

# On-site Water Reuse Systems

in Nirvana Country, Gurugram, India



**Nirvana Country Township is a high-end residential colony in Haryana State, which reuses treated effluent from on-site wastewater treatment facilities for urban greening in several residential areas.**

The Nirvana Country development serves 4000 units in eight residential societies with a population of almost 12'000 residents.

## **Collection & Transport**

Blackwater (toilet) and greywater (bath/shower, laundry, and kitchen) are collected and treated together onsite (in the basement). An underground pipe transports the treated effluent to neighbouring residential estates for reuse.

## **Treatment**

A Moving Bed Biofilm Reactor (MBBR) treats wastewater in the basement. This technology has only a small spatial footprint in comparison with other biological treatment processes and ensures reliable and high quality treatment.

## **Products & Benefits**

Up to 100'000 litres of the treated effluent from the on-site wastewater treatment facilities in The Close South settlement (shown here) is piped to two neighbouring settlements for urban greening, thus, saving precious groundwater resources.

## Introduction

Nirvana Country Township is part of a rapidly expanding urban development in Sector 50 of Gurugram<sup>1</sup>, located 30km south-west of New Delhi, in Haryana State, India. New Delhi today has 32 million inhabitants and is India's most populous metropolitan area. In India, progressive water reuse legislation is increasing. The most important reasons for this are the combined effects of droughts, heat waves and sinking groundwater tables, which have led to growing water stress and over-extraction of groundwater resources. As a case in point, the average groundwater level in Gurugram has dropped from 6.6 metres in 1974 to under 22 metres in 2014 [1]. The State of Haryana has, therefore, introduced major policy changes that promote decentralised urban wastewater treatment and reuse systems (DUWTRS) for non-potable uses. In 2018, a new Haryana state policy mandated that new developments withdrawing more than 50m<sup>3</sup> of groundwater per day had to install on-site sewage treatment plants (STPs) and reuse the treated effluent for non-potable uses.

The Nirvana residential area was built in two phases – the first phase in 2006 to 2009 and the second phase between 2016 and 2019. Until 2016, the high-end real estate development consisted of five residential societies (named A, B, C, D, and E). To date, it has increased to eight, which all have their own Resident's Welfare Association (RWA). The latest additions were the Fresco and The Close South (TCS) residential areas, built in 2016 and 2019, respectively. Today, the Nirvana Country development serves 4000 units in eight residential societies with a population of almost 12'000 residents. Unlike other residential colonies, Nirvana houses an expansive amount of greenery. With the increase in green spaces, the water demand for horticultural purposes grew. Until 2017, the residential areas A, B, C, D and E met their non-potable water demand through water tankers.

In 2017, Fresco constructed an on-site STP because public authorities denied its request to connect to the centralised sewer system. With the commissioning of the STP, Fresco reused around 20% of the treated water for irrigation, whereas tanker trucks illegally disposed of

the treated excess water at night. Meanwhile, residents from A, B, C, D and E started voicing their discomfort at the high tariffs for procuring water tankers for fresh water for urban gardening. The costs of getting fresh water from sources across India had been increasing due to higher fuel costs. They began exploring alternative options and, consequently, their RWAs decided to use Fresco's treated excess water for irrigation and signed a Memorandum of Understanding (MoU) in late 2018. Since early 2019, a small pipeline for treated effluent connects Fresco with the neighbouring residential areas. Through this synergistic move, Fresco could avoid any further legal issues caused by the dumping of their excess treated wastewater and the neighbouring residential societies could meet their irrigation water demands.

However, due to the poor quality of such parameters as BOD, TSS, COD, odour and colour, which exceeded twice the permissible limits, as well as the low-pressure of the delivered treated wastewater, in April 2020, the RWAs of settlements D and E again jointly explored alternative water sources. They found a new partner in TCS. Built in 2019, TCS was subjected to the newly introduced state policy and, thus, had a more modern on-site STP producing treated excess water. D and E were able to negotiate a new MoU, this time with TCS. Since January 2021, a new water pipeline connects the treated effluent of the TCS high-rise development to the neighbouring D and E estates in Nirvana. Today, the treated effluent is used for urban greening without any complaints or quality issues. Effluent water quality testing is done every six months.

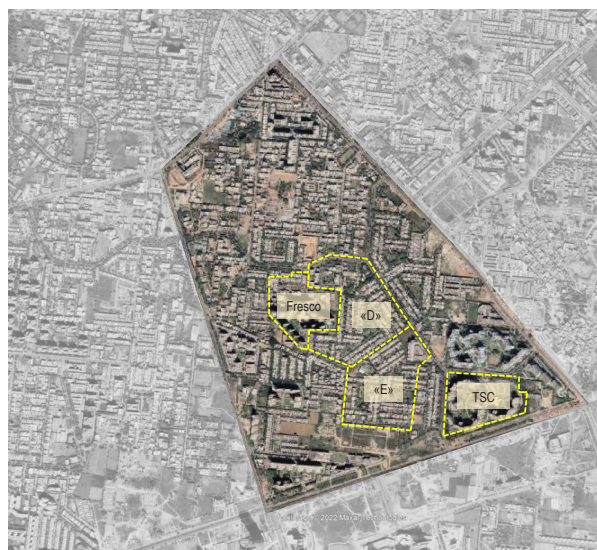


Figure 1: Sector 50 in Gurugram with the Nirvana Country residential colony.

<sup>1</sup> Formerly known as Gurgaon.

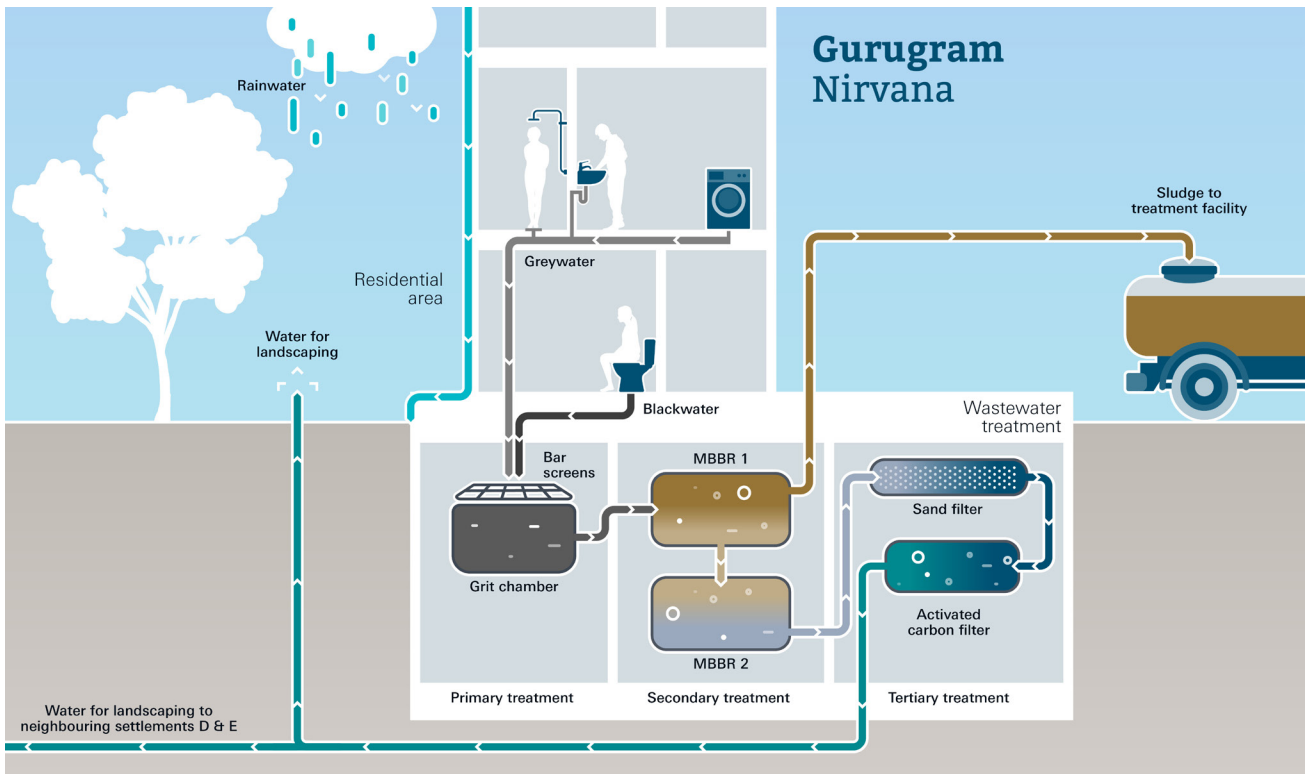


Figure 2: Schematic overview of the wastewater treatment and reuse process of The Close South high-rise settlement.

Nirvana Country Township is an example of a successful bottom-up initiative of an eco-conscious RWA interested in reusing treated wastewater for urban greening. The MoU and the installed 'mini-grid' for water transport could be a promising template for high-density settlements. The successfully established micro-water market qualifies the Nirvana case as a lighthouse example for DUWTRS at neighbourhood scale. In this brief, we examine the key drivers that have contributed to the successful implementation of the pipeline in Nirvana Country and the challenges. This report is structured around the five main analytical dimensions of the Lighthouse project. By examining these dimensions, we hope to gain a better understanding of the key factors that have led to its success, and to identify recommendations for other cities that seek to adopt similar decentralised urban water solutions.

## System Set-Up and Technology Description

Constructed in 2019, the TCS apartment complex was equipped with cistern flush toilets, which are common in new Indian high-end developments. The wastewater is transported with conventional gravity-based technology to the small-scale treatment plant situated in the basement of each high-rise apartment complex.

The treatment plant is equipped with a state-of-the-art on-site Moving Bed Biofilm Reactor (MBBR) wastewater treatment process. The MBBR technology has only a small spatial footprint in comparison to other biological treatment processes. If operated and maintained adequately, it ensures reliable and high quality treatment. Currently, between 300'000 to 400'000 litres of effluent is treated at TCS per day. According to our interviewees, the Haryana State Pollution Control Board (HSPBC) conducts half-yearly quality controls of the effluent. Since its commissioning, TCS's treatment plant meets its internal targets, as well as the water standards prescribed by the Government of Haryana.

Learning from the poor implementation of the PVC piping network installed for the Fresco project, E and D decided to install HDPE pipes to transport treated water for reuse. HDPE pipes are more durable, leak free, and can handle higher water pressure. However, they are more costly and require trained personnel for installation and energy intensive installation equipment. The agreed limit of treated water received at D and E is 100,000 l/d. This was calculated based on previous peak water consumption data (Fresco) of 70,000 l/d and a 30,000 l/d safety margin.

## Drivers & Barriers: Framework Conditions

### Governance & Regulative Conditions

In India, water governance and management has received steady recognition at the national level since 1974. Regulatory agencies and both national and state governments have to abide by the Water Act. Urban wastewater management is mainly driven by the Ministry of Housing and Urban Affairs (MoHUA), the Ministry of Environment, Forest and Climate Change (MoEFCC) and their line agencies [7]. Regulatory agencies ('Pollution Control Boards') are responsible for monitoring water quality by monitoring groundwater, surface water and wastewater. While 'reuse or recycle' were mentioned for the first time in a government policy in 1992<sup>2</sup>, the *National Environment Policy* developed in 2006 (8) emphasised recycling sewage and used water. The National Urban Sanitation Policy 2008 (7) soon followed and recommended water recycling and reuse. Subsequently, the *National Water Policy* 2012 (6) focussed on reducing water pollution, while embracing the imperatives of recycling and reuse. While the vision is set by the national departments, the responsibility for policies and regulations lie with the State Governments.

In Haryana, the key policy document regarding the reuse of treated wastewater, the *Draft Policy on Reuse of Wastewater* [2], was published in 2018 ("2018 Mandate") and ratified in 2019 [3]. It provided ambitious goals for the reuse of treated wastewater for non-potable use in residential, commercial and industrial contexts. By 2025, the goals aim at: (i) achieving a minimum sewer connection coverage of 80% in all of Haryana's towns and cities (ii) attaining 100% treatment of wastewater arriving at treatment facilities, and (iii) increasing reuse of treated wastewater from 25% to 50% (and from 50% to 80% by 2030). The minimum percentage of wastewater reuse for all towns and cities is stipulated at 25% and includes domestic indoor and outdoor uses of non-potable water. These include urban greening/irrigation, water for extinguishing fires, toilet flushing and other non-potable uses defined by municipalities. In late 2018, the Gurugram Metro Development Authority (GMDA) issued notices to all residential societies and developers to install on-site STPs and gradually increase the amount of water reuse by 2030. All new real estate developments built after 2018, therefore, feature

state-of-the-art STPs, most of which are MBBRs or SBRs (Sequencing Batch Reactors).

The 2018 Mandate introduced 'No Objection Certificates' (NOC) for developers installing non-potable water systems. A NOC is an essential legal document, in this case issued by the GMDA, stating no objection to the covenants mentioned in the certificate. In other words, it makes the pipeline structure a legal construction as attested by the GMDA. In addition, the (previously existing) 'Occupancy Certificate' (OC) confirmed that a building adheres to national building codes and is suitable for occupancy. Theoretically, in case of non-compliance of water quality standards after spot checks, based on how much the quality varies from the prescribed standards, the officials can charge a fine (up to Rs.50,000 / US\$ 625), which may be extended up to Rs.2,00,000 / US\$ 2500). In cases of repeated non-compliance, the NOC of the plant and the OC of the residential site can be annulled. However, in reality, control and enforcement are unreliable and insufficient. For example, as mentioned above, the SPCBs are responsible for monitoring wastewater quality in all Indian States. Interviewees reported that the Haryana SPCB (HSPCB) is understaffed and struggling to keep pace with the growing number of DUWTRS in urban areas. A main reason is that the 2018 Mandate has allocated additional tasks to HSPCB, without providing it with additional funds. Thus, regulators had to work on more STP sites with the same resources. In addition, as interviewees report, the HSPCB is insufficiently and unreliably enforcing corrective measures in regards to non-compliance to water quality standards. However, reportedly, within Nirvana's residential societies D and E, water quality reports are shared with the operators and residents every six months to maintain transparency of the system performance for the received treated water.

### Contractual & Financial Arrangements

In Haryana, the 2018 Mandate shifted the financial burden for sanitation from public service providers to residents. No financial support (e.g. tax reliefs or subsidies) is provided by the government to builders or residents. Building owners and residents are responsible for both capital expenditures for the installation (CAPEX) and operational expenditures (OPEX) for DUWTRS. In addition, while it is mandated to reuse water, treated wastewater cannot yet be

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<sup>2</sup> 'Policy statement for Abatement of Pollution (PSAP), 1992' (15) which presented pollution prevention methods through the promotion of "treatment technologies, reuse or recycle".

sold for a price. Therefore, transferring excess treated wastewater to local users does not generate an income for the society or offset any costs. Consequently, the 2018 Mandate was not well received by developers and property owners. However, with implemented prices to be set in the foreseeable future, (see next section), new financing (and business) models will likely emerge. This, in turn, should increase DUWTRS legitimacy among developers and building owners, respectively.

In India, private real estate companies or developers plan and construct new townships and residential developments, which are then sold on the market. The Indian Real Estate Act (2016) states that these developers are responsible for providing and maintaining the essential services of a building/residential development until a formal RWA is formed [6]. Hence, the developers also have initial responsibility for operation and maintenance (O&M) of the wastewater treatment plants. The Real Estate Act also includes a five-year warranty clause on “*structural defect or any other defect in workmanship, quality or provision of services*” [6]. It additionally states that a housing society must establish a RWA within three months after a majority of the houses have been reserved. As the name suggests, a RWA's primary intention is to work towards their residents' overall welfare. At some point, the RWA has to take over responsibility, e.g. for the wastewater treatment plant. This can be several years after the commissioning, but typically happens after one to two years. The RWAs ensure that monthly or annual payments (maintenance charge) are made to a residential welfare fund to guarantee O&M and any necessary extension or repair work. In Gurugram, most RWAs outsource O&M of onsite STPs to private companies, as is also the case with TCS.

In the case of Nirvana Township, the RWAs played an essential role in the drive to use treated wastewater for horticultural needs. The initial connection to Fresco's STP, as well as the extension of the pipeline with water pumps from TCS to D and E, was initiated by and covered with RWA funds. In the case of TCS, a MBBR unit in each basement cost US\$ 25'000 (2018) and monthly OPEX is around US\$ 640, both paid by TCS. D and E covered pipeline installation costs (US\$ 3800) and monthly OPEX (US\$ 250). Since treated water cannot currently be sold for a price, only pumping charges are levied to D and E to cover electricity

costs. The MoU fixed a small monthly fee of 0.01 INR/litre, which is much cheaper compared to 1.5 INR/litre for receiving treated wastewater from a centralised STP. It is a pay per use model, where D and E only pay for the volume of water they use, not for the maximum of 100,000 l/d. Overall, assuming maximum use, D and E would today have total monthly costs of 30,000 INR (ca. US\$ 365) to cover irrigation demands. Conversely, the monthly bill for trucks previously amounted to approximately 100'000 INR (ca. US\$ 1220) and fluctuated throughout the year. Considering that societies D and E each have 300 houses, today a household pays a monthly maximum of 50 INR (ca. US\$ 0.60). This is approximately three times less compared to the previous 166 INR (ca. US\$ 2) per month/household (250 INR during May and June).

## Industry & Market Structures

The recent legislative changes at national and state levels have spearheaded the creation of an expanding market for private companies. The State of Haryana is neighboured by Delhi and Punjab. Both of these states introduced their respective state wide water reuse policy in 2018, which was soon joined by the State of Haryana. Thus, in the same year, three neighbouring states rolled out water reuse policies. This led to the emergence of a regional market of DUWTRS designers, suppliers and operators. Most RWAs outsource O&M to private sector companies. However, given Haryana's market-led approach, these suppliers remain largely unregulated. While O&M is usually outsourced, there is no evidence that other business models have developed beyond this.

There is not yet a market for reuse water in Haryana, and no profitable business model for this has been established. New legislation, such as the Haryana Water Resources Act from 2020 [4] and the 2022 Amendment [5], recognise treated wastewater as an economic resource that will in the near future become a tradeable commodity. The 2018 Mandate envisaged to “[...] *promote treated unused water as an economic resource [...]*” and defined that “[t]he price [...] shall be kept lower than the price of fresh water” [2, 3]. The 2020/2022 Act allows municipal authorities to decide the tariff for bulk water uses of treated wastewater on the principles of economy, equality and sustainability. This will incentivise future developers and RWAs to ensure high quality

treated wastewater, which can be sold to nearby users with a clear market value. However, as the respective price has not yet been set, the sale of treated wastewater still has to be approved. The Nirvana Country Township case presented here, thus, provides an early adopter example of quality effluent of one settlement (TCS) exported for external use (D & E settlements), albeit still (almost) free of charge.

### **Knowledge, Skills & Capacity**

Prior to the 2018 mandate, the city faced a major gap in terms of specialised DUWTRS regulators, technology implementers, and operators. Since then, the number of operators and suppliers for DUWTRS has proliferated in Gurugram. However, four years since the policy release, no state or city level document was found that mentioned or provided any guideline for O&M of these facilities. Thus, the technological capabilities of local service and technology providers are still very limited. The lack of formalised training and skills development in urban water management and onsite solutions have been identified as some of the greatest challenges facing the sector throughout India [2]. As of 2022, there are no certified training or courses required for small-scale wastewater treatment plant operators. Likewise, universities or technical colleges lack courses or electives that focus on this rapidly growing sector. Most of the training happens on the job and is provided by private sector service providers. This leads to operators not receiving formal training before managing STPs. In addition, since the market for local suppliers is highly competitive, there is a general sense of secrecy among operators, hindering knowledge diffusion within the sector.

### **Legitimacy and Recognition**

The Nirvana case is a policy-driven yet market-led example where state legislation (notably the 2018 Mandate and the 2020 Water Resources Act), has boosted official recognition of DUWTRS almost overnight. However, the public authorities grossly underestimated the need to provide accompanying measures. These included a lack of (adjusted) governance structures and complementary regulations, standards and labels, as well as market governance mechanisms that ensure accountability along the service chain. There is also a lack of certified training courses, standard operating procedures and minimum

requirements for the O&M of these facilities. This leads to sector-wide underperformance and substandard effluent quality for key parameters (COD, BOD, TSS). Additionally, a 'fix it when it breaks' approach endangers the legitimacy of onsite treatment systems.

Creating legitimacy for non-potable water reuse is not an easy sell in India because it is a faecophobe society. This notwithstanding, in some residential units, such as the Nirvana Township, high levels of social cohesion among the residents and their RWA allowed the development of a shared understanding of eco-friendly approaches to energy, waste segregation and water use. Concomitantly, this led to the promotion of non-potable water reuse for urban greening. To foster legitimacy among the Nirvana stakeholders, the RWA undertook a number of sensitisation events to convince the residents to use treated wastewater for irrigation where children would play. Any doubts were clarified and the RWA agreed to share the water quality test reports with all the residents on a timely basis. In addition, a bidirectional communication channel through Whatsapp (RWA internal) and MyGate (society wide security application) exists. This feedback loop allows users to provide feedback and operators to notify users, e.g. when repair works are carried out.

### **Key Take-Aways**

The implemented MoU among Nirvana's and TCS's RWAs, the successful installation and continued operation of treatment and a 'mini-grid' for water transport, the availability of adequate quantity and quality of reuse water and residents' satisfaction qualifies the Nirvana case as a lighthouse example for DUWTRS at neighbourhood scale. A specific mix of enabling conditions and constructive interventions were key to success, four of which are worth highlighting.

First, proactive legislation introduced since 2018 provided the basis for this policy-induced, yet market-led example of DUWTRS implementation. The accelerating water stress experienced in (northern) India – and respective emergence of water reuse policies in Haryana and its neighbouring states – led to the formation of a regional market of alternative technologies, suppliers and operators and acts as a catalyst in promoting water reuse. In addition, the absence

of sunk infrastructure and costs in the form of conventional sewers for new urban developments and the introduction of robust and compact treatment technologies in the past decade have been instrumental in establishing a rapidly growing ecosystem of DUWTRS providers.

Second, Nirvana Country Township exemplifies a successful bottom-up initiative of an eco-conscious RWA interested in reusing treated wastewater effluent for urban greening. A high level of cohesiveness among the residents (of D and E) enabled planning and implementation of the new pipeline. This was incentivised due to the poor quality of water that had previously been used for this purpose and cost increases for tanker trucks supplying fresh water for urban gardening.

Third, performing regular effluent quality tests and transparently sharing the results among local residents have been important, particularly in establishing and maintaining trust. In addition, The RWA conducted a series of awareness-sensitisation events about the legitimacy of using treated wastewater for irrigation. This resulted in high acceptability of DUWTRS among the residents of D and E. The water quality meets HSPCB standards and the quantity meets the demands of societies D and E. At a city level, however, interviewees report that regulators are not adequately monitoring DUWTRS performance or enforcing sanctions in cases of non-compliance.

Fourth, the MoU signed in 2021 between TCS and the neighbouring residential societies D & E, including the pay per use model, represents a legal document with mutually binding responsibilities. This could be a promising template for making best use of excess non-potable water for high-density settlements. As an early adopter, the RWA of TCS might even have anticipated the emergence of a true 'micro-water-market'. Although a profitable business model for water reuse in Haryana is not yet available, treated wastewater will soon become a tradeable commodity. The fact that the price is lower than the price of fresh water will further promote DUWTRS diffusion and might give rise to interesting new business models that focus on selling excess treated wastewater in local micro-markets. At the least, it will generate revenue that can be used to (partially) offset operating costs.

## About the Lighthouse Project

***Resource-oriented decentralised urban water management systems improve the flexibility, resilience and sustainability of water and sanitation infrastructure and are, thus, key in sustainability transitions. The Lighthouse Project assesses some of the most prominent examples.***

### Why? – Project Goals

Resource-oriented onsite/decentralised urban water management systems (DUWTRS) will play a key role in enabling sustainability transitions in the water and sanitation sector. DUWTRS close loops, recover valuable resources, produce marketable products, reduce the energy and water demand and can quickly be adapted to changing conditions. Despite increasing evidence of their potential benefits in improving the flexibility, resilience and sustainability of water and sanitation infrastructure, only a few cities worldwide have successfully implemented "lighthouse initiatives" (LHs) at scale. Systematic evidence of critical success factors and how to best implement LHs in cities in developed and emerging economies are lacking.

The Lighthouse Project conceptualised what are LHs and selected representative projects to analyse. The objectives were: 1), to identify the distinctive characteristics of LHs, 2) to identify cities and neighbourhoods that have established LHs and assess technological and institutional best practices, and 3) to synthesise the results and produce templates for the diffusion of DUWTRS in cities in developed and emerging contexts.

### What? – Key Characteristics of Lighthouse Initiatives

**Comprehensive arrangement:** Integrating new technologies into a matching socio-economic and institutional context

**Long-term perspective** (project length and available funding): Stable incentives that enable 'adaptive learning'

**Broad-scale adoption:** Fully developed value chain at neighbourhood/city district level comparable to centralised approach

**Visibility and impact beyond immediate context:** Examples that can inspire/guide initiatives to replicate core features

## How? – Research Design & Methods

We adopted a cross-comparative case study approach that synthesised results from prior Eawag projects (4S and BARRIERS) and amended them with additional secondary data and targeted expert interviews. In doing so, we generated practice-oriented lessons on how to best implement LHs and derived new theoretical knowledge on the generic conditions of their success to highlight sustainability transitions within the urban water and sanitation sector.

### Funding

This research received funding from the Eawag Discretionary Fund. Eawag is the Swiss Federal Institute of Aquatic Science and Technology.

## Now? – Recommendations

### Long-term vision, strategy and political support.

State-level legislation and binding targets fostered conducive framework conditions for water reuse in Haryana State. The goal is to achieve 50% of reuse of treated wastewater by 2025. Political support by a proactive local government (Gurugram Metropolitan Development Authority) and supportive RWAs enabled the dissemination of DUWTRS.

### Install potent enforcing mechanisms.

Enforcing mechanisms are essential to guarantee compliance with set regulations. 'No Objection Certificates' were effective in enforcing adequate construction standards of treatment technologies. Regular inspections and performance monitoring including adjusted fines in case of non-compliance (e.g. 'fit-for-purpose' effluent quality) are critical to a successful continued operation.

### Improve capacity development.

The lack of engineers, trained technical staff and suppliers is a key bottleneck for the diffusion of high-quality DWTRS. Development of a workforce that has the skills to oversee the implementation, operation and scheduled maintenance of decentralised systems is urgently needed to catch-up with the exponential development of treatment systems. Universities, technical colleges and on-the-job training schemes could jointly address these skills gaps.

### Create markets for trading reuse water.

Haryana Water Resources Authority Act (2022) recognizes treated wastewater as a commodity. The new Act allows municipal authorities to decide

the tariff for bulk water uses of treated wastewater. Authorities, such as the Gurugram Metropolitan Development Authority, should, therefore, enable the trading of treated wastewater to enable the formation of micro-markets for non-potable water reuse. Such micro-markets could provide crucial incentives to RWAs to install DWTRS that consistently meet the quality levels requested by local customers.

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**This is a condensed version of the full report, which can be downloaded at: [www.sandec.ch/lighthouse](http://www.sandec.ch/lighthouse).**

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