CITY-LEVEL TOOLKIT FOR REUSE OF TREATED WASTEWATER

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Research Direction: Depinder Singh Kapur

Author: Anurag Vijay Naidu, Faraz Ahmad and Dr. Sumita Singhal

Editor: Rituparna Sengupta

Cover and design: Ajit Bajaj

Graphics: Vineet Tripathi

Layout: Surender Singh

Production: Rakesh Shrivastava and Gundhar Das

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41, Tughlakabad Institutional Area
New Delhi 110 062
Phone: 91-11-40616000
Fax: 91-11-29955879
E-mail: cse@cseindia.org
Website: www.cseindia.org

Contents

Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
CPCB	Central Pollution Control Board
MLD	Million Litres per Day
NGT	National Green Tribunal
NMCG	National Mission for Clean Ganga
SBM	Swachh Bharat Mission
STP	Sewage Treatment Plant
TWW	Treated Wastewater Water
ULBs	Urban Local Bodies
UTs	Union Territories

1. Introduction

The toolkit for reusing treated wastewater addresses the need for a systematic and planned approach to prioritize the use of treated wastewater. As cities face increasing water stress and large volumes of treated wastewater are discharged daily, this toolkit provides a framework for integrating this 'new water' source into urban water management strategies. Reusing treated water will not only substitute fresh water, thereby augmenting the city's water supply, but will also ensure that Sewage Treatment Plants (STPs) and Industrial Effluent Treatment Plants (ETPs) adhere to treatment standards suitable for reuse.

According to a recent assessment by the Central Pollution Control Board (CPCB), urban centers generated 72,368 million liters per day (MLD) of sewage in 2020-21.[1] The installed sewage treatment capacity is 31,841 MLD, but the operational capacity is only 26,869 MLD, far below the amount generated. Only 28 per cent (20,236 MLD) of the total urban sewage is treated, meaning 72 per cent remains untreated and is disposed of into rivers, lakes, and groundwater.

Water stress has become a perennial problem in most Indian cities. With the increase in the number of inhabitants, the per capita availability of water has dropped from 1,816 cubic meters in 2001 to 1,545 cubic meters in 2011 (MoWR). The average per capita supply is below the recommended standard i.e. 135 litres/day in most Indian cities according to the Ministry of Water Resource (MoWR).[2] Increasing pressure on existing water resources in many Indian cities due to water shortage has led to a rise in the cost of water supply and industrial water tariffs. Furthermore, most of the Indian cities are situated along a major river, resulting in the extraction of a huge amount of freshwater and discharge of untreated wastewater into those rivers. This has led to a severe loss of freshwater sources in the city. Along with water shortage, cities also face problems related to insufficient wastewater treatment capacity, improper maintenance of plants and no clear framework to execute wastewater reuse projects in the city. Several cities, including Nagpur, Chennai, Kolkata, Udaipur and Surat, have demonstrated success in implementing wastewater reuse initiatives. Yet these have been mostly in the form of projects, not as part of a well thought out state-level policy or a long-term city-level plan.

In June 2014, the Government of India launched 'The Arth Ganga model,' conceptualized under the 'Namami Gange Program,' by the National Mission for Clean Ganga (NMCG). This model integrates the people of the Ganga basin with efforts for the river's rejuvenation. It promotes Zero Budget Natural Farming (ZBNF) and encourages local bodies to monetize and reuse treated wastewater and sludge, converting it into products like manure and bricks.

Additionally, the NMCG has published a National Framework for Safe Reuse of Treated Wastewater, providing guidelines for state policies and economic models for wastewater reuse, and has signed MoUs with various ministries to promote this initiative.[2] The NMCG's efforts are complemented by policies and missions like the National Urban Sanitation Policy, Swachh Bharat Mission, and AMRUT, which also contribute to wastewater management and reuse in India.

In 2021, the Government of India launched SBM 2.0, bringing a special focus on used water management in Indian cities. There is an increasing focus on environmental, social, and financial sustainability in urban sanitation. Cities are expected to design and implement solutions for the treatment and reuse of used water. Many states have already prepared their wastewater reuse policies and plans, while a few others are on the verge of doing so.

Centre for Science and Environment (CSE), through its water programme, conducted a research study, 'Assessment and Best Practices of Treated Wastewater in India,' on seven states in 2023–24. The objective of the study was to understand the status, challenges and opportunities in reusing treated wastewater in India.

Our findings highlight some critical gaps:

- While India has a strong national/state framework, policies, and action plans advocating for the reuse of treated wastewater (TWW), practical implementation at the state and city levels remains notably lacking.

- This deficiency can be attributed to either a lack of understanding within relevant departments regarding the subject or a lack of initiative/resources.

To address these issues, this customizable toolkit tailored to city-specific needs developed by CSE will serve as a guiding resource for formulating and implementing action plans aimed at the effective reuse of TWW.

Aim

To develop a toolkit for policymakers and city officials to effectively plan and manage the reuse of treated wastewater generated within the city.

Objectives

- Identify the gaps for the current & projected population and specify the necessary infrastructure needs.
- Streamlining the development and execution of treated wastewater reuse action plans within city limits.
- Ensuring equity and justice in the distribution of treated wastewater.
- Educating government authorities on various steps involved in planning of treated wastewater reuse project.

Scope

This template/toolkit is applicable for all city-specific treated wastewater reuse from centralized sewage treatment plants.

Target participants

ULB/development department officials, practitioners (engineers, urban planners etc.), academicians and decision makers.

The toolkit consists of the following steps:

A. Gathering basic information such as city profile, water supply and sanitation, estimated treated wastewater generation

B. Reuse targets for wastewater

C. Steps for planning for reuse of treated wastewater

1.1 Basic information

Figure 1

DATA REQUIREMENTS FOR PLANNING TREATED WASTEWATER REUSE INFRASTRUCTURE

City data

Demographic profile of the city

- City map with city limit, North and scale
- Population trend data from last census
- Total area in sqkm
- No of households
- Population per Ha

Water supply

- Source of water supply
- Total water supply
- Net water supply
- Per capita water demand and supply
- Coverage of water supply network
- No. of water treatment plants

Sanitation

- Percentage of coverage by sewerage network
- Collection efficiency of sewage
- No. of treatment plants and capacity adequacy of sewage treatment
- Quality of sewage treatment
- Extent of reuse and recycling of sewage
- Extent of cost recovery (O&M) in wastewater
- Cost of operations and maintenance of STP
- Proposed capacity of STP

Potential users

Social infrastructure

- No. of parks in the city and their size, location, etc.
- Public transportation: railway stations, bus stations and metro
- Green belt development

Industrial profile

- No. of industries
- Types of industries and their locations
- Water supply
- Water requirement
- Reuse practices, if any

Agricultural profile

- Type of agriculture and crops
- Location
- Irrigation area
- Water requirement

Blue infrastructure profile

- No. of lakes and ponds in the city
- Aquifer data
- Location
- Area of ponds/lakes
- Water requirement

Note: The information provided here will be utilized throughout the different stages of this toolkit.

Data Collection Guide (sources for finding relevant data)

The data points mentioned in Figure 1 are usually gathered and managed by the Urban Local Body (ULB) and its respective departments. These data points are also included in the city's 'Water Balance Plan' database developed under AMRUT 2.0, with the exception of data on social and blue infrastructure, agriculture, and industries. In case one has to acquire the most recent data, the following table outlines these data points along with the relevant departments responsible for this information at the city level.

Table 1: Sources for finding data from relevant departments

Sr.No	Data points	Name of the department
1	City map/land use map/development plan	Town Planning Department
2	Demographic data	ULB-General Administration/City Census Department
3	Water supply	Water Supply Department/PHED/Water Supply and Sanitation Board/Jal Board/Water Resource Department.
4	Sanitation	Drainage Department/PHED/Water Supply and Sanitation Board/Environmental Department/ Development Authority
5	Social Infrastructure (Parks and Gardens)	Garden/Horticulture Department
6	Industrial profile	State board of Industrial Development/City Development Plan
7	Agriculture profile	Development Plan/State or District Agriculture Department
8	Blue infrastructure (waterbodies: lakes/ ponds)	Irrigation Department/ULB/Lake Development Authority

1.2 Reuse targets of treated wastewater

In this section, city officials must establish a goal for the amount of wastewater that they aim to reuse and specify the timeline for achieving this target. These goals and timelines should be aligned with the goals stated in the national and state wastewater reuse policy of the respective state.

Note: States with no reuse policy in place should adhere to the national framework on the safe reuse of treated water established by the NMCG[3] as shown below.

Operational STPs

- 50 per cent of treated used water to be safely reused by 2025.
- 100 per cent of treated used water to be safely reused by 2050.

Non-operational STPs

- 30 per cent of used water to be collected, treated and safely reused by 2030.
- 50 per cent of treated used water to be safely reused by 2035.
- 100 per cent of treated used water to be safely reused by 2050.

Setting city's reuse targets

Operational STPs

Year	Target
2025	
2050	

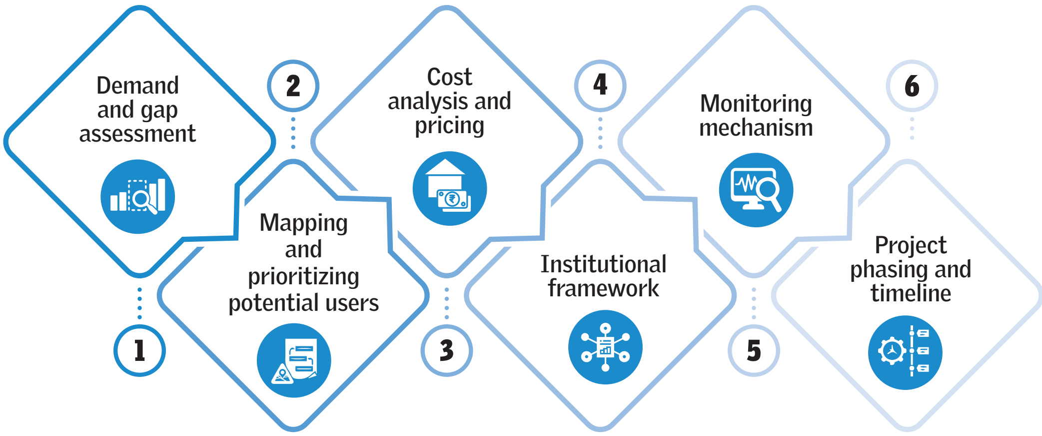
Non-operational STPs

Year	Target
2030	
2035	
2050	

2. Steps for planning of reuse of treated wastewater

The following figure illustrates the steps involved in developing a city-level wastewater reuse plan.

Figure 2: Steps involved in developing a city-level wastewater reuse plan



1. **Demand and gap assessment:** This step demonstrates the current and future demand for wastewater reuse and identifies the gaps in existing infrastructure or practices.
2. **Mapping and prioritizing potential users:** This step identifies potential users of treated wastewater and prioritizes them based on their needs and the feasibility of supplying them with it.
3. **Cost analysis and pricing:** In this step a detailed cost analysis is done to determine the financial feasibility of the reuse project, and establish a pricing strategy for the treated water.
4. **Institutional framework:** This step entails the creation of a governance structure to manage the wastewater reuse programme, including roles, responsibilities, and regulatory requirements.
5. **Monitoring mechanism**: This step involves implementing a system to monitor the quality and quantity of reclaimed water and ensuring compliance with safety and regulatory standards.

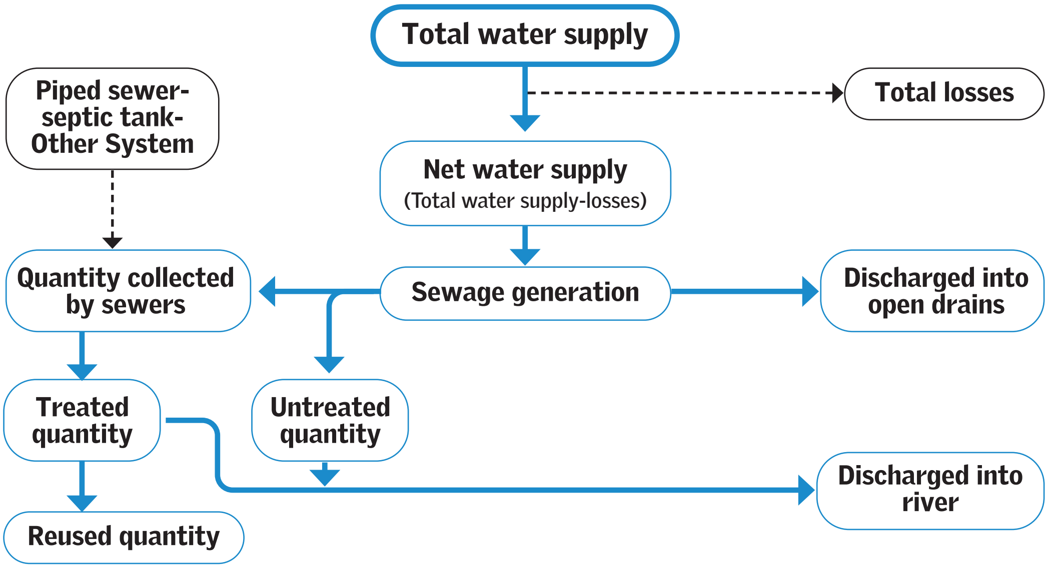
6. **Project phasing and timeline:** In this step the stages of project implementation are outlined, and a timeline is set for each phase to ensure systematic progress and timely completion.

2.1 Step 1: Demand and gap assessment

Data requirement
- Current population data
- Previous decade population data
- Population growth rate
- Total water supply
- Per capita water supply
- Sanitation system details

Once we have all the data in place, the first step to formulate a plan for reuse of treated wastewater is to make an assessment of the demand of treated wastewater and the gaps for existing and future systems. The current gaps in the infrastructure can be showcased as shown in Figure 3 below. This figure helps to understand the water supply, sewage generation, collection, treatment and reuse status within the city.

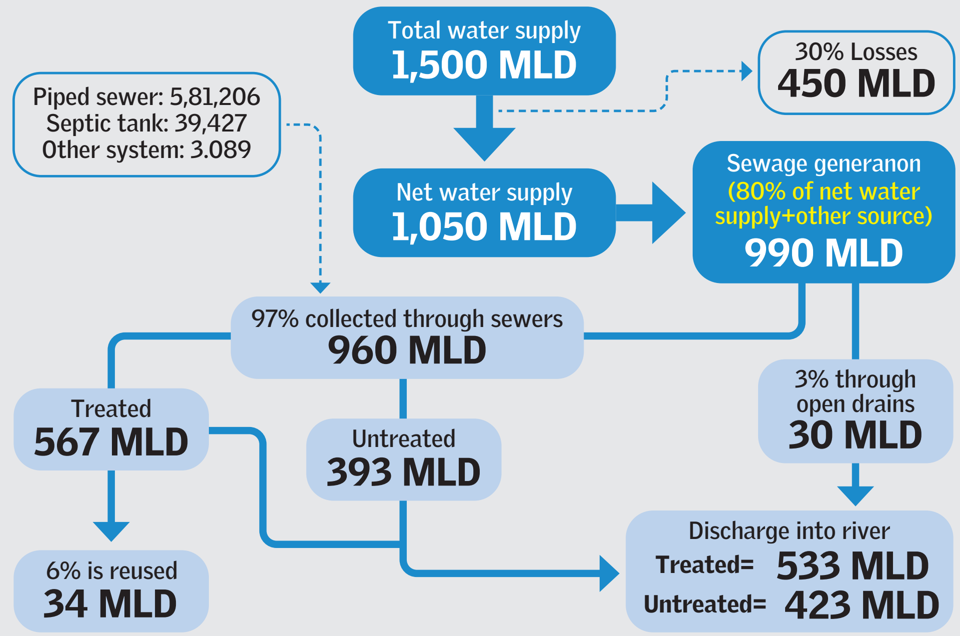
Figure 3: Existing Infrastructural Gap Assessment Framework



Identify general gaps in the system

No	Currents gaps in the water supply and sanitation systems of the ity
1	
2	
3	

Case example: Gap assessment in the existing infrastructure



Future demand assessment

In this sub section, you need to project the future population for the years 2025, 2030, and 2050. Using the following steps, calculate population for the year 2025, 2030 and 2050.

Population projection methods

1. Arithmetical Increase Method – **Pn = Po + nx**– *(Suitable for large and old cities with considerable development)*
2. Geometrical Increase Method – **Pn = Po [1 + (r/100)] ^n** – *(Suitable for new and younger cities)*
3. Incremental Increase Method – **Pn = (Po + n X̄) + ((n (n+1))/2)* ý** - *(Suitable for average sized towns with positive growth rate)*

Where

Pn = Prospective population after *n* decades from present
P0 = Population at the end of last known census
n = Number of decades between now and future
X̄ = Average (arithmetic mean) of population increase in known decades
r = Growth rate,
ȳ = Average of incremental increases of population in known decades

Projected population

Year	Population Projection
2025	
2030	
2050	

Case example: Population projection

Year	Population	Increment	Decadal growth rate	ȳ
1981	1,203,363	–	–	–
1991	1,691,430	4,88,067	40.56 %	–
2001	2,538,473	8,47,043	50.08 %	3,58,976
2011	3,115,431	5,76,958	22.73 %	–2,70,085
2020	3,500,000	3,84,569	15.15 %	–1,92,389

Increment: Difference in population between two decades i.e. 1991–1981
Average Increment (x̄) - (4,88,067+8,47,043+5,76,958+384569)/4 = 574159

Geometric Growth – (40.56*50.08*22.73*15.15) ^ (1/4) = 0.2891
ȳ - (358976+ (-270085) + (-192389))/3 = -34499.3

Arithmetic Mean Method (Po +nx) -

- Population 2025 – 35,00,000+0.4*5,74,159 = 3,7,29,663
- Population 2030 – 35,00,000+0.9*5,74,159 = 40,16,743
- Population 2050 – 35,00,000+2.9*5,74,159 = 51,65,061

Geometric Increase Method [Pn =Po (1+(r/100) ^n)]

- Population 2025 – 35,00,000*(1+ (28.91/100)^0.4) = 38,74,206
- Population 2030 – 35,00,000*(1+ (28.91/100)^0.9) = 43,98,716
- Population 2050 – 35,00,000*(1+ (28.91/100)^2.9) = 73,09,694

Incremental Increase Method [Pn = (Po + nx̄) + ((n (n+1))/2)* ȳ]

- Population 2025 – 35,00,000 + (0.4 * 5,74,159) + (((0.4 * (0.4+1))/2) * (-34499.3))= 37,20,004
- Population 2030 – 35,00,000 + (0.9 * 5,74,159) + (((0.9 * (0.9+1))/2) * (-34499.3))= 39,87,246
- Population 2050 – 35,00,000 + (2.9 * 574159) + (((2.9 * (2.9+1))/2) * (-34499.3))= 49,69,968

Note: When choosing a method for population projection, ensure it aligns with the specific characteristics of your cities as outlined in the formula box.

Assessment of future sewage generation

After determining the population for the projected years, the next step is to calculate the total water demand. This is essential to assess the need for additional infrastructure to support the future population. Use the following formula to calculate the total water demand for the years listed in the table.

Daily water demand formula

Total water demand = LPCD×P

Where:

- **LPCD — Liter per capita per day; and**
- **P — Size of the population.**

Note: Per capita water supply may vary from city to city. As per standards, per capita water supply is 135 lpcd

Future water demand

Year	Water demand (MLD)
2025	
2030	
2050	

Similarly, calculate future sewage generation as described in the following table. Refer to the case example box to understand the detailed calculations for 'Total Water Demand' and 'Future Sewage Generation'.

Future Sewerage Generation = 80 per cent of Total Water Demand

Future sewage generation

Year	Sewage Generation (MLD)
2025	
2030	
2050	

Case example: Total water demand and future sewage generation

Total Water Demand – LPCD X Population

= **135** (Standard as per CPHEEO)[4] X **3729663** (2025 Population by Arithmetic mean Method)

= **503,504,505** liters/day ---------- *(Divide it by 10^6 to convert in MLD)*

= **503.5 MLD**

Total Sewage Generation= 80 per cent of Total Water Demand

= 80 per cent x 503.5

= **402.8 MLD**

Summary of demand and gap assessment

Here, summarize all the data points related to sewage treatment gap and additional treatment infrastructure requirement (in MLD) in the following table.

1. Total sewage treatment in the year 2025 (MLD) 2. Total sewage treatment in the year 2030 (MLD) 3. Total sewage treatment gap in the year 2050 (MLD)	
4. Sewage treatment infrastructure requirement	

2.2 Step 2: Mapping and prioritizing potential users

Data requirement

- No. of STPs and their locations (Latitude and Longitude)
- Capacity of the STP
- Locations of all the potential users
- Daily water demand of each potential users
- Distance of potential users from the nearest STP

The next crucial step in planning for the reuse of treated wastewater is to map out and create a prioritization plan for potential users in and around the city based on their needs and the city's reuse objectives.

Mapping potential users

In this step, based on the data collected at the initial stage, you need to map the location of the potential users using either google earth or ArcGIS/QGIS software.

To map potential users on Google Earth[5] or ArcGIS software, the following process needs to be followed:

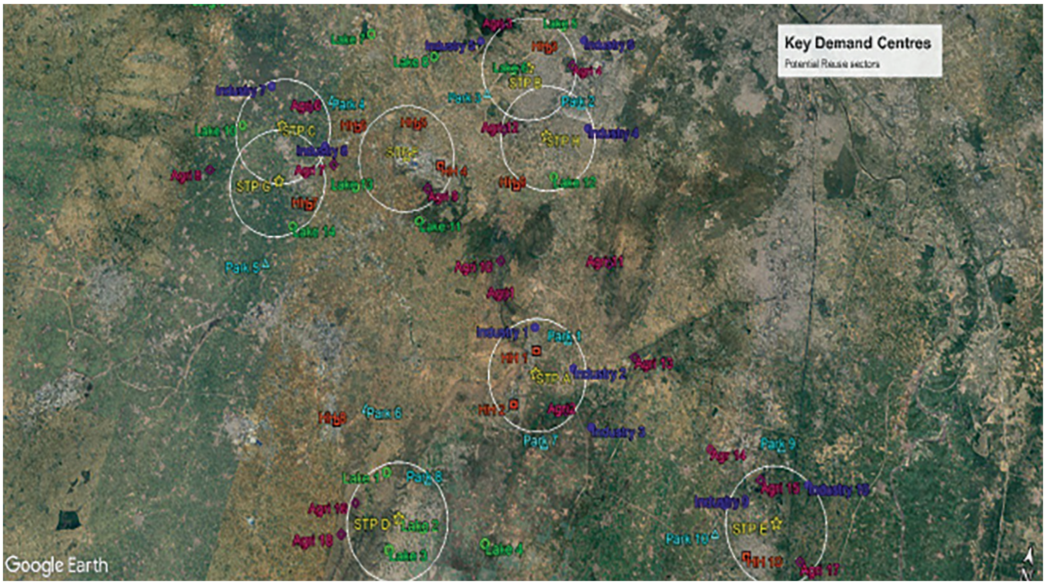
1. Identify and map all the sewage treatment plants (STPs) across the city.
2. Create a radius (as per your suitability) around the treatment plant.
3. Map all the potential users and identify users around the STP within a defined radius.
4. Measure the approximate distance of each of the potential users and record it in a tabular format given in the sub-section below (Prioritizing Potential Users).

Note: Before beginning any calculations, please ensure that you have collected the necessary information firsthand. If you have not yet gathered the data, refer to the "Data Collection Guide". This guide will help you identify the appropriate department from where the data will be sourced.

Add City Map along with STP locations and potential users.

Name of the potential user	Type	Distance from the STP

Case Example: Infrastructure Mapping Exercise



Name of the industry/agriculture/ lakes/parks/station	Type	Distance
XYZ	Industry	4.5km
ABC	Park	4.7km
KLM	Lake	3.0km

Prioritizing potential users

In this section, you need to compile detailed data points regarding potential users, including their categories, daily water requirements, the nearest Sewage Treatment Plant (STP), and its distance from them. By conducting this analysis alongside a mapping exercise, you will gain a clear understanding of the locations of potential users within the city and their corresponding water demands.

However, prioritization of reuse must be from the perspective of equity and justice and not from a techno-managerial efficiency criterion alone, on the basis of who can pay for treated waste water re use or where it is most feasible to deliver treated waste water for re use. As our cities are growing, severe inequity in water access is witnessed. The situation is worse in semi arid and arid regions and cities of India.

Reuse of treated waste water should be guided by a large understanding of Water Sensitive and Climate Resilient Cities framing.

CSE has identified reuse as one of the four indexes of a global south water sensitive cities framing.[6]

Seven categories of reuse options are listed below. More can be added based on the city-specific context.

A. Maintaining river flow

Name	Water Supplied (MLD)	Nearest STP	Distance

B. Waterbodies (lakes/ponds)

Lakes/Ponds	Total Water Intake (MLD)	Nearest STP	Distance (KM)

C. Drinking water supply augmentation

Name of the Area	Purpose (Potable/ Non-Potable)	Water Demand (MLD)	Nearest STP	Distance

D. Social infrastructure

Social Infrastructure	Type (Parks/ Gardens/Bus/ Railway)	Water Demand (MLD)	Nearest STP	Distance

E. Urban forest/Landscaping

Name	Type	Water Demand (MLD)	Nearest STP	Distance

F. Agriculture

Agriculture	Area (in Hectare)	Crop type	Water Requirement (m3/ha/day)	Water Requirement (MLD)	Nearest STP	Distance (KM)

G. Industrial

Industry	Type of Industry	Daily Water Demand (MLD)	Nearest STP	Distance (KM)

* Drinking water augmentation, urban forestry and maintaining river flow are context-specific and may not be relevant to all the cities. However, decentralized wastewater reuse and planning for our cities, are the priorities of the 21st century in the era of climate change

Drinking water augmentation can be done by using shallow aquifer recharge, it can be done by reducing the need for freshwater allocation.

It can also be done by decentralized application into lakes and waterbodies for recharge and then with additional tertiary treatment, creating new direct and dedicated decentralised water supply sources for the large number of unplanned and informal settlements.[4]

Total treated used water demand (in MLD)

(A)	Maintaining river flow	
(B)	Drinking water supply augmentation	
(C)	Social infrastructure	
(D)	Urban forest/landscape	
(E)	Waterbodies (lakes/ponds)	
(F)	Agriculture	
(G)	Industry	
Total:		

2.3 Step 3: Cost analysis and pricing

Data requirement

- Number of STPs in the city
- STP data: Utilization ratio, capital cost, O&M cost, year of commissioning, type of technology, current reuse practice/discharge location.
- Material rates from District Schedule Rate (DSR)
- Cost of conveyance system: Pipe and open channel
- Life of sewer lines
- Life of STP

After identifying the potential users and their distance from nearest STPs, the next step is to calculate the total cost per kiloliter (KL) for supplying treated wastewater. The price of treated wastewater shall be determined based on following factors:

a) Investment cost including conveyance, treatment and distribution infrastructure;
b) Operation and maintenance cost of the infrastructure;
c) Quality of water supplied;
d) Type of end uses;
e) Availability and prevailing price of alternative water sources;
f) Other social, cultural and business factors.

Per KL cost =
Total Cost of Treatment and its infrastructure+ Cost of Conveyance and O&M/Total Treatment Capacity in KL

Case example: Determining per KL cost of treated water

Sr No	Heads	Units	Cost (Lakhs)
1	Number of STPs in town	15	
2	STP/ Tertiary treatment capacity (MLD)	1000	
3	Life of an STP	15	
4	Life of sewerage	30	
5	Capital cost of STP (lakhs per MLD)	125	
6	Capital cost of sewer line (Lakhs per KM)	25	
7	Length of sewer line (Km) **(Sr no 7 x Sr no 6)**	350	8750
8	O&M cost (STP + Sewerage network) (Rs in Lakh)/ year	6600	6600
9	Per year cost of STP/TT (Rs in lakhs)= STP capex/ life of STP - (Sr no 2 x **Sr no 5)/Sr no 3**		8333
10	Per year cost of laying sewerage system (In lakh) = Cost of laying sewerage line/ Life of sewer line **(Sr no 7 / Sr no 4)**		292
11	Per year total cost of STP and Sewerage (Rs in Lakh)= **(Sr no 9 + Sr no 10)**		8625
12	Total cost of STP cost + Sewerage system + O&M per year (Rs in Lakh) = (Sr no 11 + Sr no 8)		15225
Total per KL cost (in Rs) - ((Sr no 12 / Sr no 2)* 1000/(365))			42

Summary of the prioritization of potential users

Once we have all the information regarding the potential users, their site locations and daily water requirement, using a map we further analyze these points against the accessibility (i.e. the distance of the site from the nearest STP), demand for treated wastewater and pricing.

Prioritization based on demand: Based on the preceding section on prioritizing potential users, create a priority table for each potential user according to their demand. The primary objective is to prioritize bulk consumers of freshwater for receiving treated wastewater, thereby reducing the pressure on freshwater resources.

STPs	Priority		
	High	Medium	Low

Prioritization based on accessibility: Which of the supply option would be more cost-effective in terms of recurring operational and infrastructural development expenses, while also maximizing social and environmental impact. Based on the table provided, rank the potential users and determine their priority levels.

STPs	Priority		
	High	Medium	Low

Prioritization based on pricing: Based on the per KL cost of the supply of treated wastewater for each of the potential users, rank them in the format of the table below.

STPs	Priority		
	High	Medium	Low

Note: The boxes provided above serve as reference points, and additional rows can be included as necessary.

Prioritization matrix

As a final step of the prioritization process, you need to give weightage to each of the potential users based on demand, accessibility, pricing and impact in order to identify top priority for the city. Weightage should be justified and not assumed by city officials. City officials must undertake public consultation and surveys, and provide a justification for the weightage allocated.

Care must be taken not to assume that a lack of willingness to pay for treated wastewater reuse or a lack of understanding of its value automatically justifies a lower prioritization of these users. Demand and impact are subjective and must be assessed using different criteria and several rounds of consultation. The exercise of arriving at weightage and then taking a decision on reuse is therefore the most critical part of the whole exercise.

Even within each category of reuse, such as industry, decisions about which industries should receive more or less treated wastewater must be made transparently. It should not be the case that only those willing to pay more receive the majority of the treated water.

Note: You can also prioritize the potential users as per state wastewater reuse policy of your own state.

Weightages-

- Demand and impact: 0 indicates low, while 5 indicates high
- Accessibility: 0 indicates long distance, while 5 indicates close proximity
- Price: 0 indicates a high price per kiloliter, while 5 indicates no cost or a low price
- Impact: 0 indicates lowest impact, while 5 indicates highest impact

Potential users	Demand	Accessibility	Pricing	Impact	Total	Prioritization Sequence
Maintaining river flow						
Waterbodies (lakes/ponds)						
Water supply augmentation						
Social infrastructure						
Urban forest/ landscape						
Agriculture						
Industry						
Total						

Case example: Prioritization matrix - a hypothetical example

Potential Users	Demand	Accessibility	Pricing	Impact	Total	Prioritization Sequence
Industry	5	3	4	5	17	2
Agriculture	5	4	5	5	19	1
Waterbodies (lakes/ponds)	3	3	5	4	15	4
Water supply augmentation	4	4	5	3	16	3
Social infrastructure	4	4	3	3	14	5
Urban forest/ landscape	3	3	0	5	11	6
Maintaining river flow	3	2	0	5	10	7

Summary:

Priority 1 – Agriculture

Priority 2 – Industries

Priority 3 – Water Supply Augmentation

Priority 4 – Water Bodies

Priority 5 – Social Infrastructure

Priority 6 – Urban Forestry

Priority 7 – Maintaining River Flow

2.4 Step 4: Institutional framework

Data Requirement

- Knowledge of the organizational structure of the State and Municipal Corporation along with their roles and responsibilities.
- Key stakeholders involved at city level, state level and national level.
- Interests of the stakeholders at city level and their influence on the project.

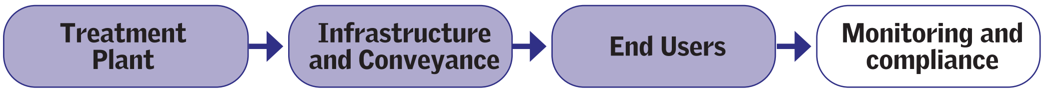
In this step, you will identify and map all stakeholders involved in the entire process, from planning to implementation of the reuse project at the city level, as well as the beneficiaries of the project, and incorporate them into a framework. Having defined roles and responsibilities helps ensure clear communication, accountability, and a more collaborative and productive work environment. Following are the various points to be considered while preparing an institutional framework.

Key points to consider for developing an institutional framework

- **Engage in participatory planning:** Ensure that the planning processes includes active participation from stakeholders who are directly affected by the end use of treated used water.
- **Define government roles and responsibilities:** Clearly outline the roles and responsibilities of various government entities and agencies involved in the process.
- **Involve diverse stakeholders:** Recognize the critical roles of various stakeholders such as industries, farming communities, Water Users Associations (WUAs), NGOs, CSOs, the private sector (small, medium, and large businesses), and research organizations in achieving safe, sustainable and reliable treated water (SRTW).
- **Clarify stakeholder roles:** Clearly define the roles and responsibilities of each stakeholder involved in the reuse project, including their participation in financing, service provision or regulatory aspects.

Identifying stakeholders at the city level

At the city level, stakeholders must be identified for four key stages of planning: treatment, infrastructure and conveyance, end users, and monitoring and compliance. The table below outlines stakeholders, their responsibilities, and their level of involvement at each stage:



Treatment Plant	Responsibility	Level of Involvement High Medium Low

Infrastructure and Conveyance	Responsibility	Level of Involvement High Medium Low

End users	Responsibility	Level of Involvement High Medium Low

Monitoring and Compliance – Post allocation	Responsibility	Level of Involvement High Medium Low

Any other Stakeholders required:

Case example: Defining roles and responsibilities of stakeholders

Stage	Stakeholders	Responsibilities	Level of Involvement
Treatment	• Municipal Water Authorities	• Manage and oversee the treatment process	• High: Ensure compliance with standards
	• Private water treatment companies	• Operate and maintain treatment facilities	• High: Provide technical expertise
Infrastructure and conveyance	• Municipal infrastructure departments	• Build and maintain conveyance infrastructure	• High: Ensure reliability and efficiency
	• NGOs/CSOs	• Monitor infrastructure projects	• Low: Advocacy and monitoring
End users	• Industrial users	• Use treated water for industrial processes	• High: Ensure proper usage and compliance
	• Farmers and Agricultural Groups	• Use treated water for irrigation	• High: Ensure sustainable agricultural practices
Monitoring and compliance	• Environmental Agencies	• Monitor water quality and enforce regulations	• High: Regulatory oversight
	• Public Health Departments	• Ensure treated water meets health standards	• High: Health safety enforcement

Final mapping of stakeholders
After mapping all the stakeholders according to their level of involvement, consolidate them into a single category in the table below.

Intensity of engagement required	Output expected from the identified stakeholders
High	
Medium	
Low	

2.5 Step 5: Monitoring mechanism

Monitoring mechanisms are the systems and processes used to track, assess, and manage the performance and compliance of various operations or projects. It is crucial for ensuring that objectives are met, identifying potential issues early, and enabling timely corrective actions. The following points need to be kept in mind while preparing a monitoring mechanism for the reuse of treated wastewater systems.

- Regulatory compliance and policy framework
- Risk assessment
- Water quality management plan
- Source water monitoring
- Distribution system monitoring
- End user monitoring
- Data management and analysis

Based on the type of end use, the implementing agency shall collaborate with appropriate institutions to monitor environmental and public health outcomes, as well as to enforce and ensure compliance with performance criteria:

- **Agricultural use:** The implementing agency may collaborate with the Department of Agriculture and agricultural universities in the respective states to guide farmers and Farmer Producer Organizations (FPOs) on suitable crops and agronomic practices. Additionally, they should emphasize the importance of incorporating sanitation safety measures during irrigation and periodically monitoring soil and farmer health.
- **Environmental use:** For uses related to the environment, the implementing agency shall partner with research institutions and civil society organizations to monitor the quality of water in waterbodies and to raise public awareness.
- **Industrial use:** In cases where the end use pertains to industries, and the quality standards are dependent on the specific industry's water quality requirements, self-compliance mechanisms shall be established.

Monitoring mechanism are mainly categorized under the following:

The table below details the various stages involved in the reuse of treated wastewater, including source, treatment, supply, end user, financial, and reporting stages. It also highlights the challenges associated with each stage and the monitoring mechanisms needed to mitigate these challenges. Here, you need to identify the likely challenges that may arise at each stage and specify how they will be monitored.

Prepare Reuse Project Monitoring Plan

Value chain	Challenges	Monitoring mechanism
Treatment		
Supply		
End Users		
Industry		
Agriculture		
Waterbodies (Lakes/Ponds) Water Supply Augmentation		
Social Infrastructure		
Urban Forest/Landscape		
Maintaining River Flow		
Financial		
Reporting		

2.6 Step 6: Project phasing and timelines

The municipal authority needs to establish a timeline and milestones for implementing the various steps involved in the project. These timelines can be categorized into short-term (0–6 months), medium-term (6–12 months), and long-term (beyond 12 months) phases. The short-term timeline will concentrate on immediate actions, such as initiating projects, conducting feasibility studies, and securing initial funding. The medium-term timeline will cover crucial phases like upgrading treatment plants and completing the land acquisition process.

The long-term timeline will focus on ongoing operations, maintenance, and monitoring, ensuring the sustainable and efficient management of the wastewater reuse project over the years.

Using the following table you are asked to fill in the timeline for the project as per city's needs.

Short-term activities (0-6 months)	Short-term activities (0-6 months)	Short-term activities (0-6 months)

Case example: Preparing a timeline:

Short term activities (0–6 months)	Medium term activities (6–12 months)	Long term activities (beyond 12 months)
• Data collection • Stakeholder mapping • Mapping existing water and sanitation infrastructure of the city. • Identifying and mapping all the potential users and their water requirement. • Identifying gaps in the current infrastructure.	• Retrofitting STPs if needed • Future projections and demand • Developing prioritization plan • Preparing a monitoring mechanism plan • Land acquisition if necessary	• Laying of conveyance infrastructure for supply of TWW • Regular monitoring of the water quality and other data points

3. References

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The *City-Level Toolkit for Reuse of Treated Wastewater*, developed by the Centre for Science and Environment (CSE), serves as a comprehensive hands-on guide for urban policymakers and city officials to manage and reuse treated wastewater effectively. Given the increasing water stress in Indian cities, this toolkit outlines a structured approach to integrating treated wastewater into urban water management strategies, which helps conserve freshwater resources and ensures better wastewater treatment compliance.

The document provides detailed steps for planning wastewater reuse projects, including demand and gap assessments, mapping potential users, cost analysis, institutional framework development, and monitoring mechanisms. With a focus on resource efficiency and long-term sustainability, this document is an essential resource for cities looking to adopt innovative water management solutions to achieve a circular economy.

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062
Phones: 91-11-40616000 Fax: 91-11-29955879
E-mail: cseindia@cseindia.org Website: www.cseindia.org