Interreg Danube Region

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MicroDrink

Transnational strategic guidelines for microplastics management in drinking water

Project MicroDrink

Drafted by University of Ljubljana, supported by Croatian Geological Survey, with input from all project partners.

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1. Introduction

Microplastics are increasingly recognised as an emerging issue for drinking water management. Although scientific understanding and regulatory frameworks are still developing, water suppliers across the Danube River Basin (DRB) must begin preparing for systematic monitoring and risk assessment. This deliverable provides strategic guidance to support that transition.

The document builds on previous project deliverables and translates them into actionable recommendations for drinking water facilities. It reflects the requirements of the Drinking Water Directive (EU) 2020/2184 and the recently adopted Commission Delegated Decision (EU) 2024/1441, which introduces a harmonised analytical methodology for microplastics measurement. While the EU has not yet defined parametric values or mandatory corrective actions, the expectation is clear: Member States and water suppliers must progressively integrate microplastics into routine water safety management.

These guidelines are intended for operators, laboratories, regulators, and public health authorities. They outline how to prepare for microplastics monitoring, interpret early findings, and embed microplastics into long-term risk-based management.

2. Existing regulations on microplastics in drinking water

The European Union has introduced a harmonised method for analysing microplastics in drinking water through Delegated Decision (EU) 2024/1441. As this act applies directly, Member States incorporate the methodology into their existing drinking water systems without formal transposition.

Across the DRB, implementation is progressing at different speeds. Some countries, such as Germany, have already integrated the methodology into their national drinking water frameworks and linked it to risk-based management. Others, including Croatia and Slovenia, are preparing through capacity-building activities, laboratory development, and pilot monitoring. In several countries, such as Hungary, Czech Republic and Austria, work is still at an early stage, with authorities focusing on understanding technical requirements before formal adoption. In parallel, non-EU countries, including Serbia and Bosnia and Herzegovina, are aligning their draft legislation with EU practice but have not yet introduced binding rules.

Because no parametric values or mandatory corrective actions have been defined at EU level, current efforts focus on establishing monitoring systems, building analytical capacity, and preparing for future regulatory steps. Drinking water suppliers therefore need to ensure readiness for the gradual integration of microplastics into routine monitoring and Water Safety Plans, even while national frameworks are still in development.

3. Strategic direction for integrating microplastics into drinking water management

Across DRB project countries, a common strategic vision is emerging: to build the technical, organisational, and governance capacity required to integrate microplastics into routine drinking water management. This vision emphasises:

- **Laboratory readiness**, including analytical capacity (FTIR, Raman), trained personnel, and quality assurance.
- **Pilot monitoring and baseline data collection**, enabling facilities to understand microplastic occurrence and variability.
- **Gradual integration into Water Safety Plans**, reflecting the risk-based approach of the Drinking Water Directive.
- **Alignment with national methodologies and EU standards**, ensuring comparability and regulatory coherence.
- **A precautionary and adaptive approach**, recognising scientific uncertainty and the evolving regulatory landscape.

This strategic direction supports long-term resilience and prepares facilities for future EU requirements.

4. Key findings from pilot actions: harmonised monitoring, results and transferability

The pilot activities represent the first coordinated attempt to apply a harmonised microplastic monitoring approach across diverse drinking water resources in the DRB. The pilots tested sampling and analytical procedures aligned with the EU Drinking Water Directive (DWD) methodology and ISO standards, generating comparable datasets across nine pilot sites. This chapter summarises the harmonised approach, key monitoring results, methodological lessons, and the broader transferability of the findings.

4.1 Harmonised Sampling and Analysis Approach

The MicroDrink project implemented a harmonised approach to sampling and analysing microplastics in drinking water, designed to comply with the methodological requirements of the EU Drinking Water Directive and relevant ISO standards. All pilot sites followed contamination-controlled procedures using plastic-free equipment and microplastic-free rinse water, ensuring consistent and comparable sampling conditions across the DRB. Each participating country conducted its own laboratory analyses using nationally available instrumentation, while an additional central laboratory in Hungary provided cross-laboratory comparison and supported consistency checks across the full dataset.

A minimum sample volume of 1,000 litres was used at all locations to capture environmentally relevant concentrations, with most partners applying a simplified 20–20 µm filter cascade that met the required size threshold while remaining cost-effective and operationally manageable. Analytical work followed a whole-sample principle wherever possible and relied on FTIR, Raman spectroscopy for polymer identification. Laboratories reported microplastics by polymer type, size class and shape, accompanied by detailed metadata on sample handling. Strict quality-control procedures, including procedural blanks and recovery tests, were applied to quantify background contamination and ensure data reliability. Although the methodology applied in the project was aligned with the recommendations and requirements of the Commission Delegated Decision 2024/1441, the implementation revealed several important challenges that still need to be addressed before such monitoring approaches can be considered sufficiently robust for wider or mandatory application. Variability in results between laboratories and pilot sites was found, indicating that the datasets cannot yet be regarded as fully comparable. At this stage, it remains unclear whether these differences stem from sampling methodologies, subsampling procedures, analytical methods, laboratory performance, matrix effects, or other factors. The experience nevertheless provided valuable insights for capacity building and practical testing under real conditions, while also underlining the need for further methodological refinement, improved interlaboratory harmonisation, and optimisation of sampling equipment and filters, and more extensive quality assurance procedures in future monitoring efforts.

4.2 Monitoring results

Karst pilot sites

The karst pilot sites, located in Croatia, Austria, and Bosnia and Herzegovina, represent fast-responding aquifers characterised by conduit-dominated flow and strong hydrological variability. Despite these dynamic conditions, microplastic concentrations were generally low to moderate. Most detected particles were within the 20–100 µm size range, with total counts typically between 50 and 150 particles per cubic metre, and only a small number of particles exceeding 100 µm. The polymer spectrum was simple and dominated by polyethylene (PE) and polypropylene (PP), with occasional detections of PET. Particle shapes were predominantly fragments, while fibres appeared only sporadically. Concentrations were often close to blank levels, and no pronounced temporal or treatment-related trends were observed. These findings suggest that diffuse surface inputs are the primary source of microplastics in karst systems, and that natural hydrological processes limit the accumulation of larger particles.

Intergranular pilot site

The intergranular aquifer sites in Hungary, Serbia, and Germany showed the lowest microplastic concentrations among all resource types. These porous aquifers benefit from long residence times and natural filtration processes, which effectively reduce particulate contaminants before they reach water intake locations. Microplastic counts were often at or below reporting limits, and differences between raw and treated water were minimal. As in the karst systems, most particles were small fragments in the 20–100 µm range, with very few detected above 100 µm. Polymer types followed a similar pattern to other clusters, with PE and PP most common, alongside occasional detections of PET, PA and other polymers. The consistently low concentrations confirm the resilience of well-confined intergranular aquifers and highlight their role as stable, low-risk drinking water sources.

Bank filtration/surface water pilot site

The bank filtration or surface water sites in Slovenia, Czech Republic, and Serbia showed the highest microplastic concentrations and the greatest variability. Raw water typically contained up to 150 particles per cubic metre, while treated water samples contained around 100 particles per cubic metre for the Czech Republic and Serbian pilots. At the Slovenian pilot site, results were generally lower, reaching up to 10 particles per cubic metre. Although these values remain low compared to many surface-water studies, they are noticeably higher than those observed in groundwater dominated systems. Polymer diversity was also greater, with PP, PET, and PE predominating, and occasional detections of PC and PMMA. As in other resource types, fragments were the predominant shape class, while fibres were rare. These systems also showed the clearest treatment-related reductions, reflecting the influence of upstream pressures such as wastewater discharges, stormwater runoff, and mixed land-use activities.

Comparative assessment

Across all pilot sites microplastic occurrence was observed: intergranular aquifers had the lowest concentrations, followed by karst systems, while bank filtration and surface water connected water sources had the highest levels. Polymer patterns were broadly consistent across the region, dominated by PE and PP, but diversity increased in systems with greater surface water influence. The 20–100 μm size class was by far the most abundant across all resource types, reflecting both environmental degradation processes and the detection capabilities of the analytical methods used.

4.3 Lessons learned from sampling and analysis

The experiences gathered across the nine MicroDrink pilot sites provide a detailed picture of the practical challenges and strengths of the harmonised microplastic monitoring approach. Although all partners successfully collected the required sample volumes, the fieldwork revealed several recurring issues with sampling equipment. The cylindrical stainless steel cartridges, which formed the core of the filtration setup, were generally functional but showed inconsistent internal water volumes, occasional overflow during opening, and variability in mesh performance. In several cases, the mesh allowed particles larger than the nominal 20 μm threshold to pass, raising concerns about filtration efficiency. Partners also reported difficulties with gasket sealing, mechanical alignment, and the cleaning and reusability of multi-layer mesh filters. These challenges highlighted the need for clearer operational instructions, systematic equipment validation, and a more robust understanding of how filtration hardware behaves under different raw water conditions. Importantly, the pilots confirmed that the second filter in the cascade cannot be treated as a procedural blank, as it is exposed to the sample stream and therefore reflects filtration efficiency rather than background contamination.

Laboratory experiences showed similar patterns of variability and learning. While some laboratories were able to process entire samples, others had to rely on subsampling due to high particle loads or incomplete sample recovery. This introduced additional uncertainty, particularly when particles were unevenly distributed across filter surfaces. Matrix effects, such as organic debris, mineral particles, and biofilm fragments, frequently complicated analysis and reduced spectral clarity, especially for small or weathered particles. Distinguishing polymers such as polyamide from biogenic material proved challenging and manual verification remained essential for reliable identification. Despite strict contamination control measures, including cotton laboratory clothing, filtered reagents, ethanol cleaning, and laminar-flow workspaces, several laboratories still detected polymer types in blanks, underscoring the persistent difficulty of eliminating airborne or laboratory-based contamination entirely.

Recovery experiments provided valuable insight into analytical performance. Most laboratories achieved acceptable recoveries with well-defined reference particles, but partners noted the limited availability of stable, traceable microplastic standards suitable for method validation. The pilots also reinforced the importance of harmonised subsampling strategies, consistent reporting formats, and transparent documentation of analytical decisions. Collectively, these experiences demonstrate that while the participating laboratories possess strong analytical capabilities, microplastic monitoring in drinking water remains technically demanding. The lessons learned form a critical evidence base for refining protocols, improving equipment design, and supporting the development of EU-wide training, interlaboratory comparisons, and quality assurance frameworks.

5. Transnational strategic actions for drinking water facilities

The MicroDrink pilot activities showed that drinking water facilities across the DRB differ significantly in their readiness to implement microplastic monitoring, but all were able to integrate the harmonised methodology with appropriate support. Facilities participating in the pilot activities reported that introducing sampling required adjustments to operational routines, including staff training, preparation of sampling locations, and coordination with laboratory schedules. These experiences highlight the importance of establishing a clear baseline understanding of each facility's infrastructure, raw water characteristics and potential microplastic sources before routine monitoring begins. Pilot action operators also noted that the placement of sampling points, particularly in bank filtration and karst systems strongly influenced sample representability, reinforcing the need for careful selection of sampling locations.

As facilities begin to integrate microplastics into their monitoring programmes, the pilot activities highlight the need for close collaboration between operators and laboratories. Several facilities reported challenges with sample handling, transport, and documentation, especially when dealing with 1,000 litre volumes and multi-filter cascades. These experiences show that facilities must develop internal procedures for contamination control, equipment cleaning, and sample transfer to ensure reliable results. Once analytical data become available, facilities should incorporate microplastics into their Water Safety Plans, using pilot findings that showed clear differences in vulnerability across resource types. For example, bank filtration locations would require more frequent monitoring and verification of treatment performance, while intergranular aquifers would require only periodic confirmatory checks. Pilot operators also emphasised the importance of internal communication and staff awareness, noting that successful implementation depended on clear instructions and a shared understanding of the monitoring objectives. Over time, integrating microplastics into routine practice will require trend analysis, periodic review of operational measures, and continuous alignment with evolving regulatory expectations.

6. Transnational framework for managing microplastic detection

The MicroDrink pilots showed that microplastic detections in drinking water are often close to blank levels, making verification a crucial first step in any response framework. Several laboratories reported that initial detections required repeat sampling due to uncertainties related to equipment performance, matrix effects, or background contamination. Facilities should therefore treat any detection as a trigger for confirmation rather than immediate corrective action. Pilot experiences also showed that hydrological conditions, particularly in karst and bank filtration systems, can influence microplastic presence, so follow-up sampling should consider rainfall events, river conditions or operational changes at the facility.

Once detections of microplastics are verified, facilities should assess potential sources using insights from the pilots. Operators in bank filtration systems frequently observed that upstream wastewater discharges and storm water inputs influenced raw water microplastic loads, while groundwater based facilities rarely identified internal sources. These observations indicate that facilities should evaluate both internal and external pathways, including treatment processes, infrastructure materials, and catchment-related pressures.

Medium term responses may involve optimising filtration or coagulation processes, as several pilot sites observed reductions in microplastic counts after treatment. Where upstream pressures are significant, collaboration with wastewater operators and catchment managers is essential.

Over the long term, microplastics should be fully integrated into Water Safety Plans, supported by the structured reporting and QA/QC practices tested during the pilots. Facilities should document all actions and contribute data to national or regional databases to support regulatory development and trend analysis.

7. Conclusions and future implementation

Microplastics present an emerging challenge for drinking water management. Although the EU has established a harmonised methodology for microplastic measurement, binding thresholds and corrective actions have not yet been defined. This transitional period requires proactive preparation by drinking water facilities.

The MicroDrink pilot activities provide the first coordinated evidence base for understanding microplastic occurrence in drinking water across the DRB and demonstrate both the feasibility and the technical demands of implementing harmonised monitoring.

The pilots confirmed that microplastic concentrations in drinking water are generally low and often close to detection limits, yet they also revealed clear and consistent differences between water-resource types. Intergranular aquifers showed the lowest levels, karst systems displayed hydrological sensitivity, and bank-filtration sites exhibited higher and more variable concentrations influenced by upstream pressures. These findings support a risk-based monitoring strategy and offer practical guidance for facilities preparing for the implementation of the Drinking Water Directive's microplastic provisions.

Pilot experiences also underscored the importance of validated sampling equipment, harmonised analytical procedures and robust quality-assurance frameworks. Variability in equipment performance, subsampling decisions and matrix effects demonstrated that microplastic monitoring remains technically challenging and that further refinement of protocols is needed. Nevertheless, the successful application of the harmonised methodology across nine pilot sites shows that coordinated, cross-country monitoring is achievable and provides a strong operational model for future implementation.

A shared strategic direction is emerging across DRB countries, emphasising laboratory readiness, baseline data collection, alignment with EU standards and a precautionary, adaptive approach to risk management. The evidence generated through the pilot activities reinforces the value of harmonised approaches and transnational cooperation, both of which will be essential as microplastic monitoring becomes a formal requirement under the Drinking Water Directive.

By implementing the strategic and operational measures outlined in this deliverable, drinking water facilities can strengthen their preparedness, support regulatory development and contribute to a more comprehensive understanding of microplastics in drinking water. These efforts will enhance system resilience, protect public health and support the development of a coherent European framework for microplastic management.