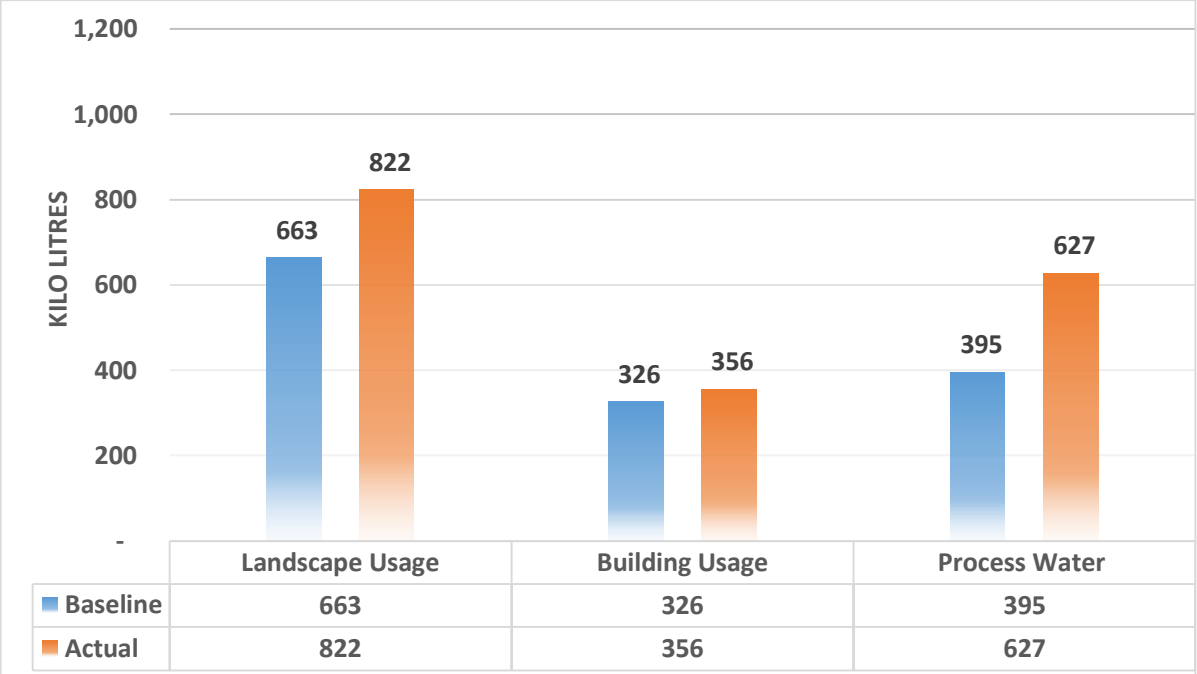
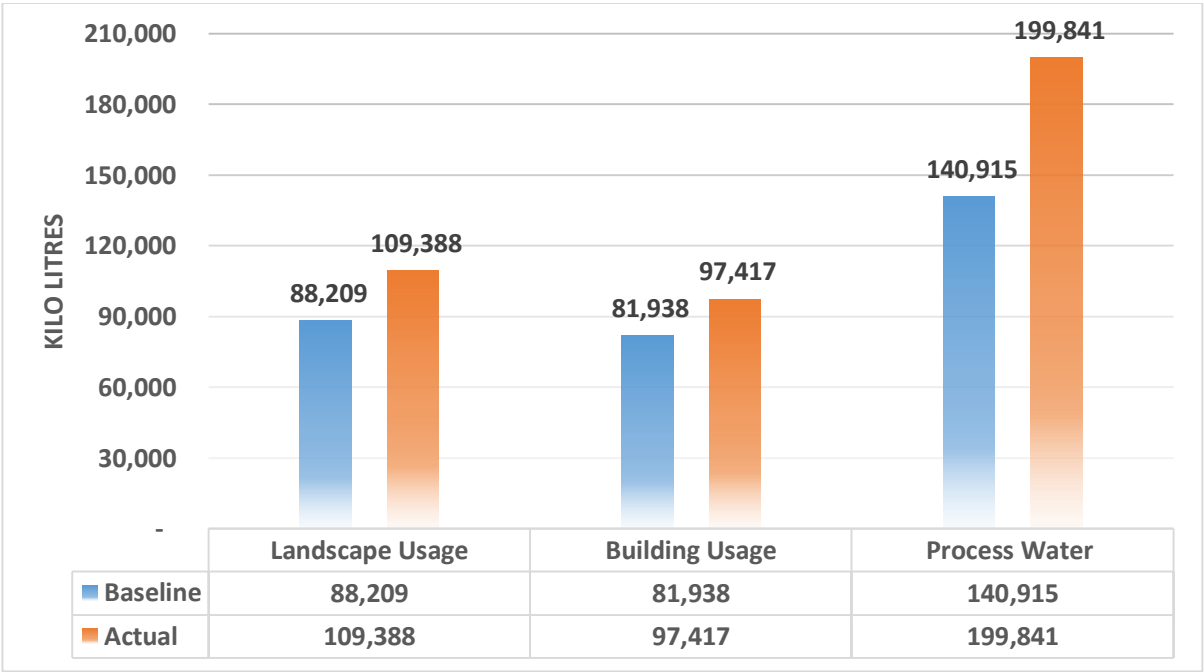
3. Graphical Representation of Daily and Annual Water Usage in Baseline & Actual case



	Landscape Usage	Building Usage	Process Water
Baseline	663	326	395
Actual	822	356	627

Figure 8 Graph b/w Daily water usage is Baseline & Actual



	Landscape Usage	Building Usage	Process Water
Baseline	88,209	81,938	140,915
Actual	109,388	97,417	199,841

Figure 9 Graph b/w Annual Water Usage in Baseline & Actual

4. Comparison between the Baseline v/s Actual Water Usage

The difference between the water usage of baseline and actual is termed as **surplus usage** of the premises. Because, the same can be saved with the implementation of the

appropriate water conservation measures. Also, the reduction in actual usage will help in reducing the load on total electricity consumption as the supply source is pump only.

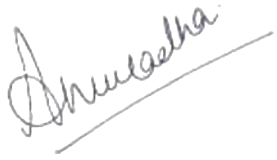
$$Annual\ Surplus\ Usage = 311{,}062\ (kilo\ litres) - 419{,}421\ (kilo\ litres)$$

$$\boldsymbol{Annual\ Surplus\ Usage\ = 108,359\ (kilo\ litres)}$$

$$\boldsymbol{Percentage\ of\ Surplus\ water\ usage\ =\ 35\%}$$

However, the surplus water can serve the following operations if maintained appropriately.

- The existing fixtures and systems in the campus usage additional water of **108,359 Kilo Litres per Annum.** This much of surplus water can fulfil daily water demand of atleast **2200 personal** which is equal to **550 houses** with an occupancy of 4 personal in each house.
- The same surplus water can fill **108 swimming pools** of size 13 m (length) x 7 m (width) x 2.5 ft (depth). The size is sane as small existing swimming pool in the campus.
- Surplus water can cater water requirement of **landscape area of 62,000 sq.ft.**
- The surplus is approximately half of the daily water requirement of all the campus occupants.
- Also, the extra running of the bore wells will affect the energy cost of the campus. The same will be covered during energy audit.



VII. Water Conservation Measures (WCM)

The water conservation measures are divided as per the type of usage to represent the achievable savings in the respective use.

- **WCM 1 – Install Water Meters**

The facility is not equipped with water meters neither at the supply nor at end usage. Water metering is must to measure and observe the water usage. Also, it is seen that the people cut down their consumption very early after the installation of a meter. Therefore, the team suggest the installation of **25 water meters** at the following places in the campus premises:

- Separate meters for each Bore wells i.e. a total of 9 meters.
- At School & Administration Building
- At each block of University Campus i.e. 2 water meters
- Five water meters in the five hostel buildings.
- One meter at Dining Area.
- One meters at STP inlet and One at STP outlet
- In-line with Laundry Supply
- One Water Meter for Fitness Centre
- One at Irrigation of School and One at university campus irrigation
- At guestroom and principal premise

1. Building Water Usage

- **WCM 2 – Use of Water Aerators and/or Replacement of Existing Water Fixtures with Low-flow Fixtures**

The annual domestic and flushing water consumption of the building occupants is **97,417 kilo litres**. The existing water closets have dual flushing and urinals are sensor-based so both of the fixtures already have respective savings. However, additional amount of water usage can be reduced by placement of aerator in to existing fixtures and/or by replacing the fixtures with new flow fixtures.

Table 16: Annual Water Usage in the Campus Premises

Fixture Type	Existing Flow Rate	Proposed Flow Rate	Savings (kilo Litres)	Savings (%)
Lavatory, faucet (Private)	9 LPM	6 LPM	37,130	38 %
Sink, Faucet	12 LPM	6 LPM		
Health Faucet/Hand Spray	12 LPM	6 LPM		
Shower Head	12 LPM	6 LPM		

The proposed flow rate of fixtures will have an annual water usage of **60,287 kilo litres** which is **38%** lesser than the existing fixtures under same operation schedule.

- **WCM 3 – Provide Thermostats at the Boiler used for Water Heating**

In the campus premises separate boiler systems are installed for heating the water for daily uses. It was seen that the boiler heated water at very high temperature which results in mixing of hot and cold water at the end use by occupants. Hence, the excess heating of the water than required temperature is appropriate as the evaporation and energy input increase with increase in heating temperature.

Therefore, the team would like to suggest the installation of thermostat to maintain the heating temperature in the range of 40 to 45 °C to prevent the mixing at the end user and reducing evaporation losses due to higher temperature.

Figure 10 Installed Water Heating System

Figure 11 Thermostat at Water Boiler

2. Process Water Usage

a) At Kitchen

- **WCM 4 – Use of Low Flow fixtures in Kitchen Premises**

As seen during the site visit, the food preparation, washing vegetable etc. uses an amount of **6,825 kilo litres** per annum as the flow fixtures in the kitchen spaces have flow rates of 15 LPM which is very high as per regular practices.

Hence, the use of water reducing fixtures in the kitchen space with flow rates of 8 LPM is. Thus, we can see save an amount of **3,185 kilo litres** annual for food processing i.e. **46 %** of existing water usage. The same percent water reduction can be seen on daily basis also.

- **WCM 5 – Installation of pre-rinse spray valves instead of high flow taps.**

The kitchen spaces have flow rates of 15 LPM which is very high as per regular practices. Use of pre-rinse spray valves in such spaces will reduce the daily as well as annual water demand. The typical flow rate for pre-rinse spray valves is 4.8 LPM which is very less. Hence, it can be seen that the use of such measures in the kitchen will reduce the water usage by 66 %.

Figure 12 Use of Pre-rinse spray in kitchen

- **WCM 6 – Use of Dishwasher instead of Manual Washing**

The existing water faucets for dishwashing have an open pipe end of size ½ inch. These fixtures have a flow rate of 45 LPM which results an average water consumption of **65 kilo litres** on daily basis as well as **20,477 kilo litres** annually.

Figure 13 Dishwasher

The dishwasher uses **25 kilo litres per day** instead existing system and results in savings of more than 60% of actual water usage.

General Recommendations

- Educate staff about the use of hand scraping before loading a dishwasher
- Instruct staff to quickly report leaks and troubleshoot
- Run rack machines only if they are full
- Try to fill each rack to maximum capacity

– **WCM 7 – Use of Grease and Oil Interceptor**

During the audit, it was found that the grease and oil content released in the kitchen reached to the sewage treatment plant from the installed pipes. The presence of such content in the STP prevent the effective operation of the treatment plant. Oil and grease gets stick to the pipe and results in clogging of the strainer and filters, thus affecting the treatment unit operations. Also, at the last stage of the waste-water-treatment process, the deposited content in the sludge making it viscous and waxy, and thus reducing the sludge-dewatering efficiency.

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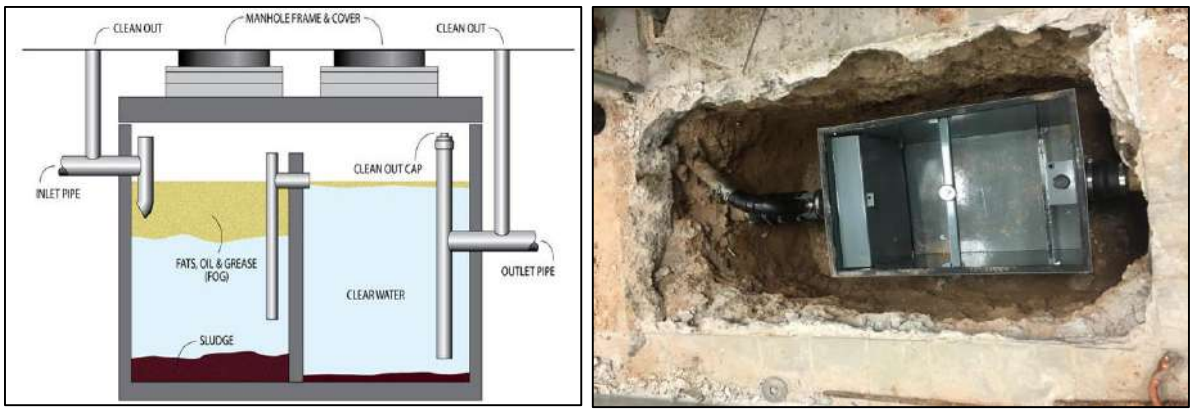

Figure 14 Grease and Oil Interceptor

The use of such system will helps in preventing the clogging of the pipe along with effective operation of the sewage treatment plant.

b) At Laundry

- **WCM 8 – Use of Regulator at the Washing Machine Water Inlet**

The existing laundry machines uses 2 kilo litres water per day and 632 kilo litres annually.

Figure 15 Equipment in Laundry

However, it was observed that many of the times the washing machine is not running on the full load but still consuming the water as per the full load capacity. Hence, it is recommended to install manual regulator to reduce the water inlet in the washing machine. This can help in reducing the overall water consumption and also the load on treatment system.

General Recommendations

- Run the washing machine at full load
- Minimize the rinse cycles as much as possible without compromising on wash quality

- Use the correct amount of soap to load size so extra rinsing is not required

c) Cooling Tower

- **WCM 9 – Prevent Leakages**

The campus is equipped with 4 cooling towers that operates 23 hours daily. It was conveyed that the make-up water is approx 1.2 lakh litres which means the effective losses of the cooling tower are reached as 1%. Also, the leakages were observed during the visit.

The water is leaking at multiple location in the cooling towers, the measured leakages cause the wastage of 12 Kilo litres per day. Also, the falling water from the top of the cooling tower is coming outside the collection pan and fans. This waste water is left out in the landscape area and causes mud like situation.

Figure 16 Leakages at Cooling Towers

- **WCM 10 – Use of Treated STP Water**

Instead of providing fresh potable water in the cooling tower, the site team can use treated water for cooling tower makeup as the properties of treated water remain well in the acceptable range. For this an automatic bypass valve with default 30 % opening can be installed on the makeup water line. Both the lines i.e. fresh treated water line and STP water should be connected through a proportional valve such that at least 30% of water is allowed to enter from STP and rest comes from fresh treated water. This can save approximately **125 kilo litres** fresh water each day.

Additional Recommendations

- Divert the kitchen waste to STP located at University Instead of School Campus as the school STP plant is working under size unlike other STP which is designed as oversized.

- Re-define the STP capacity as per actual inlet in both the STP as the current design is not appropriate.

3. Landscape Usage

a) Irrigation

The present irrigation system is manual which is not feasible as the trees are matured and grass area is watered by ponding method i.e. filling the area with water until a limit reached. These method are least efficient as the water is majorly provided during the daytime (after sunrise & before sunset) which also register maximum evaporation from the landscape.

- **WCM 11 – Use of Drip Irrigation at Mature Trees & Shrubs**

Mature trees have least water demand than the other existing plantation in the campus. These can be served best with the help of drip irrigation as the rate of watering is kept least with only provision near the tree root unlike the flooding of whole area.

Figure 17 Mature Trees and Shrubs in the campus

Figure 18 Regular and Sub-soil Drip Irrigation System

The subsoil drip irrigation system can also be used, this system provides water directly to the roots and prevent surface evaporation. The current irrigation system consumes

- **WCM 12 – Use of Sprinkler System at Turf Area**

The installation of sprinkler system reduces the turf water usage by 30%. These irrigation system provide are effective but the only disadvantage is that these traditional irrigation controllers can operate automatic landscaping systems by setting only the frequency, start time and duration of a watering schedule.

However, nowadays smart irrigation controllers are available which measures the depletion of available plant moisture to operate a system that replenishes water only as needed.

Figure 19 Grass Cover in the campus

Figure 20 Pebbles at site

The implementation of both drip & sprinkler system will reduce the daily demand from 822 kilo litres per day to 495 kilo litres per day. This means the savings of upto **40% in the daily water usage.**

Additional Recommendations

- The use of soil moisture sensor (SMS) and other many other sensors are available in the market, but these systems are least effective where the respective site have rainy days for more than 50 days. However, in our campus it is seen that the

annual average rainy days are only 28 which means the sensor only worked for a duration of one month and remain ineffective for the rest of year.

- Instead of SMS based system, manual controller are more effective in the irrigation system as the operation schedule can be removed during the rainy days and remain in operation during rest of the year.
- Pebbles near the hardscape not only store water and provide to the rainwater harvesting system but also maintain the landscape decorum. The use of such measure in landscape reduces the grass area and its related water demand.
- Water the plants in early morning or late evening to reduce evaporation loss.

Figure 21 Sprinkler System

4. Additional Recommendations

The drinking water is brought in form of water cans from the private vendors on daily basis. As mentioned above the campus have an average water demand of 5 kilo litres per day, for which, they are paying approximately 7,000 INR daily and a total of 22,12,200 INR per annum. The same demand can be fulfilled by installing onsite RO plant and/or collecting rainwater.

- **WCM 13 – Install Reverse Osmosis (RO) Plant**

As the audit team measured, the total dissolve solvent (TDS) within the campus varies from 1040 ppm to 1600 ppm which means the campus occupants can't use the supplied water for drinking purposes without any proper water treatment. Hence, the installation of RO plant is another feasible and adaptable measure.

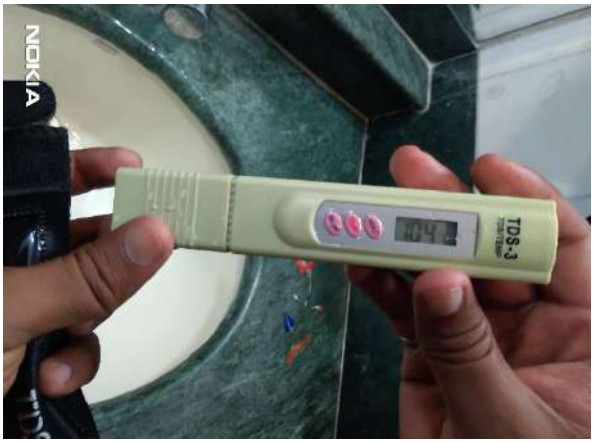

Figure 22 TDS Measurement during audit

Reverse osmosis can remove many types of dissolved and suspended species from water, including bacteria, and is used in both industrial processes and the production of potable water. Reverse osmosis is most commonly known for its use in drinking water purification from municipal water or bore well water, removing the salt and other effluent materials from the water molecules.

Though, the water purification technology provide drinking water well within required range but it cost almost twice of water as wastage. However, as the site area is very large, the outlet water from the RO Plant can further be used for landscaping and in process water.

An RO Plant of 500 LPH will cost around 1,00,000 – 1,20,000 INR and able to produce water as per the demand. The on-site plant have an advantage of producing drinking water as per the need with the time variation and also the waste water is input for irrigation.

Figure 23 RO Plant

- **WCM 14 – Rainwater Storage Tank with UV Treatment Plant**

The campus have a total site area of 60 acres and have a rainwater runoff of 1402 m^3/day. Hence, the rain water should be collected from all roof and non-roof areas of the project for reuse in drinking. This much of rainwater is sufficient to provide drinking water for the whole campus occupants.

It is not necessary to treat the rain water like in RO plant. Thus, water filters are not necessary to maintain microbial, chemical or physical quality of rainwater if catchments and tanks are well maintained. Rainwater supplies may need to be filtered to ensure effective UV treatment as UV treatment does not remove chemicals from water.

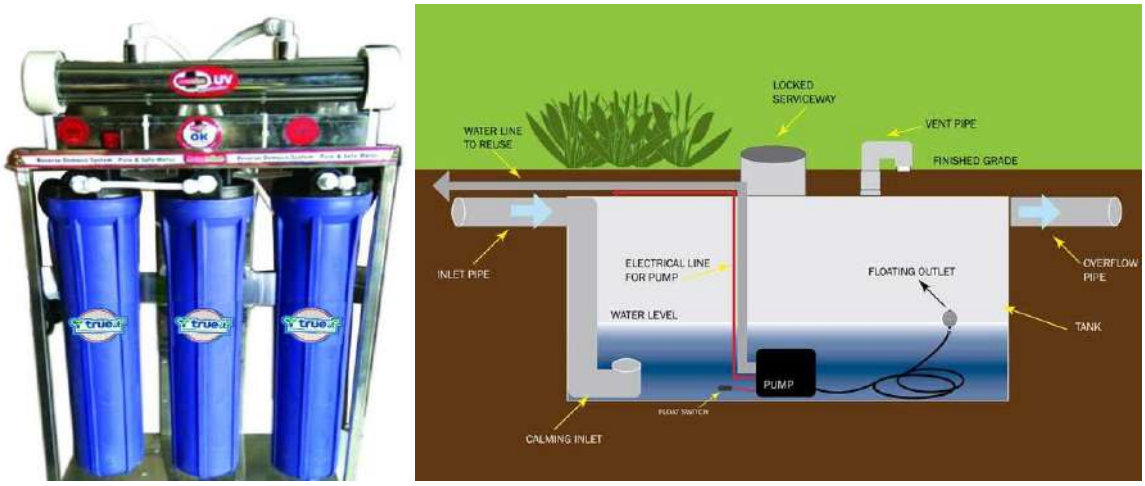

Figure 24 RO Plant and Underground Rainwater Storage

General Recommendation

- The collection of incoming rainwater during peak season is advisable as the rain is continuous during that period unlike the whole year.
- Also, the surplus rainwater can be sent to ground by means of rainwater harvesting pit.

- **WCM 15 – Rainwater Harvesting Pit**

Another medium of harvesting rainwater is providing the incoming rainwater directly to the ground. This will increase the ground water table of the location and also helps in achieving the ground water at same or at less level than the existing level.

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The whole campus have 2 operating recharge pits with a radius of 2 m and depth of 4 meter, as told during the visit. The rest pits are not in operations due to lack of maintenance.

According to the runoff calculation and soil percolation rate of site (defined in section 3), the minimum pits required are 16 to prevent the runoff from the campus. The bore well depth should not be less than 45 meters with a radius of 0.03 m.

- **WCM 16 – Prevent Leakages**

A fundamental part of reducing water consumption is eliminating leaks in plumbing systems, in the various water using fixtures and appliances. Some of the pictures depicting the same is shown below. These leaks can waste thousands of litres per day.

Figure 25 Leakage at Hostel Roof

Figure 26 Sensor Based Tap in School Building

Figure 27 Left Open in Kitchen

Figure 28 Flowing Urinals in Fitness Centre

Figure 29 Flooding at roof of Hostel

Figure 30 Leakage in Softening Plant

Figure 31 Tap in Fitness Centre

VIII. Summary

The water audit was conducted by a team of experts and recommendations have been shared in the report above. The report is an analysis of the water inflows and outflows, and presents opportunities to save water across the facility. Incorporation of the measures suggested in this report shall bring up the water efficiency in the campus and would be a step further in rendering the education city campus among the leading institutions in water efficiency. A summary of the identified water conservation measures is given below:

Table 17: Water Conservation Measures details

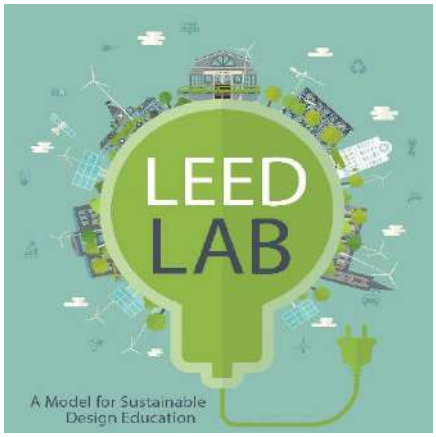
WCM	Description	Savings in Kilo Litres	Remarks
1	Water Metering	-	Directly affect the daily usage by representing the daily water usage at end use.
2	Use of Aerators in Hostel, School & University Premises	37,130 kilo litres per annum	38 % of total consumption of building occupant water usage
3	Thermostats at Boilers	-	Prevent evaporation losses due to heating of water at high temperature
4	Use of Low Flow fixtures in Kitchen space	3, 185 kilo litres per annum	46 % savings
5	Install pre-rinse spray valves	-	66 % savings
6	Use of Dishwasher	12, 601 kilo litres per annum	60 % reduction in water usage for dishwashing
7	Use of Grease & Oil Interceptor in kitchen	-	Prevent the blockage of kitchen drain pipe & Increase operating life cycle of STP
8	Use of regulator in Washing Machine	63 kilo litres per annum	10% savings of water usage in laundry
9	Prevent Leakage in Cooling tower	12 kilo litres per day	100 % savings in leakages, additional savings in Make-up Water
10	Use of Treat STP water	125 kilo litres per day	25 % Savings in total make-up water
11 & 12	Use of Irrigation System	327 kilo litres per day	40 % savings in landscaping water usage
13	Installation of RO Plant	5 kilo litres per day	100 % savings of purchased drinking water
16	Prevention of leakages in building taps	23 kilo litres per day	100 % savings in leakages

IX. Future Scope of Work

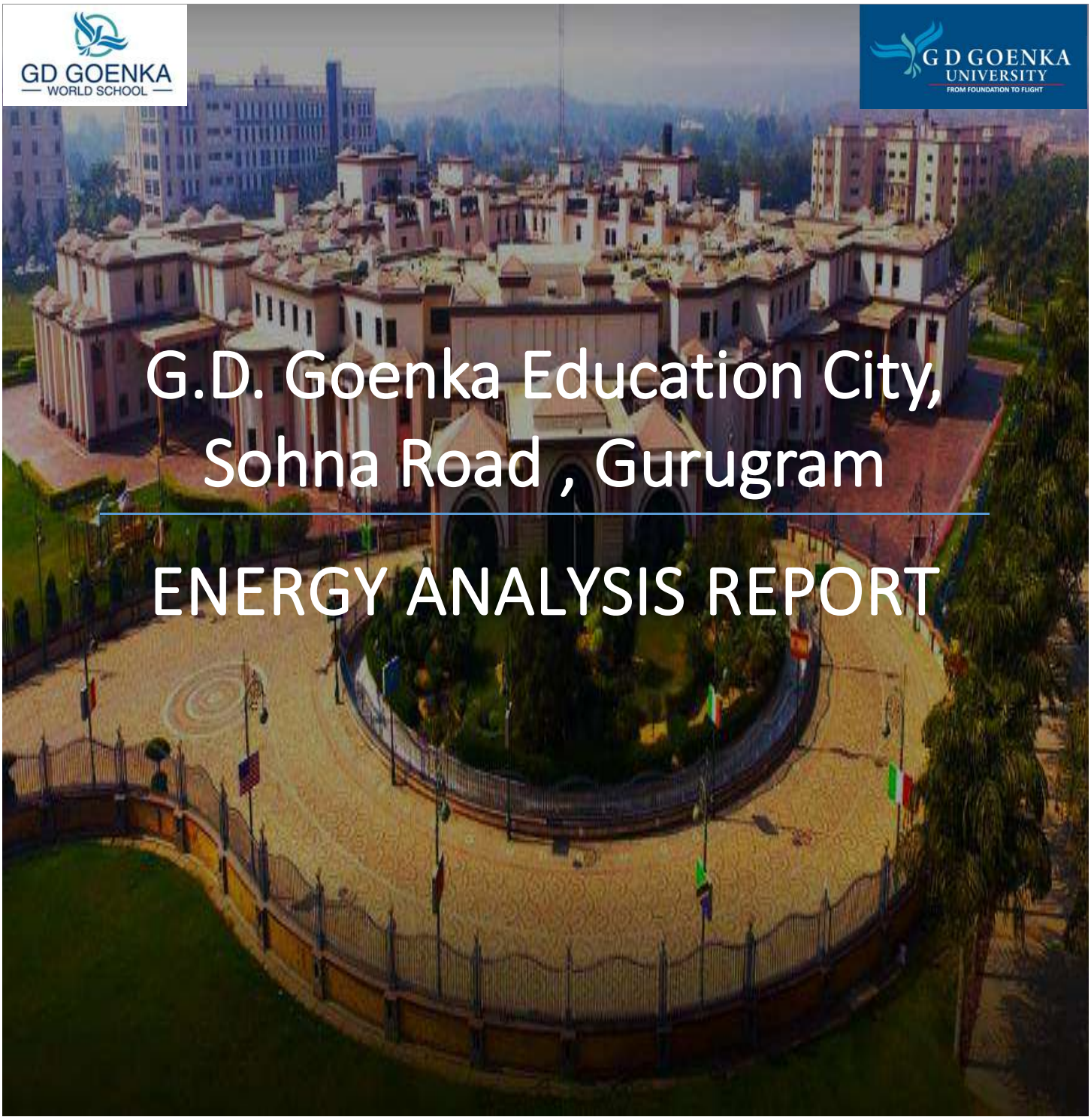
The following work will be done in upcoming days in accordance with the water audit:

- Formation of dedicated **"Sustainable Cell"** in the campus to monitor the implemented measures in the campus
- **Revise** the calculations as per adopted measures.
- Implementation of **water management policy**.
- Apply for the **water conservation awards** on behalf of institution.
- Audit team will also help in setting up of **LEED ARC and LEED Lab** in the campus premises with incorporation of **United States Green Building Council (USGBC)**

LEED Lab connects concepts to practical application by immersing students in the integrative process foundational to green buildings. In this innovative course students. Students learn about LEED's comprehensive approach, covering the prerequisites and credits related to site considerations, energy use, water consumption, waste management and occupant comfort.



LEED ARC is a new digital platform that uses data to help measure and improve sustainability performance across the built environment, from buildings to cities and beyond.



G.D. Goenka Education City, Sohna Road , Gurugram

ENERGY ANALYSIS REPORT

Prepared by-

DESIGN2OCCUPANCY SERVICES LLP, JAIPUR
Jaipur, Rajasthan

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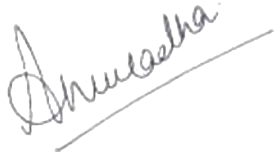


I. Introduction

Based on an inspection of the building (and some measurements), energy auditing includes an evaluation and analysis of the existing situation and the various measures that could be implemented to reduce the energy consumption and improve the indoor environment. The results are presented in an energy analysis report describing the recommended measures with corresponding investments, savings and profit.

The energy analysis in a building is a feasibility study, for it not only serves to identify energy use among the various services but also identify opportunities for energy conservation. The study should reveal to the owner, manager, or management team of the building the options available for reducing energy waste, the costs involved, and the benefits achievable from implementing those energy-conserving opportunities (ECOs). It is to reduce waste of energy and money to the minimum, permitted by the climate in which the building is located, its functions, occupancy schedules, and other factors. It establishes and maintains an efficient balance between a building's annual functional energy requirements and its annual actual energy consumption.

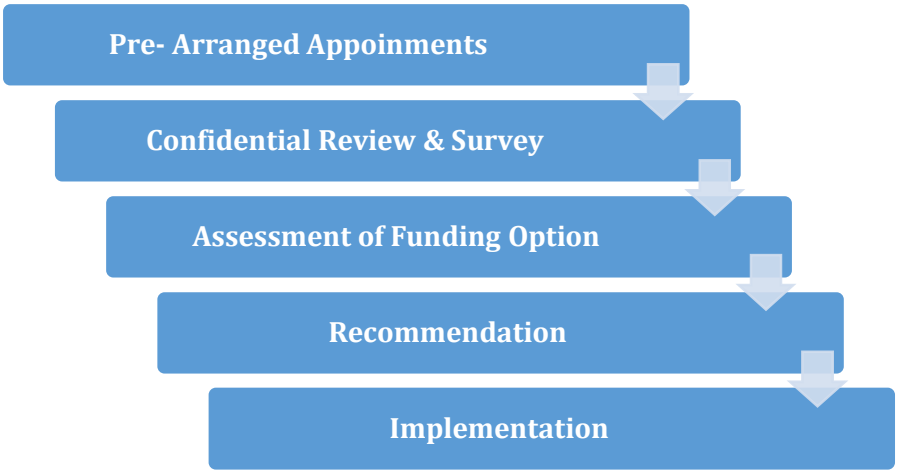


Figure 1 Energy Analysis Process Flow

II. Executive Summary

G. D. Goenka Education City campus located on Sohna Road, Gurugram, is spread over an area of 60 Acres. The education city comprises of world school and university campus. The group work towards providing an environment and curriculum where children can explore and develop every facet of themselves, enabling them to realize their true potential.

The G.D. Goenka world school campus consists:

a. *Administration Block & School Building*
b. *3 Boys Hostel (Zeus, Hercules & Centaurus)*
c. *2 Girls Hostel (Athena & Andromeda)*
d. *Fitness Centre*
e. *Dining Area*
f. *Service Block*
g. *Principal & Guest House*

Whereas, the GD Goenka University campus consists:

a. *Block-B & Block-C*
b. *Administration Building (Not in Operation now)*
c. *Basement*
d. *Workshops*

Area Bifurcation

The whole campus is divided into school campus (Campus 1) and university campus (Campus 2). The bifurcation of the area is done according to the provided drawings which is as follows:

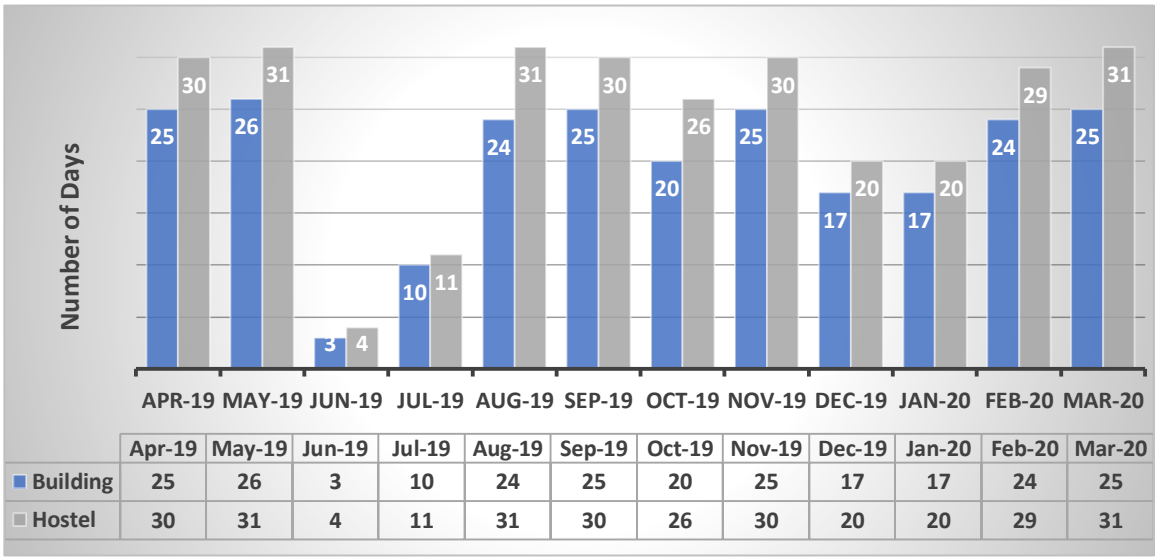
Table 1: Campus Area Bifurcation

Area Type	School Campus (Campus 1)	University Campus (Campus 2)
Total Built Up Area (sq. ft.)	714,044	234,675

Building Occupancy Schedule

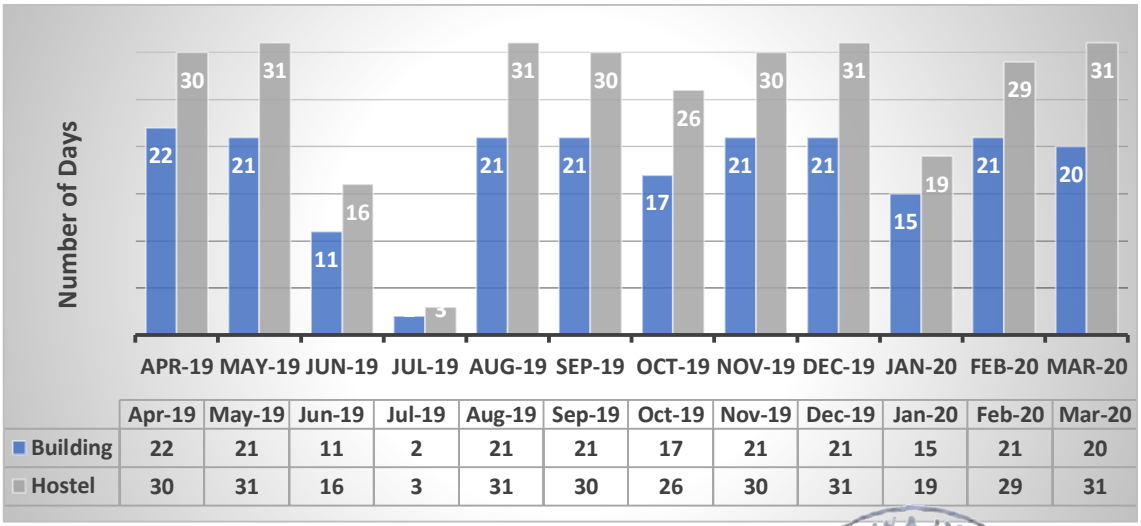
The occupancy schedule of the building varies with the number of days it remains occupant. Similarly, the water usage of the buildings within the premises are studied according to their respective occupancy schedule.

Hence, school, university, hostel buildings occupancy is considered as per the holidays within the year and their relative calendar for the year 2019-20. The schedule of the buildings is shown in figure 1 & 2 below.



	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Building	25	26	3	10	24	25	20	25	17	17	24	25
Hostel	30	31	4	11	31	30	26	30	20	20	29	31

Figure 2 School Building & Hostel Occupancy Schedule



	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
Building	22	21	11	2	21	21	17	21	21	15	21	20
Hostel	30	31	16	3	31	30	26	30	31	19	29	31

Figure 3 University Building & Hostel Occupancy Schedule

Occupancy Details

The number of occupants is also important to define the amount of water used in the building; therefore, the following details of the occupants has been considered during the calculation and report preparation.

Table 1 Occupancy

Occupant Type	Number of Occupant
School Building	
Students	675
Faculty	85
Sup. Staff	56
Total	**816**
School Hostel	
Boys	102
Girls	48
Total	**150**

Table 3: University Occupancy Details

Occupant Type	Number of Occupant
University Building	
Overall	3200
University Hostel	
Boys	403
Girls	274
Total	**677**

Table 4: Campus Staff Occupancy Details

Campus Staff	
Occupant Type	**Number of Occupant**
Warden	5
Horticulture	17
Plumbers	9
Driving Staff	72
Housekeeping	72
Catering	82
Security	54
Laundry	11
Total	**322**

Hence, it is observed that the total occupancy of the campus is **5,165.**

Brief

The Energy analysis was conducted by D2O team from **19th Oct 19 to 22th Nov 19**, at the G. D. Goenka Education City premises to study the existing practices of energy consumption and seek possible ways to conserve water. The facility was introduced by, **Mr. Surinder Jeet.**

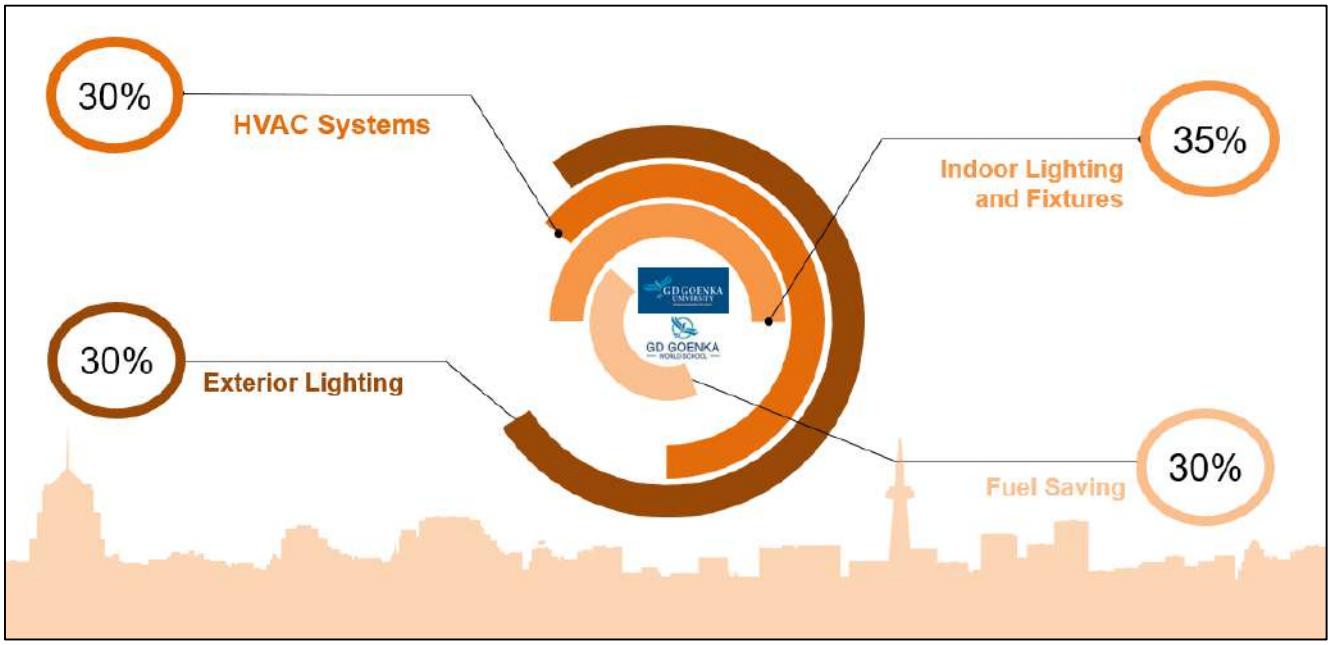


Figure 4 Scope of Energy Savings in diff End-Use

III. Assessed Parameters

Climate

The climate of the Sohna tehsil is classified as tropical steppe, semi-arid and hot. Because, the major part of the year, the air remains extreme dry. However, during the monsoon season, the dryness reduces due to rainfall presence in the area. Annual temperature & daylight hours at Sohna is as follows:

Mean Maximum Temperature (May)	40°C
Mean Minimum Temperature (January)	8°C

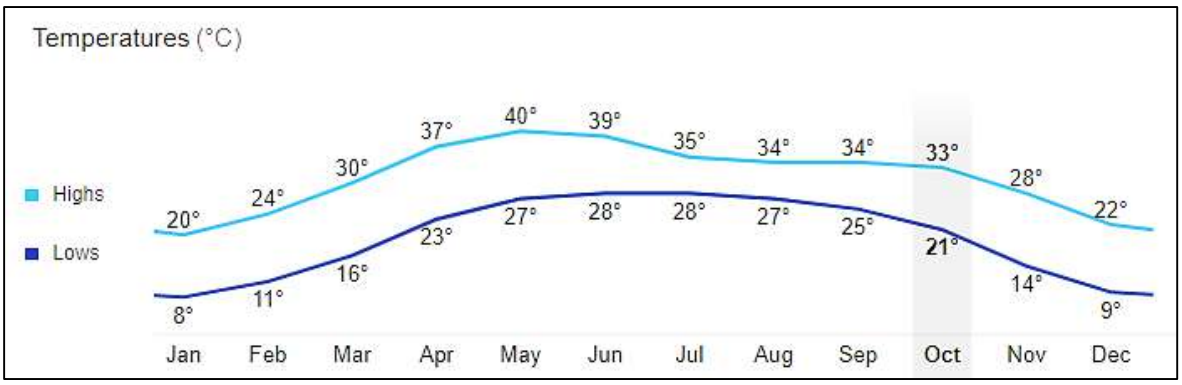


Figure 5 Annual Temperature Variation (Monthly Mean) Source-NOAA

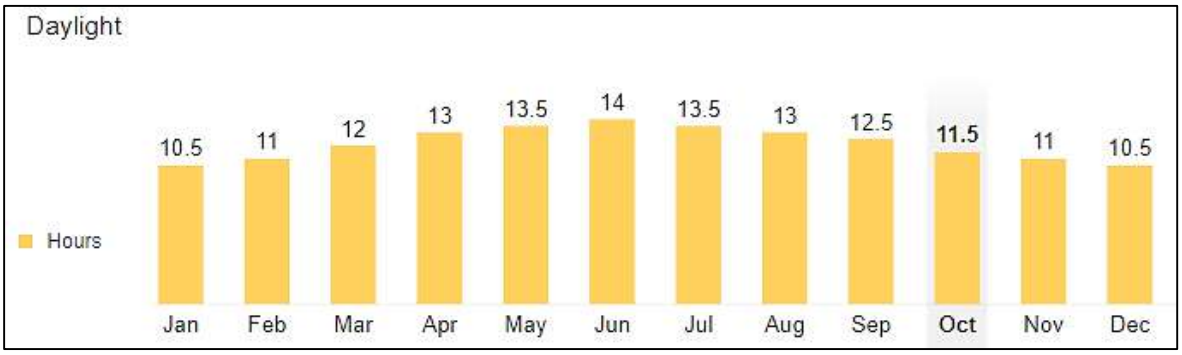


Figure 6 Annual Daylight Hours (Monthly Mean) Source-NOAA

Seasons

The Consumption of the whole campus varies as per the seasonal variation as well. The seasonal variation is also observed in the tehsil zone in a period of 3 to 4 months. The Monsoon season starts in the last week of June and remains active until end of September, this causes the penetration of moisture into the environment and results in high humidity, cloudiness and rainfall. After the departure of monsoon, October to December constitutes post monsoon season. Followed by the winter season from January to the first

half of March. At last, the summer wind prevails in the zone and remains up to the last week of June.

IV. Energy Analysis Definition & Procedure

Definition

This report elaborates the current actual energy performance of the building and real-time performance of all the energy intensive systems installed in the facility. These systems include HVAC systems (high side and low side), lighting etc. Detailed survey and testing of the energy intensive systems has been performed in order to arrive at the present performance of each equipment. The test results have been carefully analysed and presented along with improvement measures and general recommendations for each of the systems. The suggested Energy Efficiency Measures (EEMs) presented in the report are mainly of three types depending on their initial cost implications – No Cost, Low Cost and Medium Cost measures. The measures, if implemented, may help the facility team in optimizing the building operations and may result in comprehensive energy and cost savings in the long run.

Design2Occupancy team was equipped with the calibrated testing and measuring instruments to perform the system testing and arrive at present system performance. The systems included in the testing scope are:

1. HVAC low Side (AHU, FCU, etc.)
2. HVAC high Side (Chillers and associated pumping system, cooling towers etc.)
3. Lighting
4. Staircase pressurization fans, toilet and exhaust fans.

Objective

The objective of Energy Analysis is to assess the following:

a) Understand the energy consumption scenario.
b) Survey the energy generation systems.
c) Suggest potential energy conservation measures based on end uses.
d) Support with Implementation and maintenance.

V. Timeline and Procedure

Date (2019)	Performed Task
17-19 Oct	Site Visit and Award Selection
18-25 Oct	Award Application and Data Collection
30 Oct- 1 Nov	Site Visit 1. Metering 2. Fixture Count 3. Operation Analysis Identification of Supply Sources
11-13 Nov	Analysing the previous metered data Fuel and Power Data Analysis
13-19 Nov	Energy Report and ECM's and Savings

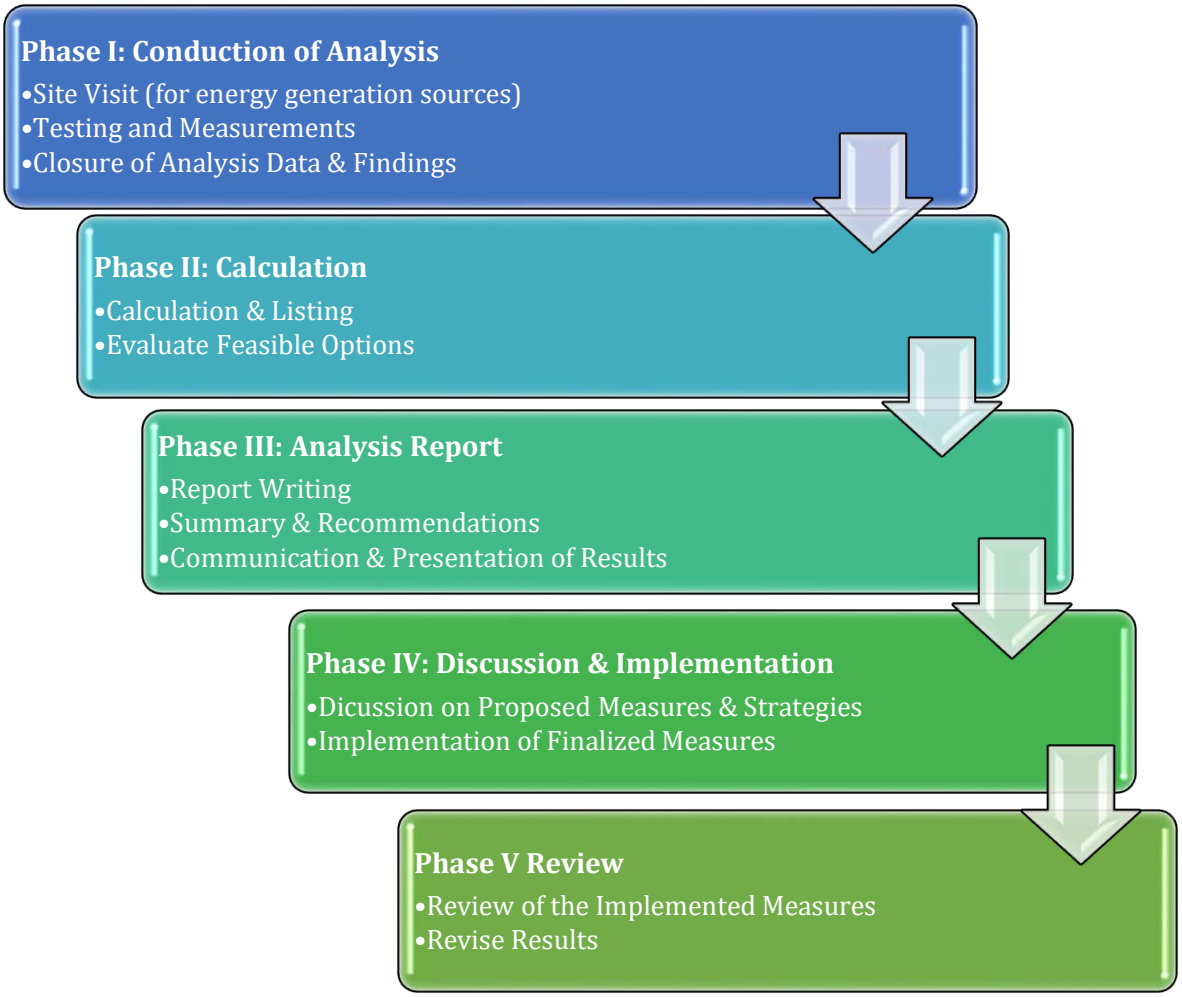


Figure 7 Energy Analysis Procedure

VI. Energy Consumption Scenario

The electric power for the entire facility is mainly procured from the state utility grid. In case of loss of grid power, 3 diesel generator sets (1250 kVA + 1250 kVA + 725 kVA) are installed at the Campus 1 and (1100 kVA + 500 kVA) are installed in Campus 2 facility for power backup.

Table 2- Energy Consumption (May 2018-April 2019)

S. No.	Month	Total Energy from Campus 1 (kWh)	Total Energy Consumption from Campus 2 (kWh)	Total Energy Consumption (kWh)
1	May-18	590,720	81,970	672,690
2	Jun-18	284,923	75,210	360,133
3	Jul-18	306,060	61,060	367,120
4	Aug-18	509,000	70,810	579,810
5	Sep-18	613,740	70,800	684,540
6	Oct-18	354,500	64,650	419,150
7	Nov-18	219,420	26,800	246,220
8	Dec-18	149,780	26,350	176,130
9	Jan-19	134,040	25,910	159,950
10	Feb-19	166,040	25,130	191,170
11	Mar-19	216,120	25,670	241,790
12	Apr-19	484,240	55,770	540,010
Total Consumption (kWh)				**4,638,713**

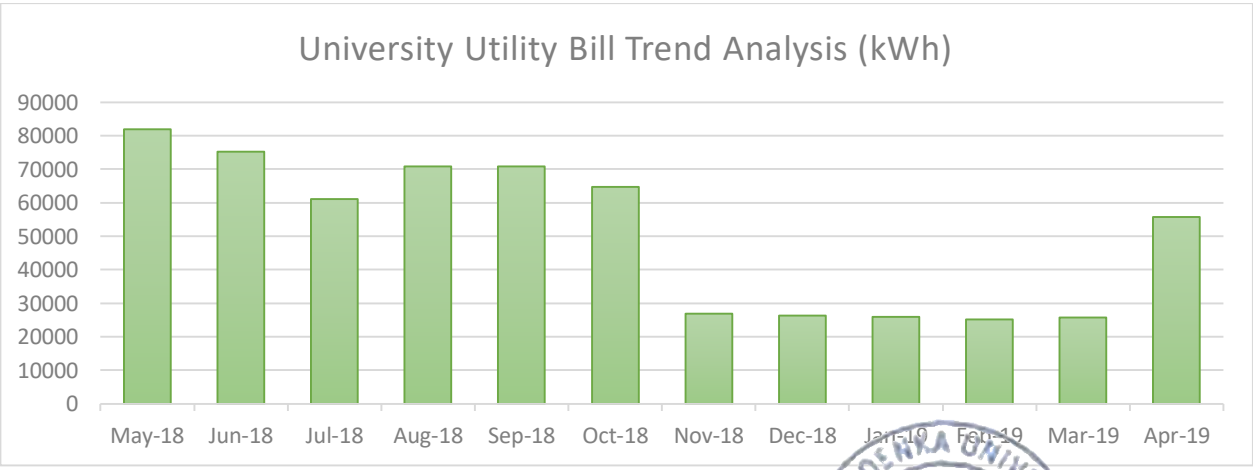


Figure 8 Energy Consumption of Campus 1

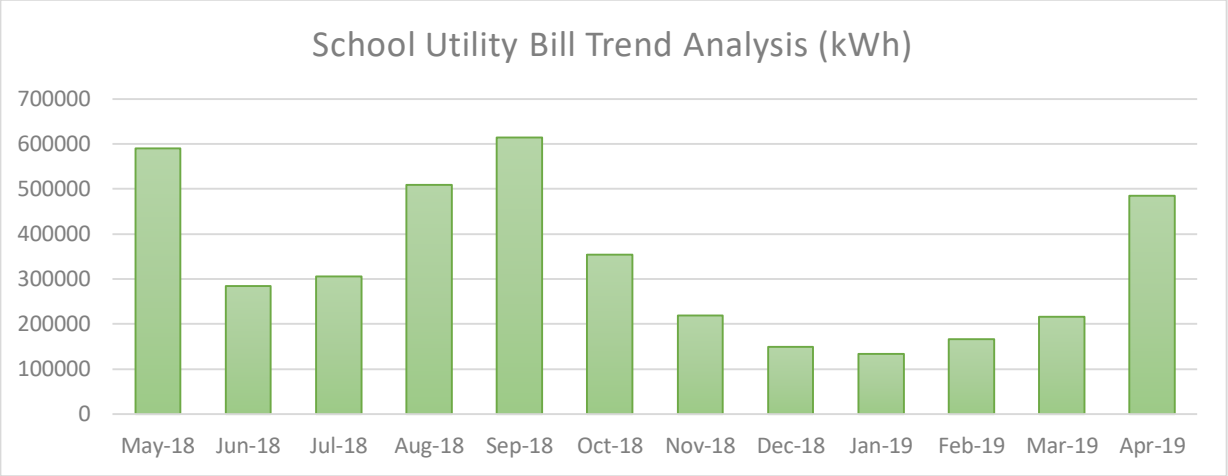


Figure 9 Energy Consumption of Campus 2

- **Comments -**

It can be seen from the above trend that the total electricity consumption has a direct linear correlation with the Cooling Degree Days, suggesting that HVAC equipment load is playing a major part in defining the total electricity consumption trend of this facility. Therefore, energy saving efforts in HVAC side will lead to major reduction in Energy expenditure of the building.

VII. Energy Performance Index

Energy performance index (EPI) is total energy consumed in a building over a year divided by total built up area in kWh/sqm/year and is considered as the simplest and most relevant indicator to analyze the energy efficiency of a building.

The total energy kWh consumption by the facility includes the electricity consumption from the grid supply and kWh generated by the DG. The total built-up area doesn't include the parking area.

Climate Zone - Composite

Table 3- EPI Calculation (May 2018-April 2019) for GD Goenka Education City

Energy Performance Index (May 2018- April 2019)	
Total Consumption (kWh)	5,030,713
Total Built up Area (m^2)	88,171
EPI (kWh/m^2/year)	57.05

The calculated Energy Performance Index (EPI) is 57.05 KWH/m^2/year from May 2018-April 2019.

As of now no specific BEE Rating or standard is available for the performance evaluation of Educational Institutions, however, in case the suggested measures are implemented the analysis team believes that the EPI of the whole campus can well reduce to efficient standards.

VIII. Electricity Consumption Analysis:

GD Goenka Education City consumes approximately 5,030,713 kWh[1] of electricity per year. The major amount of electricity is consumed in HVAC and Lighting and the rest of the electricity is utilized in plumbing systems, laundry etc. The total energy consumption breakup is shown below –

Since, end use metering is not available, it is assumed that the consumption scenario is as per the following Chart.

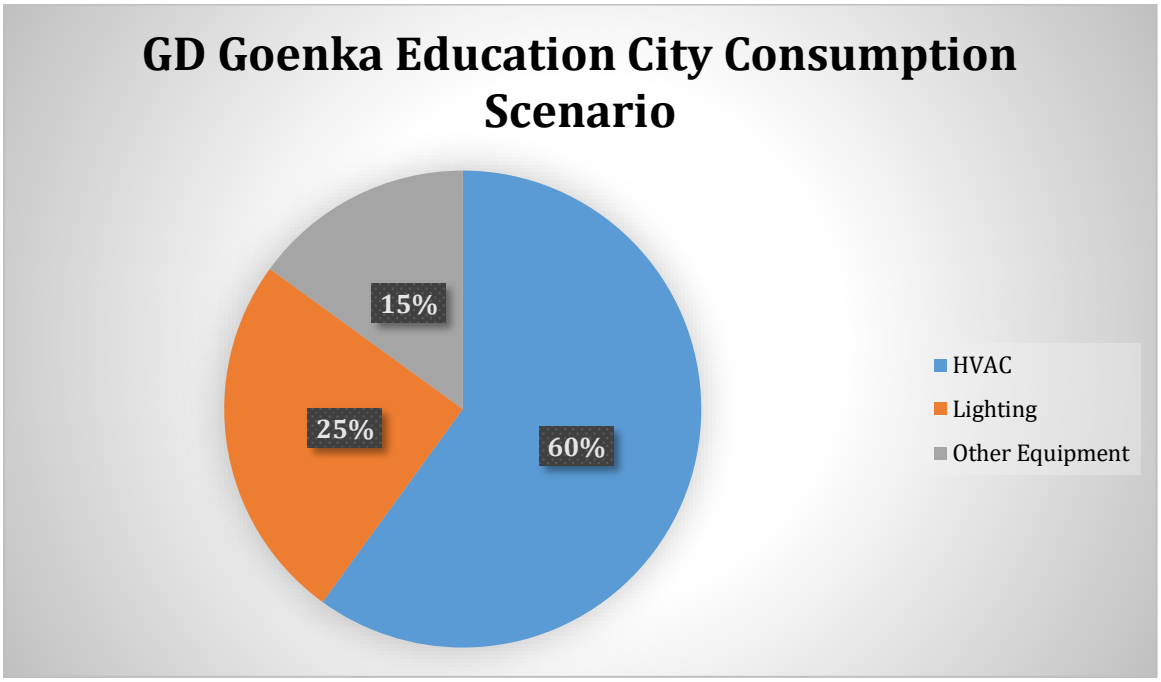


*Chart 1 Energy Consumption Break-Up (Main Supply)**

Referring to the Chart, it has been observed that the major amount (approx. 60%) of the building energy is utilized by HVAC systems followed by lighting systems. The primary energy savings in the building can be claimed in the HVAC, lighting systems.

IX. Heating, Ventilation and Air Conditioning

Heating, Ventilation and Air Conditioning (HVAC) is generally the major energy consuming system in an Educational Institution. In GD Goenka Education City, HVAC

[1] The total energy consumptions have been calculated using the energy consumption data as per the energy bills.
*Note: The energy breaks up in the chart is assumed as per the discussions and other inputs, since the facility is not installed with end use energy meters.

system are responsible for utilizing more than 50% of the total energy consumption of the facility. Being the most energy intensive, HVAC system, is also the system with the maximum energy saving potential.

The monthly breakup of consumption of energy in HVAC systems is stated in the table below: -

The HVAC system mainly comprises of -

1. HVAC High Side
   1) Chiller
   2) Pumps
   3) Cooling Tower
2. HVAC Low Side
   1) AHUs
   2) FCUs

HVAC High Side

The air-conditioned area in GD Goenka Education City is approx. 80%. Major part of the Air conditioning is served by a centralized chilled water system along with some split AC units and precision AC in UPS and server rooms. The chilled water system primarily consists of 2 Water cooled centrifugal chillers (550 TR X 2 nos.), Constant flow primary chilled water pumps (18.5kW X 2 nos.), VFD driven Secondary Chilled Water Pumps (37kW), Condenser Pumps (45kW X 2 nos.) and Cooling Towers (300 TR * 4 no.s) on the high side along with Air Handling Units (500+ nos.) on the low side.

Methodology

D2O team carried out the testing of the complete waterside HVAC system in two major parts:

A. Testing of equipment

B. Physical Inspection

Testing of Equipment

Chillers

There are 2 nos. Water Cooled Centrifugal Chillers installed at site which operate according to the cooling load requirement in the building. Following table shows the design and measured parameter values for chillers and their % deviation -

Table 4 Performance Test results for Chiller 1

S.No.	Description	Actual	
		Value	UOM
1	Electrical Power	399	kW
2	Average Voltage	438	V
3	Average Current	555	A
4	Motor loading	48	%
5	Evaporator Chilled Water inlet temp	60.1	°F
6	Evaporator Chilled Water outlet temp	52.3	°F
7	Evaporator Chilled Water temp difference	8.6	°F
8	Condenser Water inlet temp	78.1	°F
9	Condenser Water outlet temp	92.9	°F
10	Condenser Water temp difference	14.8	°F
11	Ambient Dry Bulb temp	78.37	°F
12	Ambient Wet Bulb temp	63.66	°F

Observations –

It was observed that the chillers were not fully operational at the time of inspection. Only 1 Chiller was forced to turn on and hence, as per the discussions with the Facility team full load requirements were not met.

The Facility systems are under operations from the last 16 Years, based on the same it is suggested that a proper operations and maintenance procedure has to be set up for smooth functioning of the whole system. Additionally, the same will be beneficial if the facility retrofits the old systems with the new one.

Site Observations

Figure 10 Loose Wires without proper insulation tapes

Figure 11 Rust Observed on Chiller Valves

Figure 12 Rust, improper insulation and loose wires

Figure 13 Lack of insulation and rusted joints.

Chiller Measurements

Figure 14 Temperature Set points

Figure 15 Voltage Reading on Chiller

Figure 16 Wattage indication on Chiller

Figure 17 Power Factor indication on Chiller

Figure 18 Chiller Load reading

Figure 19 Frequency reading on chiller

Figure 20 Current measurement on Chiller

Cooling Towers

There are 4 nos. of cooling towers each of 300 TR capacity with fans of 7.5 kW each, catering to the chilled water plant.

- **Observations** -

Water Balancing is required at cooling tower based on the operation of the tower and water levels in the tower.

Figure 21 Water level in CT 1

Figure 22 Water Level in CT 1

Figure 23 Leakages and improper insulation at Cooling Tower

Pumps

The facility has 2 primary chilled water pumps, 1 secondary chilled water pumps and 2 condenser water pumps out of which 1 primary chilled water, 1 secondary chilled water and 1 condenser water pumps were running during the inspection.

Following data in the tables show the measurement taken on the pumps and their deviation from the actual values.

Table 5- Primary Pump

S.No.	Description	Actual	
		Value	UOM
1	Speed	1453	RPM
2	Flow Rate	NA	lps
3	Suction Pressure	186.3	kPa
4	Discharge Pressure	220.6	kPa
5	Differential Pressure across Pump	34.3	kPa
6	Average Voltage	428	V
7	Average Current	32	A

Table 6- Secondary Pump

S.No.	Description	Actual	
		Value	UOM
1	Speed	1477	RPM
2	Flow Rate	NA	lps
3	Suction Pressure	122.5	kPa
4	Discharge Pressure	392.2	kPa
5	Differential Pressure across Pump	269.7	kPa
6	Average Voltage	426	V
7	Average Current	36.7	A

Table 7- Condenser Pump

S.No.	Description	Actual	
		Value	UOM
1	Speed	1471	RPM
3	Suction Pressure	107.1	kPa
4	Discharge Pressure	304	kPa
5	Differential Pressure across Pump	196.9	kPa
6	Average Voltage	433	V
7	Average Current	38.3	A

Site Observations

Figure 24 Pressure Gauge missing

Figure 25 Improper and Rusted Mounting

Figure 26 Oil Leakage observed near Condenser pump

Figure 27 Improper insulation observed

Pump testing

Figure 28 Testing of Motor RPM

Figure 29 Measurement of Sound Levels

Figure 30 Voltage Measurement of Condenser Pumps

Figure 31 Current Measurement at Pump

HVAC Low Side

Air Handling Units

A thorough testing of 15 AHUs (1 AHUs were not accessible due to Health Hazards related to maintenance) was performed during the visit. D2O team was equipped with all the necessary tools and instruments required for carrying out the equipment testing.

Methodology

D2O team carried out the testing of the complete HVAC system in two major parts:

A. Testing of equipment

B. Physical inspection

Testing of Equipment

Following is a list of tools and instruments deployed during the testing at project building:

- **Vane type Anemometer**- Air Flow Measurement at diffusers/grilles/filters
- **Sling Psychrometer**- Dry Bulb Temp (DBT) & Wet Bulb Temp (WBT) measurement
- **Infrared thermometer**- Temperature Measurement
- **Contact type thermometer**- Temperature Measurement
- **Clamp meter**- Voltage and Current Measurement

Supply/Return Air Flow (CFM) - Supply/Return Air Flow has been measured by the Vane Type Anemometer. The airflow volume was measured at the return filters, assuming the supply airflow is approximately equal to return airflow. The product of the speed of measured airflow (FPM) and area of the return air filter (SQ.FT.) gives the total air flow (CFM) through that particular filter. The anemometer readings have been taken at the multiple points at a filter. The average of all the readings is considered as the resultant.

Dry Bulb Temp (DBT) & Wet Bulb Temp (WBT) (°F) (Return air) – The DBT and WBT of the return air has been measured by the sling Psychrometer.

Dry Bulb Temp (DBT) (°F) (supply air) – The supply air DBT has been measured by contact type thermometer.

Input Voltage (V) and Current (I) – The input voltage and current has been measured by the clamp meter at the 3-phase input supply line to calculate the total power consumption.

****Refer to annexure II for detailed measurement/testing output and calculations for each AHU.**

Summary of Performance of AHUs -

During the inspection most of the AHU's were turned off due to the ambient outdoor temperatures.

Below table is the comparison of supply air flow by the AHU system against their designed values. Table also shows the percentage deviation of measured values from the designed values. The testing is performed on the AHUs at their operating frequency.

The designed supply air flow and power consumption (at operating frequency) are calculated using fan affinity laws (refer annexure I) and the measured values are the calculated values after performing testing on the system.

Table 8 Comparison of Supply CFM

S. No.	AHU No.	Serving Location	Operating frequency	Supply Air Flow Volume (CFM)			
				at 50 Hz	at operating frequency		% Deviation
					Designed	Measured	
1	306-309	Zeus Hostel	50.0	3200	3200	3992	25%
2	309-311	Athena Hostel (Dinning Area)	50.0	4000	4000	6216	55%
3	205,204, 214	Dining and Girls Hostel	50.0	4000	4000	7425	44%
4	GF	Fitness Centre	50.0	7600	7600	5845	-23%
5	AHU 95, 6	School Building	50.0	2000	2000	1868	-6%
6	1	School-Reception area	50.0	16000	16000	19040	19%

- **Observations and Recommendations -**

  The below table summarizes the observation for AHUs as per the above results and the recommendation to improve their performance.

Table 9 Observations and Recommendations

S. No.	AHU No.	Observation
1	All AHU's	Pre-Filters not installed
2		Dust was accumulated in all the rooms
3		AHU Tag not Given
4		AHU inside inspection light and UV light missing.
5		Limit Switch missing
6		Cable Dressing required
7		Condenser Drain pipe slope not proper.
8		External and internal cleaning required for all AHU's

Physical Inspection

The physical inspection has been done on all the AHU systems. The following critical measurements were taken during this inspection: -

- Presence and working of pressure gauge on chilled water supply and return line
- Presence and working of temperature gauge on chilled water supply and return line
- Condition of return air filters whether dusty or damaged.
- Leakage checking in the supply, return or drainage pipe
- Other physical issues like abnormal sound or vibrations etc.

The below table summarizes the physical inspection outputs of all the AHU systems-

AHU	Air Filter Condition		Fresh Air Dampers
	Dusty (Y/N)	Damaged (Y/N)	Open (Y/N)
All AHU's	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y
	N	N	Y

Site Observations

Figure 32 Proper insulation in chilled water pipes missing

Figure 33 Dead carcass present in AHU room, degrading air quality

Figure 34 Improper Placement of ducts

Figure 35 Supply duct leakages in Fitness Centre

AHU Testing

Figure 36 Supply Air flow measurement via Vane type Anemometer

Figure 37 Ambient Dry Bulb and Wet Bulb Measurements

Figure 38 Dry Bulb and Wet Bulb Measurement at Supply

Figure 39 Sound Testing near AHU

Figure 40 Current Measurement at AHU

Figure 41 Filter Cleaning Required

Figure 42 Pipe insulation required (School FAHU)

Figure 43 AHU rooms require cleaning (Harmful dust)

X. EEM for HVAC Systems

Table 17: Energy Conservation Measures details

ECM	Description	Savings percentage	Remarks
1	ECM – 1 End Use Metering and Installation of BMS	10%	For improving monitoring and logging
2	ECM 2 – Nano Thermo Technology fluid	10%	ROI depends on Chilled Water Pipe Sizing
3	ECM 3 – Active Refrigerant Agent	10%	Removes oil fouling, changes the thermal nature of the metal and lowers the boiling point of the refrigerant gas, resulting in a more efficient operating system with substantial savings in energy costs.
4	ECM 5 – EC Fans: Energy Efficient & Environmentally Friendly	20%	EC-fans are favoured for their economical use of energy and simplification of control. EC-fans are driven by energy-saving motors with electronic control (commutation unit) ensuring optimal operating efficiency. According to their design principle, these are synchronous motors, which run without slip and therefore no slippage losses occur.
5	ECM-6 Water Balancing and VSD on pumps	10%	Optimize the high side water flow to avoid: • Additional energy consumption of chillers & pumps. • Excessive water flow in HVAC low side units • Over cooling in the zone

XI. Comparison of VRF and Chiller Based system:

The project team mentioned the replacement of existing HVAC systems with VRF systems, hence for an insight D2O team would like to shed some light on both the system types.

Chiller	VRF
Merits	***Merits***
• With proper system design and installing multiple chillers, even in case of high diversity, chillers become a good option due to their good efficiency even at part load conditions. • Project size is not the constraint at all. • Non-hazardous for the occupants, as water is circulated throughout the refrigeration circuit, no chance of hazardous material entering the conditioned space. • Advantage on efficiency can be multiplied by using Thermal storage; and usage of differential tariff.	• Operation is very simple, probably as simple as operating a split air conditioning system and hence no separate manpower is required for operating the system. • Good option for providing air conditioning to apartments / villas, small installations where in the complexity of the system (a major demerit of this system) can be kept to a minimum.
Demerits	***Demerits***
• Availability of water is a must. • Requires additional space for plant room for chillers, AHU rooms and space for mounting the cooling towers. • Trained manpower is required for operating the central chiller plant.	• If decided to use for larger capacities, more space required to install many number of ODUs. Access to ODUs is necessity as all the maintenance work required will be mostly on the ODUs. • Can be hazardous for the occupants, being refrigerant circulated through pipes, susceptible to leakages, with the refrigerant possibility of entering the conditioned space. • Complex system architecture, large amount of refrigerant piping running around in conditioned space.

Cost Analysis

Case study for 1000TR capacity system

No	Parameter	Unit	VRF	W/C Screw Chiller
1	Initial CapEx, average cost	Rs / TR	50,000 ~ 65,000	50,000 ~ 55,000
1a	Total CapEx	Rs	57,500,000	52,500,000
2	Operational Cost	ikW / TR		
	Equipment (Weighted Avg. Power – IPLV)	ikW / TR	0.900	0.500
	Condenser Water Pumps	ikW / TR	NA	0.050
	Chilled Water Pumps	ikW / TR	NA	0.06
	AHUs	ikW / TR	NA	0.100
	Cooling Tower	ikW / TR	NA	0.020
	Total ikW/TR	ikW / TR	0.90	0.73
2a	*Total operational cost @Rs. 8.75/kW*	*Rs / Yr*	*35,437,500*	*28,743,750*
3	*Cost of make up water @Rs. 20/m³*	*Rs / Yr*	*NIL*	*557,000*
4	Maintenance Cost (CAMC)	Rs / TR / Yr	1800 ~ 2000	1200 ~ 1500
5	Operational maintenance Man-hours	Rs / Yr	NIL	300,000
5a	*Total maintenance cost*	*Rs / Yr*	*1,800,000*	*1,500,000*
6	Total O & M Cost / Yr (2a+3+5a)	Rs / Yr	37,237,500	30,800,750
7	O & M Cost for 15 Years	Rs	558,562,500	462,011,250
8	Life Cycle Cost (1a+7)	Rs	616,062,500	514,511,250

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XII. Maintenance Requirements for HVAC Systems

Cooling Tower

Table 10 Cooling Tower Maintenance Checklist

S. No.	Description of Service	Start Up	Weekly	Monthly	Every 6 Months	Shut Down	Annually
1	Inspect General Conditions of the unit	X	X			X	
2	Clean Debris from unit	X		X		X	
3	Inspect sump-clean and flush if required	X			X		
4	Clean sump strainer	X		X			
5	Check and adjust sump water level and make-up	X		X			
6	Inspect fill for fouling	X		X			
7	Inspect water distribution	X		X			
8	Check drift eliminator	X	X				
9	Check water quality against guidelines	X	X				
10	Check chemical feed equipment	X	X				
11	Check and adjust bleed rate	X	X				
12	Check pan heaters and accessories			X			
13	Drain sump and piping					X	
14	Inspect protective finish						X

Pump

Table 11 Pump Maintenance Checklist

S. No.	Description of Service	Start Up	Weekly	Monthly	Annually
1	Pump Use and Sequencing	X			
2	Overall Visual Inspection	X			
3	Check lubrication			X	
4	Check Packing			X	
5	Motor and Pump alignment				X
6	Check Mountings			X	
7	Check Bearings				X
8	Motor Condition				X

Air Handling Units (AHU)

Annual Maintenance

- Inspect coil.
- Inspect drain pan and drain line.
- Blow out condensate drain. Inspect fan wheels.
- Inspect drive sheaves.
- Inspect belt alignment and tension. Adjust as needed.
- Lubricate as required.
- Check bearing and motor mounting.
- Check motor operating voltage and amperages.
- Check dampers and adjust if necessary.

Operating Inspection (Three Required)

- Check belt tension. Adjust as needed.
- Lubricate as required.
- Check bearing and motor mounting.
- Check any excessive vibration or noise and correct if required.

XIII. Lighting

The lighting design for both the Campus's 1 and 2 was initially carried out with CFL and Tubelights. On the basis of site visit and inspections below table and graph shows the segregation of lighting power in different buildings of Campus 1 and Campus 2.

Campus 1 Total Lighting Wattage (W)		**Campus 2 (Total lighting Wattage, W)**	
School Building	41,280	**Block C**	22,008
Hostel and Service	154,538	**Block B**	67,345
Fitness Centre	22476		
Total	**218,294**	**Total**	**89,353**

Total Installed Fans in the whole campus	Approx. 1,200
Total Wattage (W)	96,000

Fixture Type

CFL – 2*36W

Figure 44 CFL 72 Watt Complete Fixture

CFL – 14W

Figure 45 CFL's in toilets

Fan – 80W

Figure 46 Installed Fans

CFL – 9W

Figure 47 Stair Case CFL

T5- 4*14W

Figure 48 Lecture room fixtures

T5- 14W

Figure 49 T5

Exterior Lighting – CFL's (14 W)

Figure 50 Exterior Lighting Fixtures

XIV. EEM's for Lighting and Fans

ECM	Description	Savings percentage	Remarks
1	ECM 1 – Use of Occupancy and Daylighting Sensors	10%	An occupancy sensor is an indoor motion detecting device used to detect the presence of a person to automatically control lights or temperature or ventilation systems.
2	ECM 2- Metering	5% -10%	Will help in monitoring and logging
3	ECM 3 – Retrofitting lighting and fan fixtures	25%	Retro fitting with low wattage LED's and use of efficient fans for the whole campus can reduce the power consumption over this end.
4	ECM 4 – Retrofitting of Exterior Lighting	10%	Retrofitting with low wattage LED's and using reflective shading for reduction in Night Pollution.

XV. Kitchen Inspection

It was observed that the installed stoves had a lot of carbon deposits around the burners.

Site Observations

Figure 51 Carbon Deposits around burners

XVI. EEM's for Kitchen

ECM	Description	Savings percentage	Remarks
1	ECM 1 – Replacement of Existing Burner with efficient ones	20%	As a natural tendency flame and heat tend to accumulate at the center. Efficient burners regulate this natural tendency and spread the flame evenly and uniformly across the burner. Efficient burners are flameless, smokeless and noiseless and produce uniform heat just like charcoal heat.

XVII. Additional Maintenance Requirement

Diesel Generator Heat Exchanger:

It was observed upon visit that the heat exchanger associated with the DG's were badly damaged, however the facility team reported that the reason for damages are un known. In addition to that it is also suggested to repair the Heat Exchanger fins so that proper heat dissipation can be carried out.

It may be noted that improper heat dissipation may lead to excessive load on the generator.

Site Observations

Figure 52 Damaged Heat Exchanger Fins

Figure 53 Damaged Heat Exchanger Fins

Renewable Energy (On Site Solar)

The facility has installed a total of 563.2 kW of onsite solar, however it was observed upon the inspection that due to lack of maintenance a thick dust layer has accumulated over the panels. This will lead to decrease renewable energy generation efficiencies of the panels.

Site Observations

Figure 54 Dust accumulation on Solar Panels

XVIII. Final Summary

D2O team has performed thorough energy analysis of the GD Goenka Education City. The calculations were done using all the measurement taken at all energy consuming units at the facility. The results obtained after the calculation were thoroughly observed. The possible energy efficiency measures were given for the units to reduce the energy consumption and to improve the overall energy efficiency of the facility building. The energy efficiency measures given for each unit are summarized in the below table with the investment, saving and return on investment quotient.

ECM	Description	Savings percentage	Remarks
1	ECM – 1 End Use Metering and Installation of BMS	10%	For improving monitoring and logging
2	ECM 2 – Nano Thermo Technology fluid	10%	ROI depends on Chilled Water Pipe Sizing
3	ECM 3 – Active Refrigerant Agent	10%	Removes oil fouling, changes the thermal nature of the metal and lowers the boiling point of the refrigerant gas, resulting in a more efficient operating system with substantial savings in energy costs.
4	ECM 5 – EC Fans: Energy Efficient & Environmentally Friendly	20%	EC-fans are favoured for their economical use of energy and simplification of control. EC-fans are driven by energy-saving motors with electronic control (commutation unit) ensuring optimal operating efficiency. According to their design principle, these are synchronous motors, which run without slip and therefore no slippage losses occur.
5	ECM-6 Water Balancing and VSD on pumps	10%	Optimize the high side water flow to avoid: • Additional energy consumption of chillers & pumps. • Excessive water flow in HVAC low side units • Over cooling in the zone
Lighting and Fans			
1	ECM 1 – Use of Occupancy and Daylighting Sensors	10%	An occupancy sensor is an indoor motion detecting device used to detect the presence of a person to automatically control lights or temperature or ventilation systems.
2	ECM 2- Metering	5% -10%	Will help in monitoring and logging
3	ECM 3 – Retrofitting lighting and fan fixtures	25%	Retro fitting with low wattage LED's and uses of efficient fans for the whole campus can reduce the power consumption over this end.
4	ECM 4 – Retrofitting of Exterior Lighting	10%	Retrofitting with low wattage LED's and using reflective shading for reduction in Night Pollution.
Kitchen			
1	ECM 1 – Replacement of Existing Burner with efficient ones	20%	As a natural tendency flame and heat tend to accumulate at the center. Efficient burners regulate this natural tendency and spread the flame evenly and uniformly across the burner. Efficient burners are flameless, smokeless and noiseless and produce uniform heat just like charcoal heat.