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Technical Report

Strengthening an Enabling Environment for Wastewater Reuse in Nepal's Peri-Urban Agriculture

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Executive Summary

This report assesses the enabling environment for wastewater reuse in Nepal's peri-urban agriculture, focusing on policy and institutional coherence, technical and infrastructure capacity, human capacity, financial mechanisms, and social acceptance. It finds that Nepal has a relatively strong policy foundation for wastewater reuse through national frameworks on WASH, environment, agriculture, and climate resilience. However, implementation remains weak due to fragmented mandates across federal, provincial, and municipal levels, with limited coordination between key sectors such as water supply, agriculture, and environment. As a result, wastewater reuse is still largely confined to informal and small-scale practices rather than being integrated into planned municipal systems.

The analysis shows that technical and institutional readiness is low, with less than 15 percent of wastewater treated and most systems designed for disposal rather than reuse. Key infrastructure gaps include lack of storage, conveyance, and reuse linkages, along with weak operation and maintenance systems and limited monitoring capacity. Municipalities also face shortages of trained personnel and weak coordination between sanitation and agriculture sectors, while financial mechanisms remain limited as wastewater reuse is not a budgeted priority and lacks dedicated incentives or financing windows. Private sector participation and structured PPP models for reuse remain limited.

Social acceptance remains mixed, with widespread informal use driven by necessity but strong stigma among consumers due to health concerns and limited awareness. Women and marginalized groups face higher exposure risks and limited access to information and decision-making roles. Overall, while Nepal has a strong enabling policy base, the transition to safe and scalable wastewater reuse requires stronger institutional coordination, reuse-oriented infrastructure investment, dedicated financing mechanisms, capacity development, and targeted efforts to build public awareness and trust through demonstration and transparent monitoring.

Background and Rationale

Nepal's rapid urbanization has intensified the interconnected challenges of water scarcity, wastewater generation, and demand for water in peri-urban agriculture. The urban population has grown from 14% in 2001 to over 66% in 2021, driven by migration, economic opportunities, and administrative restructuring (CBS 2021; Rijal et al. 2020). This growth has expanded into peri-urban interface zones, where dense settlements, smallholder farms, and informal enterprises coexist and compete for limited land and water resources.

In these areas, groundwater depletion and seasonal surface water shortages increasingly constrain agricultural production, whereas untreated municipal wastewater continues to flow into rivers and streams (DWSSM n.d.). Farmers, particularly those cultivating vegetables for city markets, often resort to informal irrigation with untreated or partially treated wastewater (Thapa et al., forthcoming). Despite its health risks (waterborne diseases, helminth infections, and food contamination, particularly when crops are consumed raw), this practice highlights the latent value of wastewater as a nutrient-rich, climate-resilient water source (Karki et al. 2024).

UNEP (2023) recognizes safe and productive wastewater reuse globally as a pillar of circular and climate-smart water management, which directly contributes to the Sustainable Development Goals (SDGs), especially SDG 6.3 on water quality and reuse, SDG 11.6 on sustainable cities, and SDG 12.5 on resource recovery. Nepal supports commitments under the Nationally Determined Contributions (NDCs) and the draft WASH Sector Development Plan (2024–2043) by linking sanitation (including wastewater) improvements with resource recovery and agricultural resilience. However, this potential remains largely untapped due to fragmented governance, technical and financial gaps, surrounding treated wastewater use.

Under Nepal's federal structure, municipalities are the frontline institutions for managing wastewater and environmental health, as mandated by the Local Government Operation Act (2017). Their investment decisions determine whether treatment systems are designed solely for disposal or for reuse and circular resource recovery purposes. Pilot projects in the Mahalaxmi and Kageshwori Manohara municipalities have demonstrated both the opportunities and challenges of wastewater reuse. While these initiatives provide treated water and sludge for safe agricultural use, they are hindered by limited coordination between sanitation departments for water supply and sewerage management and the agriculture departments (Thapa et al., forthcoming). Therefore, building an understanding of the potential of wastewater use in agriculture, strengthening municipal capacity, and advancing interdepartmental and cross-sectoral coordination, as well as financing mechanisms, are critical for mainstreaming reuse as a productive and safe urban water management practice.

Assessing Nepal's enabling environment for wastewater reuse thus provides insight into the readiness of current systems to support a transition from isolated pilots to scalable and sustainable practices. The analysis of the enabling environment presented in this brief examines five interlinked dimensions – policy and institutions, technical know-how, human resources and technical capacity, financial mechanisms, and social acceptance as discussed in Ires (2025), Taron et al. (2024), and Gebrezgabher et al. 2018.

Key Parameters for an Enabling Environment for Wastewater Reuse

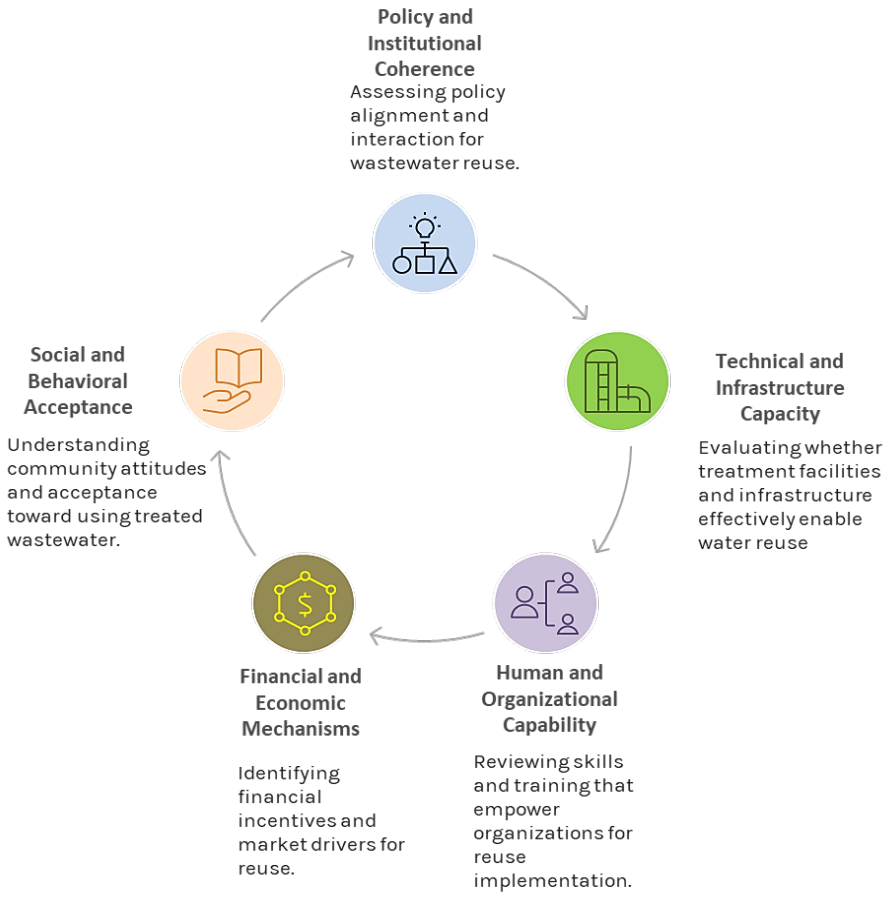

Figure 1. Parameters to assess the enabling environment for wastewater reuse in agriculture
Source: developed by authors

Collectively, these dimensions (as shown in Figure 1) provide a clear picture of Nepal's current readiness and highlight priority areas for strengthening the enabling environment to realize the full benefits of wastewater reuse in peri-urban agriculture. Addressing these gaps is essential for advancing a green, resilient, and inclusive development agenda that leverages circular resource management for sustainable growth in the region.

Policy and Institutional Coherence

Challenges and opportunities

According to the Government of Nepal (2015), Articles 30 and 35 guarantee the right to a clean environment and access to clean drinking water and sanitation. This underscores the state's obligation to protect health; ensuring treated wastewater reuse in agriculture with appropriate safeguards thus becomes a public health imperative to uphold these rights—reducing disease risk for farmers and consumers while securing safe water access for all. Nepal's policy environment increasingly acknowledges the need for integrated water, sanitation, hygiene, and agriculture management. The Environment Protection Act (2019), National WASH Policy (2020), the draft WASH Sector Development Plan (2024–2043) (Government of Nepal n.d.) sets a national goal of universal safely, managed sanitation, and wastewater treatment by 2043, emphasizing resource recovery, reuse, and circular economy principles (DWSSM, n.d.), including irrigation.

Complementary policies, including the Sanitation and Hygiene Master Plan, 2010 (Government of Nepal, 2010) and the National Adaptation Plan (2021–2050) (Government of Nepal, 2021), promote safe wastewater management and reuse for climate resilience in the country. The Agriculture Development Strategy (2015–2035) (Government of Nepal, 2015) likewise calls for efficient climate-smart irrigation that incorporates the use of treated wastewater. Nepal's international commitments, such as the Sustainable Development Goals (SDGs) and

Nationally Determined Contributions (NDCs) under the Paris Agreement, reinforce wastewater reuse as a low-emission and resource-efficient development pathway (MoFE, 2020). Together, these frameworks provide a strong enabling base, although municipal operationalization remains limited.

Under the federal structure, roles are distributed across tiers as follows:

- **Federal:** Ministry of Water Supply (MoWS) and its Department of Water Supply and Sewerage Management (DWSSM) oversee water and sanitation policy; Ministry of Agriculture and Livestock Development (MoALD) leads irrigation and agriculture; and Ministry of Forests and Environment (MoFE) regulates effluent discharge and environmental standards.
- **Provincial:** Under Nepal's federal structure, Provincial Governments possess constitutional authority over agriculture, environment, water supply, public health, and provincial development planning (Schedules 6 and 7 of the Constitution). Beyond coordination, provinces have the mandate to enact laws, allocate budgets, implement infrastructure, and regulate environmental standards. In the context of wastewater reuse in agriculture, provinces can legislate risk-based reuse standards, finance decentralized treatment systems, integrate safe reuse into agricultural extension services, and establish monitoring mechanisms that safeguard farmers and public health.
- **Local:** Municipalities are autonomous governments vested with legislative, executive, and judicial powers under the Constitution (Schedule 8) and the Local Government Operation Act (2017). They have the power to create new policies, leverage finance, and implement sanitation services (including wastewater treatment operations), drinking water, local irrigation, agriculture, and environmental protection under the Local Government Self-Governance Act, 2016. However, not all these aspects are often considered a priority, and only a few municipalities, such as Mahalaxmi and Dhulikhel, have Fecal Sludge Management (FSM) bylaws, although explicit agricultural reuse provisions are rare.

In practice, despite constitutionally defined mandates across federal, provincial, and local governments, overlapping jurisdictions and weak intergovernmental coordination constrain effective wastewater governance (Table 1). Institutional fragmentation and limited technical and financial capacity create barriers to scaling decentralized wastewater systems, as highlighted in governance-focused analyses of decentralized sanitation (e.g., Bright-Davies et al., 2018). These constraints hinder integrated planning, regulatory enforcement, and coordinated management across sectors. Secondly, wastewater plants are often designed for disposal rather than reuse, and irrigation programs seldom recognize treated wastewater as a potential resource (Thapa et al., forthcoming).

Table 1. Assessment of Policy and Institutional Coherence for Wastewater Reuse in Nepal

Policy / Institutional Element	Current Provisions & Relevance	Key Gaps / Incoherencies	Federal role	Federal agencies	Provincial role	Municipal role
National policies & frameworks	WASH Sector Development Plan (2024–2043); Sanitation & Hygiene Master Plan (2023); Environment Policy (2019); NAP (2021–2050).	Reuse is not mainstreamed across WASH–agriculture–water policies; limited vertical integration.	Develop National Guideline for Safe Agricultural Reuse; define fit-for-purpose standards.	MoWS; MoALD; MoFE; MoUD; MoF; NPC.	Enact provincial policies aligned with federal standards; integrate reuse in Provincial strategies; allocate budgets.	Enact by-laws; integrate reuse in municipal WASH plans; implement and enforce local wastewater collection and treatment systems.
Agriculture & irrigation policy	Agriculture Development Strategy (2015–2035); National Water Resources Policy (2020); Irrigation Policy (2013).	Treated wastewater is not defined as irrigation source; no crop-water quality matching guidelines.	Recognize treated wastewater as irrigation source; develop crop-quality matching framework.	MoALD; DWRI; MoWS.	Implement irrigation extension; supervise inter-municipal irrigation schemes.	Integrate treated wastewater in local irrigation planning; coordinate farmer cooperatives.
Environmental regulation & standards	Environment Protection Act (2019); Draft Treated	Weak enforcement; limited	Operationalize reuse standards; strengthen	MoFE; EPA divisions; MoUD.	Provincial environmental monitoring and enforcement.	Local pollution control enforcement; inspection and

	Wastewater Standard (2081).	monitoring capacity.	monitoring systems.			compliance monitoring.
Urban infrastructure & sanitation systems	Municipal WASH plans; ADB-supported WWTP projects; FSM bylaws in some municipalities.	Infrastructure planning not systematically linked to reuse potential.	Integrate reuse design in wastewater projects; promote DEWATS.	MoUD; MoWS; MoF; TDF.	Urban development coordination; infrastructure co-financing; technical support.	Plan, build, operate and maintain treatment; contract PPP/DBO operators.
Planning, monitoring & investment frameworks	Integrated Urban Development Plans (IUDPs); Municipal WASH Plans; TDF financing.	Reuse not included in grant indicators; no dedicated monitoring framework.	Include reuse indicators in fiscal transfers; establish data-sharing platforms.	MoF; NPC; MoUD; MoWS.	Integrate reuse in Provincial Development Plans; monitor outcomes.	Include reuse in municipal budgets; collect and report performance data.

Assessment of policy and institutional coherence

Despite a strong policy foundation, several systemic barriers hinder the institutionalization of safe wastewater reuse.

1. **Absence of enforceable reuse standards:** Although there are microbial and chemical thresholds for different reuse applications, authorities have not officially adopted or operationalized them yet. This limits the regulatory clarity for municipalities and investors.
2. **Limited municipal planning and enforcement capacity:** Most municipalities lack technical staff trained in wastewater reuse planning, monitoring, or quality testing. Budget allocations remain heavily skewed towards water supply, with minimal investment in treatment or reuse infrastructure (DWSSM n.d.).
3. **Weak inter-sectoral coordination:** The water supply and sewerage department and the agriculture sectors operate largely in isolation. Existing coordination bodies, such as WASH Coordination Committees, rarely engage agricultural officers or irrigation stakeholders in reuse discussions, leading to missed opportunities for integrated planning (Karki et al. 2021, Quarta et al. 2018).
4. **Financing and incentives:** The absence of dedicated financing windows for reuse projects within the Town Development Fund (TDF) and challenges in accessing performance-based grants constrain innovation for many municipalities. Public–private partnerships in wastewater reuse are still in their infancy.
5. **Monitoring and accountability deficits:** Municipalities often lack systems for the routine monitoring of effluent quality or reuse volumes. Without data, it is difficult to assess compliance or demonstrate the benefits of reuse in terms of water savings and nutrient recovery.

Collectively, these gaps indicate that while Nepal's policy supports wastewater reuse, translating this vision into operational municipal strategies requires clearer standards, institutional coordination, and capacity support.

Technical and Infrastructure Capacity

Challenges and opportunities

Nepal's wastewater reuse capacity remains informal and small-scale, constrained by limited treatment infrastructure and a lack of reuse-oriented system designs. While sanitation coverage has expanded rapidly, sewerage networks and treatment capacity have not kept pace with urban growth or peri-urban agricultural demand (DWSSM n.d.).

Treatment coverage and infrastructure performance: Less than 15 percent of the generated wastewater in Nepal is treated, with most effluents discharged into natural water bodies. Existing centralized plants in Kathmandu, Lalitpur, and Pokhara operate below their design capacity due to low sewer connectivity, intermittent power supply, and limited effluent monitoring. Few are configured to meet agricultural reuse standards, and fecal sludge treatment plants (FSTPs), such as Lubhu (Mahalaxmi) and Kageshwori Manohara, are not linked to reuse infrastructure, such as storage ponds or conveyance systems (DWSSM n.d., Thapa et al. forthcoming).

Decentralized and nature-based systems: Technologies such as Decentralized Wastewater Treatment Systems (DEWATS), constructed wetlands, and anaerobic baffled reactors have demonstrated technical feasibility in peri-urban settings where land and resources are limited. However, sustainability challenges persist, such as limited funding, poor maintenance, limited infrastructure, and minimal monitoring, leading to short-lived pilot systems that often decline after external support ends (Prajapati 2024; ENPHO n.d.).

Reuse-oriented design and monitoring gaps: Even when treatment facilities are in place, reuse integration remains minimal. Key infrastructure gaps, such as storage ponds, irrigation linkages, and farmer access points, prevent the productive use of treated effluent. Nepal's Wastewater Effluent Standard (2023) establishes quality parameters for wastewater discharge, including tolerance limits for effluents released into inland surface waters (MoFE 2023; Prajapati 2024), yet implementation faces significant barriers. Municipal-level capacity for water quality monitoring needs to be developed, as identified in ADB project assessments (ADB 2018). Treatment plants often operate without well-prepared operation and maintenance manuals or systematic environmental monitoring protocols (ADB 2018; Bartaula 2016). Consequently, routine monitoring of effluent quality remains limited, with studies documenting inadequately treated effluents and ineffective pathogen removal in wastewater treatment plants in the Kathmandu Valley (Gautam et al. 2019; Sthapit et al. 2022). These institutional inefficiencies and infrastructural deficiencies contribute to public resistance against reclaimed water reuse initiatives (Poudel et al. 2023), undermining both informed decision-making and public confidence in wastewater management systems.

Assessment of technical and infrastructure capacity

The current technical environment in Nepal is characterized by limited wastewater reuse infrastructure, isolated functional plants, low integration of reuse, insufficient recognition of how women and marginalized groups are differently affected, and inadequate monitoring frameworks. Although technological options exist and are well understood, a lack of priority and weak coordination between sanitation engineering and agricultural water management limit their systemic adoption (Figure 2). Moving forward, scaling reuse will require the following:

- Retrofitting treatment systems to include **reuse-oriented design features**,
- Institutionalizing **Operation and Maintenance (O&M) financing mechanisms**, and
- Establishing **national and local monitoring protocols** to ensure water quality and build user confidence.

Figure 2. Assessment of technological and infrastructural readiness

Source: developed by authors

Human and Institutional Capacity

Challenges and opportunities

Human and institutional capacities remain critical constraints to advancing safe wastewater reuse in Nepal. While policy awareness is growing, the technical, organizational, and coordination capacities necessary for large-scale implementation remain fragmented and underdeveloped (Thapa et al., forthcoming).

Municipal and local institutional capacity: Municipalities hold primary responsibility for sanitation and wastewater management under the Local Government Self-Governance Act (2017). However, most lack the specialized expertise required to design, operate, and monitor reuse systems. Staffing is dominated by civil engineers focused on infrastructure delivery rather than on resource recovery, water quality management, or reuse planning. Coordination between the sanitation (WASH), sewerage management, and agricultural sectors is limited, leading to parallel, non-integrated planning (DWSSM n.d.). For instance, sanitation plans may prioritize wastewater treatment infrastructure, whereas agricultural programs may overlook the reuse of treated effluent for irrigation.

Technical knowledge and training gaps: Nepal faces a shortage of trained professionals capable of managing reuse-oriented systems. Laboratory capacity and monitoring skills remain minimal, and agricultural extension officers rarely receive training on safe reuse, crop–water quality matching or post-harvest safety (Rutkowski et al. 2007, Karki et al. 2019). Consequently, farmers, especially women, who use wastewater informally lack guidance on how to minimize health risks.

Role of development agents: Academic institutions such as the Institute of Engineering (IOE), Tribhuvan University, provide environmental engineering training but have not mainstreamed circular economy and water reuse modules in the curriculum. NGOs and partners, including the Environment and Public Health Organization (ENPHO), WHO, WaterAid Nepal, and Bremen Overseas Research and Development Association (BORDA), among others, have supported decentralized wastewater treatment and capacity building. However, most of these efforts focus on short-term, donor-driven projects, which limit opportunities for sustained institutional learning and capacity development after external support ends (Shrestha et al. 2020).

Private sector and service delivery models: Private sanitation service providers, such as vacuum truck operators, treatment plant managers, and contractors, play an expanding role in the sanitation chain. However, reuse-oriented participation remains minimal, constrained by the lack of technical certification, accreditation mechanisms, and Public–Private Partnership (PPP)-based performance contracts (Bekchanov and Evia 2018, Boukalová et al. 2020, Nepal 2024). To catalyze private sector investment, policy action is needed to establish clear business incentives and a supportive regulatory framework.

Capacity-building landscape: Overall, capacity development remains fragmented, donor-driven, and short-term, focusing on individuals rather than institutions. Nepal lacks a national capacity development framework and a continuous professional development program for wastewater reuse. Therefore, municipalities rely heavily on external consultants, limiting institutional ownership and sustainability (DWSSM n.d.). Currently, there are also no institutional avenues for informing farmers on the safe use of wastewater.

Assessment of human and institutional capacity

Human and institutional capacities for wastewater reuse are developing but remain unsystematized. Municipalities demonstrate willingness and growing awareness; however, technical expertise, coordination mechanisms, and institutional mandates remain insufficient for sustained implementation (Figure 3). To strengthen this enabling dimension, Nepal needs to do the following:

- **Prioritize and institutionalize interdepartmental coordination** between the water supply and sewerage department and the agriculture units at the municipal and provincial levels.
- **Embed wastewater reuse curricula and applied research** in universities and training centers.
- **Develop national certification and accreditation systems** for private operators; and
- **Establish a coordinated, long-term capacity development program** led by federal ministries and supported by the development partners.
- **Include information packages or awareness for all farmers (especially women)** on the safe use of wastewater.

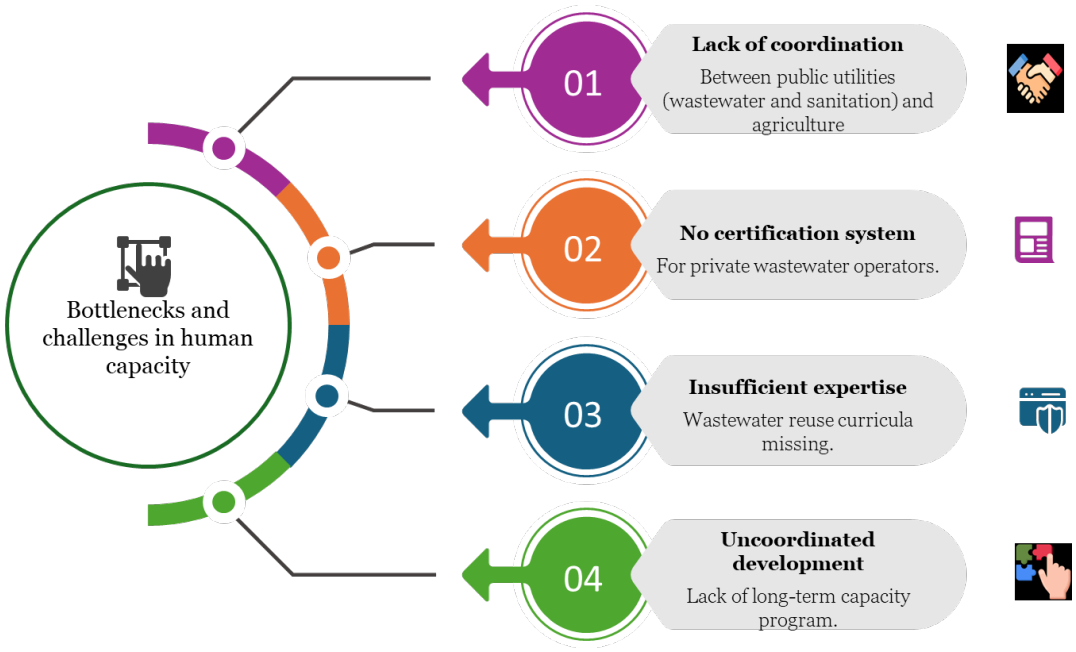

Figure 3. Bottlenecks and challenges in human and institutional capacity
Source: developed by authors

Strengthening human and institutional capacity will be pivotal in operationalizing the technical and financial enablers outlined earlier, ensuring that wastewater reuse transitions from pilot projects to a mainstreamed, well-governed municipal function.

Financial and Economic Mechanisms

Challenges and opportunities

Financial and economic mechanisms are central to scaling wastewater reuse from isolated pilots to sustainable municipal services and agricultural input. The Intergovernmental Fiscal Arrangement Act (2017) governs the distribution of federal grants to municipalities for wastewater infrastructure. These grants are recommended by the National Natural Resources and Fiscal Commission (NNRFC) based on the local needs and performance. The Ministry of Water Supply (MoWS) remains the primary driver of capital investment for large-scale wastewater infrastructure. Despite the policy recognition of resource recovery, budget allocations, incentives, and investment instruments remain minimal, leaving wastewater reuse initiatives fragmented and underfunded (DWSSM n.d.). Federal transfers dominate WASH financing, but most funds stay at the centre, leaving provinces and municipalities under-resourced for wastewater infrastructure (Quarta et al. 2018).

Federal grants and provincial budget allocation: Municipalities receive various grants (Conditional, Special, Complementary, and Fiscal Equalization) to fund local projects. However, the federal government still controls approximately 78% of the total WASH budget, with only a small fraction specifically earmarked for wastewater treatment (WaterAid n.d.). Conditional grants are the primary vehicle for wastewater projects, which are allocated to provinces and municipalities for projects approved at the federal level. The province acts as an intermediary and can add funds based on technical readiness, matching funds criteria, or political priority/lobbying. This might create a further bottleneck if the municipality is not ready to co-finance, doesn't have a WASH Plan or detailed engineering design, or if the alignment of priorities differs between the Mayor and the Provincial Ministry.

Municipal budgeting and priorities: Municipal budgets prioritize visible infrastructure, such as roads, agriculture, and water supply, over wastewater management. When wastewater appears as a budget line item, it is usually confined to capital investments in treatment plants, with limited provisions for operation, maintenance, or reuse integration. Few municipalities quantify the economic value of treated water or nutrient recovery, reinforcing the perception of wastewater treatment as a cost center rather than a productive asset (Bekchanov and Evia 2018; Thapa et al. forthcoming).

Public financing and the town development fund (TDF): The Town Development Fund (TDF) provides concessional loans and grants for urban infrastructure, but lacks a dedicated window for water reuse or circular economy projects through the Urban Infrastructure Development Program. Its eligibility criteria emphasize sanitation coverage and health outcomes, not resource recovery or reuse performance. Introducing a “reuse readiness” or “circular sanitation” financing window, coupled with performance-based disbursements, could

incentivize municipalities to integrate reuse into infrastructure design and reward outcomes such as pollution reduction or treated water utilization (World Bank 2020).

Incentives and fiscal transfers: Nepal has no performance-based grants or green fiscal transfers linked to wastewater reuse or pollution reduction programs. Current intergovernmental fiscal transfers rely on demographic and poverty indicators, rather than environmental performance. Establishing environmental fiscal transfers (EFTs) or reuse-linked subsidies could motivate municipalities to invest in reuse systems and monitoring activities. At the farm level, no subsidies or risk-sharing mechanisms currently exist to encourage farmers to adopt treated wastewater irrigation (Poudel et al. 2023, Bekchanov and Evia 2019).

Private sector participation: Private engagement remains limited to short-term desludging contracts, with few bankable business models for wastewater reuse. The absence of clear revenue mechanisms, tariffs, or PPP frameworks constrains investments in treatment and reuse infrastructure (Bekchanov and Evia 2018, Drechsel et al. 2015). Developing service-based or cooperative public–private community partnerships (PPCP) models supported by viability gap funding and regulatory clarity could enable private participation in reuse operations (Wichelns et al. 2015, Karki et al. 2024). Most banks offer special provisions, including low-interest loans for women, that can support women's small and micro enterprises in this area, where many women already work informally.

International and climate finance opportunities: Nepal has listed wastewater reuse as a potential in its Nationally Determined Contributions for net-zero emission energy system and contributing to the reduction of methane emissions. Development partners are increasingly supporting circular economy and climate-resilient water projects. However, Nepal lacks a coordinated pipeline linking WASH, sewerage investments, and agricultural reuse. A national reuse investment framework, jointly led by MoWS, MoALD, and MoFE, could align reuse within climate adaptation and resilience portfolios, unlocking concessional and blended finance while advancing both environmental and economic co-benefits (Thapa et al. forthcoming; World Bank 2022).

Assessment of financial and economic mechanisms

Financial readiness for wastewater reuse in Nepal remains low, with scattered pilot investments and weak institutional linkages between sewerage management and agricultural financing streams (Figure 4). Scaling reuse will require a multi-pronged financial strategy that:

- Water reuse is embedded as a **budgeted component** of municipal WASH and agricultural plans.
- Creates **incentive-based fiscal transfers** tied to reuse outcomes
- Expands **the Town Development Fund (TDF)'s mandate** to include circular economy and water reuse investments;
- Mobilizes **public–private community partnerships (PPCPs)** with transparent risk-sharing; and
- Prioritize **national reuse investment pipeline** aligned with climate-finance opportunities.

Without these mechanisms, wastewater reuse will remain an unfunded mandate, dependent on short-term donor projects, rather than a sustained, self-reinforcing municipal service. Therefore, strengthening financial and economic enablers is central to unlocking Nepal's potential for safe, productive, and economically viable wastewater reuse.

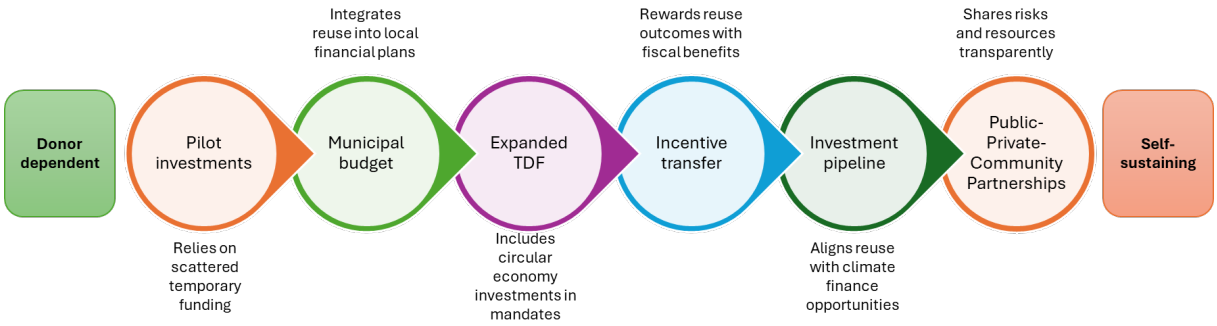

Figure 4. Driving towards self-sustaining financing mechanisms

Source: developed by authors

Social and Behavioral acceptance

Challenges and opportunities

Social and behavioral acceptance determines whether wastewater reuse evolves into a safe, mainstream practice or remains informal and stigmatized. In Nepal, necessity shapes attitudes towards reuse, limited awareness, and cultural perceptions, leading to cautious but widespread informal use alongside persistent stigma (Thapa et al. forthcoming).

Farmer practices and risk perceptions: In peri-urban areas such as Kageshwori Manohara, Mahalaxmi, and parts of the Kathmandu Valley, farmers often use untreated or partially treated wastewater during the dry season to offset water scarcity and fertilizer costs. While they recognize productivity benefits, farmers also express health and marketability concerns, particularly for raw leafy vegetables. Most apply pragmatic coping strategies using wastewater for fodder or non-edible crops to balance the risk and necessity (Shrestha et al. 2020).

Consumer and market perceptions: Consumers and retailers generally equate wastewater with contamination and fail to differentiate between treated and untreated sources (FAO 2018). This perception depresses market prices for wastewater-grown produce and discourages investment in its treatment and monitoring. The absence of labelling, certification, or public communication further entrenches mistrust (Karki et al. 2024).

Gender and inclusion dimensions: Women and tenants, who form a large share of the peri-urban agricultural workforce, face greater exposure risks but have limited access to information, protective gear, or decision-making roles in water and sanitation planning (Thapa et al. Forthcoming). Integrating women's cooperatives and local NGOs with missions on environmental justice and social changes into water reuse programs can enhance safety practices, social acceptance, community engagement and socio-technical innovations.

Awareness and behavioral change: Most WASH campaigns in Nepal focus on hygiene and sanitation, not reuse. Demonstration plots and participatory learning have proven effective in improving perceptions and safety practices elsewhere. Adapting such models in Nepal, coupled with transparent water quality monitoring and community-led communication, could foster trust and the uptake of treated wastewater in agriculture (National Sanitation and Hygiene Coordination Committee n.d.).

Assessment of social and behavioral acceptance

Public perception remains one of the most significant barriers to scaling up wastewater reuse in Nepal. Although necessity has driven informal adoption, persistent stigma, limited risk awareness, and weak institutional communication constrain formal uptake. Building social acceptance requires long-term participatory engagement that couples technical improvements with trust building and transparency.

By framing wastewater as a productive and climate-smart resource rather than a sanitation byproduct, Nepal can gradually shift its behavior and norms towards safe reuse practices. Demonstration-based learning, inclusive engagement of women, youths, and farmers, and visible monitoring of water quality are essential steps in cultivating a socially accepted reuse culture that supports municipal and national sustainability goals.

Pathway for Creating Enablers

This assessment synthesizes findings from five interconnected dimensions: policy, technical, institutional, financial, and social. This entailed an analysis of national policies, municipal experiences, and sectoral analyses, emphasizing both systemic bottlenecks and entry points for action within Nepal's federal governance framework.

The following matrix provides a summary of Nepal's enabling environment for wastewater reuse in peri-urban agriculture, structured across key dimensions, and identifies opportunities for action. Each dimension outlines the status, key constraints, and priority actions required to move from fragmented, small-scale reuse practices to a mainstream, safe, and economically viable system.

The short-term strategy should focus on municipal capacity-building, pilot demonstration projects, and data-driven risk communication, while the long-term strategy should prioritize policy harmonization, investment mobilization, inclusivity, and scaling of circular, climate-resilient wastewater reuse models integrated with urban and agricultural planning. Together, these actions (Table 2) provide a pathway towards inclusive and sustainable wastewater reuse systems in Nepal.

Table 2. Overall assessment and designing the pathways for wastewater reuse

Dimension	Current Status	Key Constraints / Gaps	Priority Actions / Opportunities
1. Policy & institutional framework	Emerging	Fragmented planning, coordination and collaboration among agencies MoWS, MoALD, MoFE leading to duplication of projects; weak alignment between WASH, and agriculture policies; limited municipal integration of reuse in planning.	• Develop national guidelines for agricultural reuse integrating water, sanitation & agriculture. • Enable and empower municipalities with federal-level policy frameworks for coordinated planning and investments in resource recovery and reuse. • Strengthen multi-stakeholder platforms in tiers of government to foster coordinated planning and investment mechanisms. • Include reuse targets in local WASH & agricultural plans.
2. Technical & infrastructure capacity	Low readiness	Less than 15 % wastewater treated; few plants reuse-oriented; weak O&M and monitoring; lack of storage, conveyance, and farmer access infrastructure.	• Retrofit treatment systems for reuse-oriented design (storage, conveyance, testing). • Promote decentralized/nature-based systems. • Institutionalize O&M financing and monitoring. • Integrate governance, gender, and social inclusion approaches in technical infrastructure design, implementation, and capacity development.
3. Human & institutional capacity	Developing	Limited municipal expertise on reuse; poor coordination between WASH & agriculture units; weak academic focus; short-term, project-based training.	• Establish inter-departmental coordination platforms. • Embed reuse topics in university curricula and training centers. • Create national certification/accreditation for private operators. • Design long-term capacity-development programs for farmers (especially women) and government officials.
4. Financial & economic mechanisms	Nascent	Reuse is not a budgeted priority; no incentive-based grants or reuse funding windows; absent PPCP models; weak valuation of reuse benefits.	• Integrate reuse in municipal budgets & TDF lending. • Introduce performance-based grants / green fiscal transfers. • Develop PPCP and blended-finance models.

			• Create and prioritize national reuse investment pipeline aligned with climate finance.
5. Social & behavioral acceptance	Low acceptance but adaptive use	Informal reuse is widespread but unsafe; strong stigma among consumers; limited awareness; gendered exposure risks; weak communication.	• Implement risk-communication & awareness campaigns differentiating treated vs untreated reuse. • Establish demonstration plots and certification schemes. • Implement GESI framework and engage women's groups & farmer cooperatives. • Ensure transparent water-quality monitoring.

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