POLICY PAPER

WATER EFFICIENCY AND CONSERVATION IN URBAN INDIA

Centre for Science and Environment

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Ministry of Urban Development
Government of India

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BMP	Best management practice
CoE	Centre of Excellence
CPHEEO	Central Public Health and Environmental Engineering Organization
CSE	Centre for Science and Environment
CWC	Central Water Commission
IELO	Indian Environment Law Offices
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
LPCD	Litres per capita per day
MLD	Million litres per day
MoUD	Ministry of Urban Development
MoWR	Ministry of Water Resources, River Development and Ganga Rejuvenation
NRW	Non-revenue water
NWP	National Water Policy
RWH	Rainwater harvesting
SDG	Sustainable Development Goal
STP	Sewage treatment plant
ULB	Urban local body
USEPA	United States Environment Protection Agency
WEC	Water efficiency and conservation

Executive summary

According to the World Economic Forum's 2015 Global Risk report, around one third of the global population is currently water stressed, with about one billion people not getting safe drinking water—the water crisis is perceived as a top-order threat. India is no different. According to Indian government data, 22 out of 32 of India's big cities face water crises.

The urban water cycle is distinct from the natural hydrological cycle. It is the complex interplay between changing land-use patterns, increasing surface runoff, piped-water supply and sanitation systems. Because of the dynamics between the various factors, most urban areas in the country face shortages of seasonal water, which results in chaos and sometimes scuffles in summer.

Water quality is another issue as both surface-water and groundwater sources are neglected. The cost of water in urban areas is soaring and bottled-water factories are flourishing. Even so, there is ignorance and wastage of usable water from leakages and excessive consumption.

Traditional water-harvesting techniques in India have been severely neglected or encroached upon in most parts of the country. The situation has deteriorated since Independence in spite of the current system of centralized supply and management of water that does not meet the water requirements of a large number of people.

Learning from meteorological disasters (such as drought and severe floods) and difficulty in managing urban water systems (i.e. cost, operation and maintenance (O&M) and energy crisis), many developed countries (such as USA, Australia and the UK) practise water efficiency and conservation (WEC). They have developed effective measures of water conservation that mimic natural systems and effectively conserve water.

This document details the rationale behind the recommendations along with legislative provisions. WEC are incorporated from the planning stage and through various interventions suitable in urban areas. In addition, this paper reviews existing and upcoming water-related legal provisions.

This document's approach aligns with the UN's Sustainable Development Goals to be achieved by 2030 regarding availability and sustainable management of water and sanitation for all. It also aligns with goals set by the National Water Mission and National Mission on Sustainable Habitat of conserving water, minimizing waste, promoting alternative technologies and encouraging community involvement to increase water-use efficiency by 20 per cent by 2017. In addition, we have attempted to develop a roadmap for WEC in India with guiding principles, followed by short-, medium- and long-term implementation strategies for urban areas that underline that this initiative should be in line with strong legal provisions supporting WEC in the Indian context.

This paper emphasizes WEC with a holistic approach towards managing urban water. It is supported by case studies across the world for programmes, policies and projects under WEC.

1. Introduction

Our suvival depends on water. With the increase in population growth and urbanization in the last few decades, the manyfold increase in demand for water is of great concern.

The demands of a rapidly urbanizing society come when the potential for augmenting supply is limited. Water tables are falling and water quality deteriorating. As we drill deeper for water, our groundwater gets contaminated with metals like fluoride, arsenic and uranium. Our rivers and groundwater are both polluted by untreated effluents and sewage that are dumped into them. Climate change poses fresh challenges with its impacts on the hydrologic cycle,leading to more consumption and wasteful utilization of water in the country.[1]

Water supply in most Indian cities refers to the layout of infrastructure, i.e. piped water supply lines, drainage lines, sewage lines and sewage treatment plants (STPs). If piped water supply is inadequate, it is supplemented by private uncontrolled groundwater extraction, which contributes to pollution of urban aquifers, decrease in groundwater level and availability of water resources. Following this conventional approach eventually leads to inadequate municipal supply, water logging, groundwater depletion and water pollution, including siltation. For example, Delhi receives its water supply from as far as 300 km away. Mumbai, an important hub of economic activity, imports water from a distance of 150 km. An important reason for the non-usability of local water sources is that they are unprecedentedly polluted.[2]

Water in cities is treated as if it is unlimited and supplied at zero or low cost to consumers who resent the notion that water has an economic value. Further, leakage losses are a major challenge. Water distribution and house service connections for urban areas are cited as major contributors of leakage, which is as much as 50 per cent of water. Controlling leakage demands efficiency through technological interventions and monitoring systems.

The current water situation has paved the way for overexploitation of the groundwater aquifer, encroachment and pollution of waterbodies, and excessive focus on extraction technologies and infrastructure network, leading to increase in the demand–supply gap for water. The issues clearly show that conservation of water and measures to attain sustainability have not been addressed.

1.1 Need for urban water efficiency and conservation

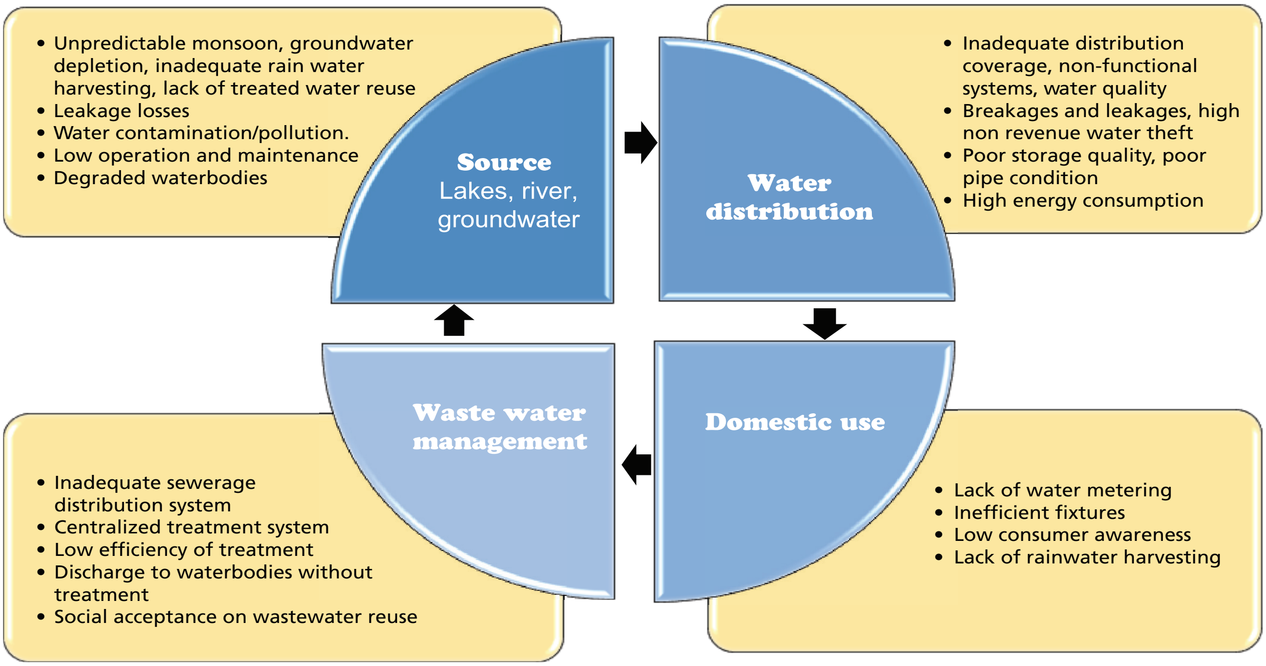
Rapid and unregulated urbanization and outdated urban water management models impacts water quality and quantity by jeopardizing the security and safety of our existing water resources. Cities are overwhelmed with water-related challenges.

The Indian water management model shows that sources of water are the primary and most important part of the water supply system (see *Figure 1: Water management in India*). This means that the conservation of locally available sources, i.e. groundwater and waterbodies, is essential for sustainability of available water. In India, however, they are overexploited and neglected.

Waterbodies are an important part of urban ecosystems. They perform significant environmental, social and economic functions—recharging groundwater to act as sponges, supporting biodiversity and providing livelihoods.

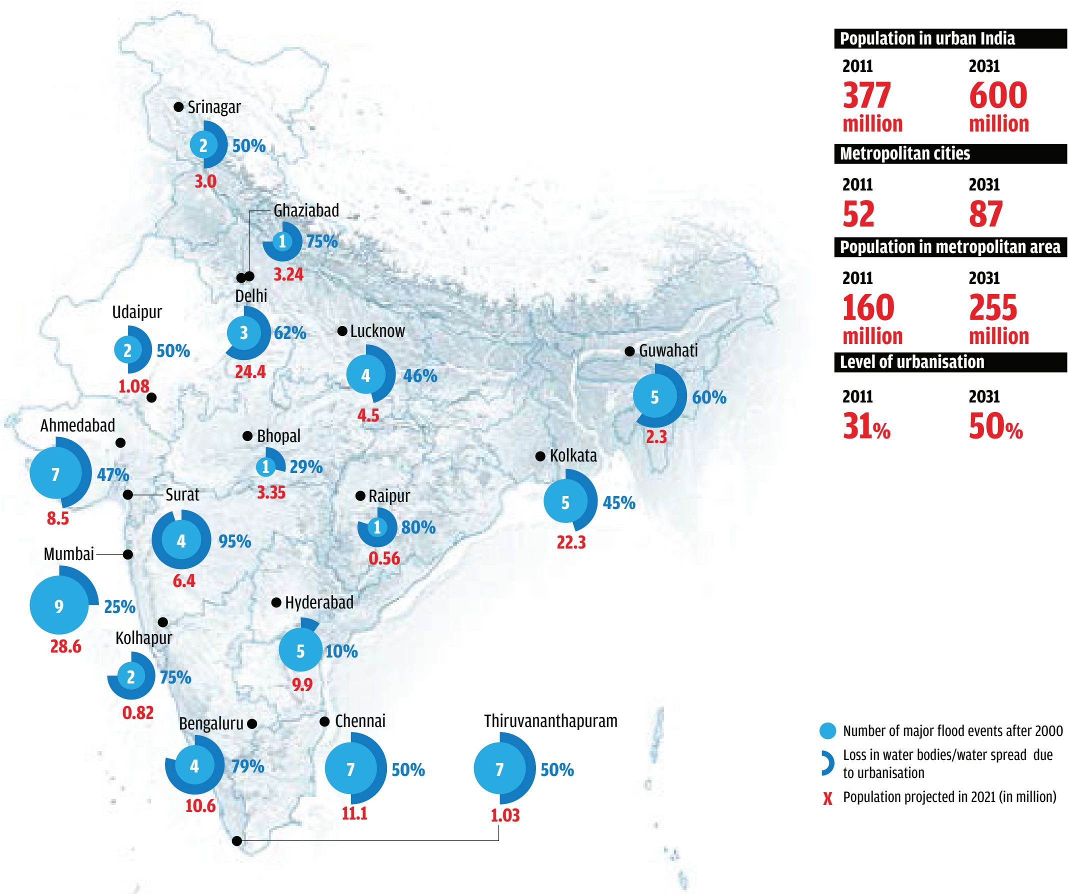
In urban India, however, the number of waterbodies is declining rapidly. For example, in the 1960s Bangalore had 262 lakes—now only 10 hold water. Similarly, in 2001, 137 lakes were listed in Ahmedabad city—65 of them have construction work underway. Hyderabad is another example—in the last 12 years, it has lost 3,245 ha of its wetlands (see *Map 1: Status of waterbodies in India*).[3]

Figure 1: Water management in India



Source: CSE, 2016

Map 1: Status of waterbodies in India



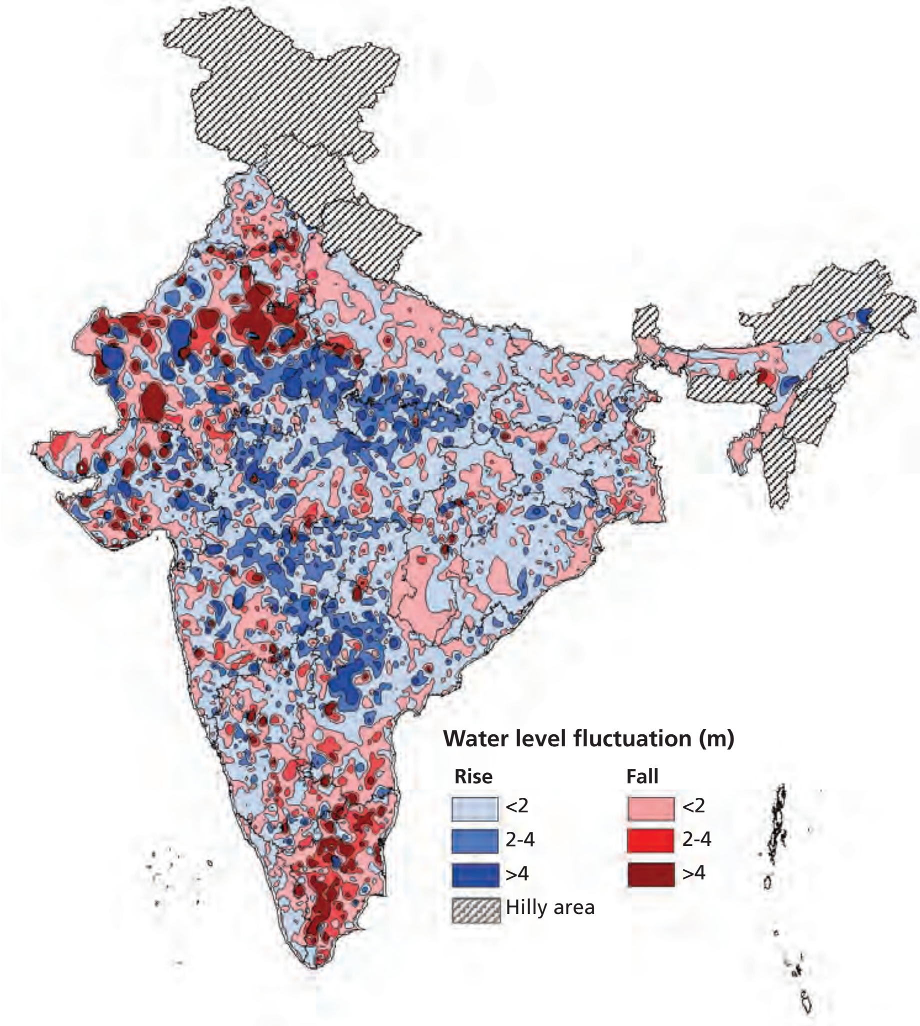
Source: S. Narain and S. Sengupta. 2016 ‘Why urban India floods—Indian cities grow at the cost of their wetlands’, Centre for Science and Environment.

Groundwater resources are often overlooked. Their resource sustainability depends on recharge through surface water and runoff. Rain is the most significant source of groundwater recharge, so any change in the rainfall pattern influences groundwater level. In 2015, half of India's meteorological subdivisions (17 of 36) received deficient rainfall during the monsoon.

According to the India Meteorological Department, the cumulative rainfall in India between 1 June and 30 September 2015 was 14 per cent less than the long-period average of 89 cm. Poor rainfall has reduced the water level in major reservoirs. The water stored in dams is mainly used for irrigation and power generation, but in some places drinking water is also supplied from reservoirs. Punjab, Jharkhand, West Bengal, Gujarat, Uttar Pradesh, Maharashtra, Odisha, Chhattisgarh and all the southern states show live storage of the reservoirs far below normal levels. Groundwater levels in these states have also dipped.[4]

A comparison of the number of overexploited zones in the country between 2004 and 2011 shows an increase in the number of overexploited blocks along with semi-critical blocks. The number of safe blocks has decreased correspondingly. Pre-monsoon levels in 2014 compared to the decadal mean of 2004–13 show Rajasthan, Gujarat, Punjab, Haryana and the southern states are increasingly depending on groundwater.[5] These states compensate the loss of surface water through groundwater extraction and are increasingly depending on the groundwater (see *Map 2: Decadal groundwater level fluctuation in Indian cities 2004-13*).

Map 2: Decadal groundwater level fluctuation in Indian cities 2004-13



Source: State of India's Environment, 2016. *Down To Earth*, Centre for Science and Environment.

A major challenge facing water utilities is the high level of water loss in distribution networks. If a large proportion of water supplied is lost, meeting consumer demands is all the more difficult. Since this water supply yields no revenue, heavy losses also make it harder to keep water tariffs at affordable costs. This situation is common in many Indian cities. Non-Revenue Water (NRW), defined as the difference between the quantity of water put into the distribution system and the quantity of water billed to consumers, averages 35 per cent in the region's (Rajasthan, Gujarat, Punjab, Haryana and the southern states) cities and can reach much higher levels. High levels of NRW in a city typically indicate a poorly managed water utility (see *Table 1: Components and causes of physical and non-physical water losses*). [6]

Leakage losses can be divided into the following heads:
Leakage on transmission and/or distribution mains: Water lost from leaks and breaks on transmission and distribution pipelines. These may be small leaks that are not visible on the surface (e.g. leaking joints), or large breaks that were reported and repaired but the leakage before repairs contributed to the annual volume of physical losses in a specific year.

Leakage and overflows at a utility's storage tanks: Water lost from leaking storage tank structures or overflows of such tanks caused, for example, by operational or technical problems.

Leakage on service connections up to point of customer metering: Water lost from leaks and breaks of service connections from (and including) the tapping point to the point of customer use. In metered systems, this is the customer meter; in unmetered situations, this is the first point of use (stop tap/tap) within the property. Leakage on service connections may be visible but are a large component of water lost due to inefficient fixtures.[7]

According to the Centre for Science and Environment report *Excreta Matters*, Indian cities face high amounts of leakage losses along with a shortage of water supply compared to demand (see *Table 2: Leakage losses in water supply*). In Agra, for instance, where there is as much as 171 litres per capita per

Table 1: Components and causes of physical and non-physical water losses

Component	Cause
Unbilled metered consumption	• Water delivered to special customers that are not billed although they are metered • Water used for operational purposes (flushing and disinfecting, if metered)
Unbilled unmetered consumption	• Water delivered to special customers who are neither billed nor metered • Difference between actual and estimated consumption • Water used for operational purposes (flushing and disinfecting, if not metered) • Water used for firefighting
Unauthorized consumption	• Illegal connections where there is no access • Illegal connections to properties that have legal connections • Illegal connections of vendors selling water
Metering inaccuracies	• Under-registration of customer meters • Poor quality and/or inaccurate meters • Inadequate meter maintenance or replacement policy • Stopped meters • Data handling errors
Leakages on transmission and/or distribution mains	• Burst pipes (sudden rupture of pipe) • Leaking joints and fittings
Leakage overflows at utility storage tank	• Seepage from old masonry or concrete walls • Float valves not working
Leakage on service connections up to point of consumer metering	• Burst pipes (sudden rupture of pipe section or joint) • Leaking joints and fittings

Source: 2008. Designing an Effective Leakage Reduction and Management Program. Water and sanitation program (WSP). World Bank

Table 2: Leakage losses in water supply

71-city survey: How leakage losses create the real shortfall in water actually supplied								
	Demand in 2005 (MLD)	**Supply in 2005 (MLD)**	**Gap in 2005 (MLD)**	**Shortfall in supply, 2005 (%)**	**Leakage loss (MLD)**	**Supply after loss, 2005 (MLD)**	**Demand-actual supply gap, 2005 (MLD)**	**Shortfall in actual supply, 2005 (%)**
Metro	17,987	16,591	1,396	8	6,150	10,441	7,546	42
Class I	2,879	2,775	104	4	706	2,069	811	28
Class II & III	129	123	7	6	21	101	28	22
Total	**20,996**	**19,489**	**1,507**	**8**	**6,877**	**12,611**	**8,385**	**40**

Source: Narain, S., 2012. Excreta Matters. *State of India's Environment. A Citizens' Report*. Centre for Science and Environment.

day (LPCD) of water to distribute, only 94 LPCD reaches users after losses. The official leakage loss in Udaipur is 40 per cent and as high as 44 per cent in Jaipur, where as much as 153 million litres per day (MLD) water is lost in distribution inefficiencies. Similarly, in the desert city of Jodhpur, where water is sourced from the Indira Gandhi Canal at considerable cost to the city, losses amount to 20 per cent.[8]

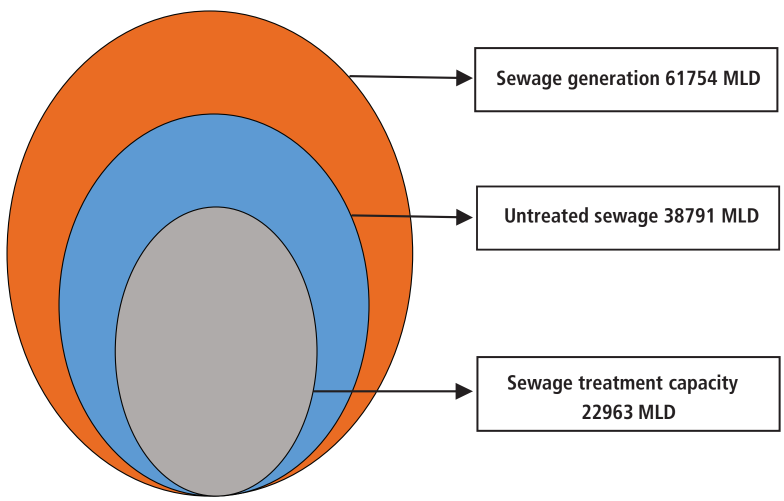
State governments and urban local bodies (ULBs) are responding to the growing demand for water by focusing on large-scale infrastructural projects of water supply to bring in more water into cities from the hinterlands, sometimes from as far as 150–200 km away. Further, there is no official data on water losses in Indian cities; 20–50 per cent of water that is pumped into the water supply system is 'lost' because of leakage, theft, burst pipeline, non-payment of water tax etc. The initiatives state governments and ULBs have taken on NRW issues have been inadequate.

About 80 per cent of the water that reaches households leaves as waste. According to the Central Pollution Control Board (CPCB), in 2015, the estimated sewage generation in the country was 61,754 MLD as against a developed sewage treatment capacity of 22,963 MLD. Because of the gap in sewage treatment capacity, about 38,791 MLD of untreated sewage (62 per cent of the total sewage) is discharged directly into nearby waterbodies.[9] These estimates are based on official figures and do not take into account private and unofficial groundwater usage or losses in the distribution systems (see *Figure 2: Water and wastewater generation*).

The current water model that primarily focuses on water supply is consequently unsustainable, given that more water supply leads to more wastewater generation, which increases cost of treatment. A paradigm shift is needed to focus on decentralized natural systems that focus on reuse/recycle, prevention of leakage losses and resource efficiency.

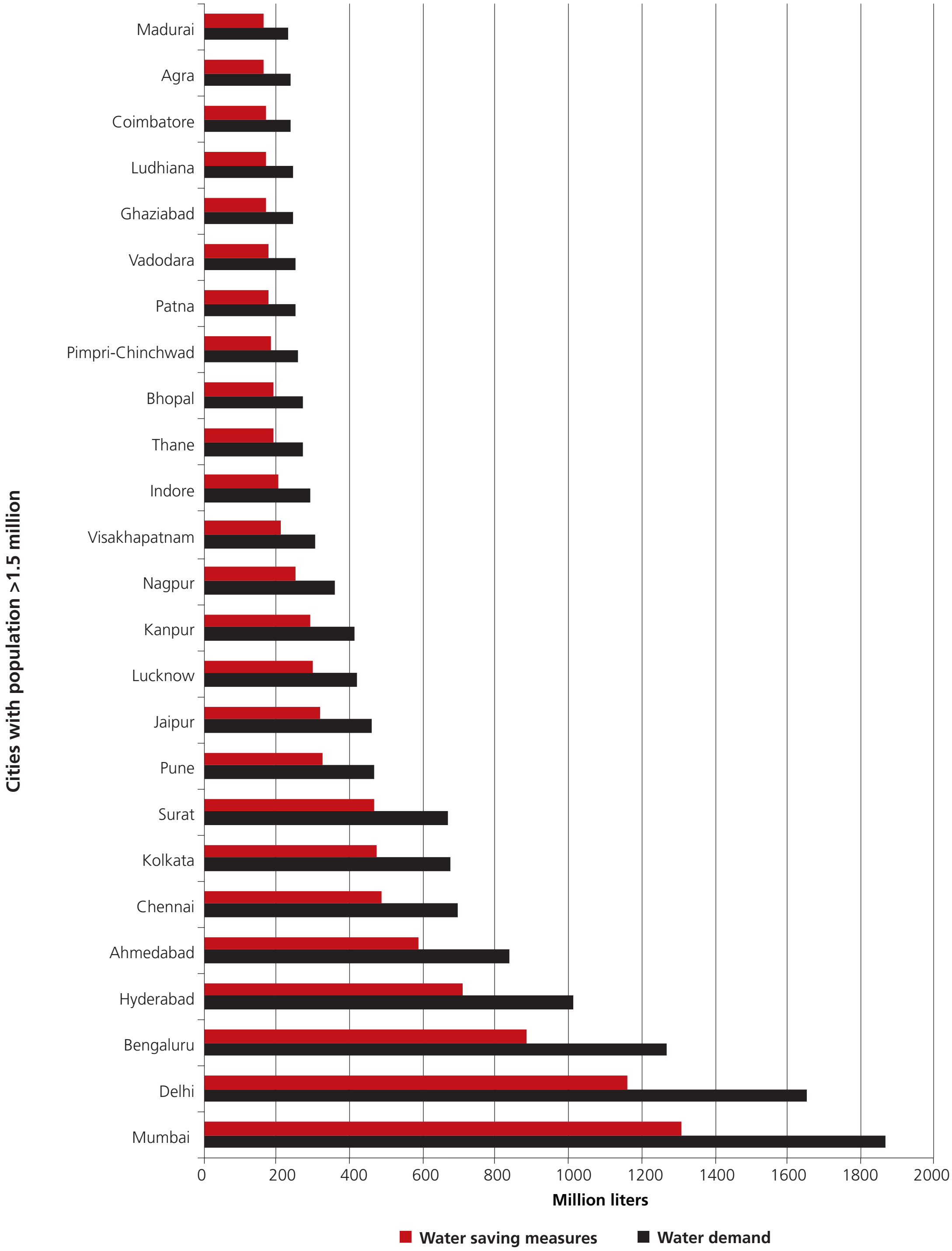
Water resource efficiency is, therefore, critical in urban water management, both in the case of water supply and sanitation services. The need is to develop a policy and the requisite enabling framework

Figure 2: Water and wastewater generation



Source: CPCB Bulletin, Volume 1, July 2016

Graph 1: Potential for water saving



Source: Compiled by CSE, 2016

aimed at mainstreaming efficiency and conservation in urban water and drainage/storm management; conservation of lakes and other waterbodies; and rainwater harvesting (RWH) and groundwater recharge, including reuse/recycling of treated wastewater. To ensure resource opportunities of future generations are not limited, we must all use our valuable water more efficiently. This can be best achieved by combining several approaches, such as raising community awareness, strong and implementable legal provisions, and market mechanisms to achieve greater recognition of the true value of water and financial incentives or assistance to facilitate change. It seems likely that water demand and supply can be brought into a sustainable balance only by changing and moderating the pattern of demand, or by introducing new localized sources of supply, or both. Above all, water losses should be minimized and water-use efficiency increased substantially. It is important to focus on water balance, not supply and demand, i.e. conservation of mass and attempts to ensure that chances of mis-accounting and subsequent misallocation of water resources are minimized.

With two national flagship programmes, Smart Cities and AMRUT, India aims to improve water and sanitation in cities. The programmes aim to make 109 Smart Cities and 500 AMRUT cities. Cities have the potential to save water by around 30–50 per cent per household.[10] CSE analysis shows that if cities with populations of over 1.5 million practise water efficiency and conservation in water use, it would reduce the demand–supply gap for water (*see Graph 1: Potential for water saving*).

This is in line with making India a water-frugal economy and meeting the Sustainable Development Goals (SDGs), i.e. improved water quality, increased recycling and safe reuse; increased water-use efficiency and improved resource efficiency. The National Water Mission (NWM) and the National Mission on Sustainable Habitat (NMSH) also emphasize on the need to conserve water, minimize waste and promote alternative technologies as well as encourage community involvement to increase water-use efficiency by 20 per cent by 2017.[11,12]

1.2 Vision, objectives and scope

Vision:
This paper envisages that urban areas of the country understand the value of water as a resource and become self-sustaining in fulfilling the growing demand for water. Local water resources are to be protected and conserved so they are available as a supplementary source of water to existing water supply network.

Aim:
This paper aims to propose a policy framework for WEC in urban areas for sustainable water management.

Objectives:
This paper aims to:
- Analyse urban water management in the Indian context
- Review existing provisions related to WEC
- Understand case studies on best management practices (BMP) from national and international experiences
- Suggest guiding principles and a way forward for WEC

Scope of the paper:
This paper's scope is to develop a policy and enabling framework to mainstream efficiency and conservation in urban water and drainage/storm management, conserve lakes and other waterbodies, and implement rainwater harvesting and groundwater recharge, including reuse/recycle of treated wastewater. The purpose is to supply quality water to urban areas, prevent crisis by making best use of available technologies and conserving existing water resources, converting them into utilizable form and making efficient use of them in different sectors. This includes strategies to improve existing management models by working on demand management, including usage of water-efficient fixtures, reducing NRW and operating, maintaining and monitoring these systems.

1.3 Approach and methodology

This paper is the outcome of CSE's research in sustainable water management over two decades, with the aim to establish policy principles, innovative technologies and implementation strategies for water and wastewater management to help lay the foundations for a water- and waste-prudent society.

CSE's findings on wastewater management in the Yamuna were published in *Sewage Canal: How to Clean the Yamuna*, which called for rethinking and re-engineering water and wastewater management not just in cities along the Yamuna, but for all rivers in India. It has elicited a national debate—along with the CSE documentary *Faecal Attraction: Political Economy of Defecation* on urban sewage management—on the National River Conservation Plan.

CSE published India's first and most comprehensive survey on water and sewage management in the two-volume *Excreta Matters*. It covered all aspects of water management in 71 cities, i.e. sourcing, treatment (water and waste), supply, pricing and equity different agro-climatic zones. It outlined an approach towards sustainable water and sewage management in Indian cities.

The Ministry of Urban Development (MoUD), Government of India has designated CSE a Centre of Excellence (CoE) in sustainable water management under its Capacity Building of ULBs scheme. The Centre has been involved in assisting the ministry in policy research and capacitating municipal functionaries through tailor-made training programmes in three areas—septage management, urban lake management, water-sensitive design and planning and preparing a roadmap for a rating system for water-efficient fixtures, part of mainstreaming water management. Simultaneously, CSE conducted several short training programmes and national exposure visits for municipal functionaries and trainers from other CoEs assisting the ministry.

CSE was also identified as a key institution to support a comprehensive capacity building programme under the National Urban Renewal Mission (NURM) for 2012–13. Under this mandate, it conducted capacity-building trainings, workshops and research in the area of sustainable water and wastewater management.

With CSE's extensive research and capacity-building programmes in mainstreaming sustainable water management, it was felt that along with training there should also be a policy paper that supports the concept of WEC in urban areas. The WEC plans would optimize existing facilities and avoid unnecessary expenditure in developing new projects. The research helped in understanding the current scenario of urban WEC in India and the world. Interaction with municipal functionaries during trainings and exposure visits helped document best management practices and taking on board key practitioners for consultation.

We have attempted a synthesis of the following to suggest possible arrangements that include WEC for sustainable urban water management:
1. CSE's background research was the base in preparing this paper.
2. Existing legal provisions (Acts, guidelines, policies) were studied in details to identify provisions related to WEC in urban areas. The studies carried out indicated that most of the provisions do not explicitly cover urban areas.
3. Guiding principles and legal provisions specifically on WEC were studied from developed countries. Case examples of BMPs adopted worldwide were also studied and analysed extensively.
4. Discussions and roundtable meetings were held with subject experts to take their opinion on explicit availability in existing legal framework on provision of WEC. Representatives from government, NGOs like NWM, Bureau of Indian Standard (BIS), International Council for Local Environmental Initiatives (ICLEI), Indian Environment Law Offices (IELO), The Energy and Resources Institute (TERI), Indian National Trust for Art and Cultural Heritage (INTACH) and other private consultants working extensively in this sector were part of the core group meeting. On the basis of their experiences, the experts contributed to bring out a sound policy backgrounder to mainstream WEC (refer to *Appendix 1*).
5. A consultation seminar was held in which experts and all the stakeholders across India were invited to share knowledge and give inputs, recommendations and suggestions for the draft policy paper (refer to *Appendix 2*).

2. Understanding urban water efficiency and conservation

While there is considerable research worldwide in, and different definitions of, WEC, few take a holistic approach, with water efficiency and conservation taken into account.

The concept of water conservation and its improved management goes back many decades. In 1950, the President's Water Resources Policy Commission published *A Water Policy for the American People*, which emphasized on the fact that the country can no longer be wasteful and careless with water resources. There is a need to manage and conserve water for future developments.[1]

According to a 1997 report of the New Mexico office of the State Engineers, water conservation is any action that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces loss or waste of water, improves efficiency of water use, increases recycling and reuse of water, or prevents pollution of water. It also states that water conservation involves two distinct areas, technical and human. The technical side includes collecting data from water audits and installing water involves changing behaviours and expectations about water use and the way things should be done. It emphasizes that both areas must be addressed for a water conservation programme to succeed—efficient fixtures and procedures.[2]

Baumann et al. (1980) defined water conservation in terms of cost–benefit as the socially beneficial reduction of water use or water loss; net social benefit is a key concepts of water conservation.[3] Water efficiency, as defined by the United States Environmental Protection Agency (USEPA), is the use of improved technologies and practices that deliver equal or better water service with less water. It further states that water efficiency encompasses conservation and reuse efforts, as well as the reduction and prevention of water loss to protect water resources for the future.[4]

The Alberta Water Council defines water efficiency as the accomplishment of a function, task, process or result with the minimal amount of water feasible. It emphasizes the importance of using water more efficiently in order to reduce water demand for a given set of beneficial uses. It considers water efficiency as part of water conservation.[5]

The Alberta Water Council defines water efficiency and conservation as:

1. Any beneficial reduction in water use, loss or waste
2. Water management practices that improve the use of water resources to benefit people or the environment
3. Accomplishment of a function, task, process or result with the least possible water used
4. An indicator of the relationship between the amount of water needed for a specific purpose and the quantity of water used or diverted

The New South Wales Conservation Strategy defines water conservation as using water efficiently and equitably so that the needs of ecosystems, human settlements and production are all met sustainably on a permanent basis. The strategy takes a holistic approach to water-use efficiency and conservation, builds on existing programmes and projects, and addresses the way in which water is used in both urban and regional environments throughout the country. The strategy aims to achieve broader awareness and commitment to water conservation and greater recognition of the scarcity and value of water in our society. The strategies range from research and education to financial incentives and water-efficient appliances and include aspects of water management and use that require direction, support or initiation. A review of the current situation in New South Wales demonstrates that the most important principles in water conservation and improvement in water-use efficiency is that individual small savings add up to a large total saving, thus contributing to the overall goal of reducing water use.[6]

According to a 2003 report 'Waste not, want not: Potential for urban water conservation in California', conservation is any action or technology that increases the productivity of water use. Collectively, these actions and technologies are referred as conservation measures, demand management, or improving water productivity.[7]

As per the Paris Climate Agreement (2016), a warmer world would increase pressure on water resources considerably. A trade-off is evident between climate change mitigation and water resource conservation.[8]

This is in line with SDG 6.4, which talks about substantially increasing water-use efficiency across all sectors, ensuring sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reducing the number of people suffering from water scarcity.

2.1 Historical water conservation practices in India

Water has been considered sacred throughout civilizations. India experiences either excess or scarce water because of varied rainfall and land topography. Yet they have managed to use natural water resources efficiently by integrating local water resources and technologies with community participation. *Appendix 3* gives an insight about the various traditional systems practised keeping in view the conservation of local water resources. It is evident that a combination of traditional techniques and community involvement utilized local resource and retained the systems.

The colonial era, however, brought the concept of government control over surface water. Under the Indian Easement Act, 1882, landowners had virtually unlimited right to use water in land under their possession and this Act is still applicable. Water exploitation in the form of canal and irrigation projects to increase revenue was more important than conservation during the colonial era.

In absence of sound legal instruments (except the Water Act) that clearly mandates conservation of this precious source of life, water availability is currently a matter of grave concern in India, especially urban areas. It demands immediate attention from the government to safeguard its sustainability for future generations.[9]

2.2 Urban water management scenario: Issues and opportunities

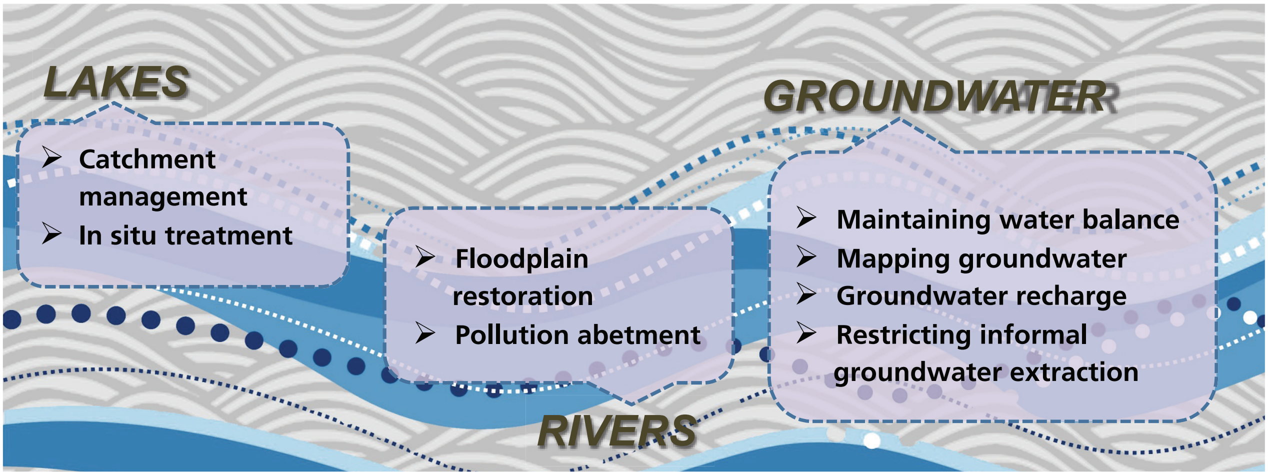
There are three major sources of water supply in nature—rivers, lakes and groundwater. It is important to conserve these for sustainable water management. To preserve sources of water, managing lake catchments is essential along with in situ treatment of waterbodies. Conserving floodplains is vital to ensure a regular flow and quality of water to maintain healthy rivers. Measures to protect floodplains include restricting construction and infrastructure on specific zones in the floodplain by declaring the zones green belt areas. In addition, practices such as reforestation and building levees/embankments (without destructing the morphology of the river) are also beneficial.

Groundwater in India is not in its pristine condition due to overextraction and contamination. Extensive groundwater mapping, recharging of groundwater by RWH and restricting informal extraction of water resource is needed to maintain the water balance (see *Figure 3: Conservation at source of water supply*).[10] The current water conservation regime in India doesn't effectively undertake these practices.

Only a holistic approach can make radical changes in this sector. While water is essential in our daily lives, the amount of water used can be efficiently moderated and adopted on different scales (see *Figure 4: Water conservation from the demand side*).

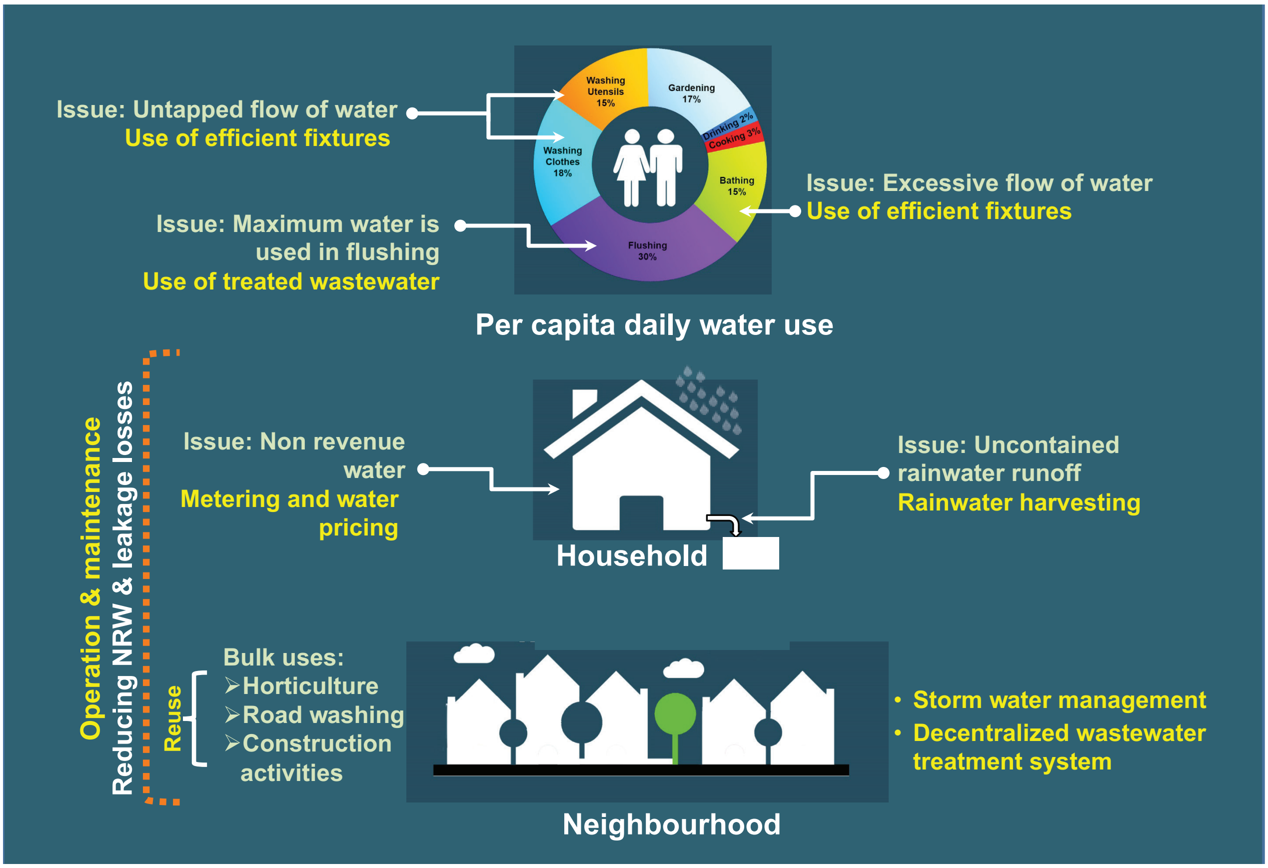
At the *individual or household level*, the most water is utilized in flushing, followed by gardening, bathing and washing. Water consumption can be reduced by using water-efficient fixtures that take care of excessive flow of water. Also, water used in low-end activities, such as flushing, can be replaced by treated wastewater. This can be further supported by xeriscaping, which does not require excess water as native species are grown.

Figure 3: Conservation at source of water supply



Source: CSE, 2016

Figure 4: Water conservation from the demand side



Source: CSE, 2016

Water in India is highly subsidized because of which it is not considered valuable. A meter system for developed areas will help decide appropriate water pricing and real-time monitoring will reduce NRW. At the *neighbourhood level*, strategies like storm-water management can lead to in situ water augmentation. In addition, local reuse of treated wastewater from decentralized wastewater treatment systems (DWWTs) at the neighbourhood level can help replace water for bulk urban requirements. Water-intensive activities are integral to the economic development of urban areas. Water for public utilities need not always be in large amounts. The quality of water required for what comes under public demand, such as for maintaining public parks, gardens and public fountains, and cleaning public toilets, will be different from the quality of potable water.

2.3 Water efficiency and conservation measures

Efforts in WEC will decrease current demand in a city and eventually stabilize at the minimum threshold. Water conservation also has the capacity to increase water supply through recycling water, minimum leakage during conveyance etc. Ideally, groundwater levels will increase and aquifer and waterbodies improve (see *Figure 5: Water efficiency and conservation techniques*).

2.3.1 In situ water augmentation

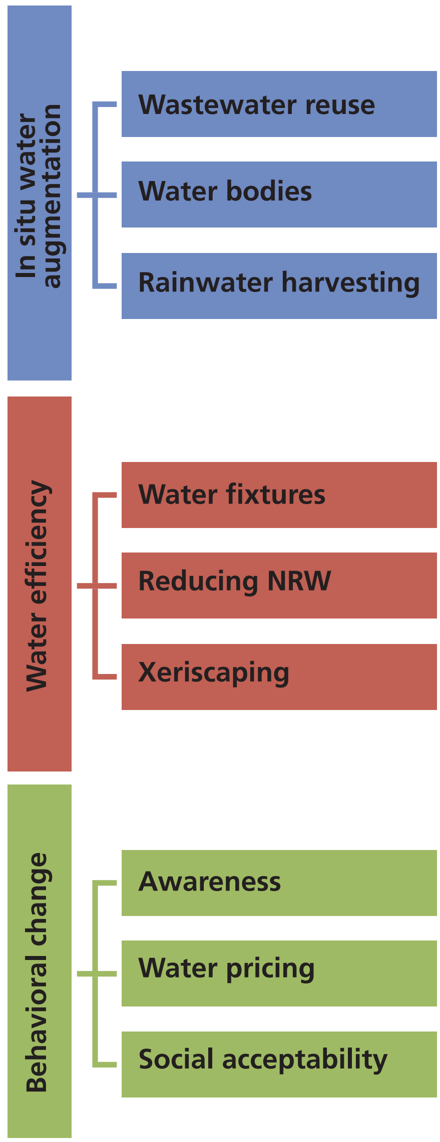
Historically, water management was through in situ water resources. Current wasteful water-use patterns have, however, resulted in water being used inefficiently.

Following historic practices while using new technologies and available water resources such as nearby waterbodies, rainwater and wastewater at the site can be used to their full potential.

RWH systems use the principle of conserving rainwater where it falls. Rainwater can be collected from catchments (roofs, paved and unpaved) areas of a site. There are two ways of harvesting the rainwater:

(1) Storage in receptacles and
(2) Recharge into the aquifer (see *Table 3: Rainwater harvesting systems*). It is advisable to harvest at least 50 per cent of the total run-off through recharge or storage systems from the catchment area to become water efficient.[11]

Figure 5: Water efficiency and consevation techniques



Conventional wastewater management also involves a centralized system of sewerage networks to provide treatment and disposal. The conventional technology of a centralized system of wastewater (sewage) collection and treatment is not just resource intensive (use of water first to flush, then to carry waste), but also capital and energy intensive. It minimizes the scope of recycling/reuse as treated water would need to be conveyed back for reuse and would add to the capital and energy cost.

Table 3: Rainwater harvesting systems

Type of recharge structures	Type of storage tanks
• Recharge pits • Recharge pits with bore • Recharge well • Recharge trenches • Recharging through abandoned bore wells or tube wells • Recharging through bore wells and dug wells	• Polyethylene • Polypropylene and other similar synthetic material (PVC tanks) • Brick masonry • Reinforced cement concrete (RCC tank) • Ferro-cement • Galvanized iron (GI tanks)

Source: CSE, 2016

The alternative approach is onsite wastewater treatment or contribution to municipal wastewater treatment and reuse. This is based on the principle of a devolving level of application so that sewage can be treated locally, reducing pumping over long distances and promoting local reuse of treated sewage. Systems that are less resource intensive (energy, O&M and capital cost) enable easy adoption for reuse.

The following are techniques that can be opted for treatment on a small scale depending on feasibility at the site (see *Table 4: Techniques adopted for treated wastewater reuse*).

Table 4: Techniques adopted for treated wastewater reuse

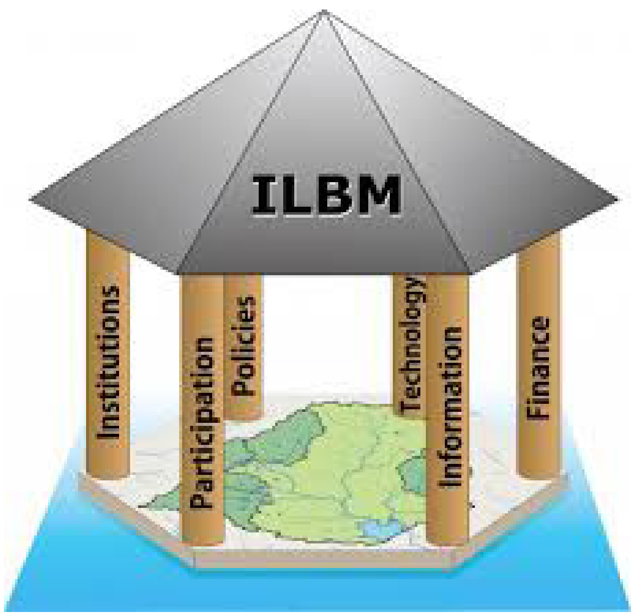
Treatment method	Treatment capacity (feasible)	Reuse
Bio sanitizer/eco chip	100 mg of eco chip can treat 1 KLD	In situ treatment of water bodies, horticulture
Soil biotechnology	5 KLD–3.3 MLD	Horticulture, cooling systems
Soil-scape filter	1–250 KLD	Horticulture
DWWTs	Should be more than 1 KLD, but plants bigger than 1 MLD are not feasible as they would need extensive land	Horticulture, mopping floors, cooling towers and flushing
Eco sanitation Zero-discharge toilets	Individual and community toilets together depending upon the number of users	Flushing, horticulture, composting
Fixed film bio-filter technology	0.5 KLD–1 MLD	Horticulture, car washing
Phytorid	0.5 KLD–1MLD	Horticulture

Source: CSE, 2016

Apart from available rainwater and reuse of treated wastewater, waterbodies (lakes, ponds) especially in urban areas have enormous value in terms of resource provision (for drinking or irrigation), regulating services (climate mediation, flood and drought management) and cultural service (religious, historic value). However, these lakes and ponds are extremely sensitive to environmental stress caused by anthropogenic activities in the basin or catchment, which reduces the natural capacity of the waterbody to restore itself and results in its deterioration.

However, traditional urban-lake management approaches have often failed to address issues beyond the waterbody itself. In order to conserve the natural integrity of these resources, a more holistic approach in planning is required. Integrated urban lake basin management focuses not only on curative methods for lake restoration but also envisions management at the catchment level (see *Figure 6: Integrated lake basin management*). It helps in sustainably managing lakes and their catchments through effective improvement in governance of lake catchments by integrating institutional planning, policy, inclusive planning with stakeholders, technologies and funding.

Figure 6: Integrated lake basin management



Source: Thornton, J.A., Lin, H. and Slawski, T.M., 2013. *People and Ponds: The Participatory Role of Humans in Integrated Lake Basin Management. Lakes & Reservoirs: Research & Management,* 18(1), pp.3–4.

2.3.2 Water efficiency

To assess and verify the balance between water supply, its conveyance and distribution, a water audit is used. It is effective as a water management tool to analyse leakages within pipes, theft of water, improve its quality and provide valuable output in terms of minimizing wastage. A water audit includes information regarding sources of water supply, pipe properties and fittings, valves, information on home connections, water demand and leakages during operation and maintenance etc.

A water audit is also effective in minimizing water wastage and increasing revenue for the municipality. Various improvement methods such as selecting appropriate material for pipes, mapping leakages supported by GIS for network-leak detection and pressure management to get longer utility service can be considered. Maintenance and monitoring systems should be the key areas of focus.

The distribution network for domestic use in cities, apart from the household level, comprises source, transmission mains, overhead tank, distribution network, house service connection, fittings etc. NRW comprises water leakage within the distribution network, water theft and tampering with water meters.

The water audit leads in measures and actions towards NRW reduction. This includes reduction of losses in conveyance, i.e. water leakage from distribution network and proper metering can also help in supply management. Also, intermittent domestic water supply may be adopted to check wasteful use.

Water-efficient fixtures are designed to use less water while maintaining the same level of performance as conventional water fixtures. Reducing water consumption by using water-efficient fixtures is a major step towards sustainable water management (see *Table 5: Saving water with water-efficient fixtures*). Efficient plumbing fixtures, sensors, auto valves and pressure-reducing devices can significantly reduce water consumption.

Table 5: Saving water with water-efficient fixtures

Fixture	Water use with standard fixtures	Water use with water-efficient fixtures	Water saved
Toilet	Single flush toilet users 10–13 litres/flush	Dual flush toilet in 3/6 and 2/4 litre models	4–11 litres/flush
Urinals	4 litres; 10–13 litres/flush	Sensor operated adjustable flush	2.2–10 litres/flush
Taps	10–18 litres/minute depending on pressure	Sensor taps	5.5–15.5 litres/minute
Showers	10–15 litres/minute	Flow restrictors	4–20 litres/minute

Source: S.K. Rohilla, S. Dasgupta. 2010. *'Rating System for Water Efficient Fixtures—A Way to Sustainable Water Management in India'*, Centre for Science and Environment.

Water-efficient landscaping/xeriscaping also minimizes water use by growing native species, using efficient irrigation systems and limiting lawn areas. Appropriate planting and efficient irrigation systems can reduce water used in irrigation by 50 per cent to 70 per cent respectively and overall water consumption by 25 per cent. Further, the green area of a site helps in reduction of storm-water runoff.[12]

A well-designed landscape is possible in two ways: by planting appropriate vegetative species, i.e. native vegetation and flora, and xeriscaping; and using efficient-irrigation equipment.

2.3.3 Behavioural change

Awareness

Urban WEC is an inclusive approach in which public participation is necessary. The dissemination of awareness with regard to water considered a precious resource, current water stress in urban areas taken cognizance of and rainfall regarded as a resource rather than a nuisance will give an impetus to effective implementation of WEC.

Water in India is not provided free, as a right, but cities have differential pricing to provide for lower rates for smaller users of water—where it is metered—and for smaller holders of property, where the tariff is based on the pipeline connection.

Across different cities, the lowest water slab varies between 6 kilolitre (kl) to 15 kl per household per month. Assuming a family of six and usage of 6 kl, each person would get 30 litres per day; with eight in a family it would be down to 25 LPCD—subsistence-level water usage. Delhi, for instance, charges Rs 2 for up to 10 kl consumption; Kerala charges Rs 4–5 for up to 10 kl. But this rate does not guarantee water, which in many cities does not reach households that are unconnected and unserved by the pipeline.[13]

The value of water in the minds of general public can be raised through increase in pricing, which will reduce wastage and promote efficient use of water. The only way urban areas can somewhat balance their water accounts is through differential pricing—charging industries and commercial establishments more than domestic users. It is clear from the country's water scenario that the challenge of water supply is not more supply, but more reach. This requires a refocusing of priorities; city governments have to be held accountable to ensure supply to all. This, in turn, requires careful planning so that water is affordable and its supply sustainable.

Capacity building

Water conservation and management also require technical know-how of ULBs for effective and efficient implementation with desired output in terms of sustainable water management. It is a continuous process that needs to be institutionalized for long-term gain. Local authorities can adopt and respond to new policies only when they have subtle knowledge and confidence about the subject.

Understanding fundamentals

An understanding of fundamentals holds the promise of change in attitude towards implementation of developmental projects with regard to sustainable water infrastructure.[14]

3. Review of legal and institutional provisions

'Right to Water' is not explicitly covered in Article 21 of the Indian Constitution but under the broad rubric of 'Right to Life'. Article 51A of our Constitution envisaged that it shall be the fundamental duty of every Indian citizen to protect and improve the natural environment, including forests, lakes, rivers and wildlife, and to have compassion for living creatures.

In order to conserve water resources, several water-related policies have been formulated. The National Water Policy (NWP) was first formulated in 1987 and updated and notified it in 2002 and in 2012, respectively. The scope of coverage widened with each notification. NWP is considered to be a comprehensive water policy that highlights NRW, water-efficient technologies, rainwater harvesting, reuse of treated water etc. It provides an overview of the water resource situation, addresses the problem because of its scarcity and suggests development with conjunctive use of surface and groundwater (refer to *Appendix 4*).[1]

Subsequently, states such as Maharashtra, Rajasthan, Odisha and Himachal Pradesh also proposed their water policies with reference to NWP (refer to *Appendix 5* for the status of state water policies). Sixteen states have prescribed their water policies while six have prepared their draft water policies, which are in the public domain for feedback. Eight states have not prepared overall policies for water management. The existing national and state water policies in general have adopted a holistic approach but these act only as guiding documents with no legal standing. They cannot be enforced and remain silent towards mainstreaming urban WEC that will overcome current water issues. The NWM, launched under the National Action Plan on Climate Change (NAPCC), recommends 20 per cent water-use efficiency programmes, including water conservation and water recycling (refer to *Appendix 4*).[2]

The provisions and decisions within the policy and plan act as a guide to identifying priority actions to reduce water demand and augment supply to achieve sustainable water management. There are numerous policies and plans targeting different objectives of water management which, in some cases, overlap. Overall, these policies address issues such as aquifer depletion, management of waterbodies and groundwater conservation. However, while existing policies were formulated with water as a subject, they did not incorporate a holistic approach to water management. These policies also lack adjudication, administration and enforcement mechanisms to achieve stipulated goals.

Seminal articles on legal, institutional and governance provision in the country were studied to understand their inclusion of WEC. Though not explicitly mentioned, there are provisions for conservation of water resources that are overlooked (see *Appendices 4 and 6*).

There are no direct, formal and binding laws specifically framed for the protection and conservation of water resources in India. After an intensive review of various legal and institution provisions, it is concluded that there is no Act or legal provision that covers water conservation and its efficient usage at the national level. However, there are some examples such as the Andhra Pradesh Water, Land and Trees Act and Rules (2002) that legally enforce water-conservation measures.[3]

There are several standards, guidelines and manuals related to water-resource management that talk about decentralized wastewater reuse through dual plumbing, improving water quality of wetlands by stopping pollutants from entering into waterbodies, enhancing water supply through reduction of NRW and provision of water auditing. These documents give the present status of water management and envisage an improvement to bring it at par with that in developed nations. They are the only source of information that implementers can refer to before they take initiatives in specific directions. However, these documents don't have the same enforcement power as legislations or formally binding laws. They focus on the issue of water management while overlooking solution details (see *Appendix 7*).

Different ministries, departments, authorities and government organizations are involved in WEC in urban areas. They work separately, with some coordination among them, to give shape to urban water management. The important aspects of water management such as groundwater management, sustainable drainage, restoration of waterbodies, reuse of treated/reclaimed water, biodiversity conservation and WEC are dealt by various institutions. Organizations like the Central Water Commission, Central Ground Water Board and Central Public Department Works, under different ministries, are involved in providing technical support, coordination and monitoring water resource.

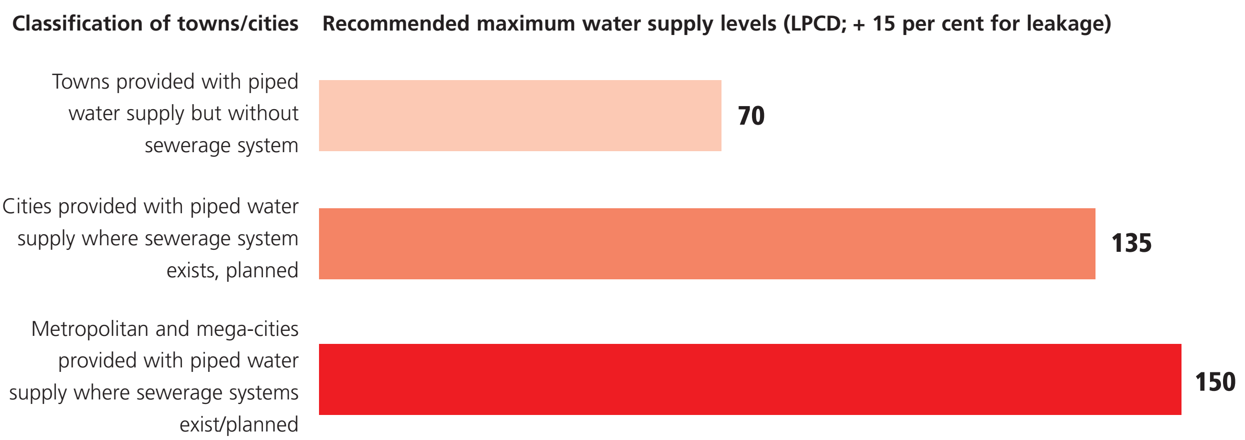
The municipal body is responsible for providing water supply in most places, while in others (mainly metropolitan cities) city-level water supply and sewerage boards have been constituted to perform this function. The common pattern in most cities is that a state-level agency, such as the Public Health Engineering Department/Division (PHED), or a state-level water supply and sewerage board does the capital work and once construction is finished it hands over the responsibility of O&M to the local government. In some cities the state-level agency does the capital work and the O&M while the revenue functions are with the local government. Out of 30 Indian states, only 15 states have PHEDs and 11 states have a water and sewerage board/Jal Nigam, an indication of the mismanagement of water resources in states (see *Appendix 5*).

Cities are expected to estimate water demand based on guidelines issued by the Central Public Health and Environmental Engineering Organization (CPHEEO), a central government agency which recommends norms for water supply based on different classes of cities. CPHEEO recommends that cities without a sewage system supply 70 litres of water per person per day; large metropolitan cities should supply 150 LPCD. In addition, a city can consider a 15 per cent distribution loss; a metro city, therefore, can supply 175 LPCD (see *Figure 7: CPHEEO standards for water supply*).[4, 5]

Several reports indicate that every city tends to make its own rules and estimates its water demand which is called the 'official demand'. Interestingly, cities always overestimate demand, so that there is an even larger demand–supply gap. This situation is then used, invariably, to justify bigger supply schemes.

The CPHEEO manual on sewerage and sewage treatment gives recommendations on quality norms for use of treated sewage for specified activities. It gives various examples of treated sewage currently used in India and abroad. The manual also provides indepth designs of various onsite sanitation systems and suggests use of decentralized wastewater treatment systems.

Figure 7: CPHEEO standards for water supply



Source: CPHEEO, G., 1999. Manual on water supply and treatment. Ministry of Urban Development, New Delhi.

CPHEEO also envisages protection of wetlands in urban areas by reducing the flow of sewage and other polluting agents through its advisory on ‘Conservation and restoration of water bodies in urban areas’.

Apart from guidelines, the MoUD initiated an exercise to develop standardized service-level benchmarks (SLBs) with respect to basic municipal services in 2006. It was prepared with the expectation that state governments and cities would adopt this performance monitoring framework at the ULB/parastatal level, and undertake to regularly collate and analyse the performance data to improve the quality of the decision-making process in the sectors identified under the framework. SLB parameters were identified for four basic urban services: water supply, sewage; solid waste management and storm-water drainage (see *Appendix 8*).[6]

The SLB mentions the percentage of wastewater received at the treatment plant that is recycled or reused after appropriate treatment for various purposes (such as in gardens and parks, for irrigation, etc). However SLB does not focus on the scope of reuse at the decentralized level. Since the measurements are at STP inlets and outlets, the indicator is reported at city/ULB levels.

Further, assuming the setting up of 109 Smart Cities in the country, a committee has been formed under the chairmanship of MoUD to come up with standards for Smart City projects with the BIS.

The BIS has developed ‘Smart City indicators’ in 17 different sectors, with 46 core indicators considered essential for assessing the performance management of city services and quality of life. The 47 supporting indicators are given to promote best practices (see *Appendix 8*).[7]

Under these indicators, the cities would need to maintain the data online with the framework developed by the Ministry of Statistics and Programme Implementation. These indicators are applicable to any city or municipality that wishes to measure its performance.

As per the above analysis, it is evident that various government organizations efforts are making efforts on WEC. There is, however, need for a concerted effort among the organizations to crystallize ideas in one document for the practical realization of sustainable water management.

For implementing any policy, stakeholders working in different sectors need to be involved. Apart from government organizations, the efforts of NGOs and other academic institutions are also required. For example, the National Bureau of Water Use Efficiency Authority (NBWUEA) has been recommended by the IELO. The need to implement a community-based decentralized system for safe drinking water supply in India is identified—TERI has prepared an implementation strategy. The Administrative Staff College of India (ASCI) advocates high-quality continuous urban water supply and sanitation (WATSAN) services for all residents, with a 24 x 7 water supply in a well-managed distribution network, which actually costs less than intermittent (two to four hours a day) systems. WWF India and International Union for Conservation of Nature (IUCN) India have taken up the biodiversity conservation angle along with conservation of waterbodies.

There are also many international organizations (non-governmental, academic, governmental, funding, and more) working on water conservation in several countries. These organizations (World Bank, UN, SWITCH, CIRIA, Asian Development Bank, USEPA, Stockholm International Water Institute, World Water Council etc.) have made significant contributions to water conservation efforts by raising awareness, creating new standards for water efficiency, fund allocation for projects under water conservation and promoting policies and plans related to water conservation (see *Appendix 9*).

There is, however, need for a common platform in which water as a resource is the main focus. *Table 6: Water conservation initiatives* summarizes existing as well as missed opportunities of the aforementioned initiatives that overlook the bigger picture.

Table 6: Water conservation initiatives

Existing approach	Missed opportunities
• Water is increasingly considered a commodity, especially after the colonial period • Most current legal provisions are influenced by historic and colonial rules and haven't been updated to reflect present-day requirements • The focus of various initiatives has been on more water to keep up with increasing demand, without sustainability taken into account • The preferred approach is to supply water from distant sources and dump wastewater at far away places • Inadequate measures of water pricing and cost recovery	• Participation of public/communities in water management has reduced or became extinct • As water is essential to life, it is covered under various institutions (ministries), with different aims and objectives. (For e.g., it is covered by MoUD, MoWR, MoEFCC). The targets or milestones for each institution/ministry are different. There is a need to bring water under one umbrella (a National Water Framework Law has already been suggested) • No action against officials who fail to provide sufficient water or water on time • Prudent use of water resources: Use of local water resource, i.e. storm water, wastewater and rainwater, is missing in most legal provisions • Integrated land-use planning and water management is missing • Underestimated and unaccounted role of groundwater as source of water supply

Source: CSE, 2016

4. Case studies

Technological guidelines recommended in BMPs worldwide are undergoing a transformation, with emphasis on sustainability and affordability. This section presents examples of WEC from countries that practise effective water-management techniques (see *Table 7: Case studies related to water efficiency and conservation*).

Table 7: Case studies related to water efficiency and conservation

Policy	Plan	Programme	Projects
• Policy principles on water conservation and water-use efficiency, California, USA • New water policy framework, Spain • National water law and policy framework, South Africa	• Water conservation and efficiency plan, Orillia, Canada • Water conservation plan, Sydney, Australia	• Four national tap programmes, Singapore • Water conservation through pricing, Texas, USA • Sustainable groundwater management, Denmark • Reduction of non-revenue water, Israel • WaterSense, USA • Toilet replacement programme, New York, USA	• Reuse of treated wastewater at Naval Civilian Housing Colony (neighbourhood scale), Mumbai, India • Urban lake management for Jakkur Lake, Bengaluru, India • Restoration plan for Lake Ngaroto, Waipa district, New Zealand • Rainwater harvesting system, Jodhpur, India • Rainwater harvesting system, Goa University, India • Decentralized wastewater treatment technology: CSE, New Delhi, India • Reuse of treated wastewater at Aravind Eye Hospital (institutional scale), Puducherry, India

Source: CSE, 2016

4.1 Policy-level interventions

Policy principles on water conservation and water-use efficiency, California, USA

Proposed in 2005

Background: California has in recent years made great strides in water conservation and efficiency in water use. The collective impacts of drought, climate change and increasing population and potential for natural disasters have made water conservation and water-use efficiency imperative.

Aim: California's goal is to reduce state-wide per capita water use by 20 per cent by 2020 through implementation of specific measures.

Approach: To enhance reliability of water supply, restore ecosystems, and respond to climate change and a growing population, the state's strategy is to practise water conservation and water-use efficiency. Programmes are implemented to assure measurement and monitoring of water use to provide accountability and transparency towards the accomplishment of water conservation and water-use efficiency goals. In urban areas, policy advocates the implementation of residential and commercial retrofit programmes, innovative pricing strategies and water-efficient landscaping, including implementation of urban BMPs.

Outcome: As the latest data from the State Water Resources Control Board indicates, urban residents are achieving significant levels of water conservation. In 2013, cumulative state-wide water saving was about 23.3 per cent.

Source: Association of California Water Agencies (2014). ACWA Policy Principles on Water Conservation and Water Use Efficiency.

New Water Policy Framework, Spain

Proposed in 2006

Background: Spain has an arid climate and ongoing cycles of drought. However, its traditional water policy did not concentrate on sustainability. In view of this, a new policy was proposed to consider water as an economic, social and environmental heritage that conserves and protects water resources.

Aim: To adopt new European regulations, including modernization of Spain's irrigation systems, new water management in the urban cycle (supply and treatment), risk-based policy planning and an environmental line of action

Approach: The inspiration of this water policy is the desire to reach a rational use of water in terms of sustainability. The goal has the following bases:

(i) Legislative
(ii) Environmental
(iii) Economic
(iv) Socio-political and
(v) Technical

This water programme entails a redirection of Spain's water policy by adding the sustainability, subsidiary, effectiveness and participation principles. In 2006, the Ministry of Environment worked with all the regional governments to establish the basis for a new national plan on water quality, such as the Sanitation and Purification Plan 2007–15. The challenges of urban supply management include anticipating future requirements with regard to water extraction and adequate maintenance of the network. The objectives are to:

(i) Improve control of water generated and supplied
(ii) Adapt facilities and
(iii) Reform and improve the water network and consumption management and incorporate technology

Outcome: Currently adaptation to the new European regulations on framework makes the new policy as an environmental line of action. Spain has finally achieved a good ecological status with regard to almost all waterbodies (groundwater, surface, coastal and transitional).

Source: Martin C. (2008). Water Policy in Spain: A Portrait. CIHEAM 2008, pp. 45–53.

National Water Law and Policy Framework, South Africa

Proposed in 2000

Background: Since 2000, South Africa's water policy has undergone rapid changes. The National Water Resources (NWR) strategy has adopted a framework to deliver safe drinking water to 14 million people who do not have access to drinking water. The National Water Policy is transformational. It not only redresses problems of the past but also helps build a better future.

Aim: The purpose of policy is to promote equitable access to water, redressing past discrimination by equivalent water distribution across the country, facilitating social and economic development, and protecting aquatic and associated ecosystems.

Approach: The National Water Policy provides a two-tier approach to the development of strategies to facilitate the management of water resources. One is an NWR strategy that includes an ecological component, including water conservation and management, and a social and economic component, i.e. international rights and obligations, estimates of present and future water requirements, integrated management by forming objectives for the establishment of institutions and determination of the interrelationships between institutions involved in water-resource management. The second is the catchment-management strategy, which sets out the objectives, plans, guidelines and procedures for the protection, use, development, conservation, management and control of water resources.

Outcome: This policy ensures the approach of involving stakeholders in water resource management and includes sustainability and water-resource management in South Africa.

Source: Karodia H. Weston. 2001, South Africa's New Water Policy and Law.

4.2 Planning-level interventions

Water Conservation and Efficiency Plan, Orillia, Canada

Proposed in 2014

Background: The estimated water demand for the city of Orillia during 2009–13 was approximately 3,904,645 m^3 annually. Of this, roughly 45 per cent was attributed to residential consumers, 41 per cent to industrial consumers and 14 per cent was unaccounted for water. The city planned to reduce water consumption and increase water efficiency.

Several measures were developed based on the observed data to achieve the following sub-goals: education, awareness, data acquisition and direct reduction. All sub-goals were designed to support the overall goal of system-wide reductions.

Aim: The aim was to reduce the total water produced at the water filtration plant annually. The following objectives were designed to achieve this:

- Develop reduction measures that meet social, economic and environmental requirements within Orillia
- Engage residents, industries, commercial businesses and institutions in water efficiency and conservation measures by providing incentives, awareness programmes and educational measures
- Develop measures that promote, monitor and engage in water efficiency within Orillia's facilities and operations.
- To reduce non-revenue water usage throughout the municipal system

Approach:

- Review the current five-year trend for water consumption within the city of Orillia
- Continue to promote existing water-efficiency efforts and provide measures to reduce the impact of the water use in the residential sectors of Orillia
- Invest and coordinate measures to encourage businesses and institutions to promote efficiency and reduction efforts
- Continue efforts to reduce municipal operations water use through the revision of operating practices and upgrading infrastructure
- Minimize peak usage by providing education, awareness and alternative activities for outside water use
- To establish a dynamic working document for water conservation and efficiency, it is anticipated that this plan will be updated every five years

Outcome: These measures reduce consumption, increase environmental awareness and provide alternative environmentally sustainable techniques. The current demographic conditions within Orillia are correlated into the initiation of measures. For this reason, measures must be socially, economically and environmentally feasible within Orillia.

Source: City of Orillia (2014). Water Conservation and Efficiency Plan. Retrieved from http://www.orillia.ca/en/livinginorillia/resources/Environmental_Services/2014_Water_Conservation_and_Efficiency_Plan.pdf

Water Conservation Plan, Sydney, Australia

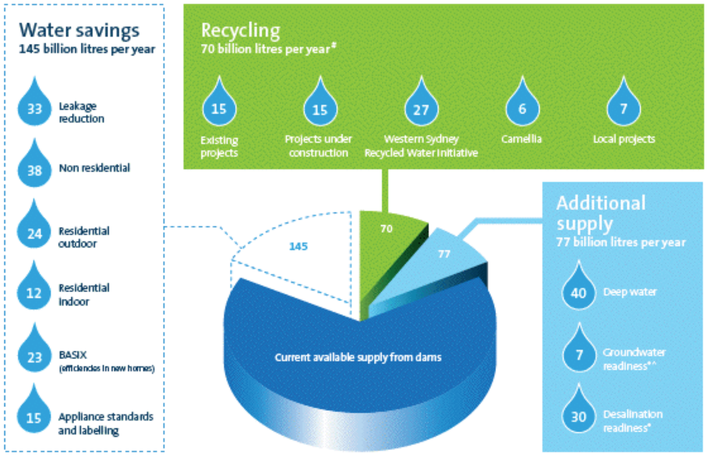
Proposed in 2006

Background: Australia is one of the driest continents on earth. It has been affected by drought several times in recent history. By early 2004, analysis regarding drought response as part of a metro-wide strategy was made. This later became the Metropolitan Water Plan 2004.

Aim: To develop a water conservation plan to respond to drought and manage the water resources of Sydney through proper management and recycling.

Approach: In 2006, as the drought intensified, the plan was further revised through government and inter-departmental stakeholder consultation to greatly expand multi-sector demand management programmes (residential, non-residential and non-revenue water) and encourage use of recycled water. It also included other emergency drought responses. The plan includes water-saving measures in residential outdoors and residential indoors, leakage reduction and creating appliance standards. This was further supported by creating recycling plans for several ongoing projects and existing projects.

Outcome: Finally, the action plan results in water savings up to 145 billion litres per year and recycling up to 70 billion litres per year apart from current available dam water.



Source: Turner, A., White, S., Chong, J., Dickinson, M.A., Cooley, H. and Donnelly, K., 2016. Managing drought: Learning from Australia. Retrieved from http://pacinst.org/app/uploads/2016/07/Managing-Drought-Report-2016-02-23-FINAL-US-Letter.pdf

4.3 Programme-level interventions

Four National Tap Programmes, Singapore

Proposed in 2001

Background: The Water Resource Institute ranked Singapore as the world's most water-stressed country. The water resources of Singapore are precious because of the densely settled land.

Singapore receives an average of 2,400 mm of rainfall annually. The constraint is the limited land to catch and store rainfall and the absence of natural aquifers and lakes.

Aim: By 2060, Singapore's water use is expected to be more than double of what it currently is (430 mgd). The Singapore government is steadily working to increase the recycling of water to meet the rising demand. A recycled water and desalinated water will supply up to 85 per cent of their future needs.

Approach: Four National Taps Programmes comprise four ways of increasing water resources, such as water from catchments, imported water, reclaimed water and desalinated water. Water management in Singapore is closely integrated with land management that includes control of storm-water pollution through sewage, sullage or other sources of pollution in the catchment. The reclaimed water is well within drinking water guidelines set by USEPA and WHO standards.

Singapore's water strategy comes in three parts. First, to maximize their own yield, this means converting land area of the country into a water catchment by keeping drains, canals and waterways pristinely clean. Secondly, to keep water as endlessly reusable and, third, to research desalination technology to meet further needs.

Outcome: Due to best land-management practice, the water catchment area has increased from half to two-thirds of Singapore's land surface. This renovation plan will boost Singapore's water catchment area to 90 per cent by 2060. The reclaimed water meets about 30 per cent of Singapore's water needs.

Source: PUB Singapore (2016). Our water, Our future. Retrieved from https://www.pub.gov.sg/Documents/PUBOurWaterOurFuture.pdf

Water conservation through pricing, Texas, USA

Proposed in 2004

Background: In 2004, the state of Texas's regional water planning groups, water providers and water users were offered the *Water Conservation Best Management Practices Guide* as a tool to plan and design effective conservation programmes. Among the BMPs cited is water conservation through water pricing.

Aim: Preventing land subsidence, addressing water shortages, providing environmental protection and water system improvements by water conservation pricing in the state etc.

Approach: This BMP was intended for all municipal-water-user group 'utilities' wishing to send price signals to customers to encourage water conservation. A utility may have already accomplished this BMP if it has a conservation price structure. Conservation pricing is characterized by the following:

1. Rates for single family residential and other customer classes may be set differently to reflect the different demand patterns of the classes.
2. Rates based on individual customer water budgets in which the unit cost increases above the water budget. Water budget rate structures are based on the philosophy that a certain amount of water is adequate for all normal necessary uses, and uses above that amount are considered excessive and charged as excessive.
3. Conservation pricing should use a consumption charge based upon actual gallons metered. The minimum bill for service should be based on fixed costs of providing that service which generally includes service and meter charges. Including an allotment for water consumption in the minimum bill does not promote conservation and it is recommended that if a minimum is included, it does not exceed 2,000 gallons per month.
4. The utility should educate customers about the rate structure and use billing software that allows the customer to compare water use on their bill with average water use for their customer class as well as their individual water use for the last 12 months.

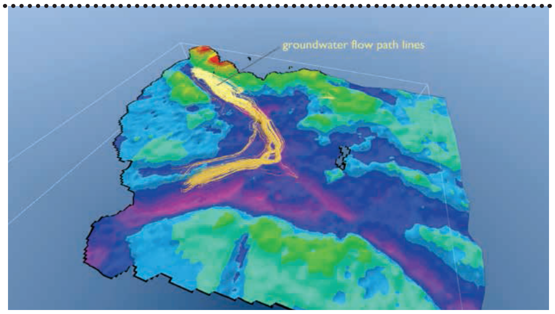
Outcome: As a result of the implementation of BMP, the per capita usage of 6 per cent homes in the state reduced to below 1,000 gallons per month. The goals of the conservation pricing initiatives have been met and accepted by the local constituents.

Source: Texas Water Development Board, Texas (2004). Water Conservation Best Management Practices Guide.

Sustainable Groundwater Management, Denmark

Proposed in 2014

Background: Although Denmark is surrounded by water, freshwater is a scarce resource. Providing enough freshwater for its growing population and increasing industrial production is critical. For this, a strategy of sustainable groundwater development is followed through groundwater mapping.



3D geological model for finding groundwater flow path

Aim: In 2014, the Danish government's decision to protect and secure Denmark's groundwater for future generations led to new innovative methods and tools for conducting groundwater mapping on a large scale.

Approach: Sustainable groundwater management includes new geophysical mapping methods, a unique geophysical database, world-class data processing tools and protocols, and innovative 3D geological modelling software. The advanced methods and tools are scientifically and internationally documented. These methods are continuously improved through tests and establishment of new boreholes.

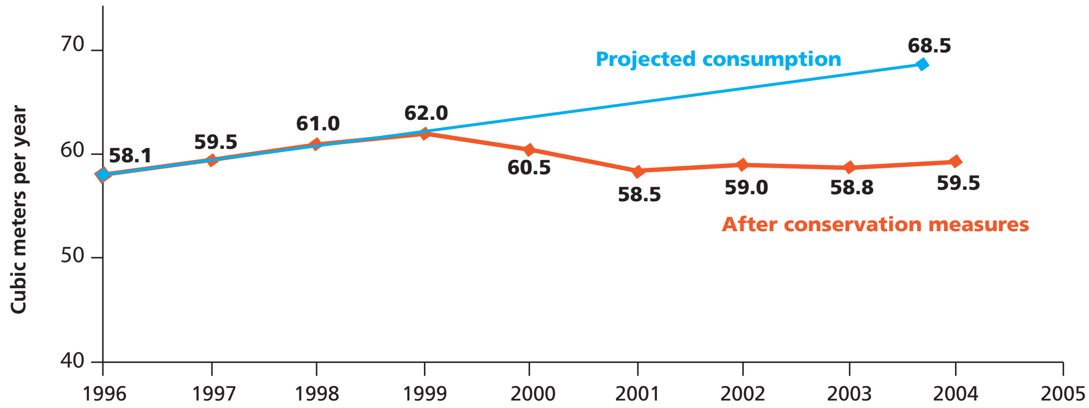
Outcome: Uniform standards and guidelines are created from the data survey. This information is available in national databases that are highly reliable, accessible and accurate. Thus, implementing policy results in sustainable water management.

Source: Geological Surveys of Denmark and Greenland (2014). Greater water security with groundwater. Retrieved from http://www.rethinkwater.dk/sites/default/files/wp_greater_water_security_with_groundwater_v2.0.pdf

Reduction of non-revenue water, Israel

Proposed in 1999

Background: Israel is characterized by desert and semi-desert climatic conditions. Its pioneers set out to make the desert bloom and succeeded. The average natural supply is 1,249 MCM/year. In recent years, the average natural supply has fallen to 1,155 MCM/year, which is 9 per cent below the long-term average.



Difference in residential consumption per capita per year after reduction of non-revenue water

Aim: Israel's Institutional Framework for Water Governance (laid in 1998) stipulates that all water resources are the property of the public. There is no private ownership of water resources in Israel and virtually all water consumption is metered.

Approach: Conveyance losses in Israel are minimized by using two policies. The first is the mandatory provision of using a metered system that immediately detects leakage. The existing manually read meters are being replaced with automated meter reading (AMR), expected to be complete by 2018. The second is pressure management by reducing pressure to levels as low as 3 to 3.5 atmospheres. The national metering system enables estimation of water losses via pipe leakages, thefts, faulty meters, etc.

Outcome: A nation-wide piping system is used for water conveyance and approximately 10–12 per cent of the water is lost in distribution, which is much lower than that in developing countries such as India.

Israel has forged the standard for wastewater recycling. Eighty per cent of its wastewater is treated and reused.

Source: Ministry of Water and Irrigation, Jordan (2015). Annual report.

WaterSense, USA

Proposed in 2006

Background: WaterSense, a partnership programme by the US Environmental Protection Agency (USEPA), seeks to protect the future of our nation's water supply by offering people a simple way to use less water with water-efficient products, new homes and services. The programme maintains high environmental standards without compromising performance.

Aim: Since 2006, WaterSense has promoted the value of water efficiency and provided consumers with easy ways to save water by labelling products with regard to water efficiency and acting as an information resource.

Approach: The WaterSense label identifies high-performance water-efficient products that embrace and encourage the use of water-efficient practices. WaterSense-labelled products use about 20 per cent less water and perform as well or better than their less efficient counterparts. By using WaterSense-labelled products, homeowners can help to save natural resources and reduce their water consumption and utility costs.

Outcome: So far, WaterSense has helped consumers save a cumulative 1.5 trillion gallons of water and over $32.6 billion in water and energy bills. By the end of 2015, a reduction of 212 billion kilowatt-hours of electricity and 78 million metric tonnes of carbon dioxide was achieved through the use of WaterSense-labelled products.

Source: WaterSense, US Environmental Protection Agency (2016). WaterSense. Retrieved from https://www.epa.gov/watersense/

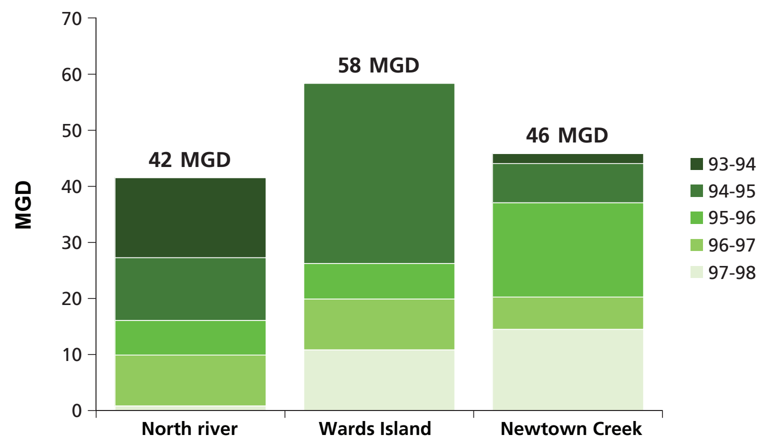
Toilet Replacement Program, New York, USA

Proposed in 1994

Background: The toilet-rebate programme was initiated in 1994 in an effort to reduce water usage. The first phase of the programme started in June 2014.

Aim: To reduce nearly 1.5 billion gallons of wastewater streaming into city sewers on an average day. The idea was to replace about 1.3 million five-gallon-per-flush toilets.

Approach: Under the programme, a residential property owner was entitled to a rebate of up to $240 for the first toilet replaced in a house or an apartment and $150 for each additional replacement. Customers were advised to fill an online application to receive vouchers that could be redeemed at a participating vendor for the purchase of high-efficiency toilets.



Total water savings in selected wastewater treatment plant drainage areas during the original Toilet Rebate Program. Total water savings represented in this graphic are attributable to the Toilet Rebate Program as well as other water conservation measures implemented at the time.

The conditions to participate in this programme were:

- The building must have four or more units
- The water meter is connected to an automated meter reading device
- The building has toilets that use over 1.6 gallons of water per flush.

Outcome: This programme eventually replaced nearly 200,000 toilets in 10,000 buildings citywide and brought a 5 per cent reduction in water consumption, leading to a reduction of carbon emissions by 15,500 metric tonnes per year, the equivalent to removing 3,300 cars from the road.

Source: New York City Environmental Protection (2016). Toilet replacement program (TRP). Retrieved from http://www.nyc.gov/html/dep/html/ways_to_save_water/toilet_replacement_program_faq.shtml

4.4 Project-level interventions

Reuse of treated wastewater at Naval Civilian Housing Colony (neighbourhood scale), Mumbai, India

Implemented in 2005

Background: India has witnessed a rapid increase in urban population during the last few decades. Lack of adequate wastewater treatment facilities has resulting untreated sewage disposal into lakes, rivers and other waterbodies. The cumulative result of unmanaged wastewater that the system cannot cope with has a negative impact on the health of people and ecosystems and is a challenge for ULBs. Conventional wastewater treatment as compared to decentralized treatment requires huge running costs for operation and maintenance over and above capital assets, energy cost and land availability.

Aim: The project implemented in 2005 is a good example of treatment of wastewater generated from neighbourhood buildings demonstrating potential of local reuse in meeting bulk non-potable water requirements i.e. for irrigating the green landscape, parks/gardens and plantations.

Approach: A decentralized system installed in the residential housing colony treats domestic wastewater (both black and grey) using soil biotechnology (SBT). This natural wastewater treatment method treats wastewater, which is used for meeting the landscaping water requirements to maintain green areas. SBT is a good example of decentralized wastewater treatment system and reuse of treated wastewater at the neighbourhood level, demonstrating the value of water and resource potential by local reuse.

The Naval Civilian Housing Colony, in Kanjurmarg, a suburb in eastern Mumbai, has 20 building blocks, including residential facilities. The DWWT system implemented treats the wastewater generated in the neighbourhood from all seven residential building blocks.

Outcome: Treated wastewater is used locally to maintain an estimated green area of 2.2 acres (0.89 hectares). It is also used for meeting 180 days of horticultural water requirements. The decentralized system has reduced the colony's dependence on water tankers. Prior to the implementation of SBT plant, six to seven tankers were required to supply water to meet green area and landscaping water requirements in the neighbourhood. The average cost of a water tanker (capacity 8,000 litres) in Mumbai is Rs 1,200 per tanker. During the last 10–12 years, the water requirements for maintaining the green area have been met by local reuse of treated wastewater available from the SBT plant. The reuse of treated water has resulted in an annual savings of Rs 1.1 million.

Source: Centre for Science and Environment (2014). Decentralised Wastewater Treatment and Reuse. Retrieved from http://www.cseindia.org/userfiles/decentralised_wasterwater_treatment_reuse.pdf

Urban-lake management for Jakkur Lake, Bengaluru, India

Implemented in 2003

Background: Jakkur Lake, in northern Bengaluru, receives rainwater from three storm-water drains, i.e. Yelahanka, Agrahara and Shivanahalli. Because of urbanization and the increase in population, the catchment area is highly encroached on and the lake receives sewage from surrounding households (12,500). The quantity of storm water reaching the lake has reduced, making the streams dry. In early 2003, the state government, local governing bodies, fishermen, end users (domestic purposes) and lake-revival groups made efforts to manage the lake.

Aim: This project ensures the regular supply of treated water to the lake which in turn acts as a water source for its sustainability.

Approach: The following steps were taken to revive the lake:

- It was fenced and de-silted.
- Islands were created and trees planted along the sides of the lake to create bird habitation and maintain natural flora and fauna.

- Wetland plantations were created near the inlet to further filter water naturally as soon as it enters the lake.
- Social sustainability is achieved through community ownership.
- The legal standards for the STP are maintained by the local governing body.
- A separate tank is built for Ganesha immersion during Ganesh Chaturthi or similar religious/cultural festivities that require immersion into a waterbody.

Outcome:
- Jakkur Lake provides livelihood to fishermen. On an average day fishermen collect at least 100 kg of various fish.
- Each day, 100,000 litres of water are drawn from the biggest step well near the lake for agricultural purposes.
- Biodiversity of the surrounding area has improved.
- Land price of nearby property has significant increased.
- Residents living near the lake are increasingly aware of the effort to revive the lake.

Source: Vishwanath S. Jakkur Lake—Urban Lake Management. Retrieved from http://cseindia.org/content/jakkur-lake-urban-lake-management

Restoration plan for lake Ngaroto, Waipa district, New Zealand

Proposed in 1995

Background: Lake Ngaroto is one of the largest lakes in the Waipa district of New Zealand. It is a valuable landscape and recreational amenity. The development of the surrounding land into productive farmland, however, resulted in radical change in the lake and its surrounding riparian margins.

Aim: In early 1995, the Waipa District Council commissioned a plan for the restoration and enhancement of the lake and the surrounding areas.

Approach: The measures taken included planting and re-fencing, and the willow invasions were treated by hand clearing, stump spraying and rapid planting of *Leptospermum scoparium*. Silt traps were constructed on all the inflows of the lake. The objective was to intercept/trap heavier silt moving along the floor of the drains. A walking track was constructed around the lake to increase public awareness. Regular ten-year maintenance programmes involving plantings and weed control are carried out.

Outcome: In the beginning of 2001, the outcomes were twofold. First, the adjacent land area was protected and, second, the lake was restored near to its historic depth and the ecology improved.

Source: Ministry for the Environment, New Zealand (2001): Lake Ngaroto Restoration: ISBN 0-478-24027-9

Rainwater harvesting system, Jodhpur, India

Implemented in 2010

Background: The traditional water management system in Umaid Heritage Residential Complex, in Jodhpur, Rajasthan is gradually getting destroyed by modernization and urbanization. The monumental structure is based on the traditional practice of RWH in Rajasthan. It acts as a storage structure for rainwater as well as a recreational space.

Aim: This structure is a good example of sustainable urban development practice in a low-rainfall region and demonstrates the value of water by conserving rainwater.

Approach: Rainwater is collected from the open areas through natural slopes as well as from the rooftops of houses (with a high runoff coefficient), which in turn are connected with the natural slope of the site through drainage conduits. The structure comprises several longitudinal open rainwater storage structures with a series of constructed tanks, making it 135-metre-long. Rainwater comes from either side of the structure. It first enters the hidden settlement tank from where it flows to the deepest series of tanks that are 18 metres below the ground.

Outcome: The RWH system captures around 21.1 million litres of rainwater, reducing the dependence on municipal water supply or groundwater. The average cost of a water tanker (10,000 litres per tanker) in Jodhpur is Rs 800–1,000. Thus, using rainwater as an alternative source of water saves about Rs 2.36 million annually. The RWH system in the township collects 30 per cent of the potential rainwater on the site to maintain the green area in the complex. Further, the system acts as a recreational space as well as a store for rainwater.

The residential complex has a great property value as it demonstrates a perfect combination of good architectural design and well-maintained green spaces in a scanty rainfall site. In addition, the RWH structure helps create awareness about RWH. The project site is frequently visited by school and college students as well as researchers.

Source: Centre for Science and Environment (2014). Urban rainwater harvesting. Retrieved from http://www.cseindia.org/userfiles/Urban%20Rainwater%20harvesting%20report.pdf

Rainwater harvesting system, Goa University, India

Implemented in 2007

Background: Goa University was largely dependent on groundwater extraction. Overexploitation of groundwater led to drying up of bore wells on the campus. In 2007, the university initiated a plan to develop RWH system to recharge fast-depleting aquifers.

Aim: The key objectives of the RWH project in Goa University is to arrest falling groundwater levels, recharge aquifers and reduce dependence on the overstretched municipal water supply for more sustainable water supply on the campus.

Approach:

- **Surface runoff harvesting:** The total catchment area contributing to runoff for the surface runoff RWH structure is 1.5 hectares to the natural depression, a pond. A protective rubble wall was built around the, which receives mainly runoff from the unpaved surrounding catchment.
- **Roof-water harvesting:** The catchment area of the rooftops at the site is about 400 m^2. The rooftop water intake pipes bring water to the storage tank made of a concrete base and laterite brick wall. The rooftop runoff storage tank has a capacity of 100,000 litres. It passes through a sand and coal filter. After filtration, the water is taken to the nearby recharge bore well feeding the aquifer at 100 metres below ground level.

Outcome: The RWH system has contributed substantially to the recharge of local aquifers in the campus. The water supply is now provided on the campus on a sustainable basis. The RWH system has resulted in an estimated Rs 2.8 million per year savings that would otherwise be required to arrange for water supply through public water-tankers.

The increase in availability of water has also contributed towards the maintenance of the university's lush green landscape and has improved the site's micro-climatic conditions. The RWH system has become a platform of creating awareness. NGOs, government officers, schoolchildren, industry representatives and researchers regularly visit the site to study the system.

Source: Centre for Science and Environment (2014). Urban rainwater harvesting. Retrieved from http://www.cseindia.org/userfiles/Urban%20Rainwater%20harvesting%20report.pdf

Decentralized wastewater treatment technology: CSE, New Delhi, India

Implemented in 2005

Background: The wastewater system at CSE is designed to treat 8,000 litres per day on the assumption that at least 100 persons occupy the premises at any given time. The treatment module includes a settler, anaerobic baffled reactor (ABR), planted filter bed and vortex. Treated wastewater is stored in an underground sump and used for gardening and landscaping CSE premises.

Aim: To treat sewage locally by sustainable decentralized wastewater treatment technology. The treatment system is a combination of different natural processes with little or no energy.

Approach: This treatment system uses the physical and biological principles of nature through aerobic and anaerobic techniques. The grey water after the oil and grease trap goes into a settler for primary treatment. Black water from toilets is simultaneously taken separately into another two-chambered settler from where it goes to ABR for secondary treatment where the suspended solids settle down. The combined treated grey and black water goes into a horizontal planted filter bed to be treated further, mainly to remove excess nutrients. It then goes into the vortex, which helps to remove its odour. Treated wastewater is stored in an underground sump.

Outcome: Tughlakabad Institutional Area has a huge water scarcity. The groundwater table is at the depth of 70 m. About 8 KL of wastewater is treated and reused. The treated water caters to the horticultural requirements of the campus.

Source: Centre for Science and Environment (2005). Decentralised/Sustainable Wastewater Treatment Technologies. Retrieved from http://www.cseindia.org/node/4603

Reuse of treated wastewater at Aravind Eye Hospital (institutional scale), Puducherry, India

Year of implementation: 2003

Background: Aravind Eye hospital, in Puducherry, has a capacity of 720 beds. It serves 137 paying patients and 465 free patients. The hospital campus covers a huge area and maintains a lush green landscape.

Aim: The project is a good example of treatment of black and grey water generated within a hospital premise and demonstrates potential of local reuse even in an environment where maintaining high standards of hygiene is essential. The system aims to reduce demand for freshwater by use of treated wastewater.

Approach: The treatment facility receives more than 340 KLD of wastewater from the hospital building. This includes grey water generated from sinks, bathrooms and kitchens and black water from toilets. The grey water and black water generated in the hospital first enters separate two-chambered settlers. The settlers for black water treatment are integrated with the four anaerobic baffled reactors in parallel because of the high organic load. The partially treated black water then undergoes secondary anaerobic treatment through anaerobic filters. The treated water is then pumped to the rooftop from where it is released at the required pressure into the planted gravel filter bed. Final treatment is done through polishing ponds where the water is stored. Pathogens are removed through the sun's natural UV rays for further reuse.

Outcome: Treated wastewater is locally reused after treatment for horticultural purposes to maintain the green area of 15 acres (6.07 hectares) within the hospital premises. Some treated water is also reused for flushing.

Source: CDD Society, 2003

5. Proposed policy roadmap for urban water efficiency and conservation

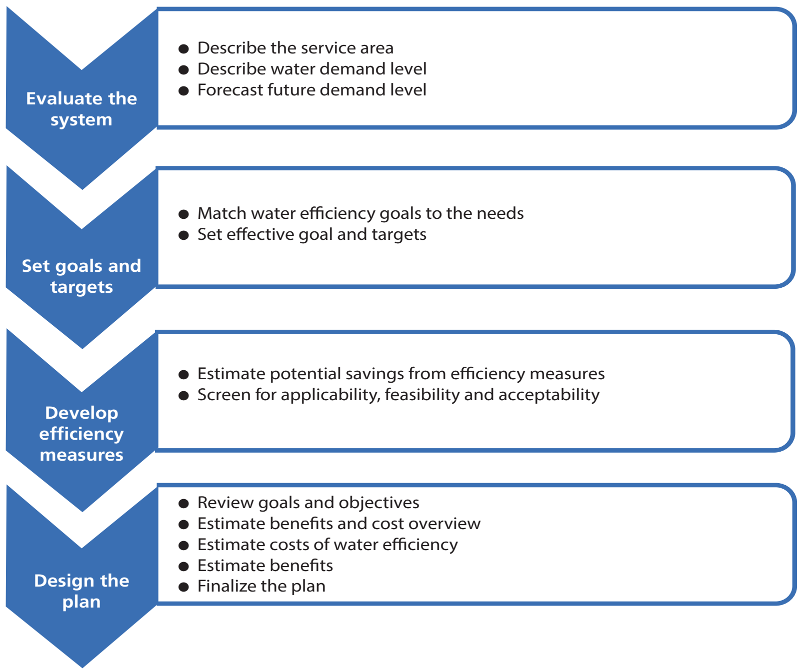
5.1 Water efficiency and conservation at planning stage

Proper planning is required to organize towns, manage their growth and make them habitable and sustainable. Large parts of cities today completely 'escape' mainstream planning. Half the populations of Delhi and Mumbai live in unauthorized areas. The considerable 'illegal development' (illegal layouts, unauthorized constructions, slums) in many towns is a frightening reality that threatens the future of urban areas and credibility of plan documents and regulations. In developing the cities, local water sources (drains, streams, ponds etc.) were completely neglected and the impact of capturing them not even considered.

Planning offers the opportunity to tie different initiatives together to transform land use for extensive development and rapid provision of infrastructure. The organizational structure with necessary managerial capacity and financial budgetary process can be built around planning which can lend itself as a platform to arbitrate global and local changes.

The first step in the preparation of a WEC plan is the establishment of objectives (see *Figure 8: Water efficiency and conservation plan*).[1] If the objectives are related to WEC, the following need to be taken into consideration: meters, data collection, distribution system leakages, goals, efficiency programmes, demand and performance reports.

Figure 8: Water efficiency and conservation plan



Source: Adapted from 'City of Orillia, Water Conservation and Efficiency Plan 2014', prepared by the Environmental Services Department of the city of Orillia.

Scope for water conservation at the planning stage:

- Planning water conservation can help reduce per capita demand, especially when cities face water scarcity. It creates more opportunity for water conservation; local area plans can help decision makers and water managers better use of community open spaces and built-up areas to lend a coherent character to the area.
- Local plans (regional, master, zonal) also provide the opportunity for devising regulations specific to the area such as buffer and eco-sensitive zones where water conservation options can be thought about. For example, floodplain buffers can act as regional recharge zones.

5.2 Proposed roadmap

Based on CSE's *Roadmap for Rating System for Water Efficient Fixtures* and discussions with relevant stakeholders (see *Appendices 1 and 2*), we propose a roadmap for WEC initiatives (see *Figure 9*: *Proposed roadmap for urban water efficiency and conservation*).[2, 3]

(a) MoUD as key facilitator

MoUD is proposed to be the key facilitator for this process. Establishing processes and institutions that would ensure cooperation and convergence between the MoUD and other ministries, especially Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR), is, however, equally important.

(b) Inter-ministerial steering committee

To ensure convergence of interests of concerned ministries, it is mandatory to meet to discuss WEC in urban areas. As part of National Sustainable Habitat Mission, MoUD will play a catalytic role in establishing a national inter-ministerial steering committee, with representatives from MoWR (including from CPHEEO and the National Buildings Construction Corporation), Ministry of Consumer Affairs, Food and Public Distribution (from the Bureau of Indian Standards), Niti Ayog and Ministry of Environment, Forest and Climate Change (MoEFCC).

(c) Technical advisory subcommittee

The Technical Advisory Sub-Committee comprises technical experts who will evaluate the feasibility of concerned recommendations. The subcommittee could have experts from relevant fields, including water, plumbing, public policy/law, management, economics, public health, engineering and CSE. The committee will give inputs on efficacy of centralized institutional setups with regard to water conservation and efficient use of water in urban areas.

(d) Capacity-building programmes

In order to make the water management systems sustainable, it is necessary to build technical and managerial capacity for WEC programmes. Well-trained personnel, including engineers, scientists and technicians, are necessary for successful projects. In some organizations, resource constraints may force staff with limited training to assume supervisory and management positions, posing a challenge to implementing effective programmes.

The following steps are essential to develop human resources effectively:

- Carrying out internal human resource development by courses and on-the-job training
- Developing human capabilities through hiring and retaining qualified personnel

In addition, operations that enhance employment opportunities and utilize reliable mechanisms that can be maintained by locally trained labour should be favoured. Use of the information, education and communication (IEC) model for community-level training is also important as several water reuse and recycling techniques involve actions at the household level. Training materials and methods need to be tailored to meet needs and qualifications of the target audience.

(e) Identify and assess conservation incentives

Incentives that will motivate water users to accept and instal conservation devices and/or implement conservation measures should be identified.

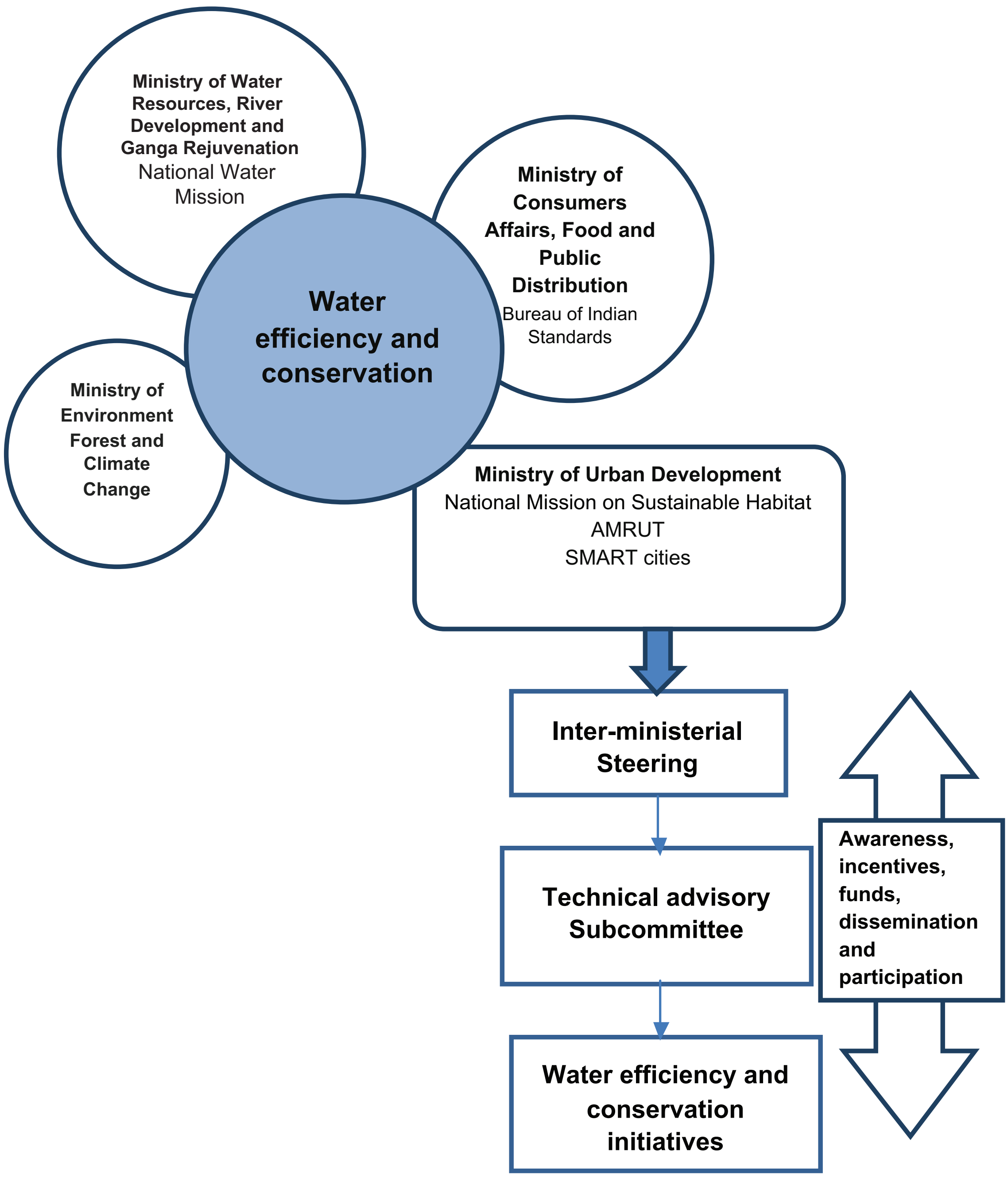
(f) Public awareness

In view of water scarcity in most parts of the country, it is important that the public be made aware of the present and future scenario of water shortage. Encouraging their participation in remedial action is crucial in implementing various interventions in this regard.

To raise the awareness of stakeholders and ensure that their voices are heard, the decision-making process needs to be participatory, with clearly outlined roles and responsibilities. Proactive public outreach initiatives, such as publications, public announcements and site visits are some means to secure wider public acceptance and support.

Civil society organizations usually play an important role in undertaking various activities aimed to raise public awareness. In some countries, local governments and politicians also take part directly to raise public awareness of water conservation, encourage better usage to improve public health, and recycle water for secondary use. Public participation can be scaled up by bringing the community into the decision-making process. Their participation also improves public participation in implementation.

Figure 9: Proposed roadmap for urban water efficiency and conservation



Source: Adapted from S.K. Rohilla, S. Dasgupta. 2010. 'Rating System for Water Efficient Fixtures—A Way to Sustainable Water Management in India', Centre for Science and Environment.

(g) Devolution of funds
This is one of the most important aspects of a project. Replacement of conventional modes with an onsite/decentralized approach will help reduce the cost of laying down a piped network. A constraint in this regard is unavailability of funds with states and ULBs, which decides concrete output in terms of smooth O&M. An innovative approach to realize sustainable management of water in close harmony with nature is needed.

Cognizant the welfare responsibility of states and scarcity of funds, the 14th Finance Commission took a radical turn and recommended an increased share of 42 per cent of the total divisible tax pool as against 32 per cent in 13th Finance Commission from the Centre to states to promote fiscal federalism. It has also doubled the grant for local bodies and recommended that the money be spent on basic amenities.

States should financially strengthen ULBs by radically shifting along the lines envisaged by the 14th Finance Commission. For this, it is pertinent for the state legislature to establish State Finance Commissions regularly to device a formula to empower ULBs on following aspects:
(a) Devolving net proceeds of funds between states and ULBs
(b) Assigning ULBs to raise money through taxes, duties and tolls
(c) Grant-in-aid to be released on a consistent and on a performance basis

(h) Policy recommendations
Policy is essential for the fulfilling of WEC objectives.

Formation of National Bureau of Water Use Efficiency (NBWUE)
It is essential that the NBWUE be established as an authority to meet the stipulated goal of the NWM of reducing water efficiency by 20 per cent by 2017. Since 'water' is a state subject, it is difficult for the Centre to set up an institution of NBWUE. However, the Constitution of India has provisions that lie with state subjects.

Two options are suggested by the Indian Environment Law Organization (IELO) to establish NBWUE.

Option 1: Enact legislation at the national level dealing with WCE. There are different provisions in the Indian Constitution to give it shape:
(a) Article 252: If two or more states approach the Parliament after passing through both houses of legislature to make a law on a state subject, it shall be lawful for Parliament to enact a law in the concerned subject. Any Act so passed by Parliament may be adopted by other states by a resolution passed by each house of the state legislature. The Water (Prevention and Control of Pollution) Act, 1974 is an instance where this provision has been used to have a national legislation on a state subject.
(b) Article 248: Parliament has the exclusive power to make any law with respect to any matter not enumerated in state and concurrent list.
(c) Article 253: To give effect to international agreement, Parliament has the power to make any law enumerated in the state list, and for implementing any international treaty, agreement or convention such as fulfilling the climate change obligation.
(d) The Central government has long been expecting to shift the subject of 'water' to the concurrent list. But this is not easy, given that it would be a retrograde step as it will disturb the decentralization and federal structure of our Constitution.

Option 2: To establish NBWUE as an authority under the Environment Protection Act (EPA), 1986. Legislation provides for the establishment of any institution or authority for protection of the environment. The functions and powers of NBWUE will be wide in respect to financial autonomy, data collection, determination of water-use efficiency, water-budget approval, ensuring water audit periodically etc.[3]

Establishment of a water regulatory authority by states
The 13th Finance Commission suggested the setting up of a water regulatory authority, like the electricity

regulatory authority, for fixing water tariffs, periodical review water sector revenue etc. Starting with Maharashtra, several other states formed the water regulatory authority as follows:

State	Name of authority
Arunachal Pradesh	Arunachal Pradesh Water Resources Regulatory Authority
Uttar Pradesh	Uttar Pradesh Water Management and Regulatory Commission
Jammu and Kashmir	Jammu and Kashmir State Water Resources Regulatory Authority
Kerala	Kerala State Water Resources Regulatory Authority
Gujarat	Gujarat Water Regulatory Authority

Source: A. Vaidya, S. Chahan, S. Siddiqui. 2013. 'Exploring regulatory and institutional mechanisms for enhancing water use and efficiency in India', Indian Environment Law Office (IELO)

The 14th Finance Commission also reiterated the setting up of a 'water regulatory authority' for effectively setting of water tariff to make municipalities financially viable.

(i) Recommendation on creation of council

Seeing the need for water conservation efforts, it is proposed to form a council as a mechanism to oversee the existing BMPs for the efficient use of water in urban areas of the country. This can be supported with MOUs signed between MoUD and state water agencies, environmental groups and other interested parties voluntarily. This council can be a partnership of agencies and organizations working in the area of water supply and conservation of natural resources. The council's membership consists of three groups:

Group 1: Consists of water suppliers. A water supplier is defined as any entity (including a city) that delivers or supplies water for urban use.

Group 2: Consists of public advocacy organizations. A public advocacy organization is defined as a nonprofit organization whose primary mission is protection of the environment, or who has a clear interest in advancing the BMPs and whose primary function is not the representation of trade, industrial or utility entities.

Group 3: Consists of other organizations who work in the similar field with an interest in the purpose of the council which are not included in Group 1 or Group 2.

The council's major function will be to encourage and oversee BMPs which are conservation programmes or measures that signatory water suppliers have agreed to implement in the manner and according to the time frame specified in the MoU.

The following are examples of foundational BMPs:

Utility operation programmes

- Conservation cell: Designation of staff coordinator or agency conservation programmes
- Prohibition on wasting water: Enforced prohibition of wasteful use of water
- Wholesale agency assistance: Support by wholesalers for conservation programmes of retail water suppliers
- Water loss control: Top-down distribution system audits calculated annually, and leak detection as needed
- Meeting with commodity rate: Metering of consumption and billing by volume
- Conservation pricing: Uniform or increasing block rate structure, volume-related sewer charges and service cost recovery

Education programmes
- Public information: To promote water conservation
- School education: Provision of educational materials and services to schools

Residential
- Water surveys and assistance: Site-specific indoor and outdoor solutions for high residential water use and distribution of water-saving devices. Rebate for high-efficiency water fixtures
- Water-sense toilets: Programmes promoting replacement of high-water-using toilets with high-efficiency toilets
- New residential development: Incentives or rules requiring higher levels of efficiency in new homes

Commercial and institutional
- Commercial and institutional conservation: Programmes to increase water-use efficiency in institutional sectors

Landscape
- Large-landscape conservation: Water efficient irrigation systems.[5]

The way forward

The steering committee must be formed by the MoUD in convergence with MoWR to take forward the idea of WEC in the context of the overall vision of the ministry. The strategy needs inputs from relevant stakeholders from the government and non-government actors. This should be the first task for the steering committee. MoUD can take lead to implement the strategies in urban areas of the country. The implementation strategy should have milestones and a target date.

Table 8: Strategies that can be adopted to implement water efficiency and conservation explains the short- to long-term strategy that can be adopted to implement WEC.

Table 8: Strategies that can be adopted to implement water efficiency and conservation

Short term	Medium term	Long term
• Technical group/steering committee • Water regulatory authority in each state • Set aim and objectives for WEC • Pressure management in reducing leakages • Target set with specific milestones • Training and capacity building • Enforce existing rules • Foster mass awareness	• Plan policy/programmes on WEC • Formation of National Bureau of Water Use Efficiency (NBWUE) • Form legal provisions in the form of Water Conservation Act • Plan pilot projects • Test water-efficient technological products • Community engagement • Provision for sustainability • Setting the target year for reducing per capita water demand • Recycle water use through dual-reticulation system • Encourage RWH mechanism in every house with roof	• Set benchmarks for water conservation and efficiency • Suggest indicators to measure conservation and efficiency • Implement monitoring and evaluation programmes • Implement institutional restructuring if required • Reduce water demand of the city • Create self-sustaining city • Update database of all the relevant information in GIS format after water audit • Sustainable urban drainage management

The present policy paper reaffirms previous suggestions given by CSE to form a policy on water conservation and efficiency. The policy should reflect the full, long-term value of water and its wider value to society, economy, environment, wellbeing, health and community cohesion as well as including scarcity value.

Conclusion

This paper fulfils the need to develop a policy and enabling framework aimed at mainstreaming conservation and efficiency in urban water and drainage/storm management, conservation of lakes and other waterbodies, and rainwater harvesting and groundwater recharge, including reuse/recycle of treated wastewater. The approach is to supply quality water to urban areas, prevent crisis by making best use of available technologies, conserving existing water resources, converting them into usable form and making efficient use of them in different sectors. Strategies are detailed to improve existing management models by working on demand management, including usage of water efficient fixtures, reducing NRW and operating, maintaining and monitoring these systems.

To minimize the negative impacts of overuse and misuse of water and ensure that it is used optimally in removing poverty and achieving economic and human development, it is necessary that we have a water policy that recognizes and adequately addresses the challenges we face or will face. A national water policy for the twenty-first century has to recognize water as a national resource for the purpose of national development goals and planning, water has to be managed in a decentralized way, with partnerships between local communities and concerned state governments. The policy should provide broad guidelines and be flexible enough to suit the various conditions in each watershed and river basin, such as the agro-climatic zone, location of polluting and other industries, the location of towns and population density. Different regions of the country, endowed differently with water in the form of precipitation, surface flows and groundwater, need their own region-specific water policy, which can be based on broad guidelines.

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Appendix 1: Stakeholder consultation meeting

Minutes of the stakeholder-cum-expert group consultation meeting for preparation of policy brief on water efficiency and conservation

25 November, 2016 in New Delhi

Addresed by Suresh Rohilla, with a brief background on CSE's journey since 2009 as CoE designated by MoUD, Government of India, in the area of sustainable water management. Dr Rohilla highlighted CSE's engagement in preparing roadmap for water-efficient fixtures, sensitization and capacity-building in sustainable urban water management earlier under JnNURM (2013) and now supporting AMRUT cities for mainstreaming BMP.

The ministry has invited CSE to prepare a policy paper **'Water efficiency and conservation'** to include:

- Need for a shift from the supply side of water management towards more prudent management
- Need for a preventive approach at the planning stage

Salient features of the CSE presentation on the policy paper presented by Mahreen Matto
The presentation set the tone for the need of policy paper of WEC at national level in India. Through the presentation, it was reflected that although there are many policies/guidelines/acts which are on water but none of them talk about the holistic approach of taking WEC together involving all stakeholders and under one umbrella. Even if some policies talk about conservation and efficiency, nothing is implemented on the ground and a focus on urban water management is missing.

The presentation also showcased how the above topic is taken in developed countries like Australia and USA (with the help of case example) and how it can be used strategically in India taking the ecosystem into account rather than water as a resource. The aim is to make a holistic policy document with an implementable action plan.

Discussion on framework of policy paper

CSE representatives:
Suresh Rohilla
- Mismanagement of water resources
- Important is to influence municipal waterbody so that they can take the initiative of WEC forward
- The need of the hour is to have practical solution which has a cooperative approach
- Refer to all the guidelines that exists, such as green spaces, building by CPWD, URDPFI guidelines

BIS representative
S.D. Rane
- Shared the Website for Draft Indian Standard with regard to Smart Cities – Indicators (http://www.bis.org.in/sf/ced/CED59(10000)_30092016.pdf)
- Technical standard for dual piping made compulsory
- NBC document released in December 2016 that covers water supply, reclamation, maximum flow permission which will be a guiding document
- Standards for water-efficient fixtures is due to be finalized and will be expedited
- Microclimate and humidity impact and air pollution has very serious impact on water conservation

Representative from NWM, Ministry of Water Resource, River Development and Ganga Rejuvenation
Joginder Singh
- Consider solid waste management as an action area in the policy document
- Dual piping, reuse of water and RWH to be considered
- Real-time monitoring of water use should be there.

Representative from IELO
Shilpa Chohan
- Started work in 2012 and finished in 2014 on 'Model National Institutional Framework on Water Use Efficiency (Industry, Commercial, Domestic Urban Sector)' based on four study states—urban, commercial, domestic sector (Maharashtra, Himachal, Chhattisgarh and Meghalaya) but action is still missing.
- Need for independent legislation for water usage and efficiency as is no one is looking at it holistically. Notification under EPA 1986 for establishing National Bureau of Water Use Efficiency as an authorized apex body.
- Political buying is very important if we want execution. Example: rainwater harvesting in Tamil Nadu

Representative from Environmental Engineers and Consultants Pvt. Ltd
P.Z. Thomas
- No apex body formation. Do not take option 2, i.e. NBWUE as an authority under the Environment Protection Act, 1986 of the 'Model National Institutional Framework on Water Use Efficiency (Industry, Commercial, Domestic Urban Sector)'
- Strict moratorium if influx of population is not factored in

Representative from ICLEI
Meesha Tondon
- Policy paper talks about water as supply side, it should also incorporate IWRM like conservation at catchment level
- Diversify the stakeholders by also including PHED, irrigation, medical, power etc.
- Institutional restructure under a single umbrella supported by example of Emscher region

Representative from Alliance to Save Energy
Pradeep Kumar
- Realistic planning needs good data. In absence of data, assumptions are taken. Need to have metered and monitoring based systems that should reflect in policy paper
- Involvement of private organization
- Benchmarking for water target

Representative from TERI
Fayaz Ahmad
- Concern of water leakage and storm-water management should be addressed in the policy paper

Representative from INTACH
Manu Bhatnagar
- Focus on urban domestic and leave industrial out of the scope as it has different set of standards
- To have indicators of water efficiency as well as other parameters for Smart Cities

Members present: S.D. Rane (BIS), Rajpal (BIS), Shilpa Chohan (IELO), Meesha Tandon (ICLEI), Fayaz Ahmad (TERI), Raktim Haldar (TERI), Pradeep Kumar (Alliance to Save Energy), Manu Bhatnagar (INTACH), Joginder Singh (NWM, Ministry of Water Resource, River Development and Ganga Rejuvenation), Rakesh Kumar Gupta (Centre Water Commission), P.Z. Thomas (Environmental Engineers & Consultants Pvt. Ltd), Abhijit Rastogi (SPA) and CSE representatives (Suresh Rohilla, Mahreen Matto, Chhavi Sharda and Mritunjay Kumar)

Appendix 2: National Seminar on Mainstreaming Sustainable Urban Water Management

27 December, 2016

Magnolia Hall, India Habitat Centre, New Delhi

The CSE Water Team conducted National Seminar(s) on mainstreaming sustainable urban water management.

Seminar 1: Mainstreaming urban water management and efficiency

Through the seminar(s) CSE proposed policy framework in the above thematic areas, highlighted BMPs and sought stakeholder consultation and involvement before their finalization.

Participants involved mixed group of stakeholders including representatives from government, non-government, academia, civil society and practitioners.

The proposed policy framework encompasses:

- Policy framework for water conservation/efficiency and energy efficiency will lead to making India a water-frugal economy and meeting the SDGs.
- Strategies introduced to improve existing management models by working on demand management including usage of water efficient fixtures, reducing NRW and operating, maintaining and monitoring these systems
- Energy efficiency is not only for sustainable urban water management but also a tool for carbon mitigation in cities
- Water-sensitive urban design and planning approach can lead to mainstreaming intervention for water and resource efficiency leading us to becoming a water prudent society.

Press release: http://cseindia.org/content/cse-proposes-novel-policy-framework-planning-designing-and-implementing-best-management
Details: http://cseindia.org/content/national-seminars-%E2%80%9Cmainstreaming-sustainable-urban-water-management-issue-and-challenges-pol

Appendix 3: Traditional systems of water conservation in India

Zings of Ladakh are small tanks that collect melting glacier water. A network of guiding channels bring water from glaciers to the tank. The melting waters of the glacier turn into a flowing stream by the afternoon. The water collected is used in the fields for irrigation purposes. Similar to Zings, *kuhls* in Himachal Pradesh, Jammu and Kashmir, and Uttarakhand are diversion channels leading spring or stream water directly to fields.
Zabo of Nagaland are pond-like structures created on the terraced hills where rainwater that falls on forested hilltops is collected by channels that deposit the runoff water. From here the water goes into paddy fields.
Stream or river-fed storage structures, sometimes built in a series, with overflow from one becoming runoff for subsequent ones. These structures are called system tanks in Tamil Nadu, *bandharas* in Maharashtra and *keres* in Karnataka.
Inundation channels called dug wells that allow floodwaters to be diverted to agricultural lands are built in the floodplains of major rivers (e.g. flood irrigation system of West Bengal). In specific types of soil and cropping regions, people also store rainwater in the agricultural fields by bunding them, e.g. *haveli* system of Madhya Pradesh.
Step wells (*baori/jhalara*) are a unique form of underground wells most prevalent in Rajasthan and Gujarat. They function both as a source of water as well as a meeting and resting place for men and women drawing water. Located away from residential areas, the water quality in baoris is considered good to drink.
Bamboo drip irrigation system is an ingenious system of efficient water management that has been practised for over two centuries in northeast India. Tribal farmers of the region developed a system for irrigation in which water from perennial springs is diverted to terrace fields using varying sizes and shapes of bamboo pipes. Best suited for crops needing little water, the system ensures that small drops of water are delivered directly to the roots of the plants. Water enters at 18–20 litres per minute, travels several hundreds of metres and finally leaves at 20–80 drops per minute at 80 feet.
Taanka is a traditional rainwater harvesting technique indigenous to the Thar Desert of Rajasthan. A taanka is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows. Water stored in a taanka can be used for potable purposes.
Water soak pits, called *madakas* in Karnataka, *pemghara* in Odisha and *johad*s in Rajasthan, are one of the oldest systems used to conserve and recharge groundwater. They are constructed where there is naturally high elevation on three sides; soil is excavated to create a storage area and used to create a wall on fourth side to hold water. Johads collect monsoon water, which slowly seeps in to recharge groundwater and maintain soil moisture. Sometimes, many johads are interconnected with a gulley or deep channels with a single outlet in a river or stream nearby to prevent structural damage.

Source: Agarwal, A. and Narain, S., 1997. *Dying wisdom. Rise, fall and potential of India's traditional water harvesting systems*, State of India's environment: a citizens' report

Appendix 4: Water policies and plans in India

Legal provisions/ policies	Key points	Provision for urban WEC
National Water Policy (1987)	• Water allocation priorities were set with drinking water as foremost • Emphasis on water zoning of the country and economic activities guided and regulated in accordance with such zoning • Maximize availability by bringing available water resources within the category of utilizable resources	• Water rates focused to cover the annual maintenance and operation charge
National Water Policy (2002)	• Envisages that water is the part of larger ecosystem • Drinking water should be provided to entire population	• Promotion for non-conventional methods for utilization of water, such as recharge of groundwater and rainwater harvesting, is mentioned • Principle of 'polluter pays' should be followed in management of polluted water.
National Environment Policy (2006)	• Mainstream the environmental concerns in all developmental activities • Covers surface water, groundwater and wetlands	• Emphasis on groundwater conservation • Impact on electricity tariff/diesel pricing on groundwater extraction is highlighted • Promotion of efficient water use techniques by sprinklers/drip irrigation. • Selecting crops that can be grown with water-efficient measures
National Water Policy (2012)	• To treat water as an economic good which, MoWR claims, is to promote its conservation and efficient use • Intended for the privatization of water-delivery services • Focused on making availability of safe drinking water as preemptive needs	• Discusses a broad aspect of water conservation in urban, industrial and agricultural uses • Measures to enhance water availability by pricing of water, recycling of grey water and watershed management, including rainwater harvesting, use of scientific techniques such as desalination is discussed. • In view of autonomous working of municipality water users association should be given statutory power to decide and collect water bills which will include sewerage charges also.
National Water Mission (2008)	• Recommends water-use efficiency programmes, including water conservation, water recycling	• Promotion of citizens and state actions for water conservation, augmentation and preservation • Increasing water use efficiency by 20 per cent by 2017
12th Five Year Plan (2012–17)	• Focuses on the need to invest in water and wastewater management that is both sustainable and affordable. • Covers recommendation for new institutions, groundwater laws. • Protection and use of local water sources before planning for the long-distance transportation of water projects. • Repair, renovation and restoration of waterbodies guidelines	• Comprehensive water audit plans to offer cost-effective water-efficient technologies. Mainly for industries • Provision to create forum that provides gateways on water conservation (RWH/recycling and reuse/ water conservation devices)
National Mission on Sustainable Habitat	• One of the eight core missions under NAPCC to make cities sustainable through improvements in energy efficiency of buildings, water supply and water management.	• Wastewater reuse, storm-water management including rainwater harvesting, wherever possible

Source: Compiled by CSE, 2016

Appendix 5: Status of policies, departments and boards in Indian states

S. no.	State	State water policy	PHED	Water and sewerage board
1	Andhra Pradesh	Andhra Pradesh State Water Policy (2008)	√	Hyderabad Metropolitan Water Supply and Sewerage Board
2	Arunachal Pradesh	X	√	X
3	Assam	Assam State Water Policy (2007)	√	Assam Urban Water Supply and Sewerage Board
4	Bihar	Draft State Water Policy (2010)	√	Bihar Rajya Jal Parishad, (BISWAS Board.)
5	Chhattisgarh	X	√	X
6	National Capital Territory of Delhi	Delhi Water Policy (2016)	X	Delhi Jal Board
7	Goa	Goa State Water Policy (2000)	X	X
8	Gujarat	Draft State Water Policy	X	Gujarat Water Supply and Sewerage Board
9	Haryana	Haryana State Urban Water Policy (2012)	X	X
10	Himachal Pradesh	Himachal Pradesh State Water Policy (2013)	√	X
11	Jammu and Kashmir	Draft State Water Policy	√	X
12	Jharkhand	Jharkhand State Water Policy 2011	X	X
13	Karnataka	Karnataka State Water Policy (2002)	X	Bangalore Water Supply and Sewerage Board
14	Kerala	Kerala State Water Policy (2008)	X	X
15	Madhya Pradesh	Madhya Pradesh State Water Policy (2003)	√	X
16	Maharashtra	Maharashtra State Water Policy (2003)	X	Maharashtra Water Supply and Sewerage Board
17	Manipur	Draft State Water Policy,2015	√	X
18	Meghalaya	Draft State Water Policy,2015	√	X
19	Mizoram	X	√	X
20	Nagaland	Draft State Water Policy	√	X
21	Odisha	Orissa State Water Policy (2007)	X	X
22	Punjab	Punjab State Water Policy (2008)	X	Punjab Water Supply and Sewerage Board
23	Rajasthan	Rajasthan State Water Policy (2010)	√	X
24	Sikkim	X	√	X
25	Tamil Nadu	Tamil Nadu State Water Policy (1994)	X	Tamil Nadu Water Supply And Drainage Board /Chennai Metropolitan Water Supply and Sewerage Board
26	Telangana	X	X	X
27	Tripura	X	X	X
28	Uttar Pradesh	Uttar Pradesh State Water Policy (1999)	X	Uttar Pradesh Jal Nigam
29	Uttarakhand	X	X	Uttarakhand Peyjal Nigam
30	West Bengal	X	√	X

Source: Compiled by CSE, 2016

Appendix 6: Water acts in India

Acts	Key points	Provision for urban WEC
Pre-Independence		
The Easement Act (1882)	• All rivers and lakes under absolute right of the state and No individuals right or claim can be made over it	• To control water use for the larger public good, the northern India Canal and Drainage Act was brought to the forefront
Land Acquisition Act (1894)	• Land owner's right over the groundwater under the consideration of easement connected to dominant heritage i.e. Land	-
Post- Independence		
7th Schedule—Entry 17	• States will have jurisdiction over water within their boundaries	-
Union List—Entry 56	• In the public interest, state are subject to Entry 56 in the Union List that allows the Central government to regulate and develop the interstate river and river valleys	-
River Board Act (1956)/ Interstate Water Dispute Act (1956)	• Centre to advise state government on regulation and development of interstate river development projects. This Act has not been used in practice	• Guide government on conservation and optimum utilization of water resources • Conservation is mainly at catchment level
Water (Prevention and Control of Pollution) Act (1974)	• To prevent and control water pollution and restoring of wholesomeness of water • Establishment of Central and State Pollution Control Boards (CPCB/SPCB)	• Emphasis on dealing with industrial pollution • Poor enforcement with respect urban waterbodies conservation
Water (Prevention and Control of Pollution) Cess Act (1977)	• To levy and collect cess on water consumed by industries and local authorities. • Prescribes the maximum quantum of water to be used by different industries	• Mandatory for local authorities and industries to affix water meters • Act provide opportunity to mandate on water use efficiency for different users • Rebate on protecting water from being polluted and also on water saving from over exploitation
Environmental Protection Act (EPA) (1986)	• Water is defined as component of Environment. • Central Ground Water Authority formed under EPA	• Authorize the Central government to protect and improve water quality
Andhra Pradesh Water, Land and Trees Act and Rules (2002)	• Component of groundwater protection with registration of wells • Gives provision to formulate guidelines to recycle and reuse waste water by various sectors including ULB	• The only Act enacted by any state in India that covers a matter related to water conservation
Maharashtra Water Resource Regulatory Authority Act (2005)	• Promote efficient use of water and to minimize the wastage of water and to fix reasonable use criteria for each category of use.	• Promote water harvesting for surface water availability for areas where groundwater availability is poor • Review and revise the water charges • Augmentation of water resources through recycles and reuse especially for industries
Town and Country Planning Acts of various states	• Himachal Pradesh, Bihar, Kerala, Gujarat, Tamil Nadu formulated TCPA	• Cover developmental aspects related to water (supply and sewerage). • Suggest preparation of Master plans which indicate conservation of existing water bodies in cities

74th Constitutional Amendment (1992) 12th Schedule	• Devolution of powers to ULBs for governance • 18 tasks listed for ULB	• Task 6 deals with water supply for domestic, industrial and commercial usage • Task 8 deals with the protection of environment and promotion of ecological aspects
Draft National Water Framework Act proposed in 2011	• An Act to provide a broad overarching national legal framework of general principles on water as a vital and stressed natural resource • An umbrella statement of general principles governing the exercise of legislative and/or executive (or devolved) powers by the states and the local governing bodies	• Includes differential water pricing with full cost recovery to be made for high and medium income group • Water market should be regulated in the interests of equity, social justice, resource conservation and the protection of the aquifer

Source: Compiled by CSE, 2016

Appendix 7: Water guidelines and manuals in India

Guidelines and manuals	Key points	Provision for urban WEC
Guidelines and benchmarks for green large area development	• Focuses on preservation of surface water and water quality, protecting and enhancing on-site water resources, reusing and recycling wastewater and sustainable storm-water management for large-area development	• Promotion of dual plumbing/dual water distribution system to recycle and reuse treated wastewater • Encouraging decentralized wastewater systems and safe disposal of generated sludge in all large development
EIA	• Tool for imposing restrictions and prohibitions on new projects or activities, or on the expansion or modernization of existing projects or activities based on their potential environmental impacts on water and other natural resources	• The risks of contamination of water from pollutants that affect drainage and runoff
Advisory on Conservation and Restoration of Water Bodies in Urban Areas by CPHEEO	• Reflects the environmental and social impact of lake restoration and also suggested steps in Lake Conservation, additional support by the Government of India for the water conservation is discussed.	• This document gives only management, not technical, support
BIS Standards	• Sets acceptable limits and the permissible limits for water	• Assessing the quality of water resources, and to check the effectiveness of water treatment and supply by the concerned authorities.
CPHEEO Manual	• Summarizes legal and policy matter related to water quality monitoring and management	• Useful for formulation of action plan to restore water quality. • In-spite there is no consideration for storm water which largely affects water quality.
General Guidelines for Water Audit & Water Conservation by CWC	• Discusses action plans for water conservation and describes steps for water audit	• Water audit—studying and reducing NRW—proved to be an effective tool to minimize water wastage and increase revenue for municipality • Focuses on surface water as well as groundwater, rainwater harvesting, improving water quality, and cleaning up polluted rivers and lakes etc.
NRW reduction tool kit by JnNURM	• Provides the idea of auditing water supply and calculating losses at various stages	• Helps enhance efficiency of transmission and distribution network
Conservation and management of lakes by MoEFCC	• Describes legal and regulatory framework and technologies involved in lake restoration	• Removing the nutrients from the lakes, control of organic load, control of the nutrient input are helpful in restoration of lakes. • Catchment based initiatives along with policy initiatives for protection of lakes is discussed.

Source: Compiled by CSE, 2016

Appendix 8: Water and sanitation: Service-level benchmarks

Benchmarks at a glance

Water supply services		
S. No.	**Proposed Indicator**	**Benchmark**
1	Coverage of water supply connections	100%
2	Per capita supply of water	135 lpcd
3	Extent of metering of water connections	100%
4	Extent of non-revenue water (NRW)	20%
5	Continuity of water supply	24 hours
6	Quality of water supplied	100%
7	Efficiency in redressal of customer complaints	80%
8	Cost recovery in water supply services	100%
9	Efficiency in collection of water supply-related charges	90%
Sewage management (sewerage and sanitation)		
1	Coverage of toilets	100%
2	Coverage of sewage network services	100%
3	Collection efficiency of the sewage network	100%
4	Adequacy of sewage treatment capacity	100%
5	Quality of sewage treatment	100%
6	Extent of reuse and recycling of sewage	20%
7	Efficiency in redressal of customer complaints	80%
8	Extent of cost recovery in sewage management	100%
9	Efficiency in collection of sewage charges	90%
Solid waste management		
1	Household-level coverage of solid waste management services	100%
2	Efficiency of collection of municipal solid waste	100%
3	Extent of segregation of municipal solid waste	100%
4	Extent of municipal solid waste recovered	80%
5	Extent of scientific disposal of municipal solid waste	100%
6	Efficiency in redressal of customer complaints	80%
7	Extent of cost recovery in SWM services	100%
8	Efficiency in collection of SWM charges	90%
Storm-water drainage		
1	Coverage of storm-water drainage network	100%
2	Incidence of water logging/flooding	0%

Source: Handbook of Service Level Benchmark 2008, Ministry of Urban Development, Government of India

Appendix 9: International organizations working in the area of water efficiency and conservation

<table>
<tr><td>World Bank</td><td>World Bank—Water Global Practice

Helping countries achieve water security for all, while eliminating extreme poverty by 2030 and boosting shared prosperity for the poorest 40 per cent, lies at the core of the World Bank Group's goals. The World Bank's Water Global Practice (GP) was established in 2014 to confront the complexities of the 21st century. Based on the idea that water security should be everyone's business, GP decided to move beyond the traditional lens to embrace Water Writ Large, linking improved water management and the services it delivers as an input to achieving the SDGs in other sectors.</td></tr>
<tr><td>UN</td><td>UN-Water Work Programme 2016–2017 including an Integrated Water Resources Management (IWRM)
• UN-Water is the entity that coordinates the work of the United Nations on water and sanitation. UN-Water's overarching focus in this 2016–2017 biennium is to support Member States as they start implementing the 2030 Agenda
• Informing policy processes and addressing emerging issues
• Supporting monitoring and reporting on water and sanitation
• Building knowledge and inspiring people to take action

In recent years, the United Nations has started to take the need for water conservation to heart. In response to a looming threat of water shortages, the UN has created a plan for a Water for Life Decade, including an Integrated Water Resources Management (IWRM) plan.</td></tr>
<tr><td>GIZ</td><td>GIZ's Integrated Water Resources Management (IWRM) Working Group

GIZ is active in over 130 countries on behalf of the German Federal Government. It currently provides advisory services to 400 water and wastewater utilities in 16 countries around the world in order to improve their services. Integrated water resources management (IWRM) takes into account all interests that exist in a given water catchment area.</td></tr>
<tr><td>The Global Water Partnership</td><td>Integrated Urban Water Management (IUWM): Toward Diversification and Sustainability

The Global Water Partnership is an intergovernmental organization of 13 regional water partnerships, 84 country water partnerships and more than 2,800 partner organizations in 169 countries. The vision is to have a water secure world through IWRM.

An IUWM approach integrates planning for the water sector with other urban sectors, such as land, housing, energy, and transport to avoid fragmentation and duplication in policy- and decision making.</td></tr>
<tr><td>SWITCH</td><td>SWITCH approach

The SWITCH Consortium represented academics, urban planners, water utilities and consultants. The main goal of SWITCH was finding new solutions to increase the efficiency of urban water systems through rethinking old paradigms and developing new solutions.

A major outcome of the SWITCH project is the development of the 'SWITCH approach', that is envisaged to cause a 'switch' in urban water management practices, of cities towards sustainability. The Switch project adopted a 'grey to green' approach, recognizing that green infrastructure (like parks and clean rivers) is not only 'nice to have', but also provides 'the environmental foundation that underpins the function, health and character of urban communities'.</td></tr>
<tr><td>CIRIA</td><td>CIRIA is the construction industry research and information association.

Working with the members and the wider industry, CIRIA have delivered over 1,000 collaborative projects, providing authoritative guidance and helping to solve common industry challenges. The various programme of research projects encourage industry collaboration and help improve the quality, efficiency, cost effectiveness and safety of the modern built environment.

Sustainable water management
• 2802 Accreditation and/or assessment of SuDS—scoping study
• 2866 Guidance on the inspection and maintenance of SuDS
• 2969 Local Authority SuDS Officer Organisation (LASOO)
• 2970 Guidance on natural flood management
• 3043 Incentivization and funding for SuDS
• 3079 Delivering successful integrated water management through the planning system
• 3083 Resource pack to improve SuDS construction
• 3085 Guidance on cost effective SuDS delivery</td></tr>
</table>

WaterAid	Global Strategy 2015–2020 WaterAid is an international organization whose mission is to transform the lives of the poorest and most marginalized people by improving access to safe water, sanitation and hygiene.
Asian Development Bank	Water for All ADB's 'Water for All' policy and vision, adopted in 2001, guides ADB's work on water and development. It seeks to promote water as a socially vital economic good that needs careful management to sustain inclusive and equitable economic growth and reduce poverty. It also advocates a participatory approach in meeting the challenges of water conservation and protection.
The Environmental Protection Agency (US)	EPA WaterSense The EPA of the US, and its counterparts in countries around the world, help to enforce environmental protection policies and regulations that reduce pollution and the waste of important resources such as water. EPA WaterSense labels on products help consumers pick out products that minimize water pollution/waste, actively rewarding companies for conserving water.
The Stockholm International Water Institute	Founded in 1991, the Stockholm International Water Institute (SIWI, for short) is a policy institute based in Stockholm, Sweden that performs research, helps build institutional capacity and provides advisory services regarding water resources. Each year, SIWI holds a 'World Water Week in Stockholm' event, where they award prizes to organizations and individuals who have made significant contributions to water conservation. These awards include the: • Stockholm Water Prize • Stockholm Junior Water Prize • Stockholm Industry Water Prize
World Water Council	Established in 1996, the World Water Council is an international organization that works to 'promote awareness, build political commitment and trigger action on critical water issues to facilitate the efficient conservation, protection, development, planning, management and use of water'. To this end, the Council has helped facilitate numerous dialogues on the subject of water conservation amongst nations, such as the 'Water for Food and Environment' and the 'Water and Climate' dialogues.

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