CAMPUS ON THE SABARMATI

IIT GANDHINAGAR

WATER AND WASTEWATER MANAGEMENT

WATER AND WASTEWATER MANAGEMENT

Apurva Parikh

L. P. Srivastava

Sudhir K. Jain

Harish P. M.

Marjorie Greene

Vishnu Deth

Satchit Bhandarkar

Mouli Kethineedi

DISCLAIMER

The material presented in this document has been prepared in accordance with generally recognized engineering principles and practices. This document is intended for use by individuals who are competent to evaluate the significance and limitations of its content and accept responsibility for the application of the content in part or full. The authors and IIT Gandhinagar will not be responsible for any direct, accidental or consequential damages arising from the use of material contained in this document.

Development of this document was supported by the Indian Institute of Technology Gandhinagar, Gujarat, India.

NOTE:

Most of the text, drawings and graphic material in this publication was prepared by Multi Media Consultants Pvt. Ltd. and presented to IIT Gandhinagar in several technical reports describing the water supply and liquid waste management system. It is hoped that this publication will be of interest to design professionals and others interested in campus planning and development, and that it will also serve as a useful educational tool for students and professionals.

ILLUSTRATIONS/ PHOTO CREDITS
Gaurav Shukla, Multimedia Consultants Pvt. Ltd., Green Campus Development Consortium, Marjorie Greene, Ivan Brzev and Vishnu Deth

LAYOUT
Gaurav Shukla

ISBN: 978-81-934412-7-5

Indian Institute of Technology Gandhinagar
Email: director@iitgn.ac.in
Website: www.iitgn.ac.in

FOREWORD

Once created, universities may last not just decades, but centuries. Hence, it is a rare privilege for anyone to participate in the process of creating a new university. Establishment of the Indian Institute of Technology Gandhinagar (IITGN) has enabled all of us associated with the Institute to innovate in creating curricula, organizing governance, and nurturing a unique culture and ethos of the Institute. The philosophy of education has been to push traditional boundaries with an emphasis on multi-disciplinary approaches and crosscutting thematic areas.

Just as the Institute endeavours to think out of the box for its academic programmes and governance, it has also been doing so for development of its 399 acre campus on the banks of the Sabarmati River. It is our firm belief that the physical environment makes a huge contribution to shape the processes of learning and knowledge creation. The campus has been conceptualized keeping in mind the long-term objectives as well as the present needs and immediate future. The guiding principles of the campus development have been

- An ambience that attracts visitors and conveys to them that they are on a university campus unlike any they have visited before
- Functional convenience for the academic community for mutual interaction, learning and research
- Low energy and resource consumption, as well as minimal upkeep and low maintenance costs

The engagement of a large number of professionals and academics in brainstorming and in executing the design and construction has enabled us to introduce numerous innovations in the development of the campus. This publication is one in a series that explains the complex decision making, design, and construction process for the new campus. The publications in this series have been made possible because of several visits of Marjorie Greene to IITGN as a Scholar-in-Residence. She worked to systematically compile the various materials presented here, collaborating with IITGN colleagues as well as our architects and consultants.

ABOUT THIS PUBLICATION: This document showcases the water and wastewater management systems developed for the Institute campus. The systems include drawing water from the Narmada Canal as well as capturing rainwater. Once used, this water is treated in a sewage treatment plant that includes a root zone treatment system and is then recycled for irrigation purposes.

Sudhir K Jain
Director and Professor
Indian Institute of Technology Gandhinagar

EXECUTIVE SUMMARY

The IITGN campus is located in a semi-arid region of Gujarat, with low rainfall and extremely high summer temperatures. Water has been a scarce resource for generations and hence been treated respectfully. The planners of the IITGN campus were aware of the need to manage water resources wisely and designed systems accordingly. In fact, the role of water in the design of the new campus is one of its central planning principles, from the Scenic Drive through ravines to the River Sabarmati, and the River Promenade to seasonal ponds that anchor the Central Vista, from the Jal Mandaps placed strategically on campus for rainwater harvesting, to the natural treatment of all sewage and the recycling of this water for horticulture.

Basic guidance was provided by the Masterplan, emphasising a sustainable approach to campus water management. Several features make the campus water system innovative. A separate pipeline had to be installed from the Narmada Canal, bringing fresh water across the Sabarmati River. The campus is collecting rainwater from its rooftops through a series of drainage pipes and, after treatment, using this water for drinking purposes. After much consultation and debate, the campus planners went ahead with the recommendation from the master planners to install a root zone treatment system for the sewage. These features along with a host of other water efficiency features placed water as a central element in the campus Masterplan.

The overall campus water management system that was developed can be summarized as follows. Fresh water is piped from the Narmada Canal directly to the Water Treatment Plant (WTP) on campus, where it is treated and then distributed to one of three Water Service Centres (WSC) for chlorination. It is held in these WSCs and then distributed directly to buildings on campus for drinking, cleaning, domestic functions, etc. Rainwater from rooftops throughout the campus is collected and stored in large underground tanks designed by the landscape architect and designated as Jal Mandaps (water pavilions). This water is piped to the WTP where it is treated and mixed with the Narmada Canal water. Once the water is used, it is piped to the Sewage Treatment Plant (STP) where it is treated by feeding the collected waste to a bacterial mass that converts the decaying matter into a stabilised basic mixture of water, carbon dioxide and mineral-rich residue. This process is completed by passing the effluent through a settlement tank, an anaerobic baffle reactor including anaerobic filters, and through the roots of *Canna indica* in a process known as root zone treatment. This treated water is primarily used for irrigation purposes. Some of it is also intended to be used for toilet flushing after tertiary treatment through ultrafiltration to ensure its quality is acceptable for use in residential units. Surface runoff of rainwater is captured through a series of drainage pipes leading to intake wells for feeding the two natural ponds, with surplus water sent to the Sabarmati River.

Figure 1. Ultra filtration Unit

ACKNOWLEDGEMENTS

The authors would like to acknowledge the contributions of all the stakeholders in the design, development, engineering, construction and maintenance of the water and wastewater system. Many consultants as well as IITGN faculty and the project manager, Central Public Works Department (CPWD) of the Government of India, were involved in the intricate process of developing the piping and distribution systems. Special acknowledgement is due to the master planners Dr Vinod Gupta and Ar Ujan Ghosh, of M/s Green Campus Development Consortium for conceptualising the entire sustainable water system, including the promotion of rainwater harvesting and the DEWATS sewage treatment process, and to Mr L K Bhargava, the project manager from CPWD for implementing the system.

Recognition is also due to M/s HCP Design Planning and Management Pvt. Ltd. for their role in managing the infrastructure component of campus development, as well as to the entire team at M/s Multi Media Consultants Pvt. Ltd. for their role as water, sewage and road consultants, and to the team at the M/s Consortium for DEWATS Dissemination Society (CDDS) for the implementation of the sewage treatment plant based on the root zone treatment system.

The cooperation of the Gujarat Water Supply & Sewerage Board (GWSSB) in bringing water from the Narmada Canal to the campus is also deeply appreciated.

This project would not have been possible without the financial support provided by the Government of India.

TABLE OF CONTENTS

TABLE OF CONTENTS

Water is treated with respect and conserved as much as possible in the IIT Gandhinagar campus

1 Introduction

It is impossible to overemphasise the importance of water to a functioning, vibrant campus, particularly a residential campus. There is a need for water for drinking, washing, cleaning, flushing, irrigation, cooling, and landscaping. At the new Indian Institute of Technology Gandhinagar (IITGN) campus, identifying sources for clean, potable water, systems to bring the water in, systems to treat sewage and systems to deal with recycled water, all presented various challenges. On a semi-arid, undeveloped site, the campus has developed an environmentally responsible water collection and distribution system that includes piping in and using fresh water and capturing rooftop rainwater and once used, recycling all this water for irrigation purposes. The treatment of sewage is itself innovative, passing through anaerobic reactors and a root zone treatment system. The campus has zero discharge—all water is ultimately recycled. This publication summarises the role of water on the new campus, including the sources and uses of the water, and the practices put in place that contribute to IITGN's sustainable water management practices.

Figure 2. Irrigating with recycled water

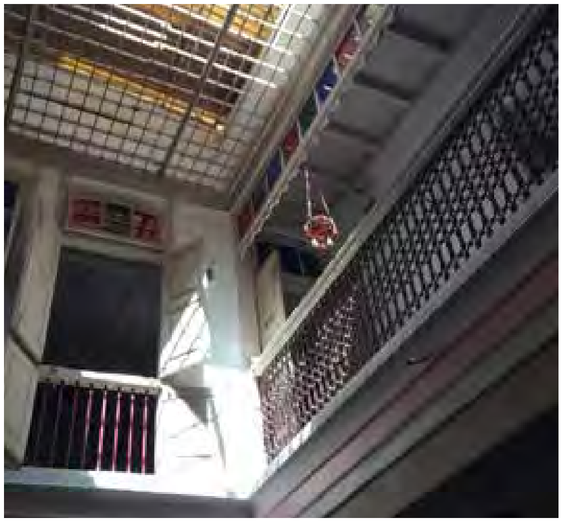
2 Regional Context and Historical Attitude to Water

The IITGN campus is located in the central part of the state of Gujarat, a semi-arid region with low rainfall, ranging from 600 to 800 mm per year. The region is regularly affected by droughts and severe water shortages and can have extremely high temperatures (45°C and above) in the summer. For generations, water has been seen as a scarce resource to be treated respectfully, and residents of this region have used creative techniques for capturing or harvesting such a precious commodity.

This region is well known for its many stepwells. The stepwell, or *vav* in Gujarati, is a groundwater storage structure in which water is reached by descending a set of steps. Many of the oldest stepwells in India were built in Gujarat, with some dating as far back as 200—400 C.E. The stepwells provided water for drinking, bathing and washing and were often used for social purposes as well--women would congregate in the cooler air at the bottom of the wells. They were also used for festivals and rituals. They often had intricate carvings down the steps, and in fact Gujarat is the site of a UNESCO World Heritage-designated stepwell, Rani ki Vav. According to UNESCO, this seven-storey stepwell is considered to have been built at the height of craftsmens' abilities in stepwell construction (Figure 3). The structures grew out of favour with the introduction of pipe and pump systems.

Figure 3. Rani Ki Vav stepwell, Patan

The old city of Ahmedabad is also known for a unique water-harvesting system. There, in the *pols*, the housing clusters in the old walled city, one can still find houses with water storage wells below the living area. Houses have been built around a central open verandah (chowk). Rainwater from the rooftops falls into these chowks, where, after the first flush or cleaning rain of the monsoon, rainwater drains into a well with a limestone lining (Figure 4). Water is stored there for residents to use for drinking throughout the year. When the city started piping in water to these neighborhoods most residents closed up these tanks or used them for other kinds of storage.



a) Rain water comes through opening in roof

b) Collects in center chowk or verandah

c) Draining from chowk into underground cistern

d) Water accessed by lifting cover of cistern

Figure 4. A typical rainwater harvesting system in a pol in Ahmedabad

These strong historical references for strategies to harvest and store water in such a semi-arid climate influenced the thinking of the campus master planners and landscape designers. Rainwater harvesting and storage was seen as reflective of the regional context, in addition to being a sustainable water management practice.

3 Site Location

The campus site covers 399 acres on the eastern bank of the River Sabarmati, across from the city of Gandhinagar. The site is in two separate parcels with the village of Palaj in between the parcels (Figure 5). This site is described in more detail in a separate document in this series: Planning the Sustainable Campus. A highway forms the boundary on the eastern side of campus and the western side of campus is bounded by the Sabarmati River. Of the total site area, the southern part encompasses 305.1 acres and the northern parcel encompasses 93.9 acres. The elevation of the site varies from a base elevation of 73.5 m in the south to 82.5 m in the north. The lowest point on the site is a base elevation of 55 m in the ravines located to the west of Palaj Village. There are two seasonal ponds on the site.

The carrying capacity of a site can be defined in different ways and in a water-scarce area an important factor is the sustainable quantity of water available. Developing a sustainable water supply has been an important component of the building of the new campus.

Figure 5. Site map of the IIT Gandhinagar campus

4 Guidance Provided by the Masterplan

As conceived by the master planners, water is meant to be a very visible component of the campus experience. This encompasses physical features such as the River Promenade, the Jal Mandaps, the root zone treatment tanks visible from the Scenic Drive, and the seasonal ponds anchoring the Central Vista, as well as an overall sustainable approach to water management, with an ultimate goal of zero import of water.

The Masterplan specified creating a facility for receiving, storing, testing and treating water at the Water Treatment Plant and distributing water through Water Service Centres. Water of different qualities from various sources is brought to these centres and stored in the reservoirs. Stored water is tested and subjected to the required treatment and disinfection. The final treated water is pumped into the distribution mains. Three Water Service Centres have been built on campus:

WS Centre I: Academic Complex

WS Centre II: Student Hostels

WS Centre III: Staff Residences

The decentralised approach helps to keep the distribution mains small, thus simplifying maintenance. The maintenance downtime is short and in case of any problem, only a portion of the campus would be affected. Decentralised WSCs also facilitate any up-scaling of the installation to match with the phased development of any particular zone--Academic Complex, Hostels or Staff Residences.

The Masterplan specified three qualities of water to be distributed on campus:

1) **Fresh Water**: Water that is taken from sources such as the Narmada River, a lake, tube wells, storage reservoirs and rainwater harvesting systems. Water from sources free from pollution and toxic chemicals and treated to make it fit for human consumption is called fresh water. This water is essential for drinking, cooking, bathing, washing and ablution.

2) **Irrigation Water**: Water required for landscape irrigation need not be fresh water. Once used by human beings, it can be used for irrigation after treatment. In the final design of the campus water system, irrigation water and recycled water for flushing are supplied from the same source, i.e., treated sewage water.

3) **Recycled Water for Flushing**: The water required for toilet flushing does not come in direct contact with the human body and can hence be of an inferior quality to the fresh water required for drinking, bathing and washing. The water that has been once used for drinking, cooking, bathing, washing, ablution, etc., can be treated and reused for flushing of toilets.

The Masterplan specified that the sewage treatment system for IIT Gandhinagar would be based on the following principles:

a) Low energy consumption

b) Minimum use of chemicals

c) Ease of operation and maintenance

d) Ability to withstand variations in flows (vacation-time flows are less)

Thus, a system was developed to treat domestic sewage primarily through a biological process (Figure 6).

Figure 6. Root Zone treatment system where *Canna indica* plant roots help to treat the effluent

These goals, as articulated in the Masterplan, have been met in large part through the careful design of the IITGN water system. IITGN tasked HCP Design Planning and Management Pvt. Ltd., the architects who were designing the student hostels in Phase 1, to be the main consultant for the infrastructure. Multi Media Consultants Pvt. Ltd. were brought on as a subconsultant to HCP, as water, sewage and road consultants. A specialized subconsultant was brought in by IIT Gandhinagar for the design of the DEWATS sewage system, the Consortium for DEWATS Dissemination Society. All these consultants worked together in designing the water and sewage system.

In summary, fresh water is piped from the Narmada Canal directly to the Water Treatment Plant (WTP) on campus, where it is treated and then distributed to Water Service Centres (WSC) for further chlorination. It is held in these WSCs and then distributed directly to buildings on campus for drinking, cleaning, etc. Rooftop rainwater is collected and stored throughout the campus in large tanks the landscape architect designated as *Jal Mandaps* (water pavilions). This water is piped to the WTP where it is treated and mixed with the Narmada Canal water. Once the water is used, it is piped to the Sewage Treatment Plant (STP) where it is treated and then sent back in a separate distribution system to be used for irrigation. Surface runoff of rainwater is captured through a series of drainage pipes and sent to the seasonal ponds through intake wells. Overflow of the ponds will go to the Sabarmati River.

5 *Water Sources on Campus*

There are several sources for the water being used on campus with different sources depending on the use. Each is described briefly below. Figure 7 illustrates the campus basic water cycle. As shown in this figure, the campus uses two qualities of water coming from multiple sources. The two qualities are fresh water for domestic use (drinking, cooking, bathing, washing) and recycled water for flushing and irrigation. Currently recycled water is only being used for irrigation, because of a huge demand with all the new plantings.

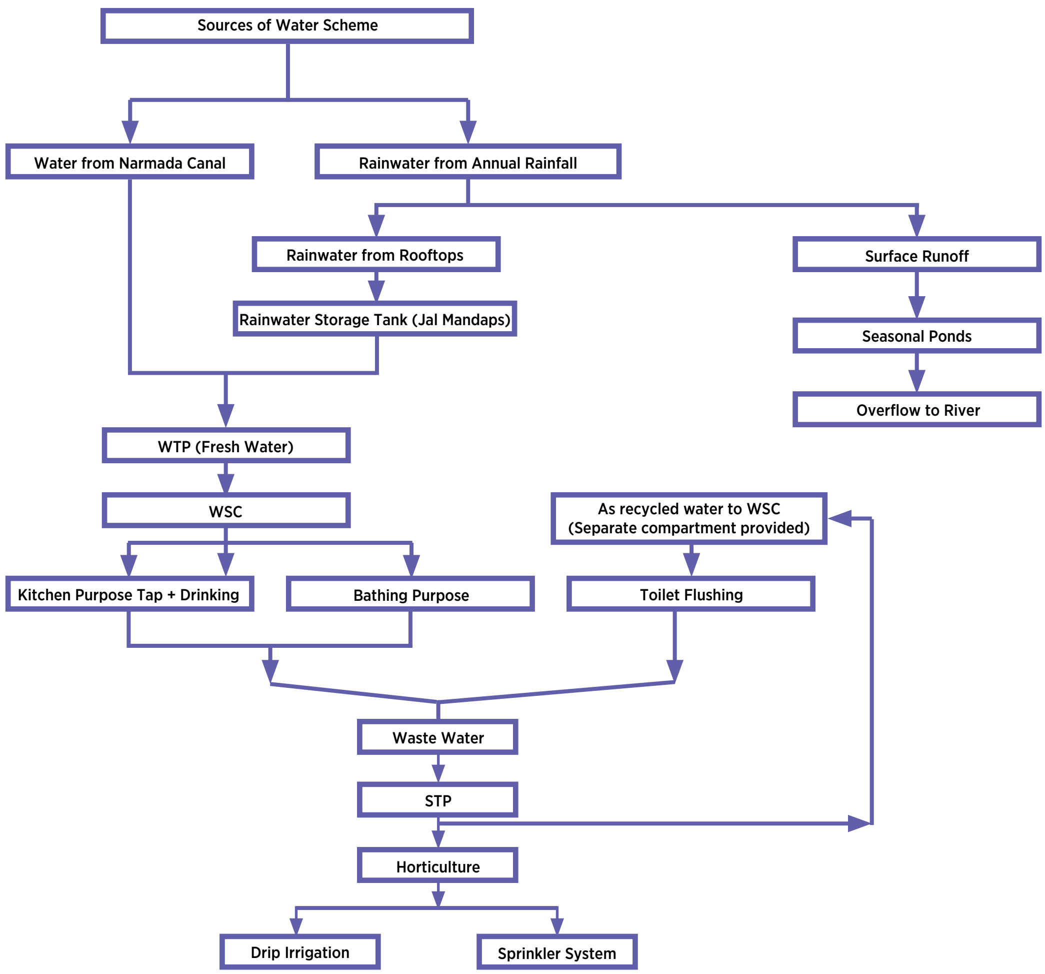


Figure 7. The water cycle at IITGN

5.1. Fresh water from the Narmada Canal

The raw water from the Narmada Canal is supplied by the Gujarat Water Supply and Sewerage Board (GWSSB) from a pipeline that presently transports water from the Narmada Canal to Gandhinagar City and to the thermal power plant at Gandhinagar. A new tributary pipeline was laid specifically for the campus to bring water from the main Gandhinagar City pipeline. This dedicated pipeline is 8 km long and has a capacity to bring 4.6 million litres per day to campus. Tapping has been done from the existing 1800 mm Dia MS water supply line of Narmada Canal at Dholakuva Circle. A 300 mm diameter ductile iron k9 pipe has been used to connect the WTP with the existing supply line. Two flow meters have been installed, at the starting point at Dholakuva, and at the end point at the WTP.

The Narmada Water Story (*Written by Prof Harish P.M. to the students in March 2016)*

The Narmada water story starts several years back when IITGN was successfully able to negotiate with GWSSB (Gujarat Water Supply and Sewerage Board) to lay a new pipeline from the main Narmada canal pipeline to our campus. This, I imagine, would have been no easy task--imagine a new pipeline just for our campus from the city of Gandhinagar, crossing through the river bed and the ravines and skirting forest lands, private party lands and those under legal disputes. Having been told that Narmada water has low TDS [total dissolved solids] and is potable, this was a great relief as this eliminates the need for reverse osmosis (RO) systems. Given that RO systems are unfriendly to the environment (for every litre of water you drink out of an RO system, approximately two litres of water is wasted in the back end), the prospect of avoiding the RO resonated with our green campus vision. But knowing how many of these external agencies function, our construction team was more than aware that we ought to have a backup plan. With this view, they examined the three tube wells already on campus and did the necessary testing to ensure that they have the necessary capacity and yield to serve an entire campus for extended periods of time. The only dilemma being that to use the tube well water for drinking, we will need ROs. The Narmada water pipeline got delayed for several months with various hurdles, including some land disputes and contractor issues. The construction team bravely went ahead with their backup plan and judiciously installed only a minimum number of ROs and activated those RO-associated water coolers on campus. This led to the limited number of working water coolers on campus (there were also a few breakdowns of the ones that were working, but that is another story). But now we are over the hump. After some extraordinary coordination and numerous visits and phone calls to various offices in Gandhinagar, the Narmada water pipeline was finally completed. In fact, did you know that they had to cut off the water supply for the entire city of Gandhinagar for one whole day while they made the final connections of the new water pipeline? We now have Narmada water on campus, we have a state of the art water treatment facility, and the water coming in your taps will directly be drinking water. I imagine that by the time you are reading this, you may have already received confirmation that the water treatment plant is tested and fully operational and all tap water is drinking water.

5.2. Bore Well Water

There were three existing wells on the property before campus construction began. These bore wells are basically drilled vertically into the underground aquifer and water is then pumped to the surface. These existing wells were tested to make sure they would be able to provide the necessary capacity while other systems were being developed on the new campus, and they now exist to provide redundancy in the water supply system on campus.

5.3. Rooftop Rainwater Collection

All the rooftops of the approximately 2,21,000 sq m of built up area of Phase IA campus buildings (both housing and academic buildings) are connected to a rooftop rainwater collection pipe network. These pipes are connected, with a gravity feed system, to the rainwater storage structures located throughout the campus (Jal Mandaps) that have been designed to be prominent landscape features. While there are currently four Jal Mandaps that have been constructed, ultimately there will be six in the system. The Jal Mandap features are described in more detail in the section below on Water Storage and Distribution. The four current Jal Mandaps are connected to approximately 42,000 sq m of rooftop area of the buildings on campus.

The rooftop network can currently collect approximately 26,075 cubic metres of rainwater in the monsoon season. This assumes average rainfall during the monsoon months and an 85 percent efficiency in the overall system. Assuming an average consumption of water from the Water Treatment Plant of 640 cubic metres/day during the rainy season, there is enough rainwater to supply the campus for approximately 40 days. Table 1 shows the details used in these calculations. It is clear from the table that careful water management of each of the Jal Mandaps is required, as once the tank is near capacity the tank needs to be emptied so that it can fill again. Each tank fills between 4 and 7 times in the rainy season. The tanks have level indicators and no tank will be allowed to be at more than 90% capacity before the water is pumped to the Water Treatment Plant.

Table 1: Rainwater Harvesting Calculations

Jal Mandap Near	**Rooftop area** (Sq m)	**Capacity of Jal Mandap** Cubic metre (cu m)	**Expected rainfall** during June-Sept (m)	**Total rainwater the Jal Mandap can hold** (cu m)	**How many times of capacity of Jal Mandap**
Dining	5,370	628	0.914	3,338	5.3
Academic (Near STP)	11,038	1413	0.914	6,860	4.9
Hostel	9,122	1413	0.914	5670	4.0
Housing	16,423	1413	0.914	10,207	7.2
Total	**41,953**	**4,867**	**0.914**	**26,075**	

Average consumption of water from WTP in rainy season (A) : 640	cu m per day	
Total expected qty of water to be collected (B):	26,075	cu m
How many days can be sustained with this qty of water (C= B/A):	40.8 days	

Formula used:

STORAGE = ROOF TOP AREA * RAINFALL (MM) * 0.8 (RUNOFF) * 0.85 (EFFICIENCY)

5.4. Surface Rainwater Runoff

During the monsoon season surface rainwater runoff is collected via a gravity-main network. After calculating the intensity of rainfall, the rainwater collection network was designed based on standards provided by the Central Public Health and Environmental Engineering Organisation (CPHEEO) of the Indian Ministry of Urban Development. The surface runoff network is shown in Figure 8. Originally the surface rainwater runoff network was meant to have collection pipes feed water into the two seasonal ponds at either end of the Central Vista. However due to various site conditions, these pipes had to be installed at a depth below the ponds so that the water could no longer be taken from the pipes to the ponds. Therefore the surface rainwater first is collected in an intake well and then pumped to the ponds.

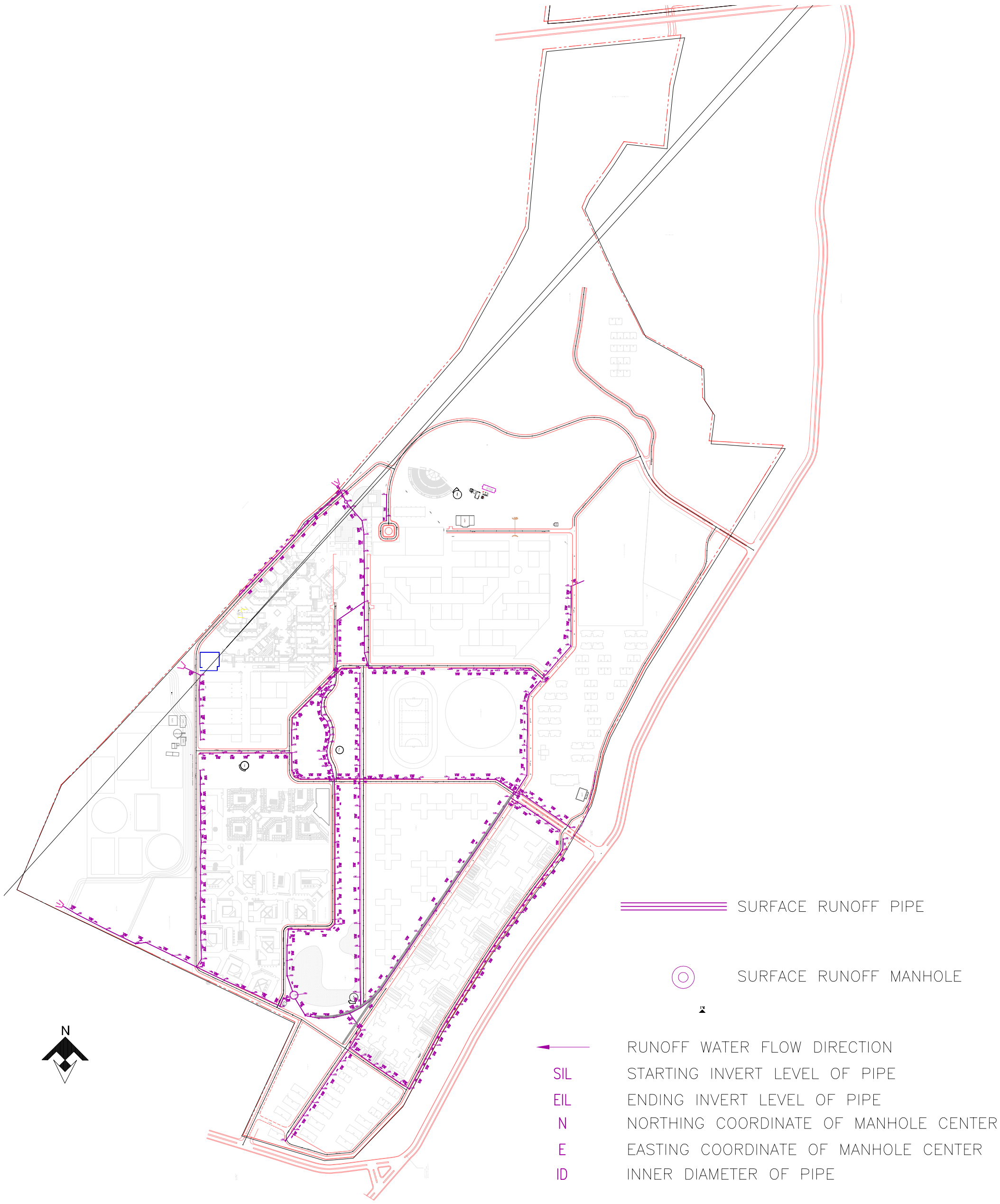


Figure 8: Surface runoff network

5.5. Recycled Water

As specified in the Masterplan, recycled water can be used for toilet flushing and irrigation purposes and does not need to be of the same quality as drinking and washing water. Raw sewage from the campus is thus collected and pumped through Sewage Pumping Stations 1 and 2 to the Sewage Treatment Plant. Treated sewage received from the Sewage Treatment plant is then pumped through the Recycled Water Pumping Station to the Water Service Centres (Figure 9), where it then goes back into the designated recycled water pipes to be used again for flushing and irrigation.

Initially, for several years at the new campus, recycled water was being used for both flushing and irrigation. However, as the campus is growing, and there are many new plantings, there is a very high demand for irrigation water. To meet this demand, all the recycled water is currently being used for irrigation, and there is still the need to supplement with fresh water. Irrigation water does not need to be as treated as the water used for flushing, so there are also some cost savings in using all the recycled water for irrigation. Some of the piping has been modified so that all the recycled water is going either to one of two irrigation tanks (one in Housing and one in the Academic Block), or directly to the lawn areas along the Central Vista.

Figure 9: Typical pumping arrangement at a WSC: pumping and distribution system for fresh and recycled water

Recycling Water at the Sewage Treatment Plant *(Written by Prof. Harish P.M. to the students in April 2016)*

In a world in which water is rapidly turning into a treasured resource and some experts are predicting dark and turbulent days ahead, it seemed to be a no-brainer to have a full-scale sewage treatment facility that would treat the waste water generated on campus and recycle most (if not all) of it. The wise master planners of our campus went one step further and proposed that given our landscape and opportunities, developing a natural sewage treatment plant made much more sense than investing in a more expensive, energy-intensive and less environment-friendly treatment plant based on chemical treatment. A three-stage treatment plant was developed, wherein the first two stages are completely natural stages and consist of an anaerobic reactor and a root zone treatment stage using live plants whose roots do all the work. The third stage is a filtration stage that involves no chemicals. The idea was that this recycled water will be used in all the flushes and all the gardening operations. The natural-process-based treatment facility did present the challenge that the time scales are slow, and it would take several months for the waste water to fill the entire facility and be processed. (Eventually it will be a continuous process.) The recycling system also meant several parallel networks of recycled water pipelines, parallel sets of separate tanks for flush water and horticulture water. I imagine a full-scale system of this complexity and sophistication may not have been seen by many of the executing agencies. So between coordinating with various pump operators and valve operators (who operate numerous valves and pumps in this complex system), understanding the complexities of the system, making ad hoc arrangements until the recycled water is available from the other end of the treatment facility, testing and fine tuning the system, I imagine there would have been several slip ups from which the various agencies will continue to learn. There is bound to be another round of disruptions when we fully transition over to recycled water, but soon all systems will stabilize, and we will be able to say proudly that we recycle our waste water.

6 Water Storage and Distribution Network

6.1. Distribution Network

A complex distribution network has been designed to handle water from the various sources described above. All buildings are provided with dual plumbing with separate lines for fresh water and recycled water from the Water Service Centre. Each of these lines goes into its own chamber in a multiple chamber rooftop tank where the two waters are separated by an air chamber between (Figure 10). The freshwater tank is further divided by a wall that prioritises distribution to the building fire hoses. If the freshwater tank for the use of the occupants should go dry, there is still water for firefighting. In addition, each building has a separate piping system that drains off roof rainwater into the Jal Mandap storage tanks (Figure 11).

Figure 10. Rooftop storage tank with separate chambers for fresh and recycled water

Figure 11: Different pipes for firefighting, clean water, recycled water, rainwater from housing roof

The distribution network for fresh and recycled water has been designed to directly pump both types of water from the Water Service Centres to the rooftop terrace tanks on each building. Ductile Iron (DI) K-7 pipe has been used in this distribution network as these pipes have excellent properties of machinability, impact resistance, high wear and tear resistance, high tensile strength, and corrosion resistance. The water distribution network is designed with the necessary sluice valves and other required appurtenances at different locations to ensure isolation and easy maintenance of the system. The fresh and recycled water distribution network is shown in Figures 12 and 13.

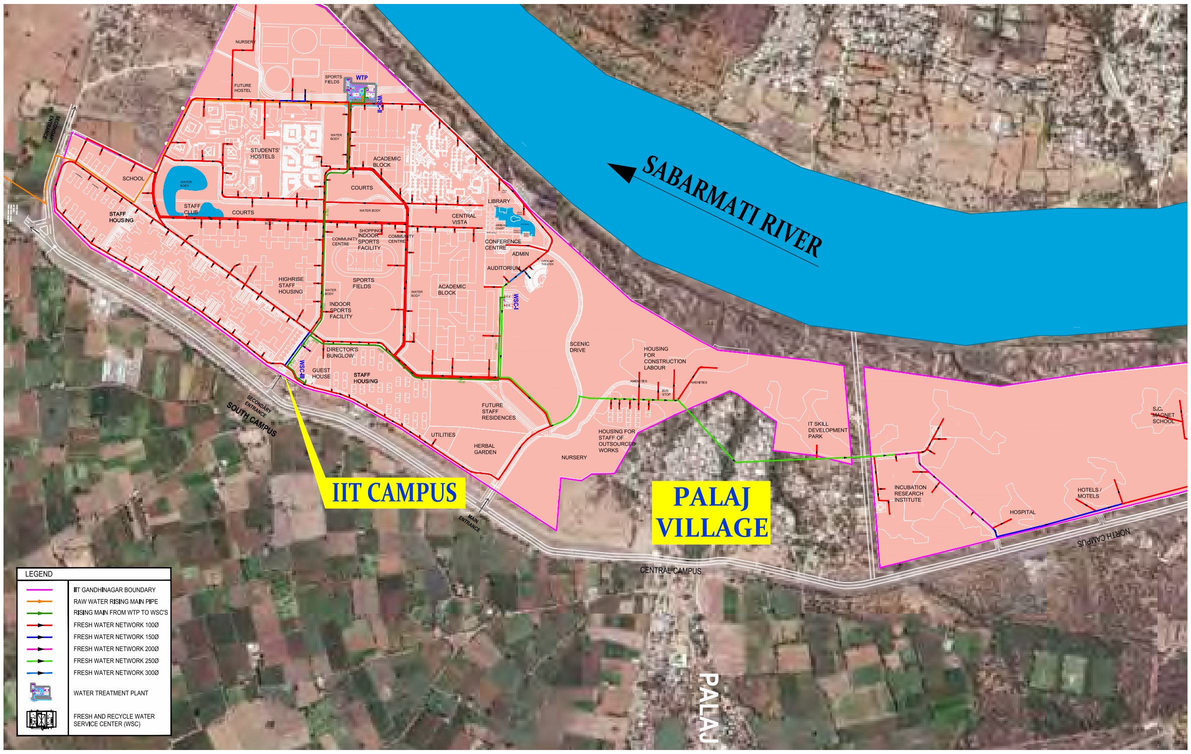


Figure 12. Fresh Water Distribution Network

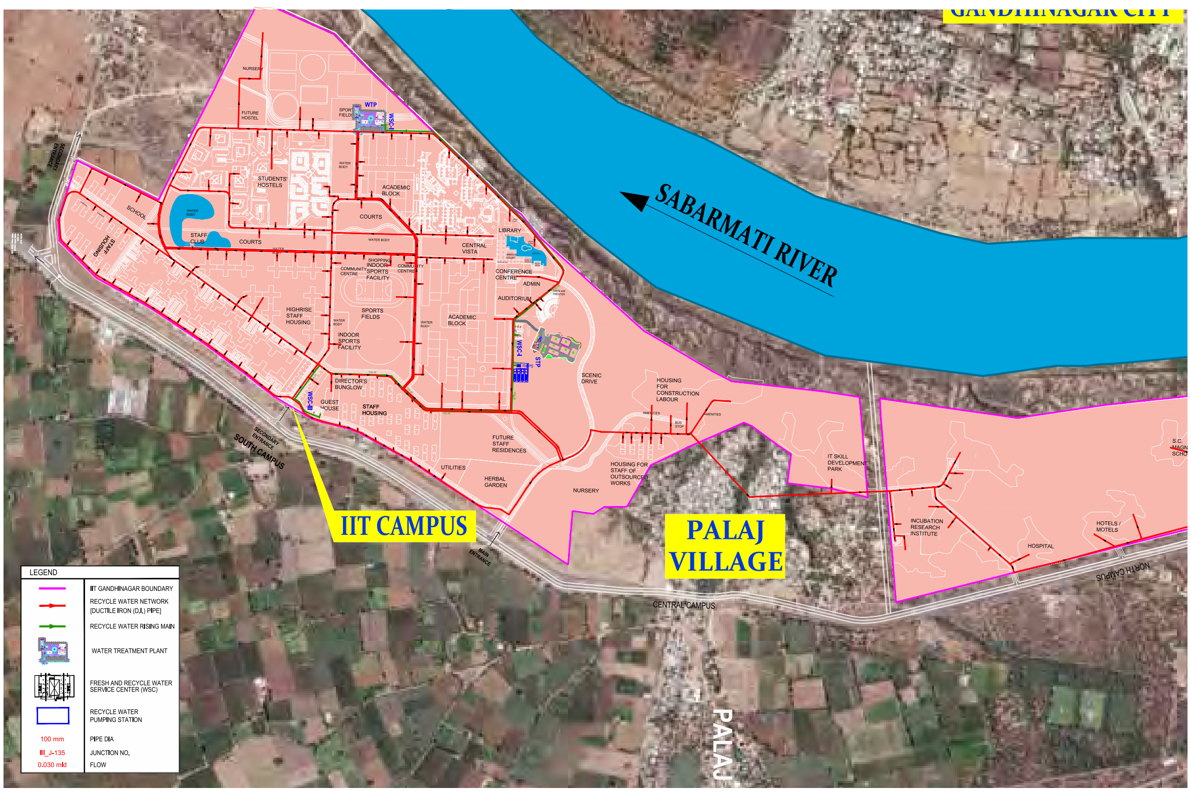


Figure 13. Recycled Water Distribution Network

The total pipe length for both the fresh and recycled water distribution network is approximately 20,000 metres each. Brick masonry manholes have been placed every 30 m for efficient cleaning and maintenance of the system (Figure 14).

Figure 14. Masonry manholes under construction

6.2. Jal Mandaps

A separate piping system was designed for the collection of rainwater on the roofs of each building (Figure 15) and then for the transfer of this water, using gravity, to feed the rainwater collection tanks, called Jal Mandaps by the landscape architect, and designed to be attractive viewing pavilions as well as storage tanks. In fact, the above-ground structures of the Jal Mandaps have been designed specifically as social spaces. They take inspiration from the vavs in Gujarat, encouraging social interaction. There are four out of six Jal Mandaps currently in use on the campus. The rainwater collected in each of these Jal Mandaps is pumped to the Water Treatment Plant where it is mixed with Narmada Canal water, treated, and piped back to the rooftop tanks through WSCs after chlorination to be used eventually as drinking water.

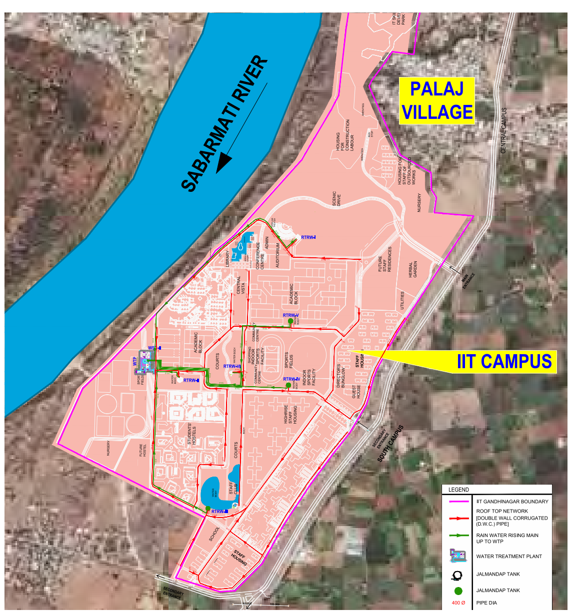


Figure 15. Rooftop Network of Distribution Pipes

The skeletal representation of a Jal Mandap is shown in Figure 16. Figure 17 a, b and c shows several completed Jal Mandaps.

The monsoons in 2017 were the first opportunity to test the system. Although the Jal Mandaps themselves were clean, after the first heavy rains it was clear that there was both sediment and stagnant water in the pipes leading from the Jal Mandaps to the Water Treatment Plant (WTP), as those pipes had been lying unused for months. Those pipes required flushing. As the system was designed as a closed system, there were no obvious valves or diverter pipes that could be opened to flush out the stagnant water. Modifications have now been made to alter the orientation of the inlet pipe in the WTP to outside the flash mixer chamber, allowing IITGN to flush out the pipelines from the Jal Mandaps to the WTP. Moving forward, the plan now is to continue to clean the rooftops and scrub the tanks out in the summer before the monsoons come. Water from the first rains will be used to flush out the system, discharging this water on the ground where it can seep in.

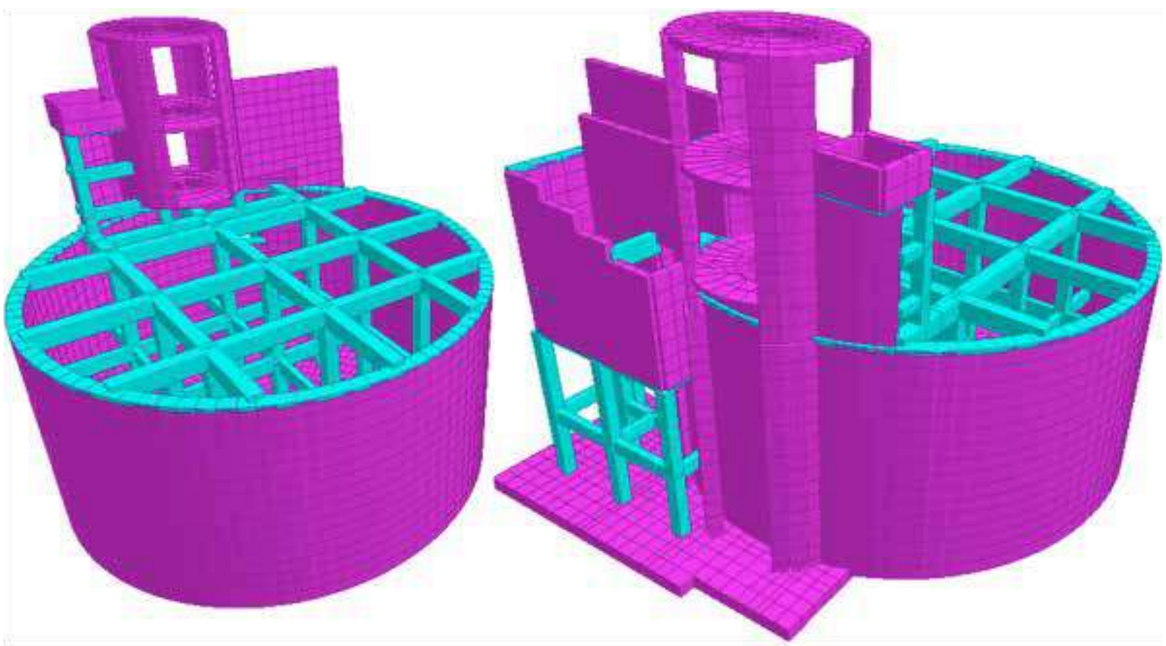


Figure 16. Skeletal representation of a Jal Mandap structure

(a)

(b)

(c)

Figure 17: Three of the completed Jal Mandaps

6.3. Seasonal Ponds

There are two seasonal ponds in the southern area of the campus, serving as landscape features by anchoring the Central Vista at each end (Figure 18). One is located near the Arrival Court, in the central east, covering an area of 0.6 ha (Figure 19), and the other seasonal pond lies in the southern area and covers 1.45 ha. Excess water from these ponds discharges into the Sabarmati River through a series of reinforced cement concrete (RCC) pipes 1200 mm in diameter. Ultimately the plan is to use the stored water in the natural ponds for landscaping and horticulture.

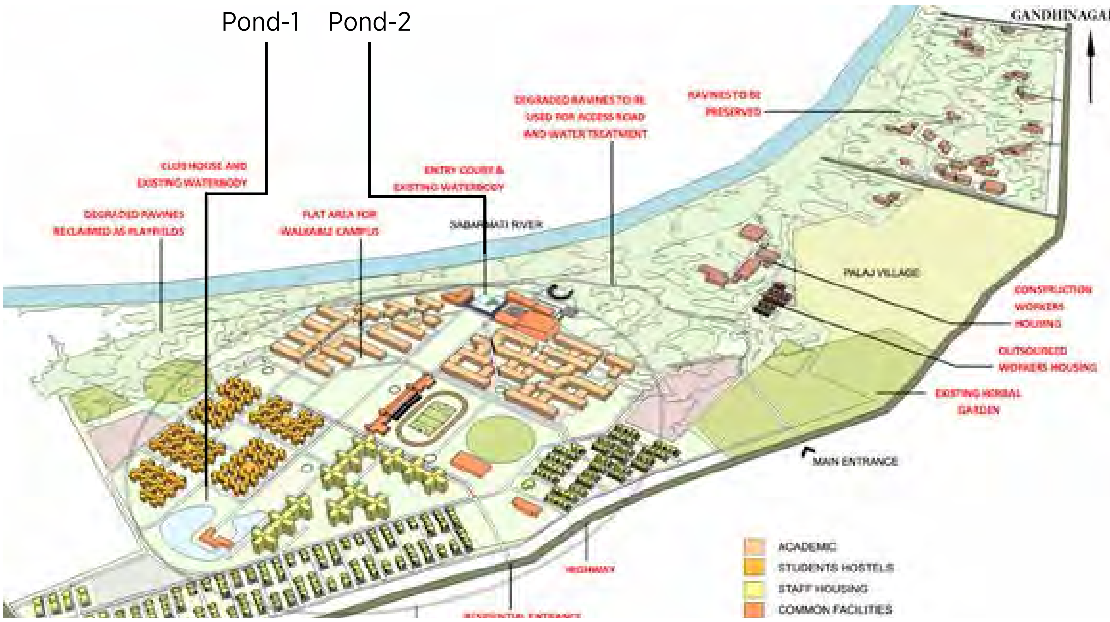


Figure 18. Plan of campus showing the location of the 2 seasonal ponds

Figure 19. Pond near Arrival Court and Academic Complex

Seasonal pond near Housing Jal Mandap

7 Water Quality, Water Treatment and Monitoring

The water from the Narmada Canal is treated in a straightforward fashion in the Water Treatment Plant (WTP). Water with the required head from the Narmada Canal is piped directly to the inlet chamber of the WTP. Water from the Canal has very low total dissolved solids (TDS), a low number being an important indicator of water quality.

7.1. Raw and Treated Water Characteristics

The quality of the raw water available from the canal and the treated water quality requirements as well as actual test results are given in Tables 2, 3 and 4. To address various challenges with the water quality tests, the Institute has evolved a combination of in-house and external lab tests as well as a monitoring system.

Table 2: The Raw Water Characteristics of Narmada Canal Water

Parameters	Unit	Quality
pH	-	6.5-8
Turbidity	NTU	5 to 10
Total Oil & Grease	mg / l	10
Total Dissolved Solids	mg / l	<250

Table 3: The Treated Water Quality at WTP after Multi Grade Filtering

Parameters	Unit	Quality
pH	-	6.5-8
Turbidity	NTU	0.1 to 0.3
Total Oil & Grease	mg / l	0.01 to 0.2
Total Dissolved Solids	mg / l	<250

Table 4: The Treated Water Quality at tap point

	Free Chlorine (mg/l)	TDS (mg/l)
Academic (Block 04)	0.1	202
Hostel (Beauki)	0.1	205
Housing (Block 12)	0.1	207

Notes:

- **Total Dissolved Solids (TDS) (mg/l)**: As per IS 10500:2012 a TDS value of less than 500 mg/l is recommended.
- **Chlorine (mg/l)**: As per IS 10500:2012 a small amount of free chlorine is an indication of disinfection against viruses.
- **Turbidity (NTU):** As per IS 10500:2012 a Turbidity value of less than 1 is recommended.
- **PH Value:** As per IS 10500:2012 a PH value 6.5 - 8.5 is recommended.

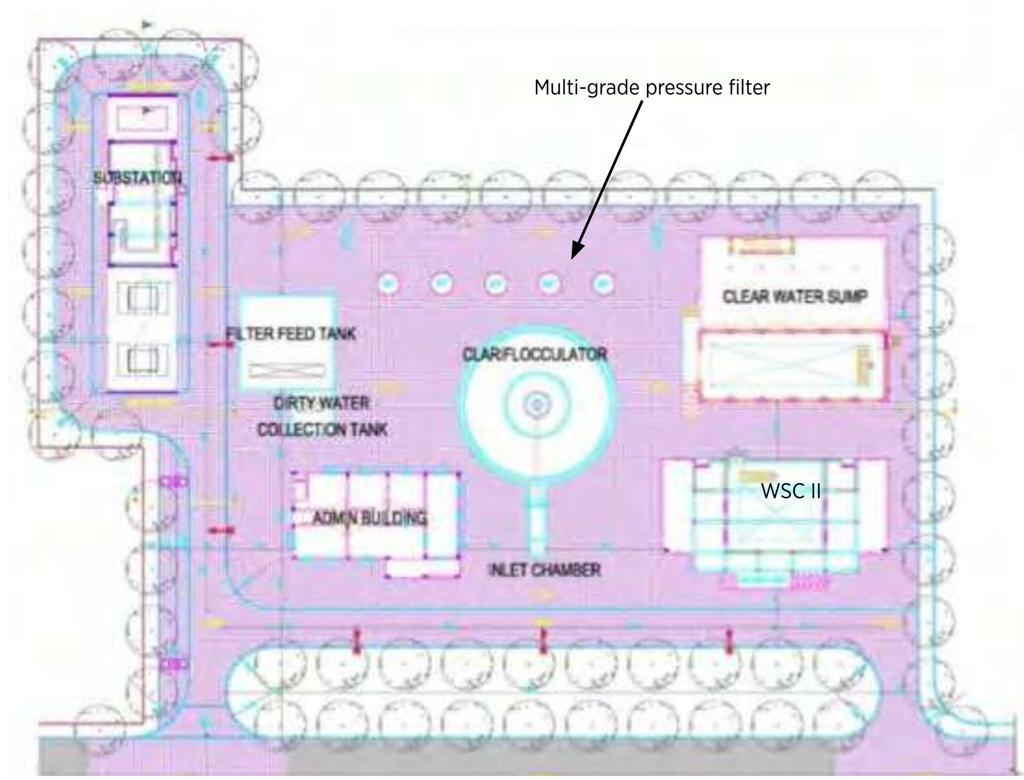


Figure 20. Layout of Water Treatment Plant (WTP)

7.2. The Water Treatment Plant

The Water Treatment Plant (WTP) has a capacity of 4.6 million litres per day. The layout of the plant is shown in Figure 20. The different steps in the treatment are as follows:

Inlet Chambers
Water coming from the Narmada Canal mixes with rainwater from the Jal Mandaps and collects first in this chamber.

Flash Mixer
Chlorine in the form of a sodium hypochlorite solution is added at the inlet for prechlorination purposes. The water from the inlet chamber flows under gravity to the flash mixer where a dose of a coagulant (alum /poly aluminium chloride) is added and mixed properly with the water for an efficient flocculation and disinfection process.

Clarifocculator
The clariflocculator has two concentric tanks where the inner tank serves as a flocculation basin and the outer tank serves as a clarifier.

Filter feed tank
This tank has a capacity of 2.5 Lakh litres and is used to store the water after going through the clarification and flocculation processes. Filter feed tank water is pumped to the multi-grade filter for filtration purposes.

Multigrade Filter (MGF)

These filters are vertical cylindrical tanks that have various grades of gravel and sand. An air blower and filter backwash pump are required to backwash the multi-grade filters.

Clean Water Pumping Station (CWPS)

The treated water from the MGF is piped to the CWPS before distribution to the Water Service Centres (WSCs). The filter backwash pump is provided in CWPS.

The treated water from the clear water pumping station at the WTP is further pumped to three Water Service Centres at different locations in the south campus. The water is pumped three times per day in pipes that range from 200 to 350 mm in diameter.

Fresh and recycled water is supplied directly into the terrace tanks 8 hours per day (4 hours in the morning and 4 hours in the evening). Horizontal centrifugal pumps are used to pump the water. The sump for storage has been constructed considering the future water requirements of the campus. Additional pumps will be installed as necessary. The capacity of the sump for fresh and recycled water is shown in Table 5.

Table 5. Sump capacity for Fresh and Recycled Water

WSC	Fresh Water Capacity of Sump	Recycled Water Capacity of Sump
WSC I	8.65 lakh litre	8.65 lakh litre
WSC II	2.21 lakh litre	2.21 lakh litre
WSC III	3.24 lakh litre	3.24 lakh litre

Note: 1 lakh = 1,00,000

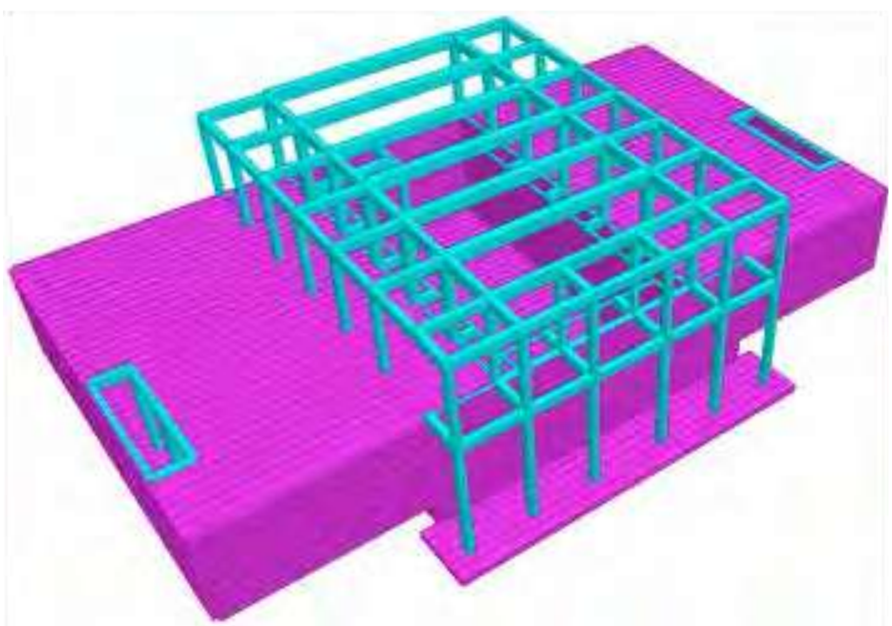


Figure 21. Water Service Centre. Fresh and recycled water in separate tanks to left and right, separated by an air chamber

A three-dimensional view of one of the Water Service Centres is shown in Figure 21.

The Water Service Centres have been designed in a way that the fresh and recycled water supply to each building is managed from the same location. The fresh water and recycled water is stored in sumps placed on either side of the pump room which houses the pumps and electric panels for both fresh and recycled water. Adequate care has been taken in the design to ensure that fresh and recycled water do not mix.

7.3. Pumps, Equipment and Instrumentation Required

Based on the pumping requirements for the water system, it was decided to use centrifugal pumps, which are considered both easier to maintain and economical in comparison to other types of pumps. The pumps were selected considering the need for eight hours per day of pumping.

Horizontal split case centrifugal pumps were selected. They are simple in construction and operation. Less maintenance of this pump is required, and what maintenance is required is comparatively easier than for many other types of pumps. Its construction features help to maintain the arrangement of pipes and valves in the pump house at the floor level, facilitating easy and speedy maintenance work.

As the name suggests, the pumps are installed horizontally at the floor level and are directly coupled to the motor. The suction and delivery nozzles are parallel to each other along the same line. This avoids the need for overhung installation of the delivery pipes and valves and makes the installation simple for operation and maintenance work. Operation and maintenance of the pumps themselves are also simple.

Enough pumps have been provided so that there are a minimum of 50% standby pumps to meet the requirements of this initial phase of campus development. To enhance the pumping capacity to meet the requirements of the next phase of development, additional pumps of identical capacity will be added to the grid with the same electromechanical considerations and provisions.

A low-tension (LT) power system for all pumping stations with required accessories and installations has been provided in this phase, including a grounding system.

In order to have a smooth, safe and reliable operation of the pumping station and in order to monitor data such as level, flow, and pressure for the safe operation and control of pumping machinery, various field-panel-mounted instruments for monitoring and control have been provided. These monitoring instruments include an ultrasonic level indicator/transmitter, pressure gauges at the delivery point, compound gauges on the suction side of each pump and a pressure gauge for the main header at the pump house, along with necessary fittings, isolation valves, manifold valve, and drain tubing up to the drain channel. Full bore electromagnetic flow meters at the main delivery header of each pump house have also been provided. A spool piece of the required size and length matching the flow meter size has been installed.

Float level switches have been installed at the drain pump pit for emergency and auto operation of drain pumps (Clear Water Pump House and Recycled Water Pump and WSCs) as well as in an underground reservoir to protect the pumps in case they run dry. There is a control panel to monitor the level and flow at each service centre.

Pumping chambers of Water Service Centre between storage tanks of fresh water and recycled water

8 *Sewage Treatment Plant*

The master planners for the campus proposed using an innovative sewage treatment system, called a Decentralised Wastewater Treatment System (DEWATS), which features root zone treatment of the sewage (Figure 22). It met the following principles as specified in the Masterplan:

a) Low energy consumption

b) Minimum use of chemicals

c) Ease of operation and maintenance

This unconventional system uses almost no power and has no mechanical parts. It is a closed system, meaning that the campus treats and recycles its sewage and is not hooked into the municipal system. There is zero discharge. This system is not commonly used and presented some unique challenges to campus planners. Finding a consultant who had expertise with the system and could work with the planners to develop an appropriate system for the IITGN campus was the first challenge. Ultimately consultants from the Consortium for DEWATS Dissemination Society (CDDS) were retained to design the IITGN system. This consortium is a nonprofit, non-governmental organisation that focuses on providing decentralised basic needs services, including wastewater treatment systems.

Some of the key features of DEWATS include its tolerance to inflow fluctuation, resource efficiency and non-dependence on energy, minimal maintenance, its reuse of waste water and no groundwater pollution through leaking underground sewage systems. It requires more land because of the need for the root zone treatment tanks, but the fact that it uses little energy makes it very efficient. There have been maintenance challenges with the system as neither the executing agency nor most consultants or contractors have been familiar with the system and its maintenance requirements. These challenges have for the most part been sorted out as of 2019 and the system should run efficiently in Phase II. The next section describes in detail how the sewage is treated in this system.

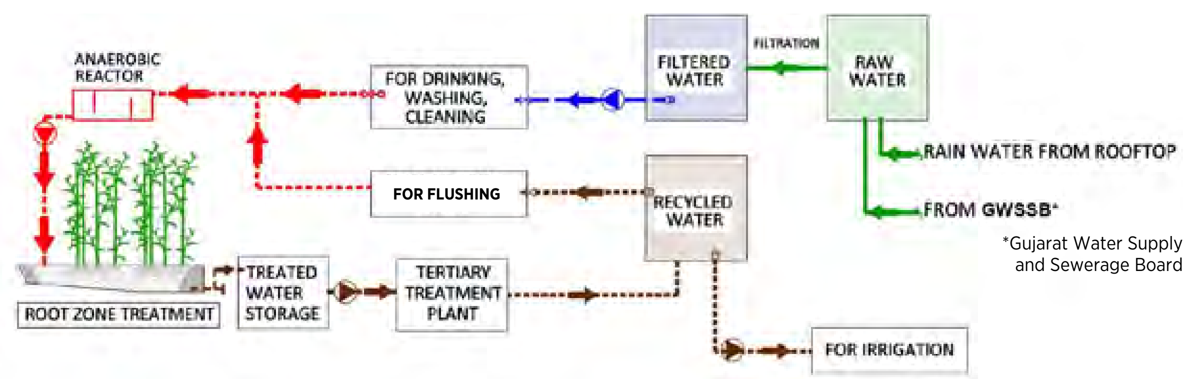


Figure 22. Decentralised Wastewater Treatment System (DEWATS): Water management system on site

8.1. The Sewage Treatment Plant

Raw sewage from the campus is collected and pumped through Sewage Pumping Stations (SPS) 1 and 2 to the Sewage Treatment Plant (STP). Sewage collection is by gravity using unplasticised non-pressure polyvinyl chloride (PVC-U) SN-8 pipes up to the sewage pumping stations. Pumping to the Sewage Treatment Plant is through ductile iron k7 pipes.

The STP has the capacity of treating 6 lakh litres per day of raw sewage. The basic steps in the process are summarised in Figure 23 and described below.

First, the raw sewage is put in the settler. This tank is designed to remove suspended solids in the raw sewage by sedimentation. Heavier particles settle to the bottom.

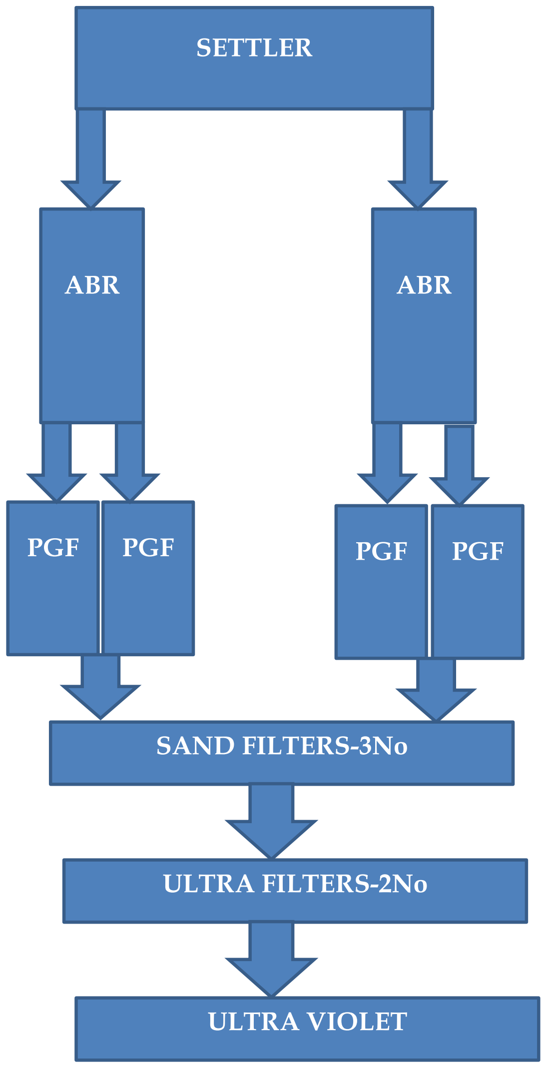


Figure 23. STP line diagram

The second step is to begin biological treatment. The effluent coming from the settler is forced to flow through a series of baffles in an Anaerobic Baffled Reactor (ABR). Anaerobic degradation of suspended and dissolved solids takes place in this stage.

The third stage is to run the sewage through a Planted Gravel Filter (PGF). This is known as a root zone treatment system, where the roots of the *Canna indica* help treat the sewage. Basically the effluent coming from the ABR is passed via gravity to a tank with gravel and *Canna indica* (Figure 24). The roots of the *Canna indica* absorbs pollutants coming from the effluent. This improves the purity of the effluent.

Figure 24. The *Canna indica* plant, used in the Planted Gravel Filter (PGF), a critical step in the sewage treatment process

The fourth stage is to pass the sewage through a Pressure Sand Filter (PSF). The effluent from the PGF is then passed through the PSF unit and as a result the suspended particles are captured in the filter bed.

The fifth step is to run the sewage through an Ultra Filtration unit to further reduce its suspended solids and turbidity. Ultra filtration uses a hollow fiber membrane encased in a pipe. Treated sewage water from the Pressure Sand Filter flows inside the shell of the UF membrane which filters the remaining residual solids and thereby further reduces the biological oxygen demand (BOD) of the effluent.

The final step in the sewage treatment system is to run the treated effluent through Ultra Violet Disinfection. Any remaining bacteria in the effluent are disinfected through these penetrating ultraviolet rays.

After passing through ultra filtration and ultra violet disinfection the treated effluent is then pumped to the Water Service Centres in separate storage tanks. Currently the water does not go through ultra filtration as it is pumped directly to irrigation tanks to be used for campus irrigation. The units that perform these final disinfection steps are routinely maintained, however, so that when the campus decides to use recycled water for flushing as well, the units can quickly be brought online to pass the flushing water through these final treatment steps. Table 6 shows the expected sewage generation for each phase of campus development.

Table 6. Expected sewage generation for each phase of campus development

Phases of Campus Development	**Average Sewage Flow (Million litres per day)**	
	Sewage pumping station I	**Sewage pumping station II**
Phase 1 a	0.32 mld	0.18 mld
Phase 1 (Additional Flow)	0.52 mld	0.28 mld
Phase 2 (Additional Flow)	0.61 mld	0.46 mld
Total Sewage Generation	**1.45 mld**	**0.91 mld**

8.2. Pumps, Equipment and Instrumentation Required

Pump houses and tanks have been built for ultimate capacity, however electromechanical works have been installed for the first phase only. Further installation can be done as required.

8.2.1. Pumps

The centrifugal submersible non-clog pumps are used to pump raw and treated sewage. Sewage submersible non-clog pumps installed directly in a wet well are more economical than horizontal non-clog (HNC) pumps (which are installed in a dry well) or other types of pumps. The pumps for the sewage pumping stations were selected considering the requirement for 24 hours continuous pumping and for the RWPS-STP considering 8 hours of operation.

Submersible non-clog pumps are simple in construction, installation and operation. Such simplicity helps to reduce the considerable infrastructure construction costs. These types of pumps are largely accepted in sewage pumping stations in urban areas. The pump can be maintained without entering the sump well of the pump station which can be unpleasant and hazardous.

8.2.2. Instrumentation and Control Works

Before sewage enters into the wet well of the pumping station, at both Sewage Pumping Stations 1 and 2, the following equipment was installed to improve the performance of the pumps.

A manually operated cast iron sluice gate was installed on the inlet pipe. One removable stainless steel (SS) coarse bar screen with 25 mm bar spacing at the inlet chamber was also installed to remove floating materials and the higher size solids from the sewage.

In order to have a smooth, safe and reliable operation of the pumping station and in order to monitor the level, flow, and pressure for the safe operation and control of the pumping machinery, various field-panel-mounted instruments have been provided for monitoring and control. These include:

- Diaphragm-type pressure gauges at delivery of each pump along with necessary fittings, isolation valves, manifold valve, drain tubing up to drain channel, etc. All valves and fittings are stainless steel.
- Ultrasonic-type level indicators/transmitters at the wet well of each SPS.
- Displacer-type level switches along with flexible rope and waterproof junction boxes at the wet wells for dry run protection of the pumps.
- Full bore electromagnetic flow meters at main delivery header of each pump house at treated sewage collection sump and SPS, spool piece of required size and length matching flow meter size.

A control panel is provided so the operator can monitor the level and flow parameters.

Sewage Treatment Plant

Both 200 mm and 250 mm diameter ductile iron k7 pipes have been installed to convey pumped sewage from the sewage pumping station to the STP. Figure 25 shows the sewerage network.

	Pipe length (mt.)
From SPS I to STP	1,500 m
From SPS II to STP	50 m

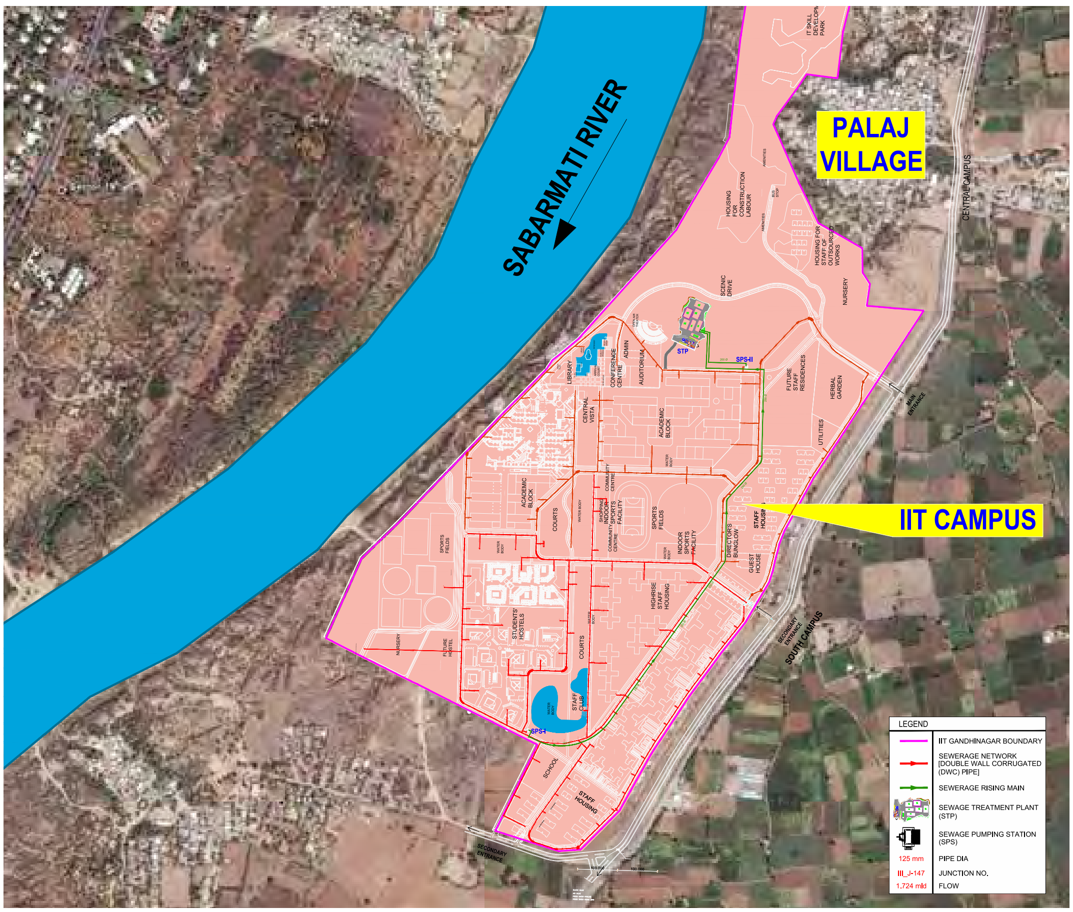


Figure 25. Sewerage network

9 *Water Usage and Patterns*

Since the campus has now been occupied for more than three years, IITGN is beginning to assemble a robust set of data on water usage and sewage flow. An analysis of these data indicate the following pattern:

Of the raw water coming from the Narmada Canal and treated in the Water Treatment Plant, 90—95% is usable as fresh water, depending on the season. The highest percentage is available as fresh water during the winter and pre-monsoon season, while the lowest percentage is available during the monsoon and immediate post-monsoon season. Rejected (or dirty) water after treatment at the WTP is used for irrigation of the campus plantings. One of the tanks for irrigation water is shown in Figure 26.

Approximately 70 to 75% of the treated water is consumed in the housing, hostels and academic offices. The balance of the treated water is used for irrigation, supplementing recycled water, particularly in those areas where the designed recycled water irrigation system has not been provided. A small quantity of water is used for air conditioning, vehicle and floor washing, and another small quantity is wasted, due to occasional overflows from any of the approximately 92 overhead water tanks on various buildings.

Approximately 75% of the treated sewage is available as recycled water, whereas 25% of the treated sewage is consumed through evaporation losses in the PGF, backwash and sludge etc.

The usage pattern may undergo significant change after commissioning of more buildings presently under construction (Phase 1B) and an increase in recycled water. As more recycled water is generated it may be possible to cover almost the entire landscape area with an irrigation system using recycled water, (Figure. 26) resulting in a reduction of consumption of fresh water for irrigation. Prevention of overflow from overhead tanks by using high pressure float valves may also help conserve water.

Figure 26. Irrigation tank and equipment in Housing area

Water treatment plant

10 Using Natural Water Features on Campus

Water plays an important role in defining the character of the campus, not only through the development of the water and sewage systems, but also through the natural features present at the campus site. It was decided during the master planning stage to incorporate these features in their natural state as much as possible in the campus development.

10.1. Seasonal Ponds and Arrival Court

As mentioned earlier, the campus has two seasonal water bodies that anchor both ends of the Central Vista. One lies at the southern end of the campus while the second water body is close to the Arrival Court. To highlight water as a key feature on campus the Arrival Court has been designed around this pond, so that visitors see water as a main element in campus planning (Figure 27). Although both ponds typically only have water during part of the year, campus planners are discussing whether or not to take steps to fill these water bodies more regularly. They both attract a variety of bird species and offer recreational seating.

Figure 27. Architectural rendering of the Arrival Court and pond

10.2. Ravines

One of the very striking features of the IITGN campus is the presence of many deep ravines (Figure 28). The steep nature of these ravines and the fact that they cover so many acres dictated the shape of the campus, confining most of the development to approximately 225 acres mostly in the southern part of the site. These ravines drain naturally to the Sabarmati River, and a conscious decision has been made by campus developers not to alter these natural drainage patterns. IITGN has also built small check dams in the ravines, both to reduce erosion caused by the velocity of the water draining there during the monsoon season, and to recharge the groundwater table.

Figure 28. Existing ravines

10.3. River Sabarmati

One of the conceptual anchors of the open space system of the campus, as defined in the Masterplan, is the riverfront promenade, a walkway and road along the River Sabarmati, at the western boundary of the site. The river is the most prominent landscape feature in the area and the promenade celebrates this (Figure 29). Some of the academic buildings also open to the riverfront, drawing students and faculty to the water for contemplation and relaxation.

Figure 29. River promenade

11 Water Efficiency Initiatives

11.1. Waterless Urinals

IITGN began experimenting with waterless urinals at the temporary campus in Chandkheda and found them to be quite successful. The same technology, the Zerodor, developed by a research group at IIT Delhi, was then brought to the new campus in Palaj. They are used in the student hostels.

11.2. Water-Efficient Fixtures

Throughout the campus water-saving aerators are used in all the washbasins, sink taps and faucets. These dispense water at a controlled rate by mixing foam with the stream of water. The use of foam basically adds air to the water stream, resulting typically in about a 70% reduction in water consumption compared to the taps and faucets that do not have such regulators installed. IITGN has also installed energy efficient, dual flush toilet tanks in washrooms throughout the campus, including housing, hostels and the Academic Complex.

11.3. Solar Water Heaters

All the residential buildings on campus have solar water units installed on their rooftops (Figure 30). All the hot water in each building is processed through these tanks. The Housing area has 90 solar hot water units (three per building), each with a capacity of 500 litres per day. The Hostel buildings including the Dining Mess have 44 solar hot water units each with a capacity of 500 litres. The hostel units have electrical backup, set on timers, to provide additional heating for three hours in the morning and three hours in the evenings.

Figure 30. Solar water heater tank with solar panels in Housing

11.4. Passive Downdraft Evaporative Cooling (PDEC)

A Passive Down Draft Evaporative Cooling (PDEC) system is installed in the student dining facility of the hostels. This system consists of a set of nozzles at the top of a central shaft through which a fine water mist is generated using a pump. This fine water mist released at the top of the shaft evaporates thereby cooling the air at the top of the shaft. This cooler air sinks on account of cooler air being heavier than ambient air, and enters the lower floors containing the dining areas (see Figure 31). This system is effective in hot and dry weather and is able to achieve an additional cooling effect of nearly 5 degrees Celsius giving needed relief during the Summer months. The system needs very nominal maintenance (cleaning of nozzles and filters).

A similar system along with night purge systems were installed in the classroom complex in the academic area. However, it was found not as successful for two reasons. First, higher humidity in classrooms that had audio visual and electronic equipment was not desirable, and second, while the cooling achieved in the mess was comfortable for the short transitionary usage such as while eating a meal, it was not found to be comfortable enough for extended durations such as a few hours of lectures.

Figure 31. Shaft for the Passive Downdraft Evaporative Cooling in the student hostel mess


Water Treatment Plant

12 Credits

Owner	**Indian Institute of Technology Gandhinagar**
Advisor Works	Mr Nagaraja B. N. (up to 30-04-2013)
	Mr L. P. Srivastava (from 06-05-2013)
Owner's Architect	Ar Shobhit Tayal, Design and Planning Counsel Pvt. Ltd., Ahmedabad
Owner's Engineer	Mr A. K. Kothari, Superintending Engineer (up to 28-01-2013)
	Mr G. C. Chaudhary, Superintending Engineer (from 04-02-2014)
Faculty Team	Prof Sudhir K. Jain, Director
	Prof Amit Prashant, Civil Engineering
	Prof Ashwini Kumar, Civil Engineering
	Prof Bhaskar Datta, Biological Engineering
	Prof Harish P. M., Mechanical Engineering
Infrastructure Consultant	**M/S HCP Design, Planning and Management Pvt. Ltd**
Water, Sewage & Road	Multi Media Consultants Pvt. Ltd.
	Mr Apurva Parikh, Director, Multi Media Consultants Pvt. Ltd.
Sewage Treatment Plant	Consortium for Dewats Dissemination Society (CDDS)
	Mr Satchit Bhandarkar, Regional Coordinator, CDD Society
Project Management	**Central Public Works Department (CPWD), Government of India**
Project Manager	Mr L. K. Bhargava, Superintending Engineer (up to 29-01-2016)
	Mr Kapil Deo Narayan, Superintending Engineer (from 29-01-2016)
Building & Works Committee	**Indian Institute of Technology Gandhinagar**
Chairman	Prof Sudhir K. Jain, Director, IITGN (2009-present)
Members	Prof Neelkanth Chhaya, Former Dean, Faculty of Architecture, CEPT University, Ahmedabad (2009 - present)
	Shri Kiran S. Wagh, Chief Advisor (Civil Infrastructure), IIT Bombay (2009 - present)
	Shri R. Subramanian, Former Additional Director-General, CPWD, New Delhi (2009 - 2012)
	Chief Engineer (Capital), Roads & Buildings Dept, Government of Gujarat, Ahmedabad (2009-2012)

	Director (TS-I), Ministry of Human Resource Development Government of India, New Delhi (2009 - 2011)
	Shri A. K. Jain, Former Special Director General, CPWD New Delhi (2012 - present)
	Shri L. P. Srivastava, Former Additional Director General, CPWD & Advisor (Works), IITGN (2012 - present)
	Prof Ashwini Kumar, Professor-in-Charge, Planning & Resources, IITGN (2012 - 2014)
	Prof Harish P. M., Dean (Campus Development), IITGN (2014 – August 2018)
	Prof Gaurav Srivastava, Dean (Campus Development), IITGN (Sept. 2018 - present)
	Dr Prabhat Kumar, Former CMD, Bharatiya Nabhikiya Vidyut Nigam Ltd, Kalpakkam, (2012 - 2016)
	Shri M. B. Bhalala, Former Chief Engineer, Road & Building Department, Government of Gujarat (2009 - present)
Secretary	Shri B. S. Punalkar, Registrar, IIT Bombay (2009 - 2013)
	Shri P. K. Chopra, Registrar, IITGN (2013 -present)

Project Progress Monitoring Committee

Members	Shri L. P. Srivastava, Advisor (Works), IITGN
	Shri A. K. Jain, Former Special Director General, CPWD, New Delhi
	Shri Kiran S. Wagh, Chief Advisor (Civil Infrastructure), IIT Bombay
	Shri Prabhat Kumar, Former CMD, Bharatiya Nabhikiya Vidyut Nigam Ltd, Kalpakkam (up to January 2016)
	Shri Balraj Chadha, Chief Engineer, CPWD, Gandhinagar (up to May 2016)
	Shri A. K. Agarwal, Chief Engineer, CPWD, Gandhinagar (July 2016 - present)
	Shri Laksh Bhargava, Project Manager, CPWD (up to January 2016)
	Shri Kapil Deo Narayan, Project Manager, CPWD (up to January 2019)

This publication is the one in a series describing the development of IIT Gandhinagar's campus on the bank of River Sabarmati in Gandhinagar. The campus development provided numerous opportunities for innovation and the series is meant to document these.

The focus of this document is on the water and wastewater management systems put in place at the new campus. Built to be a zero-discharge system, rainwater and fresh water from the Narmada Canal are used and then reused for flushing and irrigation purposes. Sewage is treated in a root zone treatment system.

Copies can be obtained by writing to the librarian@iitgn.ac.in

INDIAN INSTITUTE OF TECHNOLOGY GANDHINAGAR
PALAJ, GANDHINAGAR - 382 355

www.iitgn.ac.in

ISBN 978-81-934412-7-5
9 788193 441275 >