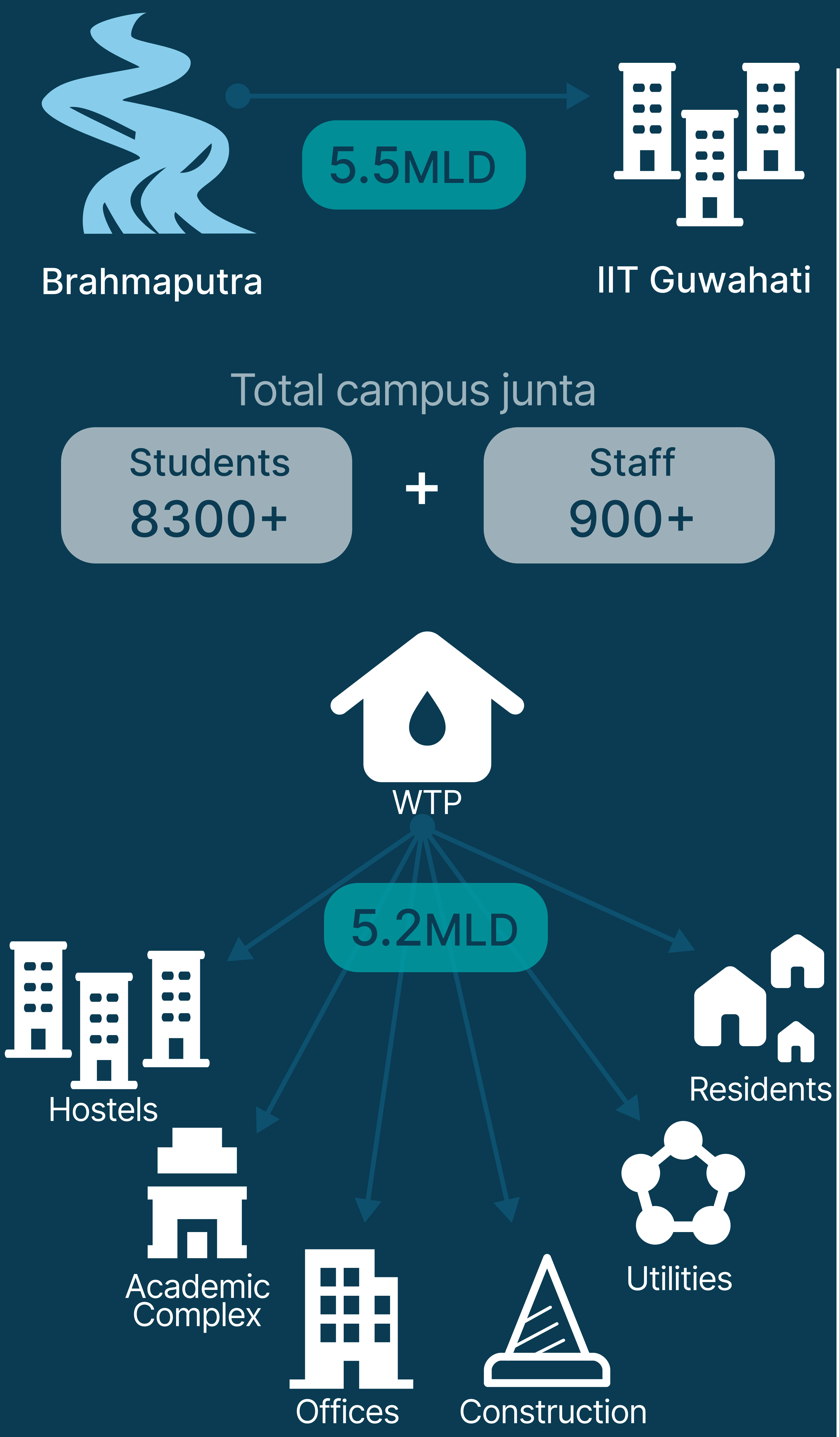

Water Wise
Consulting
Hostel ID - 78

Water Wise Consulting



IMPORTANCE

Critical Water Security

Guwahati, located near the Brahmaputra River, faces **severe water scarcity** despite its proximity to a major water source, highlighting the urgent need for sustainable water management

Global Need

Addressing both local water management challenges at IIT Guwahati while **contributing to broader global initiatives** for universal access to clean water and sustainable water management

Health and Well-being

The water scarcity and purity concerns directly affect the **health and well-being** of the campus community, particularly in several hostels where frequent shortages occur

Regional Water Management

This project **serve as a model** for other institutions and communities in the region, as it addresses both water scarcity and quality issues in an area with complex water management challenges

Problem Statement

To develop a broad and comprehensive strategy to tackle water scarcity and ensure water purity at IIT Guwahati, leveraging analytical, and technological solutions while considering environmental, financial, and logistical factors

CHALLENGES

Financial Constraints

- **Limited financial resources** for implementing advanced systems
- Necessitates finding **cost-effective** and innovative approaches to water management.

Environmental Impact

- Significant environmental implications of **large-scale water extraction** and usage
- Need for carefully considered and management
- Including potential effects on **local ecosystems** and groundwater levels.

Infrastructure Assessment

- Analyzing **existing infrastructure** for water storage, recycling, and purification
- Requires extensive technical expertise and resources
- Involves comprehensive evaluation of **current systems** and identifying areas for improvement

Behavioral Changes

- Implementing behavioral interventions to promote **efficient water usage** among the campus community
- Requires careful planning and sustained effort
- Includes **changing long-established habits** and creating awareness about water conservation

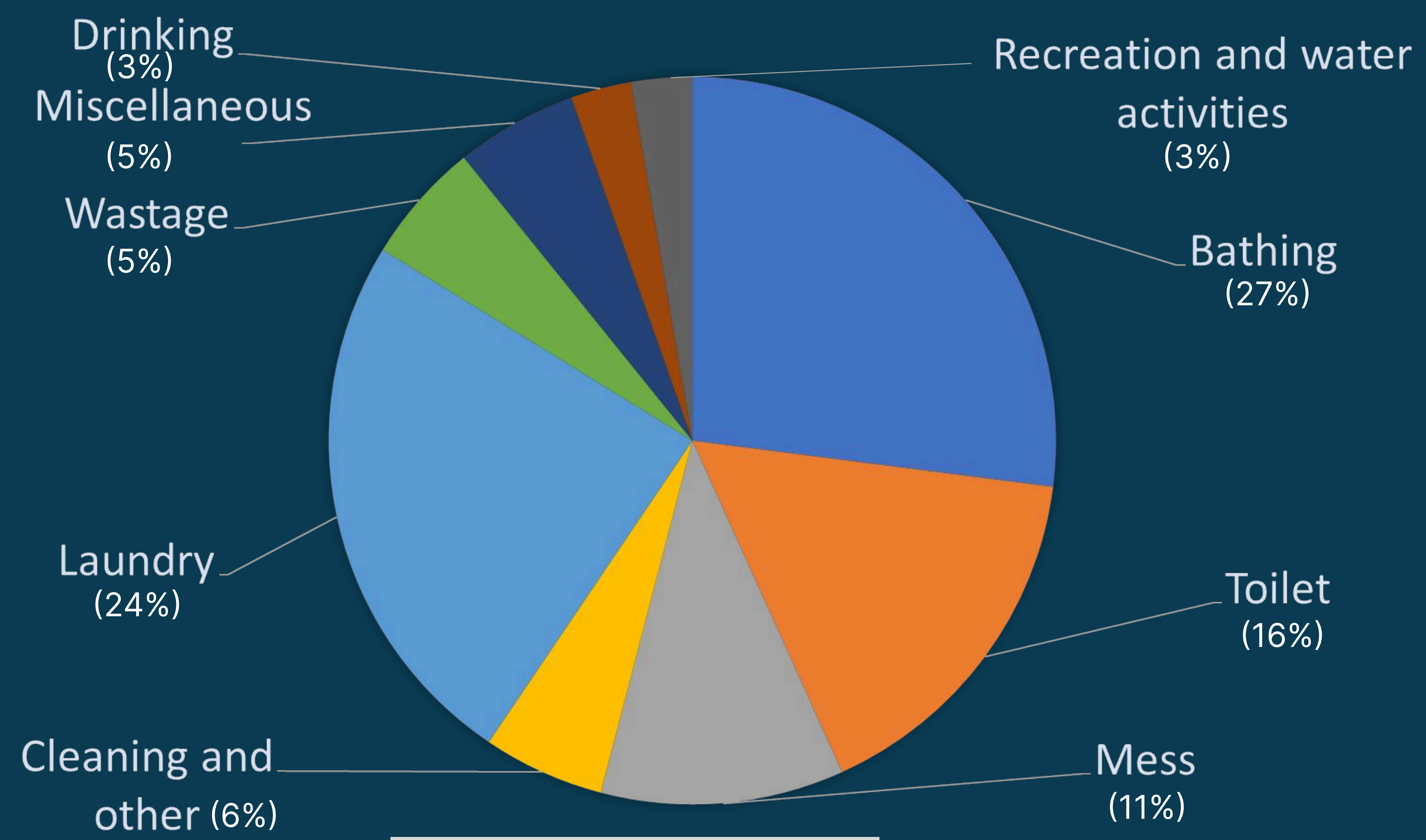
Operational Continuity

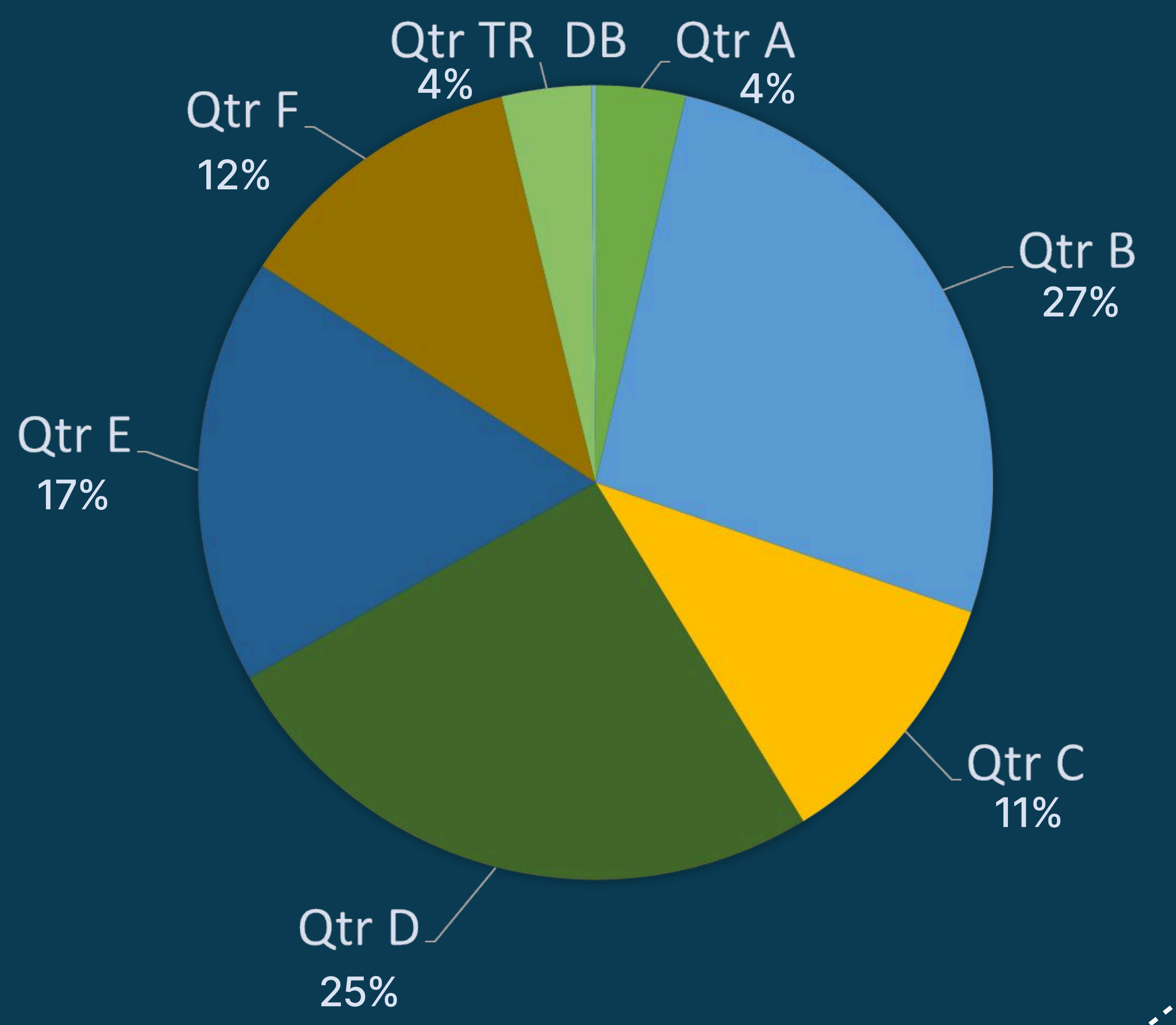
- Balancing implementation with **minimal disruption** to campus life and academic activities
- The solutions implemented in a way that **maintains normal** campus operations while achieving the project's objectives.

Consumption Analysis

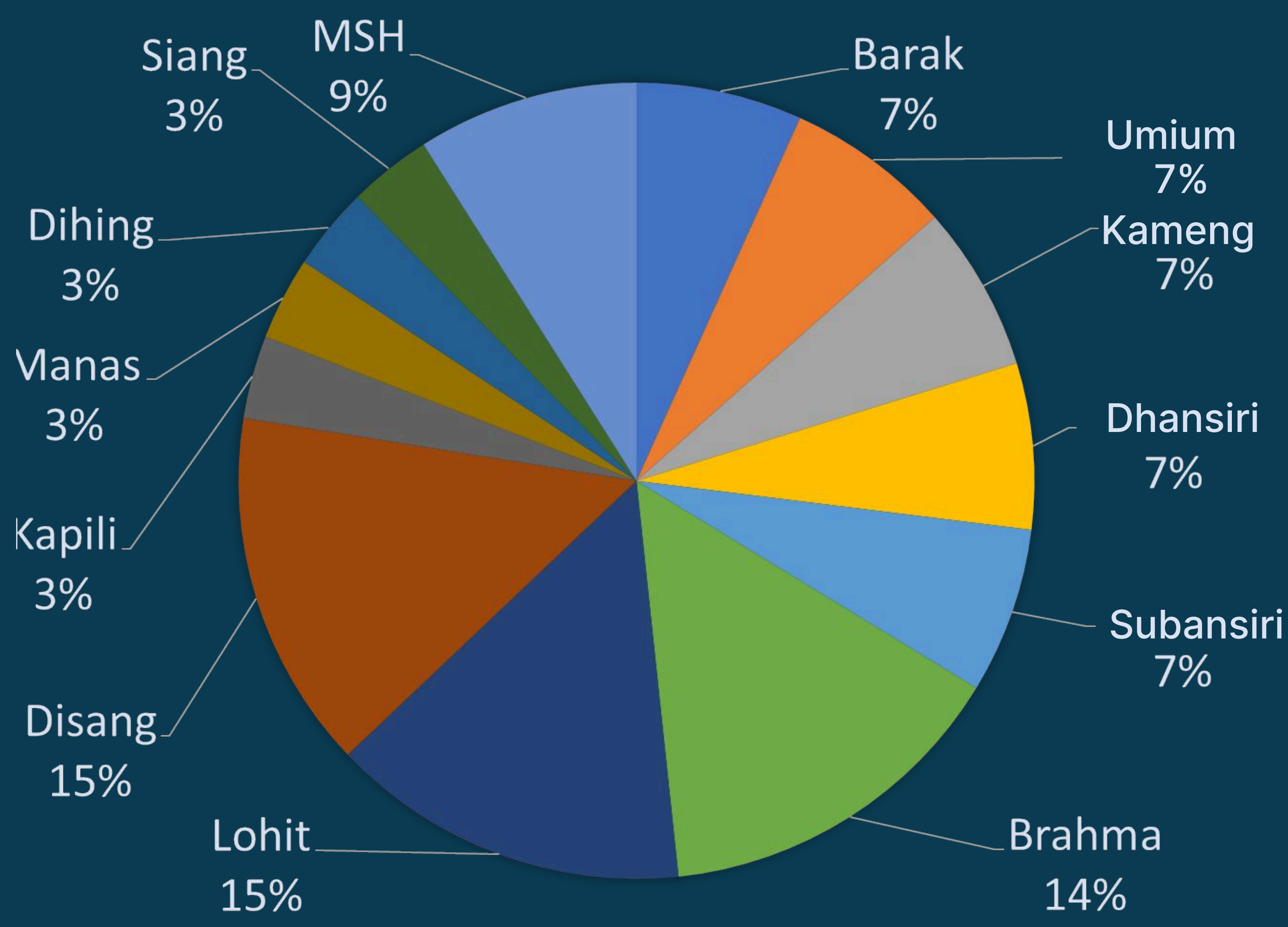
Average Daily Water Consumption of Students

Activity	Water Usage (L)
Bathing	50
Toilet	30
Mess	20
Cleaning and Other	10
Laundry	45
Wastage	10
Miscellaneous	5
Drinking	5
Recreation and Water Activity	5
Total	180



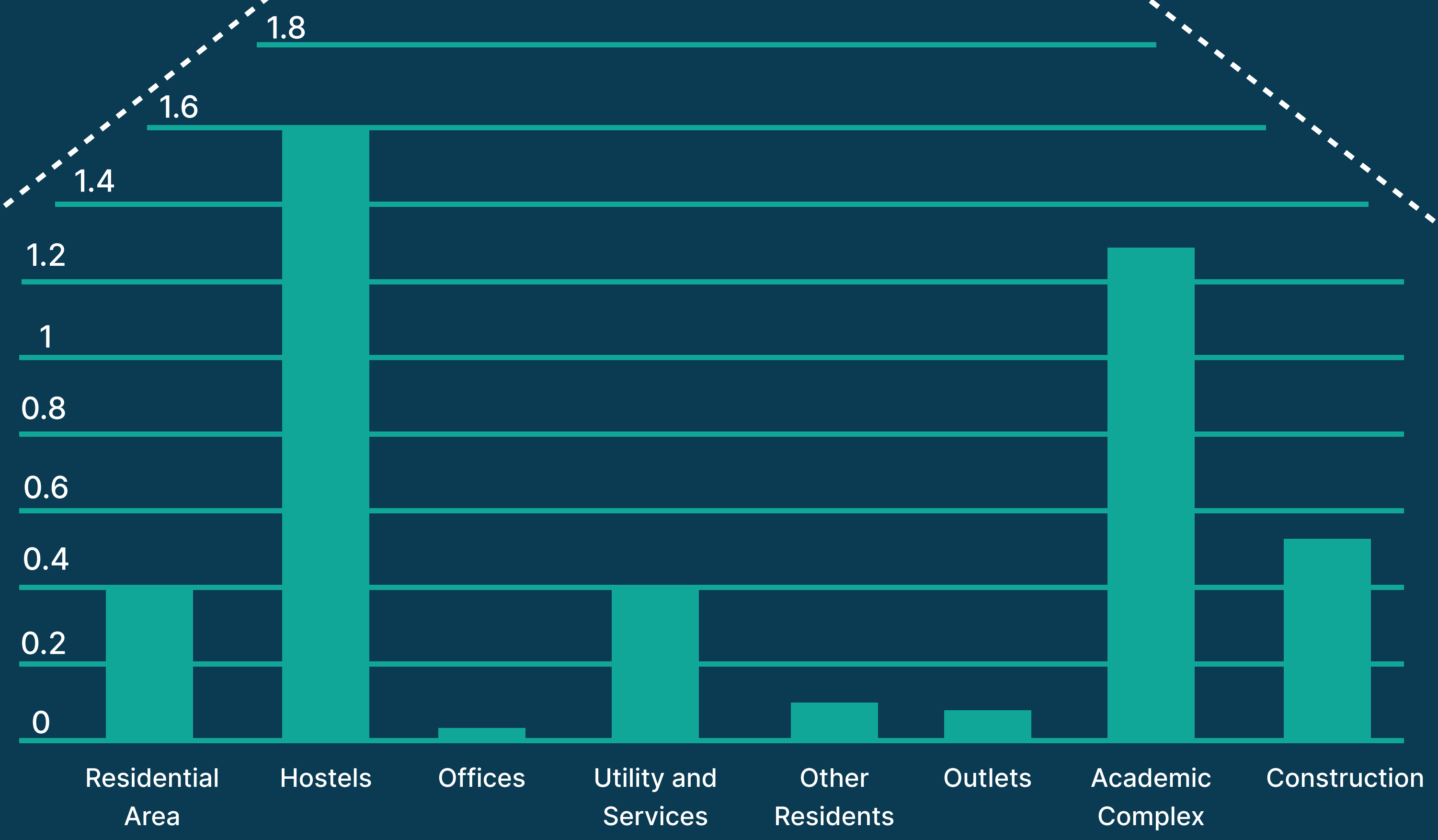


Quatres Water Distribution



Hostels Water Distribution

Water Distribution



Problem Analysis

Problem about purification and quality

Chemical Shortages and Heavy Metal Contamination

Due to a shortage of essential purification chemicals, we rely primarily on alum and chlorine for water treatment. However, this method is insufficient for effectively removing heavy metals, leading to potential contamination.

Metals not treated	After treatment	Ideal amount
Iron	0.8±0.02	0.05
Arsenic	14±1.4	1
Lead	1.04±0.2	0.1
Zinc	6.4±1.2	5

Turbidity Issues

Current Observed Range: 10-14 NTU

Ideal Turbidity Levels: Less than 5 NTU

Health Risks:
Elevated turbidity can lead to various health hazards, including: Gastrointestinal infections , Diarrhea ,Nausea

Other Concerns:
Increased turbidity promotes bacterial and viral infections by providing a medium for microbial growth.

Insufficient Aeration

- Proper aeration is crucial for the **removal of iron** and other dissolved gases.
- Currently, the aeration process is inadequate due to **less contact time**, leading to high iron content in the water, which affects both quality and taste.

Oxygen and Temperature regulation

- **Increased Water Temperature** – Higher temperatures accelerate chemical reactions and impact aquatic ecosystems.
- **Lower Dissolved Oxygen (DO)** – Warmer water holds less oxygen, stressing aquatic life and increasing fish kill risks.
- **Algal Blooms & Water Quality Issues** – Elevated temperatures promote harmful algal growth, degrading water quality.

Problem about Distribution and Storage

Distribution Problem

- **Lack of Pipeline Infrastructure:** Newly constructed hostels and sections do not have pre-installed pipelines, requiring a new setup each time, leading to inefficiencies.
- **Unequal Water Supply:** The current system struggles to distribute water evenly, causing shortages in various hostels.
- **Affected Hostels:** Married Scholars Hostel (MSH) and Gaurang do not have primary pipelines, resulting in frequent water shortages in some sections.

Pressure Problem

- **Reduced Flow Due to Sub-Pipelines:** The creation of additional sub-pipelines without increasing flow pressure leads to weak water supply in certain hostels.
- **Aging Pressure Pumps:** The pumps responsible for maintaining pressure have lost efficiency due to lack of upgrades, worsening water flow.
- **Hostels Facing Issues:** Gaurang and multiple blocks of MSH experience frequent water scarcity due to low pipeline pressure.

RO and Water Purification Problem

- **Aging Filtration Systems:** Many RO filters and water dispensers are outdated, leading to reduced water purification efficiency.
- **Lack of Maintenance:** Filters are not being cleaned or replaced regularly, affecting water quality.
- **Health Concerns:** Poor water purification across hostels is leading to a decline in drinking water quality, posing potential health risks.

Storage Problem

- **Limited Storage Capacity:** Some hostels do not have sufficient water storage, leading to shortages.
- **Frequent Water Cuts:** Due to low storage, hostels run out of water before refilling cycles are completed.
- **Affected Hostels:** Dhansiri and MSH are particularly impacted, often facing sudden disruptions in water supply.

Infrastructure-Related Contamination

- **Rusting and decaying pipes**, along with aging filters and storage tanks, contribute to additional contamination.
- Corrosion leads to leaching of metals into the water supply, further worsening water quality.
- **Accumulation of biofilms** in pipelines increases microbial contamination, leading to potential health risks.

Problem Analysis

Problem about Inflow Mechanism

Working Mechanism

- Water is extracted using large pumps placed near the surface water source.
- Pipes transport water to treatment plants for purification before distribution.
- The barge floats on water due to Archimedes' Principle
- The shape and weight distribution of the barge ensure it remains stable
- Barges can be self-propelled (equipped with engines) or towed/pushed by tugboats
- Dynamic positioning systems (in modern barges) help keep the barge stable in offshore operations.

Problems

Prone to Contamination

- Surface water is exposed to pollutants such as industrial waste, sewage, and agricultural runoff.
- Stagnation of water occurs, so **water from STP leaving and WTP intaking mixes** and problem occurs

Seasonal Dependence

- Water levels in lakes and rivers fluctuate due to droughts or excessive rainfall affecting supply reliability
- **Pipe from floating barges hits bottom** and pollutants also reach WTP, causing more use of power

Sedementation

- High deposit of sediments in river bed, leads to decrease in in-take of water.
- **Quality of water reduces** and overall contamination increases.

THE 2019 CASE

The campus experienced severe water quality issues due to excessive sedimentation around the Water Treatment Plant (WTP) intake and Sewage Treatment Plant (STP) output. This sediment buildup formed a sand barrier, leading to water stagnation and disrupting the natural flow.
As a result, the low-quality treated water from the STP was not effectively discharged, accumulating in stagnant pools. This stagnation caused the WTP intake to draw in degraded water, leading to contamination. The consumption of this poor-quality water resulted in widespread health issues among campus residents, including diarrhea, nausea, and other waterborne diseases, creating significant distress.
To resolve the crisis, the sand barrier was manually broken, a high-risk operation, to restore natural water flow and prevent further stagnation.

Problem about Water Level in Brahmaputra

Sediment Variation

- Guwahati's Location: Guwahati is situated at the **narrowest section** of the river, leading to **significant reduction in water flow velocity**
- Rapid Sediment Settling: Due to the decreased flow velocity, sediments and silt carried by the river tend to settle **more rapidly on the Guwahati side, altering the riverbed profile overtime**
- Increased Sediment-Trapping: The natural sediment-trapping effect makes the area more susceptible to water contamination
- Impact on Barge Operations: The combined effects of sediment accumulation and water contamination **impact barge operations**

Higher Evapotranspiration

- Higher Evaporation Rates: Rising temperatures lead to **increased evaporation from the river surface** and more transpiration from surrounding vegetation. **Reducing water availability**, especially during dry seasons.
- Exacerbation of Declining River Levels: The region become more susceptible to drought-like conditions
- Altered Hydrological Cycle: Prolonged heat **reduce soil moisture**, **lower groundwater recharge**, and increase water demand for agriculture and human consumption.
- Worsened Contamination and Water Quality: The combination of water stagnation and higher silt accumulation **worsen contamination** and water quality issues.

Irregular Rainfall Pattern

- Vulnerability to Climate Change: Guwahati is one of the regions most vulnerable to **climate change**
- Decline in Annual Rainfall: There has been a steady decline in annual rainfall levels
- Decreased River Water Levels: The shift in precipitation patterns has led to a **continuous decrease** in water level.
- Factors Intensifying the Issue: →Erratic monsoons →Prolonged dry spells →Rising temperatures
- Compounded Decline in River Flow: →Upstream water usage for agriculture →Industrial activities →Hydroelectric projects
- Impact on Guwahati: →Sluggish water movement →Increased deposition of silt →Greater challenges for navigation →Ecological disruption disruption

Location

- High-Terrain Region: Guwahati is situated in a **high-terrain region** surrounded by hills
- Rapid Rainwater Drainage: Rainwater drains rapidly from hilltops into the river due to steep slopes
- Short-Lived Water Level Spikes: Most **runoff flows quickly into the river** rather than percolating into the ground, leading to short-lived spikes in water levels
- Decreased Overall River Flow: Rapid runoff and the city's location at the **river's narrowest section** contribute to a decrease in overall river flow
- Eroded Sediments and Debris: Eroded sediments and debris from the hills are carried into the river

Problem Analysis

Problems in Water Regulation and Maintenance

Lack of Proper Regulation & Overburdening of IMP

- The entire water management system is handled solely by the Infrastructure & Project Management (IPM) department, leading to work overload and inefficiencies.
- Due to the absence of dedicated water regulation policies, critical aspects such as maintenance, upgrades, and supervision are often overlooked or improperly handled.
- No defined accountability structure, leading to delays in issue resolution.

No Regular Inspection for Leakages & Pipeline Maintenance

- There is no structured process for identifying and fixing leakages in pipelines, leading to water wastage and infrastructure damage.
- Delays in addressing leaks result in higher repair costs and inefficient water distribution.

No Supervision by Student Body & Faculty Over Maintenance Processes

- There is no active involvement of students and faculty in monitoring ongoing maintenance activities.
- A student-faculty oversight committee could ensure proper execution, timely reporting, and verification of maintenance work.
- Lack of engagement leads to reduced accountability and inefficiencies in water management.

Neglect in Water Tank Maintenance & Cleaning

- Water storage tanks lack regular inspections, cleaning, and scheduled maintenance, which can lead to contamination and health hazards.
- Without periodic checks, sediment buildup and microbial growth can compromise water quality.

Irregular Cleaning & Maintenance of RO Filters & Dispensers

- Reverse Osmosis (RO) filters and water dispensers require frequent maintenance for safe drinking water.
- Currently, there is no proper monitoring system to ensure they are cleaned and replaced at appropriate intervals.
- Poor maintenance can result in unhygienic water supply and reduced filtration efficiency.

Lack of Plumbing Regulations for Leaking Pipes and Taps

- No structured plumbing regulation for reporting and fixing leaking taps, broken pipes, or faulty fixtures.
- Small leaks often go unnoticed, leading to significant water loss over time.

Absence of Faculty Supervision Over IPM

- There is no direct involvement of professors in overseeing water regulation and maintenance.
- Faculty supervision could help implement better technology, ensure efficient resource management, and improve regulation frameworks.
- Without faculty support, opportunities for upgrading systems and optimizing water usage are missed.

Solution

Brahmaputra River: Position this on one side of the image, where water will be drawn.

Water Intake and Pumping Station: Show this structure near the river, with pipes leading from the river to the first set of ponds.

Cluster of 10 Ponds: Distribute these ponds across the 30-acre land. Each pond should be shown with its water storage capacity.

Pond System to improve the inflow mechanism of IITG

Maintenance Zones: Highlight areas where maintenance infrastructure will be located for cleaning and monitoring the system

Pipes and Water Distribution System: A series of pipes will connect the ponds to the pumping station, which will then distribute water across the IIT campus.

Overflow Spillways: Each pond will have a spillway connected to a drainage system or catchment area.

Continuous supply

This approach reduces dependence on Brahmaputra water level for inflow.The system will continuously draw water from the Brahmaputra River, ensuring a steady flow of water to the campus.

By drawing water continuously from the nearby Brahmaputra River, the system will store 1 million liters of water across 10 interconnected ponds. The system will manage excess water through spillways during heavy rainfall, preventing overflow and flooding.

Cost-Effective

Once constructed, the system will have low maintenance and operational costs compared to other water supply methods like water treatment plants.

Temporary arrangement of Flexible pipes

- **Lower Maintenance Costs** – Reduced risk of damage due to flexibility, minimizing repair and replacement expenses.
- **Adaptability** – Easily adjusts to varying water levels, sediment movement, and environmental changes.
- **Optimal Material Choice** – HDPE (High-Density Polyethylene) is the best material considering durability, flexibility, and affordability.
- **Cost-Effective** – Lower material and installation costs compared to rigid piping solutions.
- **Ease of Installation & Repairs** – Simplifies installation and maintenance, especially in river conditions.

Technical Specifications & Cost Analysis

- Maximum Capacity: 10 MLD (Million Liters per Day)
- Flow Rate: 0.3 m/s
- Pipe Diameter: 20 inches
- Number of Pipes: 2
- Pipe Length (per pipe): 200 meters
- Cost per Meter of Pipe: ₹2500

Item	Estimated Cost (INR)
Land Development	2,00,000
Pond Construction (10 ponds)	5,00,000
Pumping station and water intake	70,00,000
Piping (500 meter)	5,00,000
Spillways (10 ponds)	5,00,000
Water distribution system	15,00,000
Annual maintenance	5,00,000
Contingency (15%)	12,00,000
Total cost	1,14,00,000

Solution

Pipeline Improvement

HDPE Pipes

For a large-scale water supply network and high pressure systems , HDPE pipes (PN 6 to PN 10) provide the best balance of performance and cost-efficiency, ensuring a reliable and sustainable water transport system.

Durability: Expected lifespan of 50+ years under normal operating conditions.
Flexibility: Can be bent and installed without breaking, making them ideal for uneven terrain.
Corrosion Resistance: Unlike metal pipes, HDPE does not corrode or rust.
Chemical Resistance: Resists acids, alkalies, and chemicals, making it suitable for a wide range of applications.
Leak-proof Joints: Uses heat fusion welding, reducing the risk of leaks and water loss.

Advantages

Cost-Effective : Lower initial cost than metal pipes , Minimal maintenance reduces long-term expenses.
Lightweight & Easy Installation : Weighs much less than concrete or metal pipes, reducing transportation and labor costs.
High Strength & Longevity : Can withstand high pressure, making it suitable for water supply networks.
Environmental Benefits : 100% recyclable material.No harmful leaching into the water supply.
Resistance to Freezing & UV Exposure : Can expand without breaking, making it suitable for varying climates.

PVC Pipes

PVC pipes for secondary pipelines for usages like irrigation and drinking water transport. PVC pipes are excellent choice for medium to low pressure zones.

Durability: Lifespan of 30-50 years depending on usage conditions.
Lightweight: Easier to transport and install compared to metal pipes.
Corrosion Resistance: Does not rust or degrade when exposed to moisture and chemicals.

ADVANTAGES

Cost-Effective : Lower initial cost compared to HDPE.
Ease of Installation : Simple solvent welding or push-fit connections reduce labor costs.
Chemical and Corrosion Resistance : Can withstand exposure to acids, alkalies, and salts.
Durability and Strength : Moderate flexibility prevents breakage under pressure..
Versatile Applications : Used in potable water supply, drainage, irrigation, and conduit systems.

Pump - Pressure System

Proposed Pumps : Centrifugal Pumps

- The pump uses a rotating impeller to create a vacuum that draws liquid into the pump.
- The liquid is then pushed outward by centrifugal force through the discharge outlet.
- The faster the impeller rotates, the greater the pressure and flow rate.

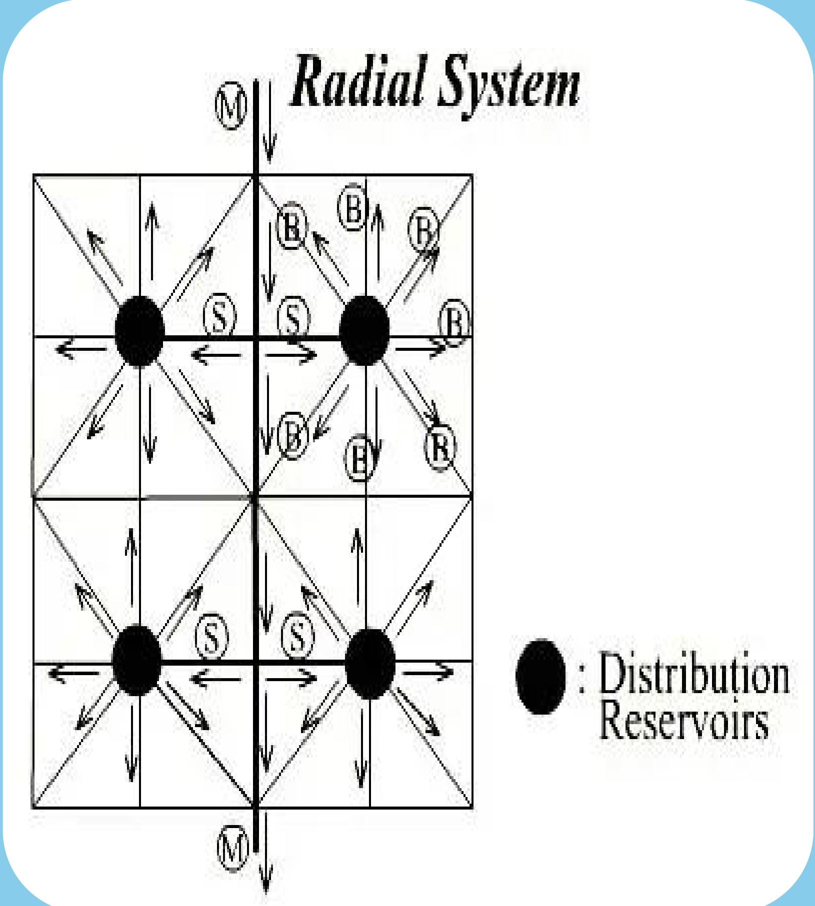
Advantages of Centrifugal Pumps

High Efficiency: Ideal for handling large volumes of liquid.
Simple Design: Fewer moving parts, leading to low maintenance costs.
Wide Applications: Used for water supply, cooling systems, chemical plants, etc.
Continuous Operation: Works efficiently for prolonged periods without overheating.

Operational Costs

- **Maintenance Costs:** Annual servicing can cost ₹2,000 - ₹10,000 depending on size.
- **Installation Costs:** ₹1,000 - ₹10,000 depending on complexity.
- **5 HP Centrifugal Force (18000 L/hr) :** ₹25,000 - 50,000 if water drawn 12 hours in a day
- **3 HP Centrifugal Force (10000 L/hr) :** ₹15,000 - 30,000 if water drawn 24 hours

Proposed Pipeline System : Radial system



We propose to build radial distribution system for water distribution substituting existing tree / Dead end system for any pipeline setup plans in future

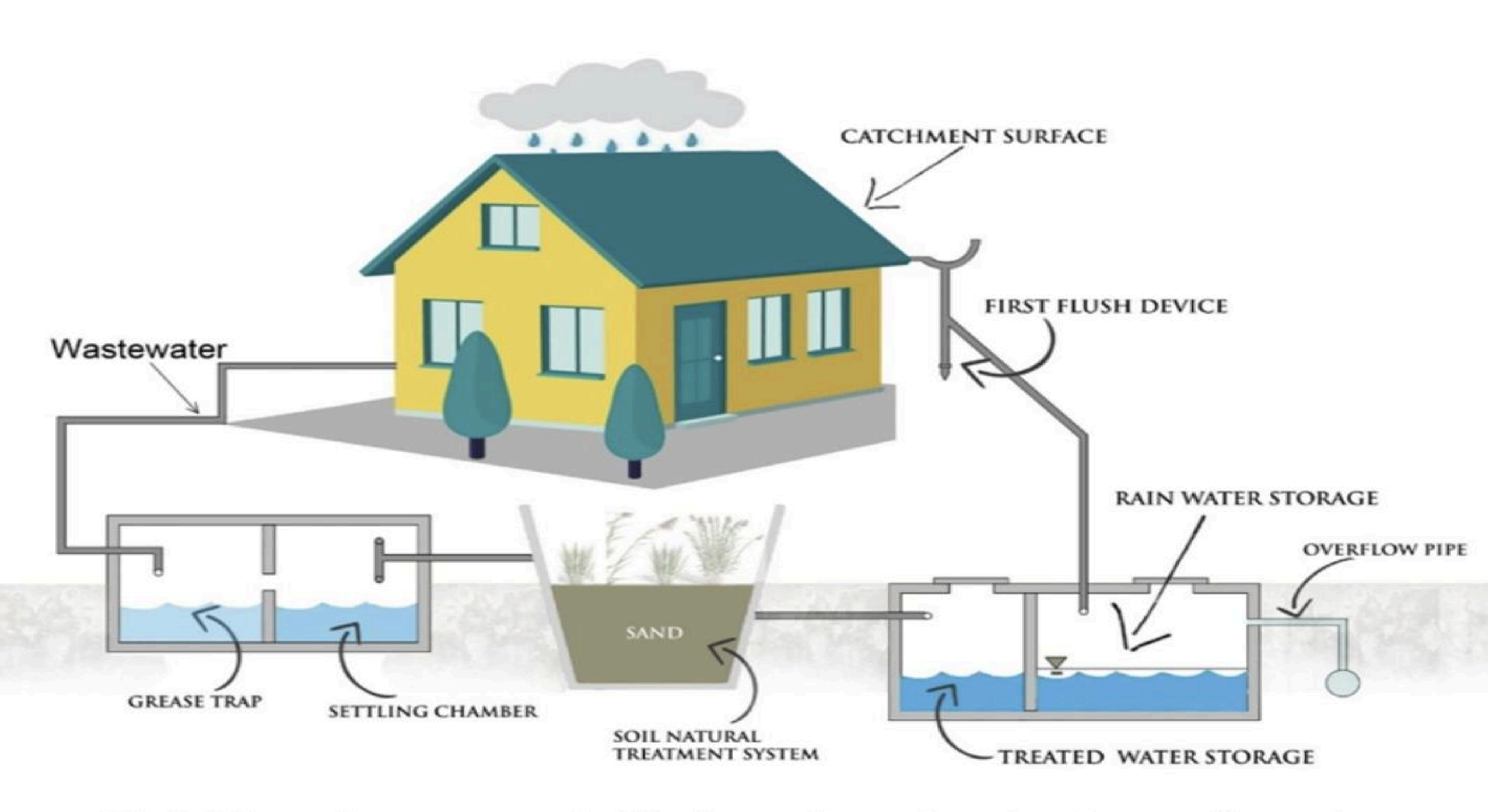
Efficient Water Distribution
- Water flows radially from central distribution reservoirs, ensuring even pressure throughout the network.
- Quick delivery of water to consumers with minimal delays.

Reduced Water Loss & Leakage
- Shorter pipe lengths in the system minimize leakage points, reducing water losses.
- Efficient management of water flow helps in early detection of leaks.

Ease of Maintenance & Repairs
- Individual radial zones can be isolated for maintenance without affecting the entire system.
- Faster repair work due to well-defined distribution zones.

Rainwater Harvesting

Average rainfall in Guwahati 1700-1800 mm/yr



Sustainable rooftop Rainwater Harvesting System

- Delivery system, which includes the gutters, PVC pipes may be installed to transport water from the catchment area to the storage tank
- A subsurface tank can be constructed to store the collected rainwater.
- In order to draw water from the storage mechanical pumps can be used.
- A first flush diverter will prevent the first few liters of contaminated rainwater of the roof from entering the water tank.
- The roof surfaces made of galvanized corrugated iron sheets, flat RCC roof and tiles may serve as an ideal roof catchment surfaces.

HOSTEL

For a hostel : 10,000 m² roof area

Total Rainwater Collected
Rooftop Area×Rainfall×Runoff Coefficient
= 10000*1.8*0.8=14400m^3
=14,400,000L per year

For a normal household of roof area around 100m: 144,000 L per year

We can use a storage tank of 1000-2000L

Costing for Hostel system

Component	Unit Cost (₹)	Quantity	Total Cost (₹)
Gutters & Downpipes (PVC)	150 per meter	200 meters	30,000
First Flush System (Large Scale)	10,000 per unit	2 units	20,000
Filtration System (Sand, Gravel, Carbon, etc.)	30,000 per unit	2 units	60,000
Storage Tank (50,000L capacity)	8 per liter	50,000 L	4,00,000
Pipes, Valves, & Fittings	-		40,000
Installation& Labor	-		60,000
Overflow and Maintenance Setup	-		20,000
Total Estimated Cost	-		₹630,000

Costing for Household system

Component	Unit Cost (₹)	Quantity	Total Cost (₹)
Gutters & Downpipes	200 per meter	30 meters	6,000
First Flush System	2,000 per unit	1 unit	2,000
Filtration	3,000 per unit	1 unit	3,000
Storage Tank (1,000L plastic)	8 per liter	1,000 L	8,000
Recharge Pit	12,000 per pit	1 pit	12,000
Miscellaneous	-	-	2,000
Total Estimated Cost	-	-	₹30,000

Groundwater Recharge Technique

Recharge Wells

Recharge wells involve directing the collected rainwater into existing borewells or new wells designed specifically for groundwater recharge. Water is allowed to infiltrate deep into the underground aquifers, thereby raising the water table over time.

Recharge Pits

Recharge pits are small excavated areas filled with gravel and sand. They allow water to slowly seep into the ground, promoting infiltration. These are usually placed at strategic locations across the campus, such as in open grounds, parking lots, or near walkways.A typical recharge pit might be 2m x 2m x 2m, filled with gravel

Percolation Trenches

Percolation trenches are shallow ditches dug along campus paths, garden areas, or parking lots to channel rainwater into the ground. These trenches are filled with gravel and sand, promoting faster water percolation.Typically, trenches are about 0.5m to 1m deep and 1m wide, depending on the location.

Solution

Policies and Regulation

There are no measures in place to check water quality at a hostel level.
There are currently no checks on the working of IPM.

We suggest a committee consisting of Professors from departments of Civil, Chemical and Biotech department, Hostel Wardens and members from SMC.

Objectives of the committee
- To monitor the quality of drinking and utility water regularly.
- Maintain detailed records of all water tests, incidents, and corrective actions taken.
- Organize workshops and seminars on water conservation practices.
- Ensure transparency by making water quality reports accessible to the campus community.
  Working of the new committee

Policies

This is overseen by members of SMC and the hostel warden.
1. Weekly lab tests of water at WTP, checking multiple parameters including pH, turbidity, microbial contamination, heavy metals, chemical pollutants, etc.
2. Prepare and submit an annual water quality report to the institution’s administration.

Department	Representative role	Responsibility
Chemical Engineering	Water Quality Chair	Oversee purification processes, contaminant analysis, and treatment innovations
Civil Engineering	Infrastructure Chair	Manage distribution networks, storage systems, and leak detection protocols
Bioscience and Bio Engineering	Sustainability Chair	Monitor ecological impacts, river health, and groundwater recharge initiatives
Students	2 Elected Representatives	Advocate for hostel/department needs and lead behavioral campaigns

Department-Specific Responsibilities

Chemical Engineering Team
- Develop low-cost purification systems (e.g., electrocoagulation for iron/arsenic removal)
- Test IoT water quality sensors (pH, turbidity) at 15 campus locations 1
- Partner with startups to pilot SLIPS-based atmospheric water harvesters

Civil Engineering Team
- Redesign pipelines using hydraulic modeling software to reduce 40% distribution losses
- Implement phased rainwater harvesting:
  Phase 1: Rooftop systems in 3 hostels (500 KL storage)
  Phase 2: Campus-wide SARMA-style recharge pits
  Audit borewells using AI leak detection tools

Bioscience Team
- Conduct Brahmaputra biodiversity surveys to set extraction limits
- Map groundwater depletion using GIS and recommend no-extraction zones
- Lead mangrove planting drives along riverbanks to stabilize soils

Student Roles
- Tech Squads: Maintain real-time usage dashboards (liters/block/hour)
- Behavioral Task Force: Run "Save 1L/day" challenges with hostel-wise rankings
- Innovation Hub: Compete in hackathons to design low-cost flow restrictions

Decision-Making Protocol
- Voting: Majority rule on budget allocation and infrastructure projects
- Quarterly Reviews: Public dashboards track water availability, purity metrics, and project progress

Collaboration Mechanisms
- Smart Meter Installation: Civil (hardware), Chemical (data validation), Students (deployment)
- Monsoon Preparedness: Bioscience (flood modeling), Civil (drain cleaning), Chemical (contamination prep)

Conflict Resolution
Water Rationing Disputes: 3-stage process:
a) Student reps gather hostel feedback
b) Infrastructure Chair proposes allocation formula
c) Committee vote with ⅔ majority required

Solution

Water Distribution and Leakage Monitoring Sensors

Purpose

Measure water pressure and flow rate to detect leaks, blockages, and irregularities in water distribution.

Technology Used

- **Smart Pressure Sensors (IoT-based):**
  Detects water pressure variations in pipelines.
  Installed at critical junctions, near tanks, bends, and branch connections.
  - Types:
    - Piezoelectric Pressure Sensors: Ideal for high-pressure environments.
    - MEMS-based Sensors: Highly accurate for low-pressure applications.
- **Flow Meters (Ultrasonic or Electromagnetic):**
  Measure actual water flow rate and compare it with expected values.
  Detects leaks (higher flow rate) or blockages (lower flow rate).
- **Wireless Sensor Networks (WSN):**
  Transmit real-time data to monitoring dashboards.
- **Cloud Connectivity & IoT Dashboards:**
  Sensors send data to a cloud system for analysis.

Recommendation

Use a combination of pressure sensors and flow meters for comprehensive monitoring of water distribution and leakage detection.

Item	Estimated Cost (INR)
Piezo-electric Pressure Sensor	3,000 – 7,000
MEMS Pressure Sensor	2,500 – 8,000
Flow meters	30,000 – 80,000
Wireless Sensor Network	4,500 – 10,000
Cloud Connectivity & IOT	10,000 – 12,000

Water Level Monitoring Sensors

Purpose

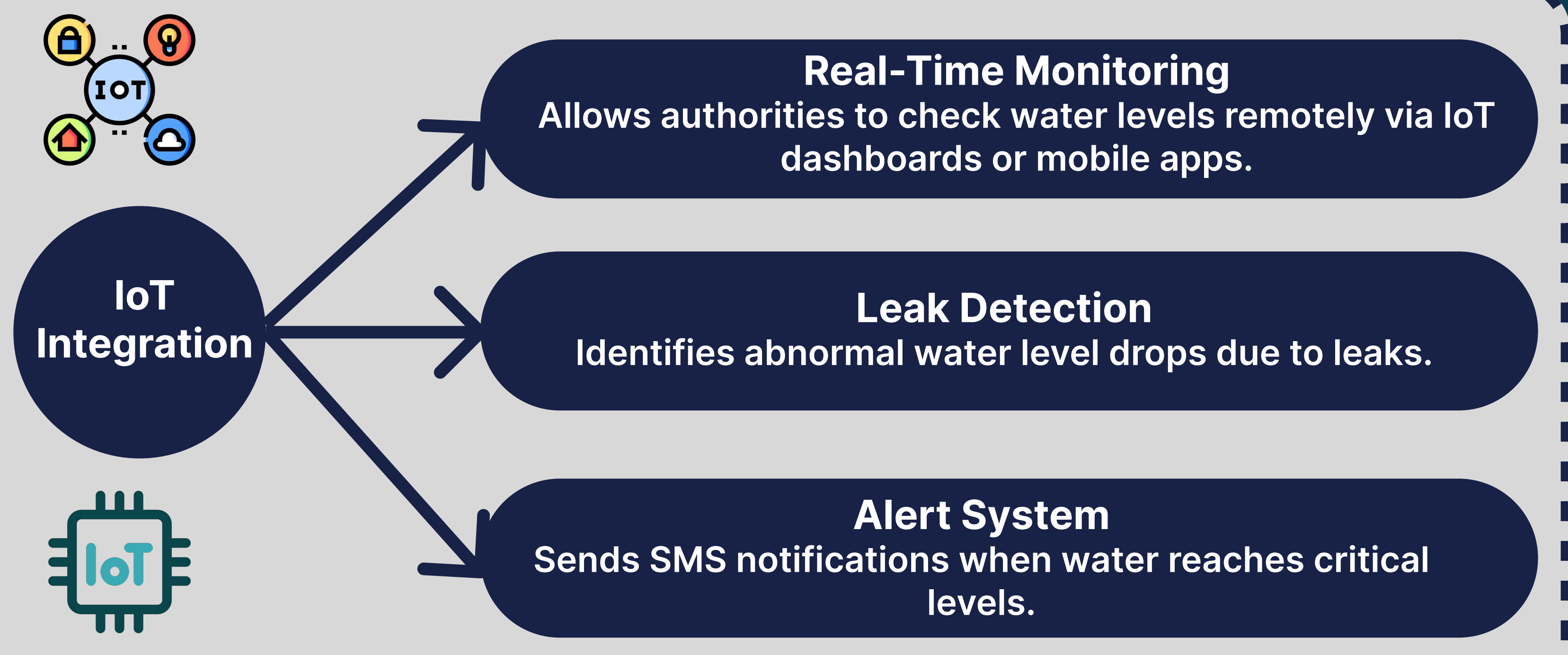
Monitor water levels in tanks and reservoirs and create an alert system

Technology Used

- **Float Sensors:**
  Use a floating switch that moves with the water level.
  - Advantages: Simple and cost-effective
  - Disadvantages: Prone to mechanical failure.
- **Digital Reed Switch-based float sensors.**

Costing

Float meters cost range from Rs.1,000 to Rs.2,000



We will process all collected data using **ESP32 micro controllers** deployed across all hostels, ensuring real-time data acquisition and transmission to a centralized **IoT dashboard**. This dashboard will continuously analyze water distribution, level, and quality parameters, generating automated alerts and control signals for proactive maintenance and optimization. By leveraging IoT-based monitoring and AI-driven analytics, we aim to enhance technological intervention, improve water resource management, reduce wastage, and ensure a **sustainable and efficient** water supply system for hostel premises as well as other regions in college.

Water Quality Monitoring Sensors

Purpose

Ensure the safety and quality of water by measuring various parameters.

Technology Used

- **pH Sensor:**
  Measures the acidity or alkalinity of water.
- **Turbidity Sensor:**
  Detects the clarity of water by measuring suspended particles.
- **Conductivity Sensor:**
  Measures the ability of water to conduct electricity, indicating the presence of dissolved salts.
- **TDS Sensor:**
  Measures the concentration of dissolved salts and minerals.
- **Chlorine Sensor:**
  Monitors chlorine concentrations to ensure safe usage.

Item	Estimated Cost (INR)
PH Sensor	500 – 2,000
Conductivity Sensor	1,500 – 3,000
Turbidity Sensor	1,000 – 5,000
TDS Sensor	1,000 – 2,500
Chlorine Sensor	2,000 – 5,000
Sensor setup	3,000 – 10,000
IOT & Cloud System	5,000 – 12,000
Maintenance	500 – 2,000 per year

Solution

Working of a Water Treatment Plant

Screening
Large floating and suspended solids, such as leaves and twigs, are removed from the inflow.

Aeration
Air is introduced into the water to increase oxygen levels, which helps expel dissolved metals (e.g., iron) and makes the water less corrosive.

Coagulation
Fine particles (smaller than 1×10^{-6} m) are removed by adding a coagulant with a positive charge. This neutralizes the negative charge of the particles, causing them to clump together into soft, fluffy masses called flocs.

Flocculation
The water is gently stirred in a flocculation basin using paddles, allowing the flocs to collide and merge into larger, more easily removable flocs.

Sedimentation
The water is kept in a sedimentation tank for several hours, allowing the flocs to settle at the bottom as sludge, which is then removed and disposed of.

Filtration
Any remaining suspended solids are removed by passing the water through beds of sand and gravel. When the filters become clogged with trapped particles, they are cleaned through a process called backwashing.

Chlorination
Finally, the water is disinfected using chlorine to eliminate any remaining pathogenic microorganisms, ensuring it is safe for consumption.

Suggesting Removal methods For Metals

Fe (Iron)
Oxidation: 10^{-2} M using Cl_2 or $KMnO_4$
Adding coagulants: Alum
Electrocoagulation: Electrodes of Al/Fe
Aeration: Increase the contact time
Filtration: Materials like sand or carbon

26 Fe

Cu (Copper)
Adsorbents: Poly Aluminum Chloride (Can remove fluoride too)
Chemical Precipitation: Sodium Sulphide, Lime (used in Factories)
Copper-Specific Filters: Uses chelating agents (Citric Acid, Tartaric Acid)

29 Cu

As (Arsenic)
33 As

Adsorption: Alumina, Iron salts, Biocomposites (Cellulose-based membranes)
Coagulants: Ferric Chloride
Reverse Osmosis and Ultra filtration (Cost-effective)

Pb (Lead)
82 Pb

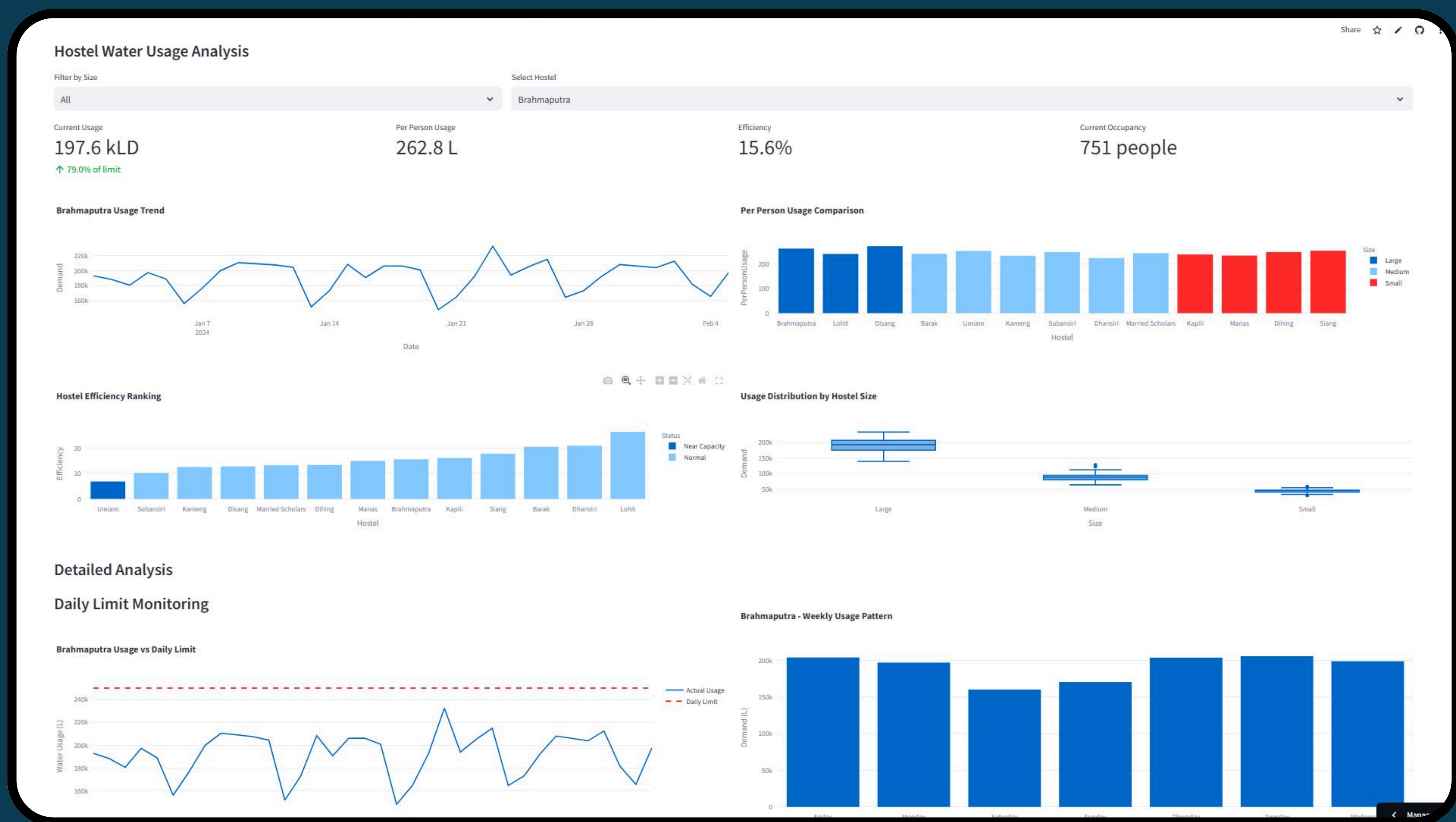
RO / Activated Carbon Filters
Biosorption: Orange peels / Moringa Oleifera seeds
Cation Exchange Resins: Purolite S-910

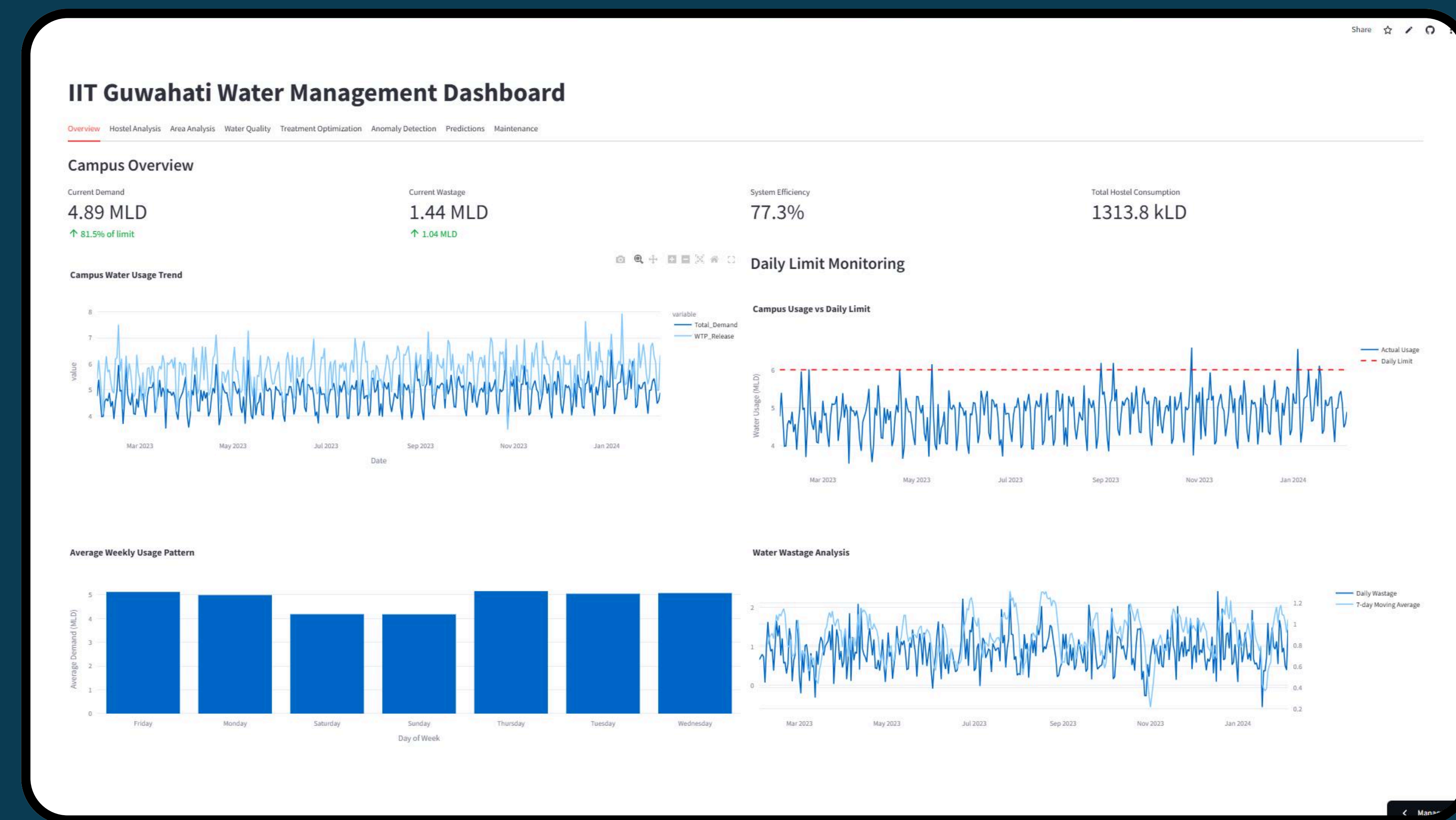
Common Method for Removal

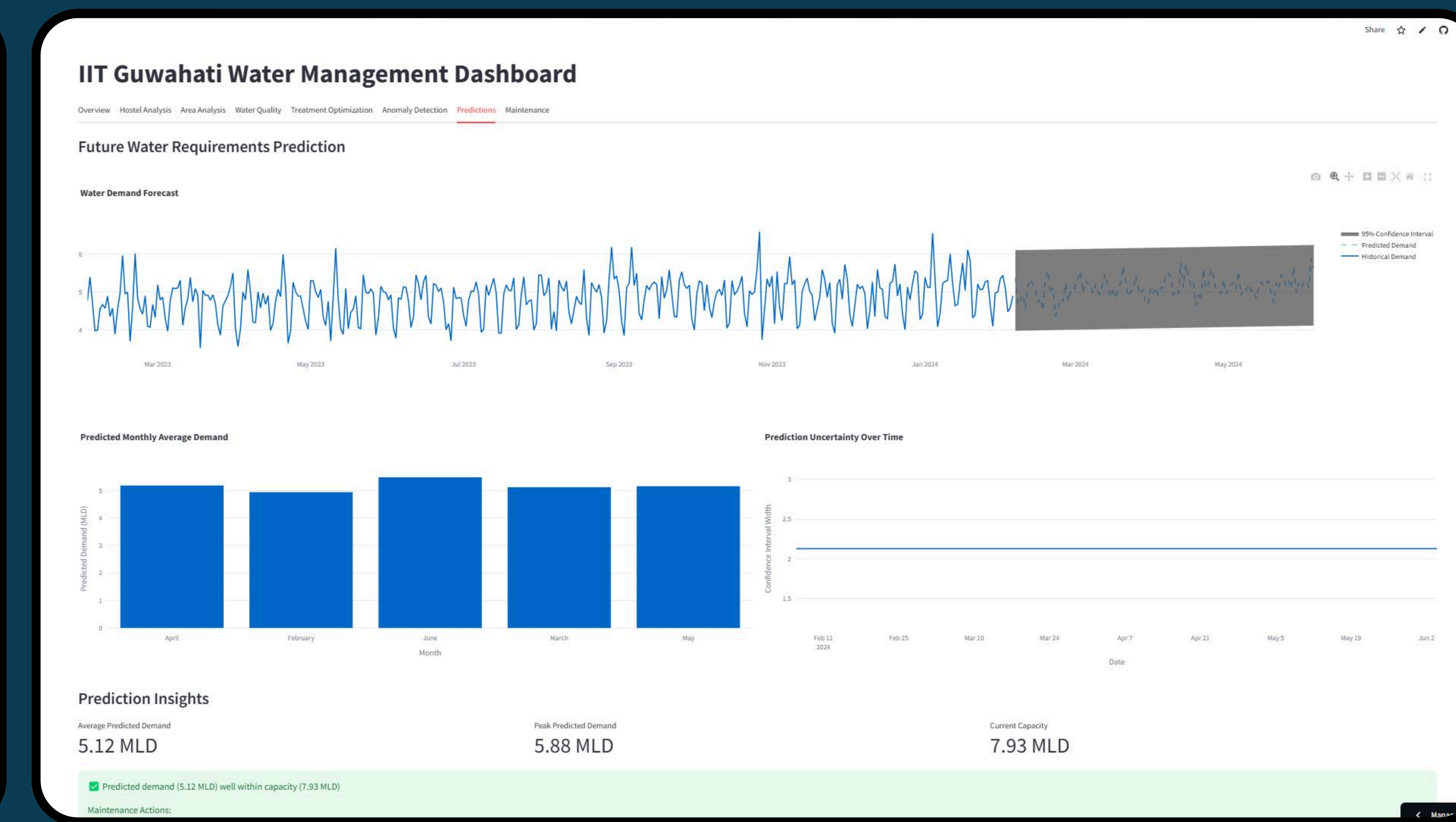
Reverse Osmosis (RO)
- **Removes:** Fe, As, Pb, Cu
- **Process:** Uses a semi-permeable membrane to filter out heavy metals and other contaminants.
- **Best for:** Household and industrial use, drinking water purification.

Activated Carbon Filtration
- **Removes:** Lead (Pb), Arsenic (As), and Copper (Cu)
- **Process:** Heavy metals adsorb onto the porous carbon surface, improving water quality.
- **Best for:** Household filters, industrial pre-treatment.

Dashboard For IPM







Campus-Wide Water Usage Analysis

- **Total Daily Demand vs. WTP Release:** The dashboard tracks the total daily water demand across the campus and compares it to the water released by the Water Treatment Plant (WTP).
- **System Efficiency & Wastage Trends:** System efficiency is calculated based on water wastage levels.
- **Weekly and Monthly Usage Patterns:** Helps in identifying peak demand periods to optimize scheduling of water-intensive activities.

Water Quality Monitoring

Real-Time & Predictive Analysis of Key Water Quality Parameters:
- COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), and TSS (Total Suspended Solids) are monitored.
- Thresholds are categorized into Normal, Warning, and Critical levels.

Violation Detection: Alerts are triggered when parameters exceed acceptable limits, indicating potential contamination or treatment inefficiencies.

Predictive Modeling for Water Quality: Uses Random Forest Regression to forecast future water quality trends.

Future Demand Predictions

Short-Term & Long-Term Forecasting: Uses trend analysis and predictive modeling to estimate water demand for the next 120 days.

Capacity Risk Analysis: Determines whether the predicted demand will exceed current system capacity.

Seasonal Demand Analysis: Evaluates demand fluctuations due to academic schedules, monsoons, and summer months.

Rivermap

Phase 1 : Pre-installation

- **Infrastructure checking**

View of all existing pipes from the blueprint of pipelines all over the institute from when it was last installed.
Identify all weak points using a pressure sensor, to identify where extra care will be taken to dig ground and remove pipes.
-Parallel working
-Scouting the place to build a well system

- **Material order**

Order HDPE pipes and PVC pipes (20% extra).
Secure trenchless equipment (family of construction techniques for installing or rehabilitating underground infrastructure with minimal disruption to surface traffic and residents)

Phase 2 : Installation of Pipes

- **Creation of Well system and tunnel** connecting river for inflow mechanism of water
- **Form a cross-functional team** with representative professors from Chemical, Civil, and Bioscience departments, along with student representatives.
- Identify critical areas for sensor deployment and prioritize implementation zones.
- **Procure initial batch of IoT sensors** (pressure sensors, flow meters, and water quality sensors).
- **Hydrostatic testing :** Use 1.5X working pressure to check
- Disinfection Flushing by doing Chlorine test

Phase 3 : Pilot Testing

Deploy pumps and change the inflow mechanism from barge to pond system.
Start use of IoT sensors (pressure sensors, flow meters, and water quality sensors).

- **Setup a pilot project** in Gaurang, MSH, Dhansiri.
- Install water distribution and leakage monitoring sensors
- Set up water level monitoring sensors in selected tanks and reservoirs.
- Deploy water quality monitoring sensors at key points in the water supply system.
- Integrate all sensors with ESP32 microcontrollers and establish the IoT dashboard.

Phase 4 : Data Collection and Analysis

- **Month 1:** Collect and analyze initial data from the pilot implementation.
- **Month 2:** Fine-tune sensor calibrations and optimize data collection processes.
- **Month 3:** Develop AI-driven analytics models for predictive maintenance and resource optimization.

Phase 5 : Campus-wide Rollout

- **Expand the sensor network** to cover all hostels and major campus buildings.
- **Implement water quality monitoring** across the entire water supply system.
- **Integrate all sensors** into the centralized IoT dashboard and refine alert systems.
- Implement **AI-driven water distribution** optimization algorithms.
- Develop and **launch mobile apps** for real-time water usage monitoring for students and staff.
- **Conduct training sessions** for maintenance staff on the new systems and protocols.

Phase 6 : Review and Expansion

- Conduct a **comprehensive review** of the system's performance and impact on water conservation.
- Identify areas for further improvement and additional technological interventions.
- Develop a plan for **expanding the system** to other areas of the campus and potentially to neighboring communities.

Scalability

Scalability at College Level

For institutes similar to IIT Guwahati we can reduce the problem of water scarcity and quality by:

- Enhancing Water Supply
- Rainwater Harvesting (RWH)

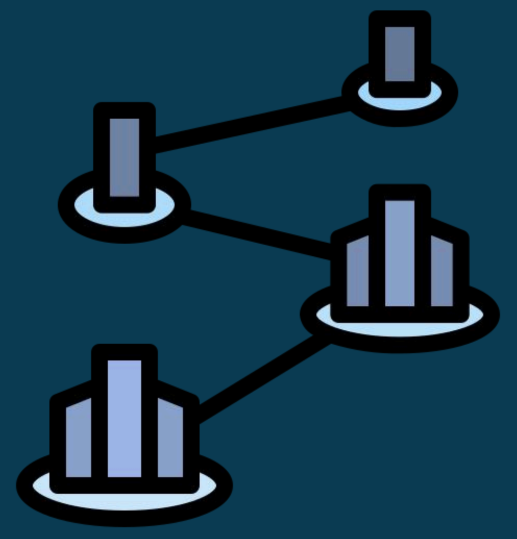
Rooftop Harvesting: Install RWH systems on academic buildings, hostels, and ministrative offices.

Recharge Pits: Direct rainwater to recharge wells to replenish groundwater.

- The pit is filled with layers of pebbles, boulders, gravel, and coarse sand.
- The pit is covered with soil, leaves, or planted earth.
- Rainwater drains into the pit and replenishes the groundwater.

Storage Tanks: Store collected rainwater for non-potable uses like gardening, flushing, and cleaning.

Ponds & Lakes: If the campus has ponds or access to a nearby river, set up a treatment plant to use this water sustainably.



Scalability at City Level

Rainwater Harvesting

- Mandatory Rooftop Rainwater Harvesting: Enforce regulations for buildings, industries, and public institutions.
- Groundwater Recharge Projects: Use recharge wells and permeable pavements to replenish aquifers.

Smart Water Metering & Pricing

- Tiered Water Pricing: Charge higher rates for excessive consumption to discourage wastage.
- Leakage Detection Systems: Implement smart meters to track and fix leaks in real time.

Protect Urban Wetlands: Designate protected areas to maintain natural filtration systems.

Upgrading Water Treatment & Sewage Treatment Infrastructure :

- Modernize Water Treatment Plants (WTPs): Ensure plants meet safety standards and operate efficiently.
- Decentralized Water Treatment: Set up smaller treatment units in high-demand areas to reduce transmission losses.
- 100% Sewage Treatment: Ensure all wastewater is treated before release.

Preventing Water Pollution:

- Waste Management Systems: Improve solid waste disposal to prevent contamination of rivers and lakes.
- Agricultural Runoff Control: Promote organic farming and controlled fertilizer use to reduce water pollution.

Scalability for Guwahati

Controlling Sediment at the Source

- Afforestation & Reforestation
- Terracing & Contour Farming

Slowing Down Rainwater Runoff and enhance groundwater infiltration

- Percolation Trenches: Create trenches along slopes and roads to slow runoff and allow seepage into the ground.
- Developing Check Dams & Small Reservoirs
- Vegetative Bunds: Create small soil ridges covered with grass to slow water flow.

Smart Drainage Planning

- Decentralized Stormwater Collection: Create multiple small retention points instead of large, centralized drains

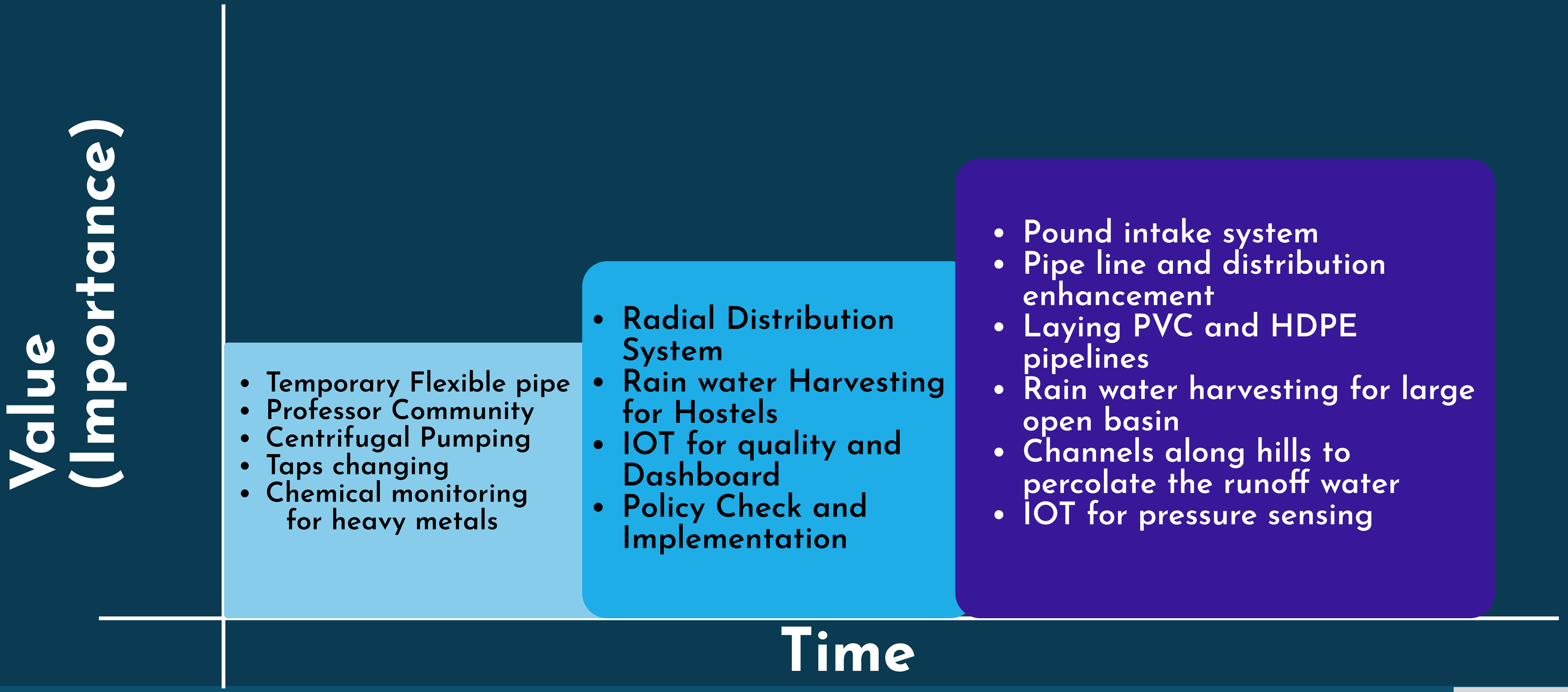
Preventing Soil Erosion from Construction & Agriculture

- Silt Fencing & Sediment Traps
- Install sediment barriers near construction sites, farms, and mining areas.
- Sediment Traps & Settling Basins
- Check Dams & Gabions

Prioritization Matrix

Solutions/Features	Reach	Impact	Confidence	Effort	RICE Score
Pond-Inflow Mechanism	7	9	8	9	56
Pipeline Material	8	8	9	7	82.3
Radial Distribution Syste...	8	9	7	7	72
Committee and Policies	9	8	8	6	96
IoT Integration	8	9	9	8	92.6
Contamination Solutions	7	8	8	7	64
Rooftop Water Harvesting	7	5	8	8	35

Mckinsey 3 Horizon implementation




THANK YOU
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