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CLEAN FLOW WB6

From Wastewater Practice to Policy

REGIONAL FINDINGS AND ADVOCACY PAPER ON

Sludge Management

REGIONAL FINDINGS AND ADVOCACY PAPER
SLUDGE MANAGEMENT

Topic	**Sludge Management - treatment, recovery, disposal and long-term sustainability of wastewater sludge**
Prepared by	Ahmed Busuladzic, Regional Coordinator, CLEAN FLOW WB6
Based on contributions from	Six Communities of Practice (CoPs) and associations of water and wastewater utilities across the Western Balkans Six (WB6): SHUKALB, SHUKOS, UTVSI, ADKOM, AWM, UPKP and AWRS.
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EXECUTIVE SUMMARY

Regional headline finding: Wastewater treatment capacity in the Western Balkans Six (WB6) is being built faster than the chain that takes sludge beyond the plant gate. Across the contributions from the WB6, the recurring problem is not treatment technology but the lack of a secured, permitted and financed destination for sludge. As a result, sludge builds up on site, goes to landfill or is exported at high cost, and the risk falls back on operators, effluent quality and municipal budgets.

The evidence is uneven. Volumes are reported in different units and years, and costs cover different services, so they cannot support a regional total or a ranking of WB6. In Albania, on-site treatment capacity also needs strengthening. The evidence is, however, sufficient to justify **three priorities:**

- No Wastewater Treatment Plant (WWTP) without a secured sludge route: a lawful interim outlet and a contingency plan for every operating plant; a costed, time-bound domestic sludge strategy in each economy; no new plant financed or commissioned without a defined and costed sludge route.
- Make sludge costs visible and finance them: separate sludge cost accounting in utilities; efficient sludge costs recognised in tariffs, with affordability safeguards; transition finance that covers operation, not only construction.
- Know what we produce: a WB6 minimum sludge dataset in tonnes of dry solids; accredited laboratory capacity, both domestic and through regional cooperation; risk-based rules so that sludge of proven quality has a legal outlet.

FOUR MESSAGES FOR CLEAN FLOW

#1	No WWTP is complete without a secured sludge route.
#2	Make sludge costs visible, eligible and financed.
#3	Count sludge consistently to finance the right solutions.
#4	Involve operators before deciding how the system should work.

Participants at CLEAN FLOW will be invited to validate the proposed priorities, identify opportunities to integrate secured sludge-management routes into existing and planned wastewater investments, and explore whether the Communities of Practice (CoPs) are ready to test the proposed WB6 minimum sludge dataset with their member plants.

PURPOSE OF THIS PAPER

This paper brings together evidence and practitioner experience from the WB6 CoPs on sludge management. It identifies common implementation challenges, important domestic differences and priority issues that require policy, institutional, financing or other action. It is intended to support regional advocacy and policy dialogue through CLEAN FLOW WB6.

The paper does not seek to harmonise domestic-level systems or imply that the same solution is appropriate in every WB6.

Basis of this paper: The six final domestic CoP Topic Elaborations on sludge management (July–October 2026). They draw on plant questionnaires, operator statements, plant case studies, and domestic-level studies and strategies. The paper notes instances where domestic figures are not comparable.

1. WHY THIS TOPIC MATTERS

Every WWTP built in the WB6 creates a stream of sludge. Sludge is the unavoidable residue of treatment. Unless it is regularly removed, treated and taken to a lawful destination, a plant cannot keep its biological process stable or meet its discharge limits. All six CoPs/operators describe the same pattern. Investment in WWTPs has moved faster than the chain that takes sludge beyond the plant gate: dewatering and stabilisation, storage, transport and a permitted outlet for recovery or disposal.

Practitioners already live with the consequences. If sludge cannot leave the plant, it builds up:

Budva (Montenegro): About one third of the sludge that should be removed stays in the biological tanks whenever contracted collections fall short. This raises sludge age and aeration energy and makes nitrogen and phosphorus limits harder to meet.

Berovo (North Macedonia): Two of six reed beds are full and three are close to capacity, with no designated outlet. At Kočani, dewatered sludge and compost accumulate on site even though the sludge line works.

Bosnia and Herzegovina: Almost three quarters of the sludge produced by WWTPs in 2021 stayed at the plants.

Durrës (Albania): Drying beds are filling up, with no plan for what happens next.

Kosovo∗ and Serbia: Landfill is the default. Even Peja (Kosovo*), which digests its sludge and produces biogas, has no permitted outlet for the digested sludge.

Mostar (Bosnia and Herzegovina): With no domestic outlet, the utility paid emergency prices: about BAM 1.35 million (≈ €689,000) in 2024 to export 1,684 tonnes to the EU.

Operators cannot solve this alone. Plants can optimise dewatering and polymer dosing. They cannot permit a disposal site, create demand for compost, set quality standards, accredit a laboratory or put sludge costs into tariffs. Those decisions belong to ministries, regulators, municipalities and financiers, and in most WB6 they have not been taken or have been taken on paper only. Kosovo* is a clear example. Its Water Strategy 2017–2036 names sludge as a priority (Measure 2.6), yet no institution, budget or timeline is assigned to it, and sludge is excluded from the regulator's tariff methodology.

The issue is central to Chapter 27 and the Green Agenda for the Western Balkans (GAWB). The recast Urban Wastewater Treatment Directive (EU) 2024/3019 sets requirements for larger wastewater treatment plants to move towards energy neutrality and promotes resource recovery, particularly phosphorus and nitrogen. The Sewage Sludge Directive (86/278/EEC), together with EU waste and landfill legislation, sets rules and restrictions affecting the

* This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

management and disposal of sewage sludge. Sludge that is stored indefinitely, landfilled without adequate controls or exported at high cost undermines the environmental benefits of EU- and IFI-financed wastewater investments and may put compliance with environmental requirements at risk.

This paper also supports the implementation of the Revised Action Plan for the Implementation of the Sofia Declaration on the Green Agenda for the Western Balkans 2025–2030, particularly Pillar 3 (Depollution), Actions 26a and 26b. These actions address the full transposition of the EU water acquis by 2030 and coordinated regional action on wastewater depollution and river basin protection by 2028, including the development of Specific Plans for Implementation (DSIPs) of the Urban Wastewater Treatment Directive. Although the Action Plan does not explicitly address sewage sludge, effective sludge management is an important part of achieving the wider objectives of wastewater treatment, pollution prevention and environmental protection.

In addition to its relevance to the Depollution pillar, sludge management has a potential connection to the Circular Economy pillar through the recovery of nutrients, organic matter and energy. However, these opportunities depend on appropriate regulatory frameworks, reliable sludge quality data, viable recovery options and adequate financing. The CLEAN FLOW findings provide practical evidence of these implementation barriers and could inform further thematic exchange under the GAWB.

For the WB6 EU integration process, sludge management represents a practical implementation challenge that extends beyond wastewater treatment infrastructure. Meeting EU environmental requirements increasingly depends on the availability of appropriate sludge treatment, recovery and disposal solutions, supported by clear institutional responsibilities, adequate financing and reliable monitoring. CLEAN FLOW provides an opportunity to bring operational evidence into policy dialogue, identify common barriers and explore where regional cooperation, particularly on data, technical expertise and practical approaches to sludge management, can support domestic implementation efforts.

Sludge management is also relevant to climate adaptation. Wastewater management, as highlighted in the EU Adaptation Strategy, is of high importance with multiple co-benefits, including water security, environmental protection, resilience to climate change. The WB6 Climate Adaptation Strategy includes measures for wastewater management and calls on the WB6 to support climate-proofing of wastewater collection and treatment infrastructure, in line with the Urban Wastewater Treatment (UWWT) Directive, and to strengthen capacities and run training on sustainable wastewater management.

WWTPs should be climate-proofed: heavy rainfall overloads combined sewers and causes overflows of untreated sewage into rivers and the sea, while in droughts rivers have less water to dilute effluent, and higher temperatures worsen algal blooms and oxygen depletion. Across the WB6, sludge is still dominantly stored at treatment plants or sent to landfills and dumpsites. Floods can wash it into rivers and onto farmland, spreading pathogens and heavy metals. This reinforces the need to climate-proof WWTP infrastructure, including sludge storage and final outlets.

2. WHAT THE DOMESTIC EVIDENCE TELLS US

2.1. Common findings

Common finding	Economies where reported	Key evidence / examples
WWTPs are built and run without a secured final outlet for sludge	All six	Albania: Lalzi has operated since 2020–21 "with the disposal route still not decided". Bosnia and Hercegovina: Sarajevo (Butila) and Mostar have no domestic solution. Kosovo*: Peja's digested sludge has no permitted outlet. Gjakova turned to a landfill contract when agricultural reuse could not be implemented. Montenegro: no permanent disposal system. North Macedonia: Berovo, Kočani and Kumanovo have no designated outlet. Serbia: sludge is stored on a plot at Vrbas–Kula, and Vranje has no final destination.
Temporary storage and landfilling dominate; circular routes remain pilots	All six	Bosnia and Hercegovina (2021): 73% stored on site, 11% agriculture, 10% landfill, 5% unknown. Serbia: more than 70% of plants landfill; solar drying and composting are pilots. North Macedonia: mostly sub-standard municipal landfills, plus on-site storage (Kočani, Kumanovo). Albania: drying beds, reed beds and lagoons. Montenegro: on-site storage (Podgorica), landfill, composting (Budva). Kosovo*: landfill and drying beds.
Domestic sludge strategies are missing, not adopted or not implemented	All six	No strategy: Bosnia and Hercegovina (at any level). Kosovo*: sludge is named in the Water Strategy without roles, funds or timeline; SHUKOS Action Plan (2025) progress is limited. Draft not adopted: Albania (domestic sludge management strategy - NSMS 2025–2050); North Macedonia (NSMS 2024–2034, 2025–26 deadlines passed). Study stage: Montenegro (Waste Management Plan 2025–2029). Adopted Programme but slow implementation: Serbia (Programme 2023–2032).
Responsibility beyond the plant gate is fragmented	All six	Competences are split across water, waste, environment, agriculture and municipalities. Bosnia and Hercegovina adds state, entity, canton and Brčko District levels, with regulations not aligned. Kosovo* utilities are responsible for their sludge but have no harmonised domestic framework for reporting and long-term management. The ministry lacks enforcement capacity, and no domestic body is responsible for sludge as a whole. Montenegro: problems are "solved individually and temporarily". North Macedonia: regional waste bodies' sludge mandates are not operational.

Sludge costs are high and rising, and are not covered by tariffs	All six (tariff gap explicit in Albania, Bosnia and Hercegovina, Kosovo*, North Macedonia, Serbia)	Indicative sludge management costs: €20–40/tonne for landfill and transport (Serbia); €25.81/tonne for transport and disposal (Kosovo*, Gjakova); €103/tonne for transport over 110 km to composting (Montenegro, Budva); and approximately €409/tonne for export (Bosnia and Hercegovina, Mostar). Emptying one reed bed in Berovo costs approximately €7,000 (North Macedonia). These figures cover different services, transport distances and sludge characteristics and should therefore not be interpreted as directly comparable. Kosovo* excludes sludge from the Water Services Regulatory Authority (WSRA) tariff methodology, and many Bosnia and Hercegovina tariffs have no treatment component.
There are no reliable, comparable sludge data	All six	North Macedonia: two complementary baselines (16 vs 17 operating plants); 11 plants returned questionnaires; Kočani does not yet measure quantities systematically. Serbia: Leskovac reports 4,000 t/y, compared with an estimated 11,000–15,000 t/y; however, data on total domestic sludge production are not available. Kosovo*: ≈1,700 t/y in mixed units. Montenegro: measured data for 4 of 12 plants. Bosnia and Hercegovina: latest domestic data from 2021. Albania: no domestic figure.
Sludge quality is hard and costly to prove, so lawful outlets stay closed	Albania, Bosnia and Hercegovina, Kosovo*, North Macedonia, Serbia, (Montenegro partly an exception)	Albania has no accredited sludge laboratory. Bosnia and Hercegovina has no laboratory for the full parameter set. Kosovo* has limited capacity, so full testing may need laboratories abroad (≈ €226 per sample at Gjakova). North Macedonia: Kumanovo landfill requires repeated proof that the sludge is non-hazardous, while suitable laboratories are scarce and costly. Serbia plans for €345 per sludge sample and €145 per soil sample. Montenegro (Budva) shows that basic routine accredited testing is possible. Serbia reports that sludge analyses can be carried out domestically in accordance with domestic legislation.
Ageing equipment and slow procurement interrupt sludge lines	Montenegro, Bosnia and Hercegovina, Serbia, Albania, North Macedonia	Montenegro (Budva): Lengthy public procurement procedures. 5 months from tender to installation, more than 60 days running with a leak, and the sludge line stopped for 6 days. North Macedonia (Kumanovo): dewatering automation largely out of order, so the line is run by hand. Serbia: frequent belt-press failures and no spare parts. Bosnia and Hercegovina: no local service support for some equipment.
Too few process specialists, and operators are left out of decisions	All six (exclusion reported in Bosnia and	There is a shortage of process engineers and technologists, with low pay and high turnover (Bosnia and Hercegovina, Serbia and Albania). CoPs/WWTP operators are not involved in drafting regulations,

	Hercegovina, Albania, Kosovo*, Montenegro, North Macedonia)	strategies and investment plans (Bosnia and Hercegovina, Kosovo*, Montenegro, North Macedonia).

2.2. Important domestic differences

Issue	Important domestic differences / exceptions
Legal basis for sludge use	Most complete in Serbia (Regulation 103/2023; Programme 2023–2032) and Montenegro (Rulebook 21/25). North Macedonia works through the Law on Waters and its rulebooks. Federation of Bosnia and Hercegovina has Regulation 28/24, while Republika Srpska has none. Albania has only general provisions (Law 29/2024, Art. 108). Kosovo* has instruments that do need alignment: AI 29/2014 allows agricultural reuse in line with 86/278/EEC, AI 02/2022 says nothing on reuse, and the two do not cross-refer. So, the requirements differ: “implement” (Serbia, Montenegro), “adopt” (Albania), “harmonise” (Bosnia and Hercegovina, Kosovo*), “confirm and update” (North Macedonia).
Agricultural use	Allowed under controls in Serbia, Montenegro and North Macedonia, but hard to apply because of microbiological limits, testing costs and few off takers. In the Federation of Bosnia and Herzegovina, the use of sludge on agricultural and forest land is prohibited under Regulation 28/24. In contrast, according to data from Bijeljina WWTP, 11% of the sludge produced in Republika Srpska was applied to agricultural land in 2021. As Republika Srpska has no specific regulation governing this area, sludge management relies on the principles of Council Directive 86/278/EEC. Permitted on paper but not practised in Kosovo*. Food crops are excluded, reuse failed over farmer acceptance in Gjakova, fragmented land and soil testing; naturally high heavy metals in Kosovo* soils add a second test. No legal pathway in Albania. A single regional position on agricultural use is not realistic.
Where the chain breaks	Montenegro: plants produce compliant sludge (Budva passed basic sludge tests in 2024 as required by law), but transport and outlets fail. North Macedonia: Kočani covers about 70% of its electricity with biogas and solar yet has no outlet for sludge or compost. Albania: on-site treatment itself is largely low-tech and under capacity. Kosovo*: the outlet is missing, even for digested sludge (Peja). Serbia: technology exists, and practitioners name finance and staff as the binding constraints. Therefore, the sludge management chain breaks where a WWTP lacks an adequate technological, institutional or legally defined pathway for further sludge management. In the absence of a systemic solution, individual operators develop their own approaches to sludge management, ranging from temporary on-site storage, agricultural use and landfill disposal to exporting.
Scale and technology	Serbia: 54 WWTPs, of which 44 are operational, with digestion and biogas (Subotica, Kruševac) and solar drying (Kruševac; Leskovac planned). North Macedonia: Skopje (≈10,600 t DS/y) will reshape the domestic balance; an

	incineration line is proposed. Kosovo*: four plants (≈168,000 PE) and about 20 small decentralised systems; Pristina Regional WWTP is planned with thermal drying and mono-incineration; whether it could take sludge from other plants is still to be assessed. Bosnia and Hercegovina: most WWTPs are small (median 6,000 PE) and provide secondary treatment. Sarajevo WWTP (600,000 PE) produces biogas and electricity, while Konjic is the only city in Bosnia and Hercegovina with an MBR plant. Albania: 14 municipal WWTPs have been built, of which 11 are operational. The plants are designed for secondary or tertiary wastewater treatment. "Shared" solutions therefore mean different things in each WB6.
Stop-gap outlets	Bosnia and Hercegovina exports to the EU (Mostar). Montenegro depends on one recipient 110 km away. Kosovo* (Gjakova) has a landfill contract. North Macedonia is assessing use as landfill cover at Berovo, subject to testing and permits. Bosnia and Hercegovina studied cement-kiln co-incineration (Butila, 2017) but did not implement it. Albania plants use some sludge for on-site landscaping.

3. WHAT IS THE IMPLEMENTATION BOTTLENECK?

What practitioners experience	What appears to be causing it	Level where action is needed
Sludge accumulates in storage areas, drying beds and landfills, increasing the risk of leachate infiltrating the soil and groundwater and threatening the environment and public health. Excessive sludge retention within the treatment process can impair effluent quality and increase the risk of discharging inadequately treated wastewater into receiving waters.	No permitted, contracted outlet; dependence on a single recipient or carrier; strategies not adopted or not implemented	Domestic + Local (utility: contingency plans)
Routes are legally blocked. Agricultural use is banned (Federation of Bosnia and Hercegovina), unregulated (Albania), contradictory (Kosovo*) or impractical (North Macedonia). A temporary lagoon at Sarajevo (Butila) cannot be permitted, and Kumanovo landfill demands repeated proof that the sludge is non-hazardous.	Rules adopted without workable alternatives or acceptance protocols; spatial-planning law does not provide for interim facilities	Domestic
Costs rise and are unpredictable, ending in emergency solutions such as export	Sludge is not a cost line in utility accounts or tariffs; no dedicated transition finance;	Domestic (regulator, finance ministry) + Utility (cost accounting) +

	investment finances the plant, not the chain	Regional (EU / IFI dialogue)
Plants cannot prove sludge quality, so landfill (if anything) is the only outlet	Gaps in accredited laboratory capacity; missing or impractical standards; industrial discharges contaminate sludge (heavy metals at Durrës)	Domestic level + Regional (laboratory cooperation)
Plans and investments are sized on unreliable numbers	No mandatory, standardised reporting in tonnes of dry solids (t DS); no verified domestic-level register. Systematic monitoring of sludge quantities, quality, treatment and final disposal is essential for developing evidence-based policies.	Domestic + Regional (common dataset) + Utility (measurement)
Dewatering lines are out of service for weeks or months, or run by hand	Ageing equipment; slow public procurement of spare parts; no local service support; small maintenance budgets	Utility + Domestic (procurement rules)
Small plants cannot organise sampling, transport and contracts alone	Lack of scale; no inter-municipal or regional arrangements for sludge	Local + Domestic

4. EVIDENCE FROM THE FIELD

4.1. Key evidence

Indicator / evidence	Source	What it tells us
About one third of sludge stays in the biological tanks when collections fall short (20–31 of 44 contracted per month)	Montenegro – Budva WWTP	Logistics, not treatment, creates the compliance risk. E.g. Budva's sludge passed basic laboratory tests in 2024. Analyses are carried out annually.
2 of 6 reed beds full, 3 nearing capacity, no designated outlet; ≈ €7,000 to empty one bed (within 5 km); no machine for emptying	North Macedonia – Berovo WWTP (14,000 PE), 2026	Storage is running out at plants with working treatment.
Landfill contract requires repeated proof that sludge (code 19 08 05) is non-hazardous; accredited testing is slow and	North Macedonia – Kumanovo WWTP (91,000 PE), 2026	Acceptance rules and testing capacity, not treatment, block the outlet.

costly; dewatering automation largely out of order		
73% of 15,884 t of sludge (2021) stored at the plants; 11% agriculture; 10% landfill; 5% unknown	Bosnia and Hercegovina – Dekonta / World Bank 2023	On-site storage is the de facto “disposal route”.
1,684 t (≈20% DS) exported at 800 BAM/t (≈ €409/t), ≈ €689,000 in 2024	Bosnia and Hercegovina – Mostar WWTP	The cost of having no domestic outlet.
Landfill with transport: €20–40/t (Serbia), €25.81/t (Gjakova: €17.50 transport and operations, €8.31 gate fee). Composting 110 km away: €103/t (Budva). Planning gate fees: cement-kiln co-incineration ≈ €30/t, mono-landfill €28–47/t, mono-incineration €36–75/t	Serbia – CoP and Programme 2023–2032 (Table 7.2); Kosovo* – Gjakova 2024 contract; Montenegro – Budva	Costs vary significantly. **Recovery routes cost more than landfill** unless policy and finance close the gap.
Laboratory costs per sample: ≈ €226 (Gjakova, AI 29/2014 parameters) plus €40 for soil; €345 for sludge and €145 for soil (Serbia planning value); ≈ €510 for an incomplete analysis (Bosnia and Hercegovina). Albania has no accredited sludge laboratory	Kosovo*, Serbia, Bosnia and Hercegovina, Albania	Proving quality is a recurring cost that tariffs do not cover.
North Macedonia: 15,000 t DS/y today → ≈39,500 → ≈50,000 t DS/y by 2040 (Skopje alone ≈10,600). Montenegro: ≈9,900 → ≈20,500 t DS/y with planned plants	North Macedonia – draft NSMS 2024–2034; Montenegro – CoP estimate (design PE)	Volumes will double or triple within the current investment cycle.
0.5–0.6 million t/y of dewatered sludge (25% DS) expected; target to halve landfilling by 2032; more than 70% of plants landfill today, although 40% of sludge volume is digested in a few large plants	Serbia – Programme 2023–2032; CoP	There is a wide gap between the target and practice at most plants.
≈1,700 t/y reported from four plants (≈168,000 PE) in m³ and t DS, liquid and solid; no CAPEX/OPEX budget line for sludge at any utility	Kosovo* – SHUKOS Comparative Analysis 2025; CoP	Even a domestic total is not possible, and the cost is “real but invisible”.
Leskovac reports 4,000 t/y against an estimated 11,000–15,000 t/y; in North Macedonia only 11 plants returned the domestic questionnaire	Serbia – CoP; North Macedonia – Sludge Data Assessment 2024	Under-reporting is systemic.
14 municipal WWTPs built, 11 operating; Orikum (53,000 PE) built in 2014 and never operated; Tirana (350,000 PE) construction halted	Albania – NSMS inventory 2021/22; CoP	Construction runs ahead of operation and of sludge planning.

4.2. Voice from the Plants

"Two of the six sludge reed beds are already full and three are nearing capacity. We will soon face a shortage of storage space, while we still have neither a designated location nor a final solution for sludge removal." – Practitioner, WWTP, North Macedonia

"We started operating in 2020 and the sludge disposal route is still not decided." – Operator, WWTP, Albania

"As a plant operator, I see an accredited sludge laboratory as essential. Without reliable results, we cannot decide how to reuse or dispose of our sludge." – Operator, WWTP, Albania

"The biggest challenge is not technology, but finances and staff." – WWTP practitioner, CoP from Serbia

Plant example – Gjakova WWTP, Kosovo*. The plant was designed for agricultural reuse, with a centrifuge and five covered drying beds (≈5,000 m², about 12 months of storage). Reuse never started due to farmers' non-acceptance, fragmented landholdings and the need for soil testing. The utility now pays €25.81 per tonne to have its sludge taken to landfill. The treatment works, but the outlet it was built for does not exist.

4.3. Evidence gaps

- **No comparable domestic-level volumes in t DS/y.** No economy has a complete, verified time series. Figures mix wet tonnes, m³ and dry solids, measured and PE-based estimates, and different years, so a regional total cannot yet be calculated correctly.
- **Share of sludge in WWTP operating costs.** Unit costs per tonne now exist for five economies (none for Albania). No input yet shows what share of plant operating cost sludge represents, which is the figure tariff decisions need.
- **Sludge and soil quality data.** (heavy metals, pathogens, organic contaminants). These data are sparse, yet they decide which outlets are lawful. Durrës reports heavy metals from industrial discharges. Kosovo* soils have naturally high metal levels.
- **Implementation tracking.** Existing plans (Serbia's 2032 landfill target, the SHUKOS Action Plan 2025, North Macedonia's NSMS deadlines) are not monitored against progress. Annex 2 lists the remaining data notes.

5. PRIORITY ADVOCACY FINDINGS AND RECOMMENDATIONS

PRIORITY 1 – No WWTP without a secured sludge route

What we see: In all six economies, plants produce sludge without a permitted, contracted and financed outlet. Sludge is stored on site (73% in Bosnia and Hercegovina; Kočani, Kumanovo), held in the process (Budva), left in filling reed beds and drying beds (Berovo, Durrës), landfilled (Kosovo*, North Macedonia, Serbia) or exported at about €409/t (Mostar). Domestic-level strategies are absent (Bosnia and Hercegovina), named but unassigned (Kosovo*), still in draft with deadlines passed (Albania, North Macedonia), at study stage (Montenegro), or adopted but slow to implement (Serbia).

Why it matters: Sludge that cannot leave the plant degrades effluent quality, raises energy use and turns EU- and IFI-financed treatment capacity into a compliance risk. Every month without an outlet is paid for with emergency solutions. Sludge stored on site or at landfills and dumpsites is also exposed to floods, which can wash it into rivers and onto farmland.

What should change: Every operating WWTP should have a lawful interim outlet and a contingency plan within 12 months, as North Macedonia's CoP proposes for Q2 2027. Options include more than one acceptance site, coordinated transport, agreed landfill acceptance and testing protocols, and larger plants receiving sludge from smaller ones, subject to feasibility

(e.g. Mostar; options at Peja and the planned Pristina Regional WWTP, where receiving other plants' sludge is not yet a project obligation, still need assessment). In parallel, each economy should adopt, confirm or update a domestic sludge strategy with a costed, timebound action plan. No new WWTP should be financed or commissioned without a defined and costed sludge route.

Who needs to act: Ministries responsible for environment, water and infrastructure (lead); municipalities and regional waste bodies (sites, permits, contracts); landfill and outlet operators (acceptance criteria); EU Delegations, Western Balkans Investment Fund (WBIF) and IFIs (financing conditions); utilities (contingency plans and data), with operators consulted through the domestic CoPs.

Level of action: Both. Delivery is domestic; the request to EU and IFI partners on financing conditions is regional.

PRIORITY 2 – Make sludge costs visible and finance them

What we see: Sludge already costs €20–40/t to landfill in Serbia, €25.81/t at Gjakova, €103/t at Budva and about €409/t for export from Mostar. Emptying one reed bed at Berovo costs about €7,000. Proving quality adds €226–510 per laboratory sample. Five CoPs report that tariffs do not cover these costs. Kosovo* excludes sludge from its tariff methodology and has no sludge budget line at any utility, and many Bosnia and Hercegovina tariffs have no treatment component at all. Serbia's data shows the investment scale: one 2,200 m² solar dryer at Leskovac costs about €1.1 million (Spanish Corporate Internationalisation Fund - FIEM Project's workshop, 2026).

Why it matters: Unfunded costs become deferred maintenance, retained sludge and emergency spending. Investors cannot size solutions, and citizens pay later through pollution or one-off budget rescues. Recovery routes will not replace landfill while they cost more, and nobody pays the difference.

What should change: Utilities should account for sludge as a separate cost centre. Regulators and tariff-approving bodies should recognise efficient sludge costs in tariffs, with affordability safeguards. Domestic funds, the EU and IFIs should provide dedicated transition finance for interim outlets, equipment rehabilitation and shared facilities, covering operation and not only construction.

Who needs to act: Utilities; domestic water regulators and tariff-approving municipalities; ministries of finance and environmental funds; EU, WBIF and IFIs.

Level of action: Mainly domestic (tariffs and budgets). Regional for cost benchmarking and a joint message to financiers.

PRIORITY 3 – Know what we produce: common data, proven quality, workable rules

What we see: No economy has a verified domestic sludge register in tonnes of dry solids, and reported figures can be a third of estimated ones (Leskovac). Quality is hard and costly to prove. Albania has no accredited sludge laboratory, Bosnia and Hercegovina cannot test dioxins or pathogens, and Kosovo* may need laboratories abroad for the full parameter set. Kumanovo must repeatedly prove its sludge is non-hazardous to a landfill. Rules on outlets are missing (Albania), contradictory (Kosovo*), restrictive without alternatives (Federation of Bosnia and Hercegovina ban on agricultural use) or hard to apply (North Macedonia microbiological limits).

Why it matters: Without numbers, investments cannot be sized; North Macedonia notes its data support only "strategic screening". Without proven quality, no outlet beyond landfill can be used lawfully, and the circular routes promoted by Directive 2024/3019 stay theoretical.
What should change: Agree a WB6 minimum sludge dataset covering t DS/y, % DS, quality, destination, transport distance, cost per tonne and contract status. It should build on the North Macedonia and Kosovo* proposals and Montenegro's questionnaire, and feed domestic registers with mandatory annual reporting. Domestic gaps in laboratory capacity should be addressed through the development and implementation of domestic plans for the accreditation of laboratory capacities and testing methods, alongside regional cooperation and the use of accredited laboratories in other economies for analyses that are not available domestically.
Review regulations on sludge use and disposal based on risk assessment, in line with Directives 86/278/EEC and (EU) 2024/3019, or domestic legislation aligned with the EU acquis, to ensure that sludge of proven quality has a legally permitted route for further use or disposal. At the same time, legally establish limit values for the quality of industrial wastewater discharged into sewerage systems and establish an effective system for monitoring and enforcing industrial wastewater pretreatment requirements. Where soils are naturally rich in heavy metals (Kosovo*), map and test land intended to receive sludge before launching any pilot project for its reuse.
Who needs to act: Domestic CoPs and associations (dataset, data collection and validation); ministries and environment agencies (registers, mandatory reporting, rules); accreditation bodies and laboratories; regional partners and donors (laboratory cooperation, technical assistance).
Level of action: Both.

6. REGIONAL ADDED VALUE

Regional cooperation can add value through:

- **Comparable evidence:** a WB6 minimum sludge dataset and common definitions (always t DS) so that volumes and costs can be compared, and added up, for the first time.
- **Peer learning:** contracted transport and routine quality testing (Budva); biogas and solar covering ≈70% of plant electricity (Kočani); solar drying and composting with a faculty of agriculture (Kruševac); thermophilic digestion (Peja) and digestion (Subotica, Durrës); landfill contracting and reuse barriers (Gjakova); receiving sludge from smaller plants and export realities (Mostar).
- **Common tools:** model contracts and acceptance specifications for transport, landfill acceptance, agricultural use and co-incineration; sampling protocols; lifecycle-cost benchmarks starting from Serbia's Programme unit-cost table; North Macedonia's sequenced implementation matrix as a model action plan.
- **Coordinated advocacy:** single WB6 message that wastewater investment must include a costed sludge route and support operation, not only construction.
- **Dialogue with regional institutions, the EU and IFIs:** for example, through the RCC regional working group (RWG) on water and sanitation, EU Delegations and WBIF, including on regional cooperation between accredited laboratories.
- **Awareness raising**: shared, evidence-based communication on safe sludge use, given public and farmer scepticism reported in Serbia, Bosnia and Hercegovina, Albania, Kosovo* and North Macedonia.

What should remain domestic:

- Transposition of EU sludge, waste and wastewater law, and harmonisation of domestic instruments.
- Whether, and under which conditions, agricultural use is allowed.
- Tariff decisions and affordability measures.
- Choice of technologies and sites; permits, contracts and spatial planning.
- In Bosnia and Hercegovina, the division of competences between central, entities, cantons and Brčko District.
- Investment decisions, which should stay specific to the economies.

7. KEY ADVOCACY MESSAGES

#1	**Secure the sludge route with every wastewater investment.** Every operating WWTP needs a lawful, reliable and financed sludge outlet, and every new plant should secure one before commissioning.
#2	**Make sludge costs visible and finance them.** Utilities should account separately for sludge management, while tariffs and investment plans should cover efficient treatment, testing, transport and final recovery or disposal.
#3	**Build comparable evidence to support credible decisions.** A minimum WB6 dataset using tonnes of dry solids should guide investments, regulation, financing and regional learning.
#4	**Design solutions with the people who operate the plants.** Operators and CoPs should be involved from the outset in strategies, regulations, investments and decisions on sludge outlets.

8. PROPOSED FOLLOW-UP THROUGH CLEAN FLOW

At Clean Flow, we want participants to validate:

- The headline finding: the main bottleneck is the missing chain beyond the plant gate rather than treatment at plant level. For Albania, besides that, on-site treatment capacity should also be improved.
- The three priorities: (1) no WWTP without a secured sludge route, with interim outlets for every operating plant as soon as practicable; (2) sludge costs made visible and financed; (3) common data, proven quality and workable rules.
- The indicators of the proposed WB6 minimum sludge dataset, and whether CoPs/operators are ready to test them with their members.

Questions that still need policy dialogue:

- Should agricultural use be enabled, and under which risk-based conditions, where it is now banned (Federation of Bosnia and Hercegovina), unregulated (Albania) or permitted but not workable (Kosovo*)? How can farmer and public trust be built?
- What role, if any, should shared or cross-border outlets play (export, the planned Skopje and Pristina thermal lines, cement-kiln co-incineration) compared with domestic solutions?
- Who should hold and validate domestic sludge data: ministries, agencies or the Associations/Operators - CoPs?
- Should EU and IFI financing of new WWTPs be conditional on a costed sludge route, and how would this apply to projects already under way?
- How should climate-proofing of WWTPs, including flood-safe sludge storage and outlets, be reflected in wastewater investments and domestic climate adaptation planning?

Possible follow-up:

- **Domestic:** each CoP brings the interim-outlet request, its plant cases and its cost evidence to the responsible ministry and regulator.
- **Regional:** Working Group B to discuss testing the WB6 minimum dataset, and to organise peer exchange around the practices listed in Section 6. CoPs have already offered commitments in return, which can feed Session 6 on what practitioners commit to:
- Montenegro: annual standardised plant data.
- Bosnia and Hercegovina: an annual domestic sludge status report.
- North Macedonia: validation of plant cases, stocks, outlets and cost baselines.
- Kosovo*: it is proposed that the utilities report quantity, quality, destination and cost annually in t DS and that SHUKOS supports data validation and keeps the domestic WWTP database, with roles to be formally agreed with Ministry of Environment, Spatial Planning and Infrastructure (MESPI) and WSRA.
- Serbia: Establishment of a domestic sludge database with mandatory reporting by utilities.
- Albania: Development of a domestic sludge inventory.
- **Further evidence / work needed:** the share of sludge in plant operating costs for two or three plants per economy; sludge and soil quality results; conversion of domestic figures to t DS/y with a stated reference year.

9. SOURCES AND CoP CONTRIBUTIONS

Albania: Topic Elaboration “Sludge management” (revised), SHUKALB members, WWTP operators, contributors O. Alla (SHUKALB), F. Çaushi (Durrës WWTP), H. Medja (Velipoja WWTP); 30.09.2026.

Bosnia and Herzegovina: Topic Elaboration “Sludge Management”, Association of Public Utility Companies in Federation of Bosnia and Hercegovina and Republika Srpska/ CoP Bosnia and Hercegovina; operators from Sarajevo, Živinice, Trebinje, Ljubuški, Bijeljina and Tomislavgrad WWTPs; 15.07.2026, revised 07.10.2026.

Kosovo*: Topic Elaboration “Sludge Management”, SHUKOS; contributors F. Lasku, D. Nishiqi, Z. Spahiu, N. Vitija, E. Humolli, with the SHUKOS Sludge Management Working Group (2025); final Version 2 (22.10.2026; updated version received 23.10.2026).

Montenegro: Topic Elaboration “Sludge Management”, Association of Waterworks of Montenegro, CoP of WWTP operators; lead author D. Đakonović (Budva WWTP), 7 operators from 7 WWTPs; August 2026, revised 08.10.2026.

North Macedonia: CoP Position on Sludge Management, ADKOM CoP of WWTP Operators; R. Atanasova (Kočani WWTP), A. Šumanski and L. Simevska-Armenska (Berovo WWTP), D. Tuševski (Kumanovo WWTP), N. Radojkova (ADKOM Secretariat); 19.10.2026 (version 5).

Serbia: Topic Elaboration “Sludge Management and Energy Efficiency in WWTPs”, Association for Water Technology and Sanitary Engineering, CoP; lead author D. Grandić Aleksić (PUC Vodovod Kruševac); 19.10.2026.

Other key sources: DEKONTA BH (2023), Municipal Sludge Status Assessment and Recommendations for Improvement, World Bank; draft Domestic Sludge Management Strategy 2024–2034 and Assessment on Sludge Data (2024), North Macedonia; Sludge Management Programme 2023–2032 (incl. Table 7.2 unit costs) and Regulation on Sludge Management (Official Gazette of Serbia 103/2023), Serbia; Waste Management Plan 2025–2029 and Rulebook on Municipal Sewage Sludge (Official Gazette of Montenegro 21/25), Montenegro; Regulation on Sludge Management (Official Gazette of the Federation of Bosnia and Hercegovina 28/24); NSMS WWTP inventory 2021/22, Albania; SHUKOS / Regional Capacity Development Network + (RCDN+) (2025) Comparative Analysis on Sludge Management Practices, v.2, and Kosovo* Water Strategy 2017–2036; Directive (EU)

2024/3019 and Directive 86/278/EEC; Revised Action Plan for the Implementation of the Sofia Declaration on the Green Agenda for the Western Balkans 2025–2030 (Pillar 3, Actions 26a and 26b); CLEAN FLOW WB6 Project Proposal.

Evidence limitations: Domestic figures come from different years (2021–2026) and bases (wet tonnes, m³, t DS; measured or design-based), so no regional total is given. Several figures come from draft strategies (North Macedonia, Albania). North Macedonia's plant figures are indicative, and Serbia's Programme unit costs are planning values based on EU experience. Costs per tonne include different components and are indicative, not strictly comparable. Quotations are reproduced as reported in the domestic inputs; Kosovo* statements are collective CoP statements.

Annex 1 – WB6 sludge snapshot

Economy	Sludge framework / strategy	WWTPs and volumes	Main routes today	Notable practice / evidence
Albania	Law 29/2024 (Art. 108) general; no rules on agricultural use or metal limits; draft NSMS 2025–2050 not adopted	14 municipal WWTPs (11 operating), ≈20 in pipeline; no domestic volume figure	Drying beds, reed beds, lagoons; landfill; some on-site landscaping	Durrës digestion and reed beds; heavy metals in sludge; no accredited sludge laboratory
Bosnia and Herzegovina	Federation of Bosnia and Herzegovina Regulation 28/24 (bans use on farmland); none in Republika Srpska; no strategy at any level	20 operating, 4 under construction, ≈1.07 M PE; 15,884 t (2021)	73% on site, 11% agriculture, 10% landfill, 5% unknown; export (Mostar)	Export ≈ €409/t; Mostar could take sludge from smaller plants; Butila co-incineration study (2017) not implemented
Kosovo*	Waste Law bans food crops; Administrative Instruction 29/2014 allows agricultural reuse; Administrative Instruction 02/2022 - silent; no strategy (Water Strategy Measure 2.6 unassigned); sludge outside WSRA tariffs	4 plants (≈168,000 PE), ≈1,700 t/y in mixed units; ≈20 decentralised systems; Gjilan, Mitrovica, Ferizaj, Pristina Regional planned	Dewatering and drying beds, then landfill (Gjakova, Prizren); digested sludge at Peja without outlet	Gjakova €25.81/t, lab ≈ €226/sample; Peja thermophilic digestion; natural heavy metals in soils; SHUKOS working group (2025)
Montenegro	Law on Waste Management (Arts. 73–74); Rulebook 21/25; Waste Management Plan 2025–2029 (studies)	8 WWTPs and 5 wetlands; 12,285 m³/y measured at 4 plants; ≈9,900 → 20,500 t DS/y estimated	Composting (Budva → Nikšić), landfill, on-site storage (Podgorica)	Budva sludge meets quality criteria; transport bottleneck (€103/t); Nikšić digesters and CHP not operating
North Macedonia	Law on Waters and rulebooks; draft NSMS 2024–2034, update and adoption proposed by Q2 2027	38 existing or planned WWTPs (17 operating), 1.78 M PE; 15,000 → ≈50,000 t DS/y by 2040	Sub-standard municipal landfills; on-site storage (Kočani, Kumanovo); reed beds (Berovo); limited composting	Kočani ≈70% energy from biogas and solar; Berovo beds nearly full; Kumanovo landfill acceptance barrier; Skopje incineration line proposed

Serbia	Regulation on Sludge Management (103/2023); Sludge Management Programme 2023–2032	54 built, 44 operational, 17 under construction; 0.5–0.6 Mt/y dewatered sludge expected	Landfill (>70% of plants); digestion in large plants; pilot solar drying and composting	Kruševac solar drying and composting; Subotica biogas; Leskovac solar dryer ≈ €1.1 M; Programme unit-cost table

Sources: final domestic CoP inputs (October 2026) and the sources in Section 9. Volumes are not comparable across economies (see Section 4.3).

Annex 2 – Remaining data caveats

- **Albania:** Durrës WWTP reports 300–400 t of sludge per year while treating 22,000–25,000 m³/day. The unit (wet tonnes or t DS) and reference year are not stated, so the figure is not used for comparison.
- **Montenegro:** Budva transport contract (44 collections of ≈14 m³ per month) implies about 7,400 m³/y, against a reported multi-year average of 3,883 m³/y. The average reflects earlier, lower production.
- **Serbia:** "40% of sludge digested" refers to sludge volume (concentrated in a few large plants), while "more than 70% landfill" refers to the number of plants. The two figures are consistent but should not be read as one split.
- **North Macedonia:** The case-study volumes for Kočani, Berovo and Kumanovo are indicative design-based values; Kočani does not yet measure annual quantities systematically.
- **Kosovo*:** Projected quantities for the planned Pristina Regional WWTP exist in its preliminary design but are not included here. Kosovo* cost and laboratory figures come from one plant (Gjakova) and from 2022–2024 period.

Associations that contributed:

- Albania: Water Supply and Sewerage Association of Albania (SHUKALB).
- Bosnia and Herzegovina: Association of Employers of Utility Companies in the Federation of Bosnia and Herzegovina (UPKP), and the Association of Waterworks of Republika Srpska (AWRS).
- Kosovo*: Water Supply and Wastewater Works Association of Kosovo* (SHUKOS).
- North Macedonia: Association of Communal Service Providers in the North Macedonia (ADKOM).
- Montenegro: Association of Waterworks of Montenegro (AWM).
- Serbia: Association for Water Technology and Sanitary Engineering (UTVSI).