

Towards sustainable wastewater management in Bosnia and Herzegovina: insights from Sweden

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Abbreviations

BiH	Bosnia and Herzegovina
EPA	Environmental Protection Agency
EU	European Union
FBiH	Federation of Bosnia and Herzegovina
GDP	Gross domestic product
IAS	Individual and appropriate systems
IAWD	International Association of Water Service Companies in the Danube River Catchment Area
ID	Identification
NALAS	Network of Associations of Local Authorities of South-East Europe
NSVA	Water and Sanitation Utility of North-Western Scania (Nordvästra Skånes Vatten och Avlopp)
PE	Person equivalent
RBD	River Basin District
RCDN	Regional Capacity Development Network for Water and Sanitation
REVAQ	Swedish national certification system for sludge
REWAISE	Resilient Water Innovation Economy
RS	Republika Srpska
SMHI	Sveriges Meteorologiska och Hydrologiska Institut
UNICEF	United Nations International Children's Emergency Fund
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive
WWTP	wastewater treatment plant

Key messages:

- Bosnia and Herzegovina faces major challenges in meeting EU Urban Wastewater Treatment Directive requirements, with estimated investment needs of EUR 3.5 billion, about 15% of its GDP as of 2024, and only 20 wastewater treatment plants currently operating, many below design load and with limited maintenance and sludge management.
 - Building wastewater infrastructure alone will not ensure compliance: long-term sustainability depends on effective organization, financing and operation of services across entities and municipalities.
 - Sweden's experience offers relevant insights for Bosnia and Herzegovina on how to make wastewater management more effective and sustainable, including pooling knowledge and technical support, fostering inter-municipal cooperation and aligning services with the scale and needs of different agglomerations.
 - Swedish trade organizations such as Svenskt Vatten and sectoral knowledge platforms such as Avloppsguiden have played a crucial role in building competence, harmonizing standards and supporting both municipal operations and Individual and Appropriate Systems. Organizations and associations in Bosnia and Herzegovina could adapt similar models to strengthen its fragmented institutional landscape.
 - Inter-municipal and inter-cantonal cooperation can significantly improve cost-effectiveness and strengthen capacity and expertise for wastewater operations. Within the current political framework, promoting such cooperation is a feasible first step.
 - Developing both centralized and decentralized wastewater solutions, tailored to urban, peri-urban and rural agglomerations, will make investments more efficient and resilient. This includes recognizing the role of Individual Appropriate Systems and developing clear standards and oversight for them.
 - With much of its wastewater infrastructure yet to be built, Bosnia and Herzegovina has a unique opportunity to leapfrog traditional centralized solutions by integrating circular and resource recovery principles from the start, recovering water, nutrients and energy while minimizing long-term environmental and financial costs.
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1. Introduction

Improvements in wastewater management provide significant benefits to human health and the environment. As such, some of the first European Union pieces of environmental protection (EC, 1991) focused on wastewater. As a candidate country for EU accession, Bosnia and Herzegovina's (BiH) most significant requirements on wastewater collection and treatment emanate from the recently updated EU Urban Wastewater Treatment Directive (UWWTD) (EC, 2024d). A recent planning document identified 338 agglomerations in BiH where wastewater collection and treatment is required. It estimated the compliance cost for meeting this demand to be EUR 3.5 billion (Suez, 2024). Such an investment represents just under 15% of the total gross domestic product (GDP) of BiH, which in 2024 was EUR 24.6 billion (Countryeconomy, 2025). Securing the financial resources and technical expertise to construct the necessary wastewater infrastructure in BiH thus represents a formidable challenge, and one that is shared by the EU's most recent member states. In 2020 the level of compliance with the obligations of the UWWTD in terms of wastewater collection and treatment respectively, was 78% and 38% in Bulgaria (EC, 2024a), 17% and 15% in Romania (EC, 2024c) and 79% and 11% in Croatia (EC, 2024b). In 2024, due to failure to comply with the collection and treatment obligations set out in the UWWTD, the EU Commission referred Bulgaria and Romania to the Court of Justice of the EU (EC, 2024e).

Building the required infrastructure, however, is only the first step in ensuring compliance with UWWTD. Wastewater management requires continuous administrative and organizational efforts to ensure sustained and satisfactory operations. This is reflected in the 20 existing wastewater treatments plants (WWTPs) in BiH. Existing facilities face problems with sludge disposal while a lack of financial support and a complex tendering process cause frequent issues with maintenance and the procurement of spare parts. Operational obstacles lead to repeated periods of downtime or reduced treatment efficiency in various installations. However, BiH is entering a period of extensive expansion of its wastewater management systems which could open space for innovation and leapfrog options that provide better opportunities to reuse water, nutrients or energy than existing standard solutions.

Sweden provides a useful point of comparison for BiH in this regard, as an EU member state that has a long trajectory of developing wastewater services through successive phases of expansion, regulatory tightening and institutional learning to comply with national as well as EU requirements. Sweden experienced a rapid, state-supported expansion of wastewater management between 1960 and 1975, when sewer network coverage increased from 50% to almost 90% of the population. Treatment processes evolved from primary and secondary treatment to tertiary treatment for phosphorus removal, and later nitrogen removal in coastal plants. BiH and Sweden are both situated in eutrophication sensitive areas (EEA, 2025) with higher requirements for wastewater management, since Sweden is mainly situated in the catchment of the Baltic Sea and BiH in the catchments of the Black Sea and the Adriatic Sea (Annex II UWWTD).

Given the similarities between the two cases, this report aims to provide a comparative analysis between BiH and Sweden, focusing on relevant legal, technical, organizational and institutional dimensions of wastewater management. By examining how Sweden

achieves compliance with EU wastewater management requirements in a cost-effective and reliable way, the report identifies good practice and approaches that could be adapted to BiH's specific context. As such, it guides prioritization and informs BiH policymakers and utilities on how to build sustainable wastewater services aligned with EU standards. Issues highlighted in the report include strengthening the pooling of knowledge and provision of know-how at entity level of the Federation of Bosnia and Herzegovina (FBiH), and Republika Srpsk (RS), envisioning inter-municipal collaborations and scaling services according to the set-up of urban areas. The report also suggests possible visionary and leapfrog solutions that could enable BiH to adopt wastewater management solutions that cater for a higher level of water, nutrient and energy recovery than the current standard solutions. While stressing the similarities that allow for drawing inspiration, it is also clear that BiH is subject to a very different political reality compared to Sweden, which is reflected in the report's recommendations.

The following section, section 2, highlights EU requirements on wastewater management. Section 3 highlights the current operational, legal and administrative situation of wastewater management in BiH. Section 4 provides an overview of wastewater management in Sweden. Section 5 discusses pooling of knowledge and provision of know-how, inter-municipal collaboration, scaling services according to agglomeration set-up and leapfrog solutions, using examples from Sweden and BiH. Section 6 highlights key implications for sustainable wastewater management in BiH.

2. EU requirements on wastewater management

One of the strengths of the UWWTD is that it contains clear requirements that facilitate monitoring and enforcement (EC, 2019). A key provision of the directive is that the population of all EU member states should be divided into "agglomerations": areas where the population, combined with its economic activities, is considered sufficiently concentrated to collect wastewater and treat it prior to release into the environment (EC, 2024d).¹ The wastewater load from each agglomeration is calculated based on the Person Equivalent (PE) measure, which is defined as the average biodegradable organic load generated by one person. PE is calculated by combining the wastewater loads from residential, industrial and commercial activities within an agglomeration. While PE is defined in terms of pollution load, it is commonly used in practice together with assumptions on wastewater quantity to support the design of treatment plants for both pollutant removal and hydraulic capacity. Depending on the PE wastewater load, the UWWTD sets out required treatment processes of the wastewater from primary to quaternary treatment, with each additional step requiring more advanced treatment of the wastewater (Art. 2:11-14 UWWTD).²

¹ The UWWTD specifies the indicative reference threshold of 10 to 25 PE per hectare, above which the population is sufficiently concentrated to delineate an agglomeration.

² Primary treatment involves physical or chemical processes that reduce the biochemical oxygen demand of wastewater by at least 20% and the total suspended solids by at least 50%. Secondary treatment, in addition, generally involves biological treatment with a secondary settlement that reduces BOD by 70-90% and total suspended solids by 90% (Annex I, Part C, Table 1 UWWTD). Tertiary treatment involves processes that, in addition, reduce nitrogen or phosphorus concentrations by 80% and 90% respectively (Annex I, Part C, Table 2 UWWTD). Quaternary treatment involves processes that reduce a broad spectrum of micropollutants in urban wastewater by 80% (Annex I, Part C, Table 3 UWWTD).

≥1000 PE agglomerations

The most basic threshold established by the UWWTD focuses on agglomerations with wastewater loads of 1000 PE or more (≥1000 PE). By 31 December 2035, these agglomerations shall have all sources of domestic wastewater connected to a collecting system with secondary treatment of the discharged wastewater (Art. 3:2 and 6:3 UWWTD).

≥2000 PE agglomerations

In 1991, the first UWWTD (EC, 1991) set the general requirement to connect all sources of domestic wastewater to a collecting system with secondary treatment in agglomerations with wastewater loads of 2000 PE or more (≥2 000 PE) by 31 December 2005. Unless special derogations are in place, this requirement applies immediately across the EU.

≥10 000 PE agglomerations

Apart from general requirements based on agglomeration wastewater load, there are various requirements that apply to agglomerations of 10 000 PE or more (≥10 000 PE) that face specific challenges. Agglomerations of more than 10 000 PE situated in areas designated as sensitive to eutrophication shall, by 31 December 2045, apply tertiary treatment on all wastewater discharge (Art. 7:3 UWWTD). These agglomerations, in areas where the concentration or accumulation of micropollutants from urban WWTPs represents a risk for the environment or human health shall, by 31 December 2045, apply quaternary treatment on all wastewater discharge (Art. 8:4 UWWTD). Where storm-water overflow or urban runoff pose a risk to the environment or human health, they should, by 31 December 2039, establish an integrated urban wastewater management plan for their drainage areas (Art. 5:2-3 UWWTD). The UWWTD also establishes a requirement on energy neutrality for WWTPs treating a load of over 10 000 PE by 31 December 2045 (Art. 11:2 UWWTD). This requirement is to be fulfilled by owners or operators of the plants by generating renewable energy, on-site or off-site, equal to the energy demand of their operations (Art. 11:2 UWWTD).

≥100 000 PE agglomerations

Agglomerations of 100 000 PE or more (≥100 000 PE) are required, by 31 December 2033, to have established an integrated urban wastewater management plan for their drainage areas (Art. 5:1 UWWTD).

≥150 000 PE agglomerations

Agglomerations of 150 000 PE or more (≥150 000 PE) are required, by 31 December 2039, to apply tertiary treatment on all wastewater discharge (Art. 7:1 UWWTD), and, by 31 December 2045, to apply quaternary treatment on all wastewater discharge (Art. 8:1 UWWTD).

The principal requirements of UWWTD are summarized in Table 1.

Table 1: Summary of principal UWWTD requirements

Threshold	Special circumstances	Requirements	Deadline
≥1000 PE		Collecting system with secondary treatment	31 December 2035
≥2000 PE		Collecting system with secondary treatment	Immediate*
≥10 000 PE		Energy neutrality of operators	31 December 2045
≥10 000 PE	Discharge in areas sensitive to eutrophication	Tertiary treatment	31 December 2045
≥10 000 PE	Micropollutants represent risk to the environment or human health	Quaternary treatment	31 December 2045
≥10 000 PE	Storm-water overflow poses a risk to the environment or human health	Integrated urban wastewater management plan	31 December 2039
≥100 000 PE		Integrated urban wastewater management plan	31 December 2033
≥150 000 PE		Tertiary treatment	31 December 2039
≥150 000 PE		Quaternary treatment	31 December 2045

*Note: The deadline for agglomerations with ≥2000 PE would apply immediately for any new EU member state on accession, unless transitional arrangements are agreed.

2.1 Individual and Appropriate Systems

The UWWTD allows for Individual and Appropriate Systems (IAS). These are on-site sanitation systems that can include different types of collection, storage or treatment systems, such as nature-based solutions, small-sized treatment systems or temporary tanks combined with regular evacuation to WWTPs (Preamble 9 UWWTD). These systems are not a free choice, however, and they require an exception (a “derogation”) from the general requirement that ≥1000 PE agglomerations establish and connect all sources of domestic wastewater to collecting systems. Such exceptions are only allowed when fulfilment of the general requirement of the directive would produce no additional environmental or human health benefits, is not technically feasible or would involve excessive costs (Art. 4:1 UWWTD). Such IAS are allowed in parts or all of the agglomerations if they are designed, operated and maintained in a manner that achieves the same level of environmental and human health protection as the generally required collecting systems (Art. 4:1 and 2 UWWTD).

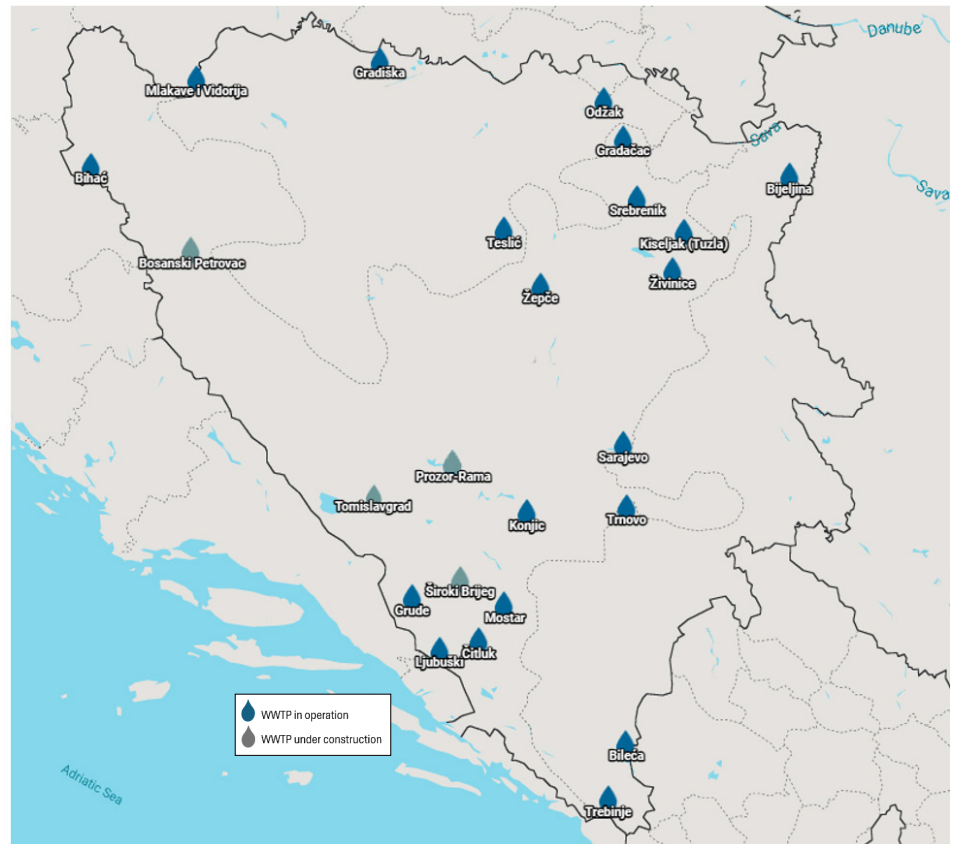
Agglomerations of less than 1000 PE are not covered by UWWTD; however, obligations from other EU directives, such as the EU Water Framework Directive (WFD) (EC, 2000), can trigger requirements for wastewater treatment. This can be the case when wastewater from smaller agglomerations is identified as a source of pressure on water bodies, preventing these water bodies from attaining “good status” (Art. 4 WFD). Water bodies that are used for the abstraction of drinking water require special monitoring and may be subject to safeguard zones (Art. 7 WFD). In safeguard zones, wastewater treatment, using IAS, can be relevant for smaller agglomerations and individual households located within these zones.

3. Wastewater management in Bosnia and Herzegovina

In BiH, with its 3.5 million inhabitants, there are estimates that indicate that roughly half of the population – including the population of large urban centres such as Sarajevo, Banja Luka, Zenica, Mostar, Tuzla and Bijeljina – is connected to sewer networks (UNICEF & WHO, 2025). However, among those larger urban centres, only Sarajevo and Mostar currently have WWTPs treating the wastewater of significant portions of the population, although these systems are not operating at full functional capacity, as indicated by data from the Aquasan database of WWTPs (Aquasan Network in BiH, 2025).. In the remaining cities, there are either no WWTPs or the existing plants serve only a small fraction of the population’s wastewater load, as is the case in Bijeljina. This indicates that connection to a sewer network does not automatically imply effective treatment of wastewater. Smaller towns and rural areas often have partial sewerage coverage with untreated discharges to receiving waters, while many rural communities continue to rely on septic tanks or direct discharge without adequate treatment.

Currently in BiH, there are 20 WWTPs in operation, while four are under construction (see Figure 1).

Figure 1. WWTPs in operation and under construction in BiH



Source: Association for Water and Environmental Protection "Aquasan Network", WWTP database, <https://aquasanbih.ba/en/content/wwtp-database/24>

Most WWTPs are currently operating below capacity, as the design often overestimates the wastewater load or the sewage system coverage is inadequate. All WWTPs face problems with sludge disposal. A lack of financial support and complex tendering processes frequently cause issues with maintenance and the procurement of spare parts, leading to periods of downtime or reduced treatment efficiency. One example is Bihać, which did not achieve key targets despite significant investments in wastewater collection and treatment. The planned connection rate was not accomplished, cost recovery remains very low, and high infiltration from groundwater and storm-water inflow reduces treatment efficiency. While the system has improved living conditions and likely enhanced the water quality of the Una River, its sustainability is threatened by insufficient financing, low tariffs, inadequate connection rates, lack of sludge disposal solutions and structural challenges (KfW, 2023). Živinice has a design capacity of 40 000 PE, of which 25 000 PE has been built and equipped in the first phase. While influent pumps and mechanical treatment can already handle the full design load, the biological stage is limited to 25 000 PE. Currently, around 4611 households (≈15 000 people) are connected, meaning the plant operates at about 50–60% of its capacity. Aquasan Network in BiH highlights that the key operational challenges for maintaining WWTPs include inadequate preventive maintenance practices, insufficient financial resources for WWTP operation and maintenance, and delays in procuring spare parts (VSA & Aquasan Network in BiH, 2025). They also note that poor maintenance and outdated equipment contribute to frequent breakdowns and reduced reliability of treatment processes. In past years, these problems have led to periods with complete shutdown of the treatment process in the Živinice WWTP, with wastewater being discharged into surface waters after only a minimal level of treatment (see Sweco & Enova, 2024).

3.1 Legal and administrative structure

BiH is administratively structured into two entities: FBiH and RS. There is also the self-governing administrative unit, the Brčko District of BiH. Responsibilities for water management and EU directive implementation are distributed across these entities. Coordination takes place through state-level bodies in areas of shared or national competence; however, in practice, policymaking and implementation remain fragmented across administrative levels, including in environmental governance and environmental data management (Directorate-General for Neighbourhood and Enlargement Negotiations, 2024).

FBiH has transposed approximately 95% of UWWTD norms into its legislation. The Regulation on Conditions for the Discharge of Wastewater into the Environment and Public Sewerage Systems (Official Gazette of FBiH 26/20, 96/20, 1/24) sets limit values and conditions for the discharge and treatment of municipal and industrial wastewater, transposing the UWWTD. The regulation requires agglomerations in non-sensitive areas to establish municipal wastewater management and ensure treatment within deadlines following BiH's EU accession: 6 years for ≥15 000 PE agglomerations, 12 years for ≥10 000 PE to <15 000 PE agglomerations, and 18 years for ≥2000 PE to <10 000 PE agglomerations. Before any discharge, municipal wastewater must undergo at least secondary (or equivalent) treatment within the same timeframes. When it comes to discharges into sensitive areas, all municipal wastewater must be treated

within 12 years after EU accession. Tertiary treatment is required for agglomerations over 10 000 PE and secondary treatment for those below 10 000 PE. This established the timeframe for harmonization with the requirements of the EU Directive. However, the River Basin Management Plan and Program of Measures for the two river basins of FBiH³ set a more ambitious goal: ensuring that all agglomerations above 2000 inhabitants are equipped with WWTPs by 2039. In FBiH, sewage sludge management has recently progressed with the 2024 Regulation on sludge from municipal wastewater treatment plants, which provides a temporary framework for sludge treatment and disposal. Although aligned with the general approach of EU Directive 86/278/EEC, it prohibits sludge use on agricultural land, in line with the position of the Federal Ministry of Environment and Tourism. As a temporary measure, it should be replaced by a permanent framework, which is already foreseen in the current Federal Waste Management Plan by 2026.

In RS, only about 50% of UWWTD provisions have been transposed, and deadlines for full compliance have yet to be defined. The Regulation on Conditions for the Discharge of Wastewater into Surface Waters (Official Gazette of RS 44/01) defines emission limit values and requirements for the collection, discharge and treatment of municipal and industrial wastewater. Unlike in the FBiH, this regulation does not set deadlines for agglomerations to establish wastewater collection and treatment systems. Timeframes and investment priorities are instead addressed through strategic planning documents, such as the River Basin Management Plan for the Sava River Basin in RS and the Plan for the Trebišnjica River Basin District, which envisage gradual development of wastewater treatment infrastructure up to 2039. In RS, sludge management is recognised in strategic and legal documents, but a dedicated and comprehensive regulation has not yet been adopted.

In Brčko District, progress is minimal, as the absence of a Water Law harmonized with EU directives prevents the establishment of legal obligation for UWWTD implementation (Suez, 2024). Brčko District BiH has a legal framework for water protection, but no specific secondary legislation that sets deadlines and obligations for agglomerations; these issues are addressed through individual water permits and development plans. In Brčko District, no specific framework for sludge management exists because there are currently no wastewater treatment plants, but one will be needed once such infrastructure is developed.

Despite the administrative complexity, the general environmental management framework in BiH includes strategies at the entity level, followed by cantonal plans (in FBiH), and finally municipal plans. This hierarchical structure is applied to solid waste management. However, in the field of wastewater management, strategies and plans exist only at the entity level and there is currently no legal requirement to develop a wastewater management plan at municipal level. This lack of municipal planning exists despite municipalities and utility companies being the ones that finance the construction and operation of these systems, primarily through loans and, in some cases, subsidies from higher levels of government.

3 Sava River District and the Adriatic Sea River Basin District in FBiH.

3.2 Master Plan of agglomerations

In 2024, BiH completed a significant step towards aligning with the UWWTD by developing a Master Plan for the delineation of agglomerations (Suez, 2024). This strategic document was created to support the effective planning and future implementation of the UWWTD requirements. The preparation of the Master Plan involved institutions at the state and entity levels, as well as water agencies and other competent public bodies. The delineation of agglomerations will be adopted through the River Basin Management Plan’s update process. However, the Directive Specific Implementation Plan and Action Plan for Implementation of UWWTD, although completed, have not been adopted due to political reasons.

Although not a requirement of the UWWTD, the Master Plan identified agglomerations down to 500 or more PE (≥ 500 PE) inside urban areas (subject of urban planning). Primarily, settlements with more than 500 PE were identified. These zones were then assessed, and where possible merged, to be categorized as agglomerations if their load exceeded 500 PE, or as IAS if it did not. The decision to identify agglomerations over 500 PE was taken following detailed discussions with national stakeholders to ensure more inclusive coverage of smaller settlements and to strengthen the basis for long-term planning of wastewater infrastructure at a national level. The intention is that the River Basin Authorities⁴ include agglomerations down to 500 PE in the River Basin Management Plans that are developed in line with the requirements of the WFD (Art 13 WFD). The Master Plan identifies 338 agglomerations within five River Basin Districts (RBDs) in BiH, which correspond to the country’s two main river basins (Sava and Adriatic) and its three administrative units.

Figures 2 and 3 visualize the information provided in the Master Plan, for BiH as a whole, regarding estimated PE wastewater load for each class of agglomerations, and total number of agglomerations, according to the thresholds specified in the UWWTD (Table 1).⁵

Figure 2. Distribution of wastewater load according to agglomeration size in BiH

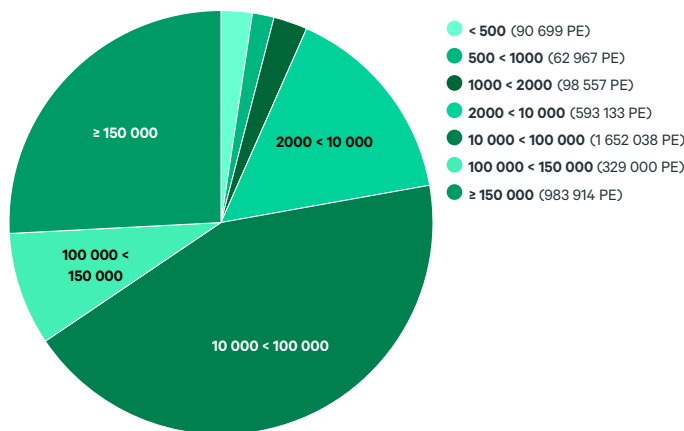


Figure 2 shows that an estimated 96% of the total wastewater load in BiH comes from agglomerations that are, or in the coming decades will be, subject to UWWTD requirements. The largest share of wastewater in BiH comes from agglomerations with between 10 000 PE and 100 000 PE load, while the second largest wastewater load emanates from the biggest agglomerations in the country, those over 150 000 PE.

⁴ <https://avpjm.jadran.ba/>; <https://www.voda.ba/>; <http://www.voders.org/>; Government of Brčko District of BiH Department for Agriculture, Forestry and Water Management

⁵ In addition, Figure 2 provides information related to PE wastewater load for settlements that are below 500 PE (<500).

Figure 3. Number of agglomeration according to size

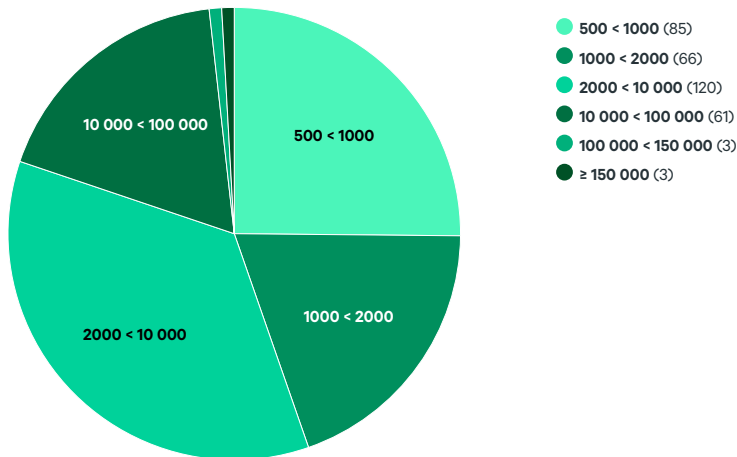


Figure 3 shows that the largest number of agglomerations in BiH are those with a wastewater load in the range of 2000 PE to 10 000 PE. The second largest group of agglomerations are those with a wastewater load below 1000 PE which are not subject to requirements from the UWWTD, but that can require wastewater treatment to comply with the WFD.

Following the strategy of one WWTP per agglomeration, the Master Plan proposes 338 WWTPs. This is a substantial number, and highlights the need for significant investment and expansion of wastewater treatment services in BiH to align with EU requirements. The proposed locations were identified based on discharge points and the most logical placement considering the digital elevation model, orthophotos, sensitive areas and nearby water bodies. These locations are preliminary and will be re-evaluated during the feasibility study phase, which will not only explore alternative sites but also assess the technical feasibility of combining two or more agglomerations into a single WWTP. The Master Plan estimates the compliance cost for building wastewater treatment and collection systems for the identified 338 agglomerations to be roughly EUR 3.5 billion, which represents just under 15% of the total GDP of BiH, which in 2024 was EUR 24.6 billion (Countryeconomy, 2025).

4. Wastewater management in Sweden

With 10.6 million inhabitants, Sweden's population is three times larger than that of BiH. In 2022, Swedish municipalities operated 1200 WWTPs as part of municipal wastewater management. The majority of WWTPs are small, treating less than 2000 PE, but 260 plants treat 2000–10 000 PE, 129 plants 10 000–50 000 PE and 44 plants are large scale, treating more than 50 000 PE (Vidal et al., 2025).

4.1 Legal and administrative structure

In Sweden, County Administrative Boards permit and follow up WWTPs between 200–2000 PE. The Land & Environment Courts handle permits for larger plants (≥ 2000 PE), with County Administrative Boards responsible for carrying out inspections of municipal operations. There are approximately 860 000 properties that are not connected to municipal sewer networks and rely on IAS. Roughly 470 000 of these properties are permanent residents, while the rest are leisure houses (SMED, 2021)⁶.

Municipalities issue permits for IAS ≤ 200 PE (FMH §13), conduct inspections and are responsible for providing means for collection and transport of septic sludge and other waste from IAS, often via contracted haulers. However, the property owner pays for the collection service. A municipal water services plan is required by Swedish law since 2023 to outline long-term strategies for municipal water and sanitation, including measures to ensure the functioning of municipal wastewater systems during heavy rainfall. This plan should also guide decisions on providing access to the municipal sewer network versus IAS solutions for different areas in the municipality. Appendix 1 provides an overview of the Swedish legal framework for the organization of wastewater management services.

4.2 Financing and cost recovery

Sweden has a strict application of the polluter-pays principle which implies that the costs for wastewater management are borne by whoever generates the wastewater (Vafa, 2021). There are typically no subsidies from the state or municipalities for wastewater management systems. All costs, including increased costs for investments to comply with stricter environmental requirements, are borne by households either through increased tariffs or via the actual costs households pay for installing and/or upgrading their IAS. All users of municipal sewer networks pay according to an established tariff structure (Svenskt Vatten, 2025a). When connecting previously unserved areas to the municipal sewer network, the property owners pay a one-time connection fee. A recent survey of 2025 tariffs across Sweden's 290 municipalities found connection fees for single-family houses ranging from approximately EUR 5000 up to over EUR 35 000, with many municipalities charging around EUR 20 000 (Svenskt Vatten, 2025a). Once connected, users pay usage fees (including a fixed fee and a consumption-based fee per cubic metre of water use) that cover operations and infrastructure investments for water provision and the management of wastewater

⁶ The data is based on a national survey with responses from 83% of Swedish municipalities.

and stormwater. On average, this works out to about EUR 88 per month for an average single-family house and EUR 55 per month for an average apartment (Svenskt Vatten, 2025a). Municipal water and wastewater utilities operate under a legal cost-recovery requirement, meaning tariffs can only recover actual costs for delivering the services (with any surplus returned to users or reinvested) (Åhlberg, 2024; de Fine Licht, 2023). Appendix 2 provides an example of the structure of municipal wastewater fees in Sweden.

For households that use IAS, the economic responsibility lies primarily with the property owners. This includes financing the capital expenditure to install or upgrade their facility, and covering ongoing operating costs such as septic tank emptying, electricity for pumps or replacement of filter media (Malmén et al., 2004).

The Water Services Act embeds principles of equity and cost-relatedness in these tariffs: charges must be set so that water and sewer costs are apportioned in a reasonable and non-discriminatory way among customers (Åhlberg, 2024; de Fine Licht, 2023). There is thus a policy aim for rough parity in financial burden between use of the municipal sewer network and IAS so that rural households are not paying drastically more than urban users for equivalent environmental protection.

4.3 Performance-based regulation of Individual and Appropriate Systems

Until the early 2000s, Swedish permits for IAS were largely technology-based, with approval focusing on the type of system installed (most commonly septic tanks with a soil infiltration or a sand filter), rather than on the system's actual performance and the sensitivity of the waterbody where effluent is discharged. Since the establishment of the Environmental Code (1999) and Naturvårdsverket (the Swedish Environmental Protection Agency, EPA) guidelines (2006:7), permits have been tied to performance standards for reducing organic matter and nutrients. Two levels of protection were introduced: a normal protection level and a high protection level for sensitive areas requiring stricter nutrient reduction, particularly for phosphorus. Instead of relying on a limited set of standard technologies, the system allows for more flexible and innovative solutions, as long as they can demonstrate adequate performance. However, this shift has created some challenges for municipal officers who need to interpret performance data from suppliers, judge suitability under the local soil and water conditions and decide what evidence is sufficient to demonstrate compliance.

5. Knowledge, collaboration, scaling and leapfrogging

This section is divided into four subsections:

- Pooling knowledge and provision of know-how;
- Inter-municipal collaboration;
- Scaling services according to agglomeration set-up;
- Leapfrogging opportunities.

In the first three subsections, Swedish examples are systematically compared with examples of the situation in BiH to derive practical lessons for policymakers and water utilities on how to build sustainable wastewater services aligned with EU standards. The first subsection explains how, in Sweden, the pooling of knowledge and provision of know-how at the national level are provided by the trade association Swedish Water and Wastewater Association (*Svenskt Vatten* in Swedish; from here on simply “Swedish Water”), and via two information platforms called the Swedish Water and Wastewater Guide (*VA-guiden*) and the Swedish Sanitation Guide (*Avloppsguiden*). The section also highlights several associations in BiH that promote sustainable water resource management and environmental protection. These include Aquasan Network Bosnia and Herzegovina (Aquasan Network BiH), the Association of Utility Enterprises in FBiH, the Association of Municipalities and Cities of FBiH, the Association of Local Authorities of RS and the Association of Waterworks of RS.

The second subsection illustrates trends of increasing inter-municipal collaboration in Sweden through the example of the Water and Sanitation Utility of North-Western Scania (*Nordvästra Skånes Vatten och Avlopp*, NSVA). This subsection explains that, despite several cases of functional interconnection, the Master Plan for the delineation of agglomerations (Suez, 2024) does not envisage any shared cross-entirety agglomerations in BiH, nor cross-cantonal agglomerations in FBiH. In the third subsection, six municipalities – three from Sweden and three from BiH – are highlighted to show how appropriate scaling of wastewater services, from more centralized to more decentralized, depends on the set-up of the agglomeration. The fourth and final subsection offers inspiration for possible leapfrog solutions that can play a role in developing wastewater systems with higher recovery of water, nutrients and energy compared to existing conventional infrastructure.

5.1 Pooling knowledge and provision of know-how

For supportive functions to pool knowledge and know-how, it is important to distinguish between municipal wastewater management systems, where the municipality is the operator, and IAS, operated by individual homeowners where the municipality is responsible for carrying out inspections. There are therefore different groups of beneficiaries that trade organizations and membership services cater for. On the one hand, the municipality as operator of the municipal wastewater management system, and contractors for the construction and support of those municipal systems. On the other hand, the municipality as inspector of IAS, individual homeowners as operators of IAS, and contractors for the construction and support of IAS. Across

these groups, sector platforms typically provide a set of core functions: standards and guidance, training, benchmarking and statistics, procurement and contract support, and structured knowledge exchange.

Swedish Water is a national trade organization, and municipal water and wastewater utilities companies are the core member organizations. The main mission of Swedish Water is to provide the best possible support for member organizations to deliver sustainable, cost-effective and safe water and wastewater services. Swedish Water has a staff of 30 professionals that provide thematic support to its 300 member organizations on construction and maintenance of infrastructure, environmental protection, climate and sustainability, operational security, communication, governance, legal matters and statistical support. The thematic support services are backed up by an applied research and innovation branch that funds research projects, the outputs of which are available to members. The dissemination of relevant knowledge and development of required skills among the member organizations' workforce is assured through the provision of recurring courses. Roughly 30 courses of varying length and depth are available to the staff of member organizations, with the most advanced courses, including a course on wastewater treatment, providing formal diplomas on completion. All these activities primarily cover standards and guidance, training and certification, plus sector statistics and benchmarking. In addition, Swedish Water works both at the Nordic level and at the European level (via the cooperation organization EurEau) to strengthen the position of water services, through for example participation in the European standardization work. Membership fees are calculated based on the number of municipal inhabitants and can range from EUR 3000 per year for a municipality with 9000 inhabitants to EUR 60 000 per year for a municipality with 300 000 inhabitants (Svenskt Vatten, 2025b).

The Swedish Water and Wastewater Guide (VA-guiden in Swedish) provides information in four core areas: water and wastewater planning, storm-water management, IAS and environmental protection. The information platform is a membership service run by three private companies in the sector. It has around 350 members, including 203 out of a total of 290 Swedish municipalities. The key services provided are business intelligence, practical regulatory interpretation and guidance, a shared document library and experience-sharing via a helpdesk and peer exchange. Business intelligence covers progress and activities in the sector while the document library provides access to thousands of reports, investigations, strategy documents, legal cases and other documents. The experience-sharing element offers a collection of training and conference material, along with concrete examples of how municipalities and companies work. The overall mission is to provide independent, comprehensive and reliable information to keep sector professionals updated. Membership fee for municipal organizations is roughly EUR 1500 per year for access to one of the four core areas (VA-Guiden, 2025).

The main knowledge-pooling platform for IAS is the Sanitation Guide (Avloppsguiden in Swedish), which provides homeowners free access to compiled knowledge about non-sewered sanitation systems. The Sanitation Guide aims for its information to be as independent and as comprehensive as possible, with its key goal being to provide guidance on the full implementation and operational cycle for individual systems. It covers topics like planning, selecting technical solutions, permit process, infrastructure

development, and operations and maintenance. For homeowners, the Sanitation Guide is an important addition to the advisory services offered by most municipalities. Managed by the same companies that run VA-guiden, it is financed partly from fees that municipalities pay for VA-guiden and partly from charging companies that present IAS technologies on the platform.

In terms of equivalent organizations and platforms in BiH, first there is the Aquasan Network BiH. This is a professional network focused on promoting sustainable water resource management and environmental protection, with a particular emphasis on the collection and treatment of wastewater in FBiH and across the country. It works on capacity building, advocating for sustainable policies and collaborating with donors such as the Swiss Agency for Development and Cooperation. Funding for the network comes primarily from projects and donor countries, rather than membership fees or contributions. Members may be engaged for specific expert tasks within the projects funded by international donors.

The Association of Utility Enterprises in FBiH brings together public utility companies in FBiH that are engaged in water supply and wastewater treatment. It supports the harmonization of tariffs through unified methodologies, infrastructure development and legal regulations. Members (public utility companies) pay annual membership fees. Additional funding may come from training fees and conference participation.

The Association of Municipalities and Cities of FBiH provides support to local government units and water sector operators in planning and implementing investments related to wastewater. It also works on raising awareness and education. Activities are fully donor funded with no membership fees.

The Association of Local Authorities of RS currently has no specific wastewater projects; however, the Association of Waterworks of RS exists to bring together public and private water supply companies in RS with the aim of improving the water supply and wastewater sector. Its focus is on the development of water collection, treatment and distribution systems, organizing training, seminars and experience exchanges. It provides consulting and management support to its members and promotes sector modernization.

In Brčko, there are no specific registered associations exclusively for wastewater; these services fall under the responsibilities of public utility companies Komunalno Brčko.

A current regional initiative is the Regional Capacity Development Network for Water and Sanitation (RCDN), which assists local governments and utilities in wastewater investment planning, awareness raising and capacity building. The project is jointly funded by the Swiss State Secretariat for Economic Affairs and the German Federal Ministry for Economic Cooperation and Development, and is implemented through the Deutsche Gesellschaft für Internationale Zusammenarbeit under the project Open Regional Fund for Southeast Europe – Modernization of Municipal Services. The implementation team brings together three regional networks: the International Association of Water Service Companies in the Danube River Catchment Area (IAWD), Aquasan Network BiH and the Network of Associations of Local Authorities of South-East Europe (NALAS). Activities are fully donor funded, with the first phase carried out in 2018–2022 and a continuation phase ongoing during 2024–2026.

RCDN partners include 12 associations of municipalities and utilities from the Western Balkans (Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, Montenegro and Serbia). Final beneficiaries are senior and mid-level staff of local governments and public utilities. The project has established an Implementation Unit, composed of Aquasan Network BiH, NALAS and IAWD, as well as a Governing Board with representatives of all partner associations. After completion, the Implementation Unit is expected to evolve into an Executive Secretariat of a self-sustaining network. RCDN aims to transfer, expand and standardize knowledge across the region, while partner associations adapt it to national regulatory frameworks. Through training, advisory services, study visits and related activities, the network endeavours to strengthen the capacities of local authorities and utility companies.

While several associations in BiH already contribute to capacity development and sector coordination, the Swedish examples illustrate additional functions that could strengthen knowledge pooling and operational support in BiH. Swedish Water combines stable, member-based financing with a clear mandate to provide continuous, utility-focused technical assistance, applied research and innovation, and a structured training offer that systematically upgrades the skills of the municipal workforce. Likewise, Sweden's two information platforms – the Water and Wastewater Guide, and the Sanitation Guide – function as permanent, practice-oriented knowledge hubs that curate and standardize guidance, case material and regulatory interpretations for both utilities and IAS stakeholders, thereby reducing transaction costs for individual municipalities. By contrast, most BiH platforms are still strongly project- and donor-dependent, and several function areas are unevenly covered, particularly: recurring training and certification, benchmarking and statistics, procurement support, and sustained helpdesk and peer-exchange services. Applied research and innovation support is also less institutionalized as a continuous member service. Of course, not all aspects of the Swedish examples may be relevant or directly transferable to the BiH context given differences in the financial base for municipalities and governance structures at the national and subnational levels. These differences naturally limit the scope for high membership fees and large permanent secretariats. Nevertheless, the Swedish experience offers valuable insights into the types of functions that sector platforms can perform. Such functions include standards and guidance on regulations, training programs, benchmarking and statistics, procurement and contract support, and structured knowledge sharing via helpdesks and peer exchange. Building on the existing structures and associations in BiH described above, BiH stakeholders could jointly explore how to gradually incorporate some of these functions, starting with low-cost knowledge-sharing formats and targeted training offers, and adapt them to BiH's political, institutional and financial realities.

5.2 Inter-municipal collaboration

In Sweden, there is a growing tendency for inter-municipal collaboration in wastewater management, to achieve more cost-effective and well-functioning wastewater systems in municipalities and regions. This collaboration creates greater opportunities to carry out effective planning for wastewater infrastructure. It also helps municipalities recruit and sustain the necessary competences and resources for wastewater operations, which can be a major challenge, especially in municipalities with small populations. The

NSVA is an example of inter-municipal cooperation, where the wastewater management and treatment solutions are localized in each municipality.

NSVA is a municipal company supplying drinking water, treating wastewater and managing storm-water in the eight municipalities of Bjuv, Båstad, Helsingborg, Landskrona, Perstorp, Svalöv, Åstorp and Örskelljunga, in the county of Scania in southern Sweden. NSVA was formed in 2009 and today serves about 280 000 residents and businesses, operating 16 WWTPs in the eight municipalities (NSVA, 2025b). All eight own an equal share of the company, which employs about 230 people. Size and treatment technologies differ between the different plants. Part of the wastewater from two of the NSVA municipalities is treated at WWTPs outside these municipalities.

Figure 4. NSVA operation area with its 11 co-owner municipalities



Source: NSVA (2025b).

The fundamental basis for the NSVA cooperative model is that each municipality's council (the elected representatives) decides on water and sewerage operation areas, water and wastewater infrastructure within the municipality, general regulations for water and wastewater, and tariffs and investments (NSVA, 2025a).

All municipalities have equal influence over the company, but each is responsible for their own special costs and each is treated based on its own conditions. NSVA's operations are paid for by the water and wastewater tariff and are not tax-financed.

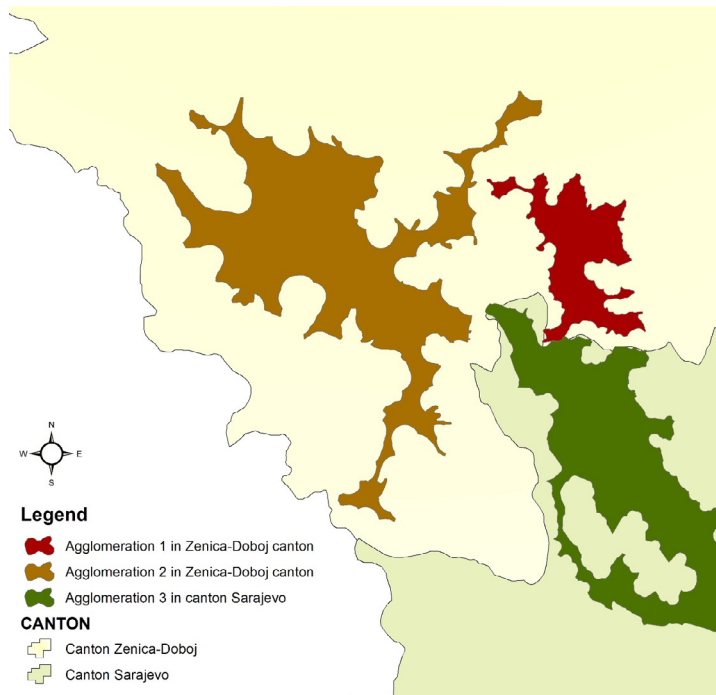
Another example where municipalities collaborate for economies of scale in centralized wastewater treatment is the *Käppala Association*, whose centralized WWTP treats wastewater from over 500 000 inhabitants across 11 municipalities located north and east of Stockholm (Käppala Association, 2019). Beyond these, VA Syd, Roslagsvatten and Gyaab are all examples of wastewater utilities owned by several municipalities under this collaborative model.

In BiH, despite several cases of functional interconnection, the Master Plan for the delineation of agglomerations (Suez, 2024) does not envisage any shared cross-entity agglomerations. Likewise, the aim of respecting cantonal borders within the FBiH was given priority over delineations that may have created more feasible, sustainable and cost-effective agglomerations in the Master Plan. The main reasons behind this delineation of agglomerations are political and organizational. Cross-entity and cross-cantonal agglomerations require harmonization of responsibilities, contracts and institutional arrangements (for instance, which utility manages the system, who collects payments and how costs are shared). From a technical perspective, however, there are several agglomerations in BiH where it would be feasible to merge agglomerations into larger units. Such consolidation could improve cost-effectiveness of wastewater collection and treatment, facilitate compliance monitoring, and reduce investment and operational costs.

Most agglomerations located along the administrative borderline between the FBiH and RS entities have the potential to cooperate in developing inter-municipal agglomerations for their mutual benefits. Examples, based on expert judgement with topographic and Geographic Information System map analysis, include Istocno Sarajevo (RS) and Sarajevo (FBiH); Dobož Istok (FBiH) and Dobož (RS); Ribnik (RS) and Ključ (FBiH); Tesanj (FBiH) and Dobož (RS); Tesanj (FBiH) and Teslic (RS); Petrovo (RS) and Gracanica (FBiH); Osmaci (RS) and Kalesija (FBiH); and Modrica (RS) and Gradačac (FBiH). Given the current political situation of BiH, it is difficult to envisage cross-entity collaboration, at least in the medium term, which is illustrated by the example of the operations of the existing Trnovo (FBiH) WWTP. Trnovo treats wastewater originating from the RS but the municipality in the RS entity currently provides no financial contribution for this service. The municipality located in RS intends to construct its own WWTP within its jurisdiction.

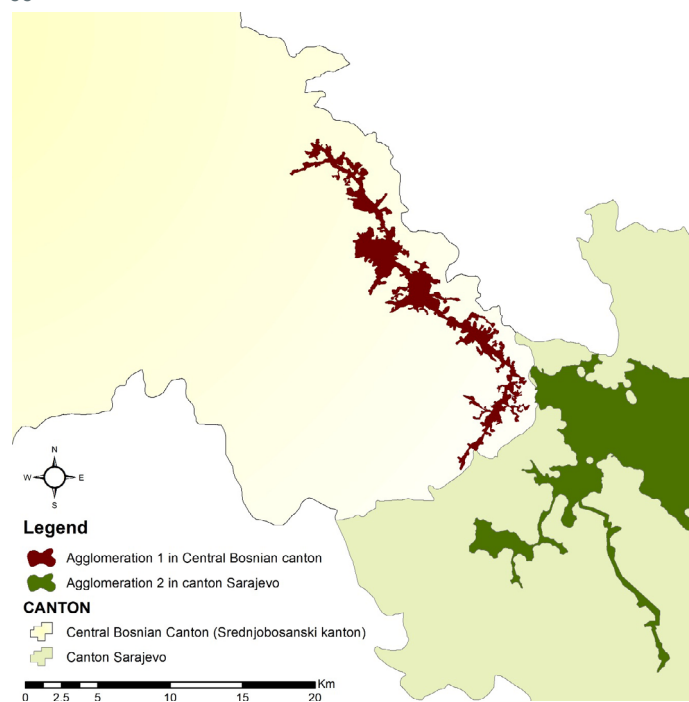
Likewise, there are several instances of feasible cross-cantonal agglomerations in FBiH that, in this initial stage of planning, have been divided according to cantonal borders. Figure 5 is an illustrative example of this, depicting three agglomerations in two different cantons that could effectively be joined. Agglomeration 1 in red (Master Plan ID nr. 143) located in Zenica-Dobož canton, could effectively be joined with the green agglomeration 2 (Master Plan ID nr. 162) situated in Sarajevo canton, but the administrative division between two cantons represents a limiting factor for such consolidation. In addition, the brown agglomeration 3 (Master Plan ID nr. 156) could potentially also be merged with the other two to consolidate three agglomerations into one.

Figure 5. Agglomerations that could be combined across Zenica-Doboj and Sarajevo cantons



Similarly, Figure 6 illustrates two agglomerations, one in red (Master Plan ID nr. 168) situated in Central Bosnian canton which could technically be consolidated with the green agglomeration (Master Plan ID nr. 145) in Sarajevo canton. However, as in the previous case, the administrative boundary between the two cantons poses a limitation to such integration.

Figure 6. Agglomerations that could be combined across Central Bosnian and Sarajevo cantons



While not envisaging any cross-entity or cross-cantonal agglomerations, there are 14 agglomerations in the Master Plan that extend across two or more municipalities that are located within the same entity and canton. Such cross-municipal agglomerations are present in both the FBiH and RS.

5.3 Scaling services according to agglomeration set-up

This subsection provides three illustrative examples from Sweden – Halmstad, Örnsköldsvik and Norrtälje – and three from BiH – Živinice, Ugljevik and Gradiška. These are presented in a comparative structure to illustrate where more centralized or decentralized wastewater systems are appropriate depending on the agglomeration set-up.

Halmstad municipality is an example of a more centralized wastewater system in Sweden which could be equally appropriate to Živinice and similarly situated municipalities in BiH. Örnsköldsvik and Norrtälje are municipalities with more decentralized wastewater systems, containing various small WWTPs and IAS solutions. In BiH, Ugljevik and Gradiška are examples of municipalities that in a similar fashion are likely to have to provide more decentralized wastewater system solutions while, in the case of Gradiška, also catering for cross-municipal collaboration with Laktaši municipality.

Centralized systems in Halmstad and Živinice municipalities

Halmstad and Živinice are examples of municipalities with agglomeration structures that favour centralized solutions. Halmstad municipality, southwestern Sweden, has 106 000 inhabitants, and it is typical in having one large WWTP (Västra Stranden) that provides wastewater services to 86% of the population. The municipality also has one medium-sized plant (Busör) in addition to several smaller plants serving more distant communities (see Figure 7).

Figure 7. WWTPs and main wastewater transfer pipelines in Halmstad municipality



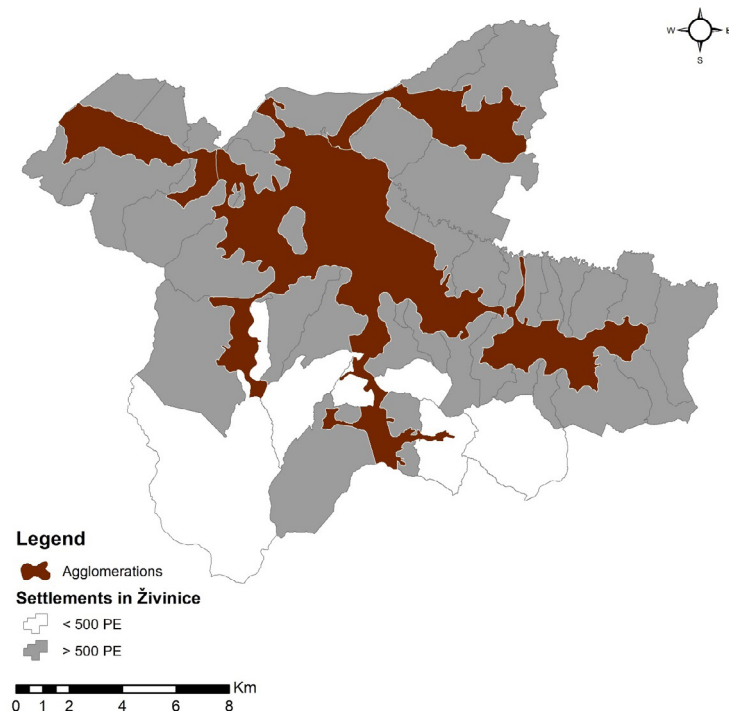
Source: Naturvårdsverket, (2022)

In recent years, Halmstad has invested in upgrading its two main WWTPs to increase their treatment capacity and is in the process of closing four of the smaller WWTPs and connecting these communities to the larger facilities. Around 3200 households rely on IAS. The municipality has identified 23 areas where IAS pose a risk of water body contamination, and hence intends to investigate how to extend the municipal sewer network to these areas.

Živinice is a relevant example of a larger BiH municipality with almost all wastewater load emanating from four agglomerations that are covered by the requirements of the UWWTD. The municipality of Živinice has a population of 57 765 (Census 2013). Within its territory, out of a total of 29 settlements, 23 have an organic load of more than 500 PE, with 55 671 inhabitants and including five industries. The remaining 6 settlements (2094 inhabitants) are considered rural areas.

Based on the analysis of sufficiently dense urban areas, there are three agglomerations delineated in category 2000–10 000 PE, and one in category 10 000–100 000 PE (see Figure 8). Three settlements in urban areas are categorized as IAS, while the rest of the populations live in rural areas. There is a WWTP in the municipality of Živinice designed to serve PE of 40 000. However, it currently only operates at a capacity of approximately 25 000 PE. Furthermore, although the plant is located within a designated sensitive area, it provides only secondary treatment. In accordance with the Master Plan and to comply with the requirements of the EU UWWTD, the facility is expected to be upgraded to tertiary treatment.

Figure 8. Agglomerations and settlements in Živinice municipality

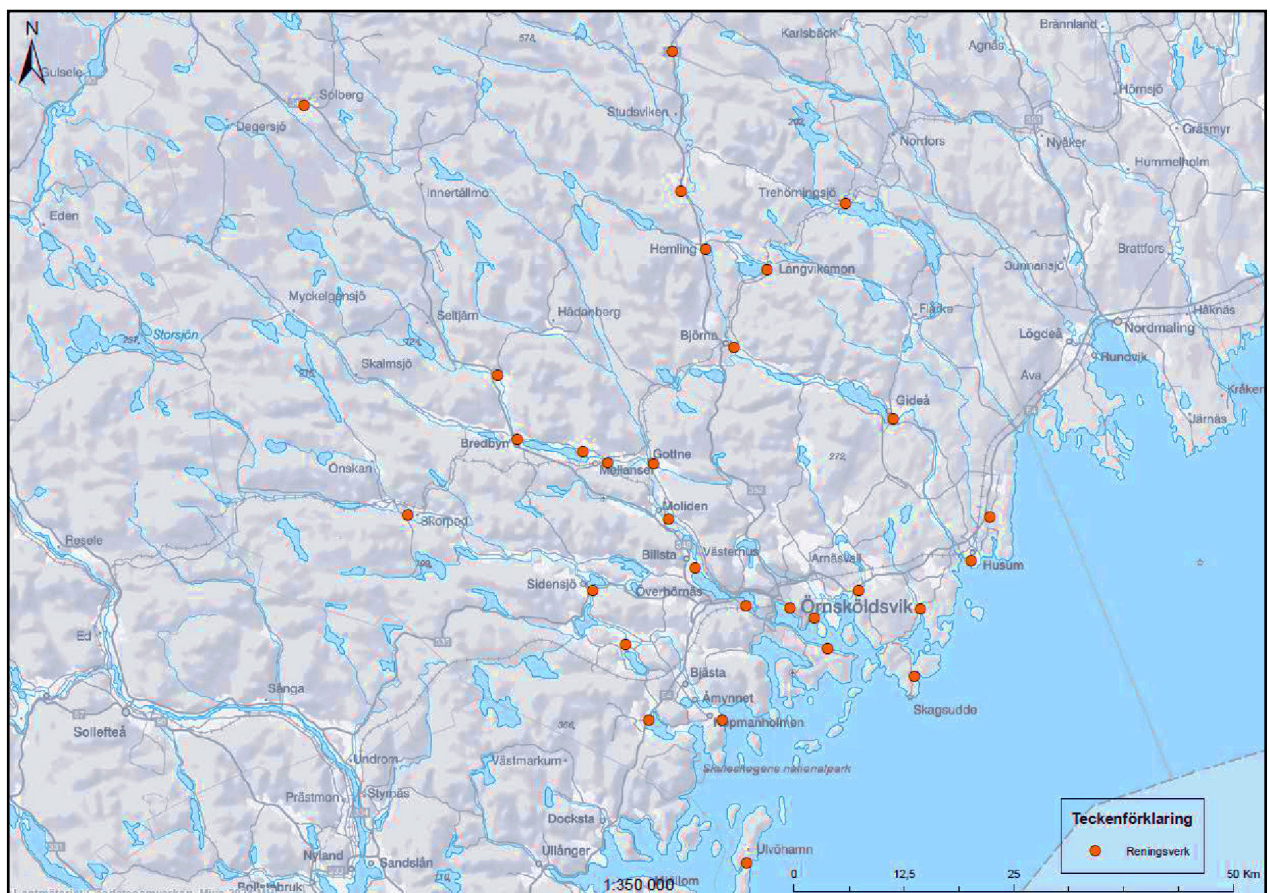


More decentralized systems in Örnköldsvik, Norrtälje, Ugljevik and Gradiška

Örnköldsvik municipality, in northern Sweden, is characterized by a hilly topography with many small towns and scattered settlements. This has shaped its wastewater management strategy into one that relies on a wide network of decentralized WWTPs (see Figure 9). Today the municipality operates around 33 wastewater plants, most of them small, serving about 55 000 inhabitants with extensive water, sewer and storm-water networks.

The topography brings both opportunities and challenges. Height differences in some valleys allow for gravity-based systems, but the hilly terrain also necessitates the deployment of about 100 pumping stations. The valleys represent flood risks, as experienced in the Kubbe village in September 2025, where water levels rose by 4 m during a heavy rain event. Simpler wastewater treatment systems are also possible in the lowland area, such as large dams and infiltration. However, managing sludge remains a persistent problem. Örnköldsvik currently uses the treated sludge as cover material in landfills, while also exploring longer-term solutions such as energy recovery. Due to ageing wastewater infrastructure, as well as increasing requirements for pollution control and resource recovery, Örnköldsvik is considering integrating circular solutions in its wastewater management. This includes reusing heat from wastewater or building new networks designed for source separation of wastewater flows, separating blackwater and greywater streams, or installing urine separating toilets.

Figure 9. Spread of wastewater treatment plants of various sizes across Örnköldsvik municipality



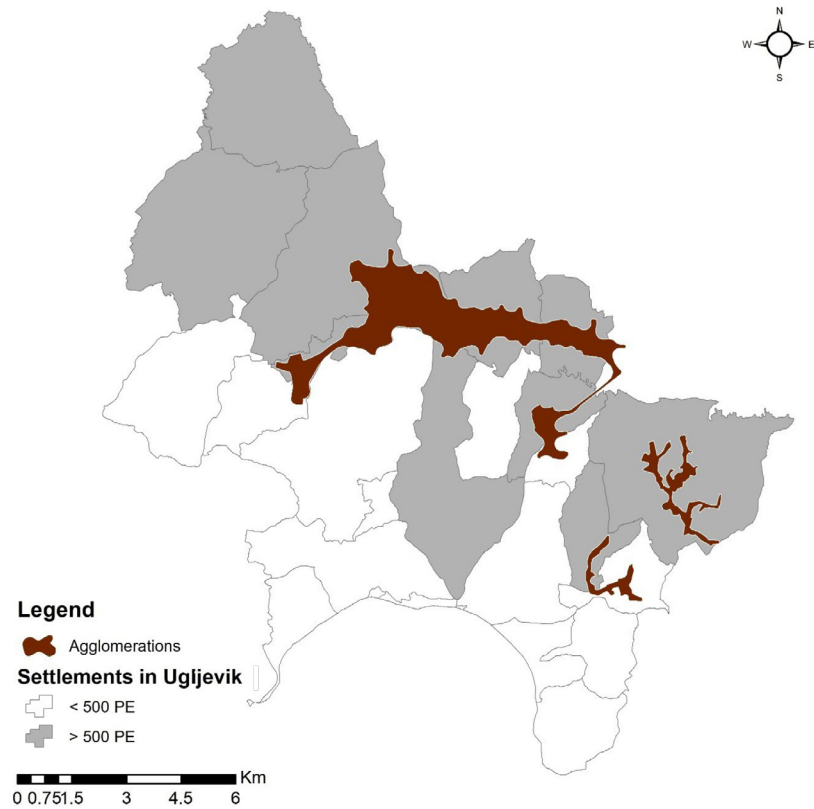
Norrköping municipality, with 65 000 inhabitants and located 70 km north of Stockholm, has more than 30 000 properties with IAS. This is mainly due to its geography as a large and relatively rural municipality, including a coastline with 13 000 islands. The municipality has a total of 26 000 leisure houses, the highest number of all Swedish municipalities. The centralized WWTPs are also dispersed, with the municipality managing a total of 17 WWTPs. Concerning existing IAS, the municipality is working proactively on inspection and inventories to identify old and substandard installations that risk contaminating ground and surface water in sensitive areas. In parallel, guidance and information to households is prioritized, especially through the *Water Centre (Vattencentrum, in Swedish)*, a knowledge-sharing platform run by the wastewater utility for public engagement on water and sanitation issues. Through the Water Centre, the municipality provides advice and organizes events that help property owners better understand the regulatory requirements and the range of options available for adequate on-site sanitation. Norrtälje adopted a water service plan in 2025 that included results of a risk assessment of 305 settlement areas (areas with >20 households) currently served by IAS (Norrtälje Kommun, 2025). Using 18 parameters such as groundwater vulnerability, shoreline proximity, recipient status, settlement density and existence of inadequate IAS, the plan identified in which locations sewer network extension should be prioritized. Seven settlements were prioritized for network expansion in the near term, while six areas were deemed as requiring further investigation. Priority areas will be reviewed every four years as the water services plan is updated.

The municipality of Ugljevik has a population of 15 710 (Census 2013). Within its territory, out of a total of 25 settlements, 10 have a load of more than 500 PE, totalling 11 984 inhabitants and including two industries. The remaining 15 settlements have an organic load below 500 PE and are considered rural areas, with a total population of 3726. Based on the analysis of sufficiently dense urban areas, only three agglomerations were identified where urban wastewater can be collected and conducted to an urban wastewater treatment plant (Figure 10).

Within the municipality, two agglomerations are in category 500–1000 PE, while only one is in category 2000–10 000 PE. According to the River Basin Management Plan in RS, one WWTP is planned to be built for the period 2022–27. As a part of the SuTra project⁷ during the year 2025, this municipality will have developed preliminary design for the sewage network and treatment until 2050.

⁷ Sustainable Transition of Bosnia and Herzegovina” (BiH SuTra), <https://bihsutra.ba/>

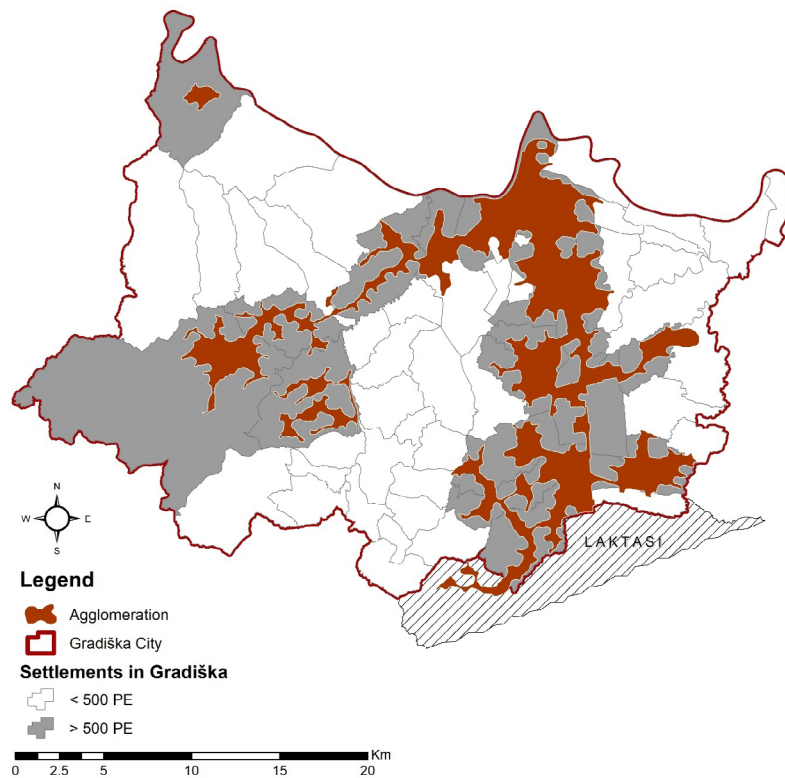
Figure 10. Agglomerations and settlements in Ugljevik municipality



Gradiška has a population of 51 727 (based on the 2013 census). Within its territory, out of a total of 68 settlements, only 26 have an organic load of more than 500 PE, with 41 584 inhabitants and including three industries. The remaining 42 settlements (10 145 inhabitants) are considered rural areas (see Figure 11).

Based on the analysis of sufficiently dense urban areas conducted for these 26 settlements, there are three agglomerations more than 500 PE of different sizes (28 898 PE, 556 PE and 1689 PE). The largest agglomeration extends across two municipalities, Gradiška and Laktaši (see Figure 11). Gradiška is thus a relevant example where cross-municipal collaboration would be beneficial for wastewater management.

Figure 11. Agglomerations and settlements in Gradiška



5.4 Leapfrogging opportunities

Sweden has generally developed large, centralized sewer networks and wastewater treatment systems in a similar fashion to other countries in Europe. The standard wastewater system has for some time removed major contaminants but generally overlooked opportunities to reuse water, nutrients or energy. Today, concerns about climate change, fertilizer resource limitations and energy use are prompting a rethinking of this model. A recent report by the Swedish EPA (Baresel et al., 2024) outlines a vision for enhanced resource recovery from wastewater in urban areas. In this vision, today's centralized WWTPs are optimized into "resource recovery plants", for example by introducing nitrogen recovery in the nutrient-rich reject water produced from the sludge dewatering process. This optimization of existing systems is complemented by the gradual introduction of various source-separating measures in newer residential areas, enabling higher nutrient and energy recovery as well as local treatment and reuse of greywater.

To increase the sustainability of sludge management in Sweden, the REVAQ certification was launched in 2008 with the long-term objective that the content of trace elements and undesirable substances in incoming wastewater should not exceed that in toilet wastewater, which means that no human-made undesirable substances are added. Through the REVAQ certification, the use of high-quality sludge on arable land is more accepted today than it was 15–20 years ago. In 2002, 7% of the sludge was used on arable land; in 2022, it was over 50% (Swe-EPA 2025). The certification is operated by Swedish Water, in close collaboration with the Federation of Swedish Farmers (LRF), the Swedish Food Federation and the Swedish Food Retailers' Federation, as well as the

Swedish Environmental Protection Agency. WWTPs can obtain REVAQ certification after a third-party audit based on four criteria: 1) a structured work program for continuous improvement of the quality of the wastewater entering the WWTPs and thus of the plant nutrients from the sludge; 2) upstream activities to reduce contamination of wastewater entering the WWTPs and thus of the sludge generated; 3) all actors are offered open and transparent information about how the sludge has been produced and about its composition; and 4) plant nutrients and organic matter from wastewater fractions are produced in a responsible manner that meets established quality requirements.

Some municipalities in Sweden furthermore pilot decentralized, source-separating sanitation systems that enable a high degree of nutrient and energy recovery. Helsingborg's H+ (Oceanhamnen) district separates greywater (water from showers, kitchens and laundry), blackwater and food waste using three dedicated pipelines, currently for around 1000 PE.⁸ Vacuum toilets reduce water use and enable efficient nutrient recovery when the toilet blackwater is treated separately – phosphorus, nitrogen, potassium and even sulphur can be harvested as clean products – and ground food waste yields extra biogas (Smart City Sweden, 2025). The treatment process with this configuration leads to three times more biogas recovery and three times more nutrient recovery compared to conventional configurations.

As part of the REWAISE project, Malmö and Lund are implementing urine-drying toilets that collect urine at the fixture and evaporate it into a dry fertilizer powder. Since urine contains roughly 75% of a household's nitrogen, phosphorus and potassium (Sweden Water Research, 2021), this approach captures the lion's share of nutrients for local reuse instead of diluting them into the sewer network. Urine drying reduces volume and makes the end product more attractive. The urine drying process has been developed by the Swedish University of Agricultural Sciences.

Hölö community, located in Södertälje municipality and with around 400 households, implemented a decentralized blackwater reuse system in response to severe lake eutrophication and failing sanitation systems in this rural area. This system features low-flush or vacuum toilets connected to sealed household tanks, with blackwater collected by the municipality and treated at a local plant, managed by a farmer. The process consists of wet-composting and urea treatment. The treated blackwater is transformed into certified liquid fertilizer that meets Swedish standards and is safely reused on 40 hectares of farmland, reducing reliance on synthetic fertilizers and preventing further water pollution (Andersson et al., 2020).

Sweden, in addition, has long-standing experience with alternative approaches to IAS. In many seasonal houses, waterless "dry" toilets are used instead of flush toilets to minimize water use and infrastructure needs. These include composting toilets where waste decomposes to humus in a tank and electric or gas-fired incinerating toilets that burn excreta to sterile ash (Avloppsguiden 2025). Urine-diverting models are also popular, with about 130 000 of them installed in properties all over Sweden (including both dry and flush variants). In these, urine is collected in a separate tank to isolate most of the nutrients. Faecal matter from dry toilets is typically collected in bins that are emptied and composted on-site or transported off-site for treatment. Some municipalities

⁸ See more: <https://www.recolab.se/>

organize collection of source-separated urine or faecal matter, but farmers can also pick up the stored urine for sanitization and later use it as fertilizer on agricultural fields (Avloppsguiden 2025). To support the safe return of nutrients from source-separated fractions to agriculture, the certification scheme SPCR 178 was introduced in 2019 (RISE, 2019). It is a voluntary standard for quality assurance of source-separated wastewater fractions – such as urine and toilet water (blackwater) from households – provided they are not mixed with bath, dish or laundry water (greywater). Since 2022, certified products must have a maximum ratio of 17 mg Cd/kg P, comply with pathogen limits for salmonella and E. coli, and meet the national guidelines for heavy metals in soil improvers.

Sweden is also working towards more sustainable storm-water handling. Eliminating combined domestic wastewater and storm-water sewers (currently 13% of the Swedish sewer networks) has been the primary ambition, to avoid overflow and discharge of untreated wastewater. However, with a changing climate this action is no longer enough, and Swedish municipalities are implementing storm-water approaches (including nature-based solutions) that reduce risks for flooding and other impacts due to more extreme weather events (Gunnarsson and Barquet 2025). After severe floods in the 1990s, the urban district of Augustenborg in Malmö municipality removed their combined sewer network and developed open storm-water handling. Here, green roofs are followed by open delay and buffer systems with ditches and ponds where vegetation or other physical obstacles slow down the speed and temporarily store the storm-water. Excess water can also flood surrounding designated areas without causing damage. Similarly, the municipality of Stockholm has implemented a storm-water strategy (Stockholm Stad, 2015) that obliges new developments and major reconstructions to locally delay and treat storm-water from impervious surfaces.

Many of the Swedish innovations described above address challenges that BiH has not yet begun to tackle systematically, given that basic collection and treatment infrastructure remains incomplete and sludge management is still a major bottleneck. At the same time, some elements of the Swedish approach may be difficult to translate directly to BiH, including Sweden's high level of municipal technical capacity, the presence of established research-utility partnerships, and the existence of stable, long-term regulatory frameworks that underpin certification schemes and source separation pilots. Nonetheless, the Swedish cases offer valuable inspiration for future planning in BiH, particularly by illustrating how resource recovery, upstream contamination control and alternative sanitation solutions can be gradually integrated as systems expand. In particular, the Swedish examples are perhaps most relevant for BiH in areas where current constraints are already evident: the widespread challenges with sludge management, the lack of systematic upstream contamination control, the absence of mechanisms to ensure the quality and safe reuse of wastewater-derived products, and the need for more resilient storm-water solutions in flood-prone areas. Municipalities facing high IAS prevalence or difficult topographies could also benefit from Sweden's experience with decentralized and source-separating systems, which offer viable alternatives where sewer networks are costly or technically impractical. By showing how these issues can be addressed through a combination of technical standards, certification schemes, innovative pilots and long-term planning, the Swedish cases provide a useful reference point for identifying where BiH's evolving wastewater systems could integrate more sustainable and resource-efficient approaches over time.

6. Implications for sustainable wastewater management in BiH

Building on the findings and comparative insights presented in this report about EU requirements, current practices in BiH and lessons from Sweden's experience, this section highlights key implications for advancing sustainable wastewater management in Bosnia and Herzegovina. Bosnia and Herzegovina faces a pressing need to expand and modernize its wastewater management systems, with large investment gaps, limited treatment coverage and significant operational challenges that threaten both environmental quality and public health. As national and entity-level policymakers, utilities and development partners seek practical steps to ensure that current and future investments in wastewater services deliver lasting benefits, we highlight the following key recommendations for their consideration.

Use the Master Plan to guide integrated development of pragmatic, site-specific wastewater solutions: With the completion of the Master Plan of agglomerations, all municipalities in BiH have an initial planning document outlining existing agglomerations in their territory that require wastewater services. An important next step is to spread and raise awareness of the Master Plan among all BiH municipalities, ensuring they have easy access to it and can include it in their municipal planning and development. With the use of the Master Plan, a pragmatic approach, focusing on taking advantage of existing infrastructure and developing the municipal wastewater management systems and IAS in tandem, should be possible. The development of IAS could furthermore be based on functional requirements, rather than technical prescriptions, to allow for site-specific solutions that take advantage of ongoing developments in IAS technology.

Prepare and adopt entity-level sewage sludge management plans: Such plans, together with feasibility studies and technical guidelines, provide a framework for the sustainable treatment, recovery and final disposal of sewage sludge from existing and planned WWTPs.

Develop municipal wastewater management plans: Although there is no legal requirement to do so, it is recommended that each municipality in BiH develop a wastewater management plan, similar to the existing waste and environmental management plans. This would ensure that planning documents are tailored and appropriate not only to areas connected to centralized wastewater management systems, but also to those that are not, such as rural areas.

Build sector capacity through stronger trade organizations and targeted knowledge sharing: The development and satisfactory operation of wastewater services requires substantial resources, capacity and knowledge. The examples from Sweden indicate that trade organizations and membership services provide relevant support and information to cost-effectively tackle the myriad challenges in providing adequate operations of wastewater systems. In Sweden there is one trade organization, Swedish Water, catering for operators and contractors of municipal wastewater management systems. In BiH, the Association of Utility Enterprises in FBiH and Association of Waterworks of RS are also focused on operators and contractors of municipal

wastewater management systems. While Sweden has the Water and Wastewater Guide, a dedicated forum catering for knowledge requirements of inspectors, operators and contractors for IAS, there is only a partial equivalent in BiH. The Association of Municipalities and Cities of FBiH has a regional capacity network for water and sanitation; however, the Association of Local Authorities of RS does not have specific wastewater collaborations. At the entity level, strengthening and developing existing trade organizations and ensuring municipal associations include a specific focus on IAS will likely improve the expansion of wastewater services and increase the cost-effectiveness of wastewater operations. Brčko District, due to its limited size, has no trade organizations and could potentially draw insight from trade organizations from both FBiH and RS.

Engage in inter-municipal and cross-cantonal collaboration to achieve cost-effective and sustainable wastewater systems: Inter-municipal collaboration can be an effective strategy to achieve more cost-effective and better-functioning wastewater systems. In Sweden, NVSA is an example of extensive municipal collaboration that creates greater opportunities to carry out effective planning and to recruit and sustain necessary competences and resources for the wastewater operations in eight municipalities. In the Master Plan of BiH there are 14 agglomerations that extend across two or more municipalities where inter-municipal collaboration will be required to provide wastewater services. It is, however, likely that from a technical and cost-effective point of view, more agglomerations that cross entity or cantonal borders should be defined. The experiences from the existing Trnovo WWTP, highlighted in the section on inter-municipal collaboration, illustrates the significant political barriers to cross-entity collaboration. Implementing cross-cantonal collaboration within FBiH, however, should be politically more feasible. Actively promoting cross-municipal and cross-cantonal collaboration – and facilitating the required administrative and legal support on entity level – could therefore constitute a strategy that is worth the additional coordination efforts given the potential operational benefits it provides. Cross-cantonal collaboration should be explored in the more detailed feasibility study phase of agglomerations where decisions are taken on the feasibility of combining two or more agglomerations identified in the Master Plan.

Tailor wastewater service structures to local agglomeration characteristics: The most suitable scaling of wastewater services, in terms of the size and shape of municipal wastewater management systems and IAS, largely depends on the agglomeration structure of the municipality. Halmstad, in Sweden, and Živinice, in BiH, are highlighted as examples of municipalities with agglomeration structures that favour centralized wastewater solutions. Örnsköldsvik and Norrtälje, in Sweden, are emphasized as municipalities with more decentralized wastewater systems, containing various small WWTPs and IAS solutions. Such decentralized solutions are likely to be more relevant to Ugljevik, Gradiška and similarly situated municipalities in BiH, with more scattered agglomeration and settlement structures.

Turn infrastructure development into an opportunity to leapfrog towards circular and climate-resilient wastewater systems: Given the important challenges facing BiH to meet the requirements of wastewater collection and treatment, it can be difficult to explore non-standard solutions. However, the fact that the wastewater system in BiH, to a large extent, will be built from scratch in the coming decades provides a unique

opportunity for leapfrogging solutions. Retrofitting Sweden's ageing, centralized infrastructure is difficult. Experts note that large pipe networks and WWTPs represent enormous sunk investments and "lock-in" (van den Berg, 2019), since utilities have little incentive to tear out systems built over decades. In contrast, countries like BiH, which are still expanding wastewater management, have a chance to leapfrog this path. Instead of repeating the old linear model, BiH could adopt circular designs from the start. By designing wastewater systems that minimize long-term environmental and economic costs while maximizing recovery of water, nutrients and energy, BiH has a chance to avoid some of the inefficiencies of conventional systems and build more sustainable and climate-resilient sanitation.

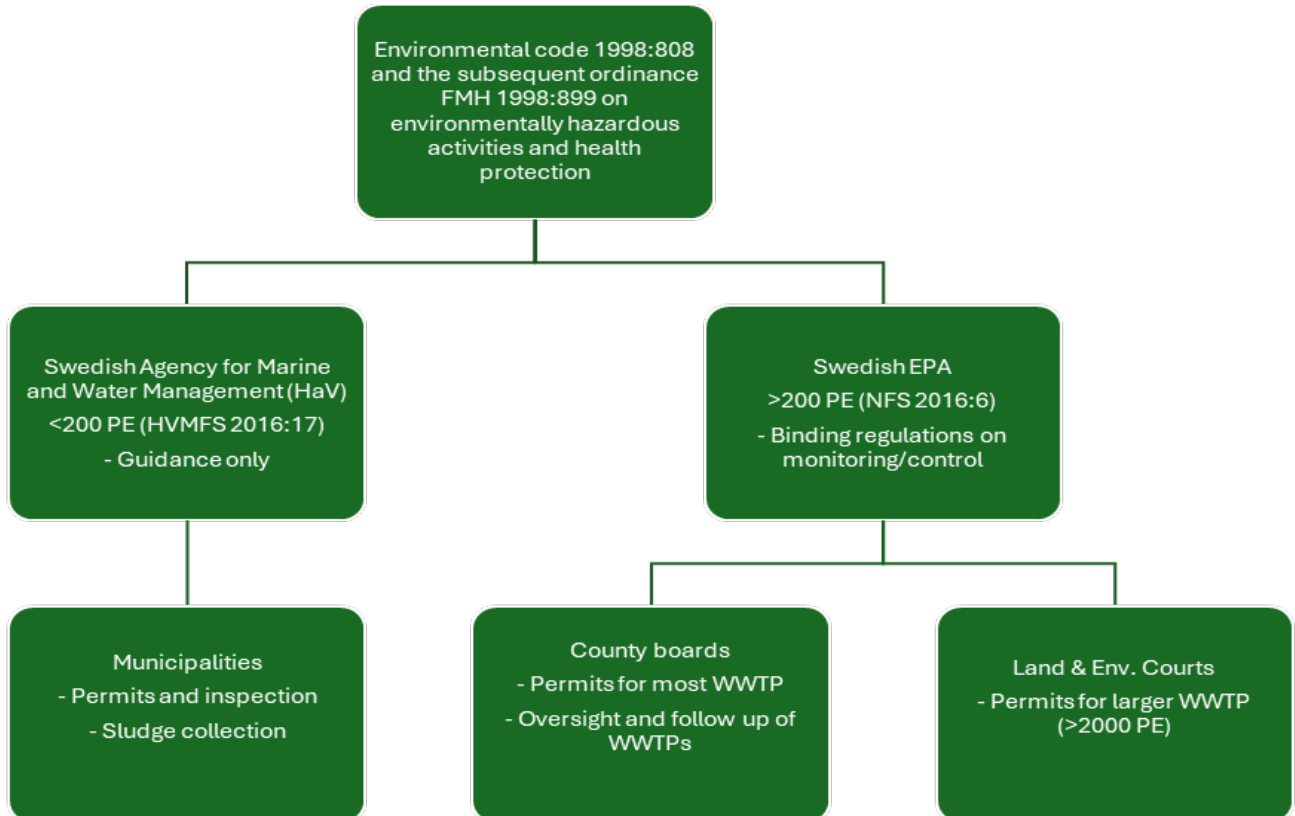
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Appendices

Appendix 1: Overview of Swedish legal and regulatory framework for wastewater management



Appendix 2: Examples of municipal wastewater fees in Sweden

Service	Fees	Notes
Connection fee (Type A property)	SEK 185 247	Includes fee components related to the service lines, connection points, the land area of the property and how many buildings there are on the property.
Connection fee (Type B property)	SEK 672 279	
Consumption fee (Type A property)	SEK 1028/month (8.2 öre/litre)	Includes fee components related to the usage of drinking water, as well as collection and treatment of wastewater and storm-water.
Consumption fee (Type B property)	SEK 610/month (5.5 öre/litre)	
Sludge emptying for on-site treatment systems	SEK 2306 for <3 m ³ plus SEK 355 per extra cubic metre	Also applies to collection of urine, faeces etc. from dry toilets.
Inspection of installation of dry toilet	SEK 1294	
Inspection of treatment plant 6-25 PE	SEK 11 646	
Inspection of treatment plant 26-200 PE	SEK 1294/hour	

Note: Fees are based on rates in Hässleholm Municipality (population 52 114) for the year 2025 (Hässleholm Miljö, 2024, 2025; Hässleholms Kommun, 2025). Type A = a typical detached single-family house without a basement, which is connected to the municipal water supply, wastewater sewer and storm-water drainage systems. The house consists of five rooms and a kitchen, a bathroom with a toilet, a laundry room, an additional toilet and a garage. It has a total floor area of 150 m², stands on a plot of 800 m², and has an annual water consumption of 150 m³. Type B = a typical multi-dwelling residential building consisting of 15 apartments that is connected to the municipal water supply, wastewater sewer, and storm-water drainage systems. The building has a total floor area of 1000 m² and is situated on a plot of 800 m². Its annual water consumption amounts to 2000 m³, and it is equipped with two parallel water metres with a nominal flow capacity of 2.5 m³ per hour.

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