

EU4GREEN

SURFACE WATER MONITORING DEVELOPMENT PLAN, BOSNIA AND HERZEGOVINA

EU 4 Green Recovery:

Support the implementation of the Green Agenda for the Western Balkans

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ABBREVIATIONS

ADA	Austrian Development Agency
ARB	Adriatic River Basin District
ASIG	State Authority for Geospatial Information
BQE	Biological Quality Element
CA	Competent Authority
CIS	Common Implementation Strategy
CISV	Central Information System for Water
DCM	Decision of the Council of Ministers
DRB	Danube River Basin District
EC	European Commission
EEA	European Environment Agency
EIONET	European Environmental Information and Observation Network
EQR	Ecological Quality Ratio
EQS	Environmental Quality Standard
EU	European Union
EU ETS MRVA	EU Emissions Trading System Monitoring, Reporting, Verification and Accreditation
FBiH	Federation of Bosnia and Herzegovina
GAWB	Green Agenda for the Western Balkans
GC-MS	Gas Chromatography–Mass Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
IPH	Institute of Public Health
ISO	International Organization for Standardization
ISRBC	International Sava River Basin Commission
LIMS	Laboratory Information Management System
MAC	Macrophytes
MDP	Monitoring Development Plan
MZB	Macrozoobenthos
PAH	Polycyclic Aromatic Hydrocarbon
PFAS	Per- and Polyfluoroalkyl Substances
PHB	Phytobenthos
PHP	Phytoplankton
PoM	Programme of Measures
QA/QC	Quality Assurance / Quality Control
RBD	River Basin District
RBMP	River Basin Management Plan
RBSP	River Basin Specific Pollutant
RS	Republika Srpska
SOP	Standard Operating Procedure
SWB	Surface Water Body
UBA	Umweltbundesamt (Environment Agency Austria)
WFD	Water Framework Directive
WISE	Water Information System for Europe

1. EXECUTIVE SUMMARY

This **Surface Water Monitoring Development Plan (MDP)** provides a structured and practical roadmap for the development, implementation, and operation of a **Water Framework Directive (WFD)-compliant surface water monitoring system in Bosnia and Herzegovina**. Developed within the framework of the EU4Green initiative, the plan supports the transition towards **sustainable water management**, improved environmental governance, and alignment with EU acquis under Chapter 27.

The primary objective of the MDP is to establish a monitoring system capable of **reliably assessing the ecological and chemical status**, detecting trends and pressures, and evaluating the effectiveness of measures under River Basin Management Plans (RBMPs). Monitoring is recognised as a **core pillar of river basin management**, providing the data necessary for evidence-based decision-making and compliance with WFD requirements.

The document outlines the **technical and methodological foundations** for WFD-compliant monitoring, including the definition of biological quality elements (BQEs), supporting hydromorphological and physico-chemical parameters, and chemical substances such as Priority Substances and River Basin Specific Pollutants (RBSPs). It describes the three monitoring types required by Annex V—**surveillance, operational, and investigative monitoring**—each fulfilling distinct roles in status assessment, pressure analysis, and problem identification.

A central component of the MDP is the **phased implementation framework**, covering:

- baseline analysis and water body characterisation (Article 5),
- monitoring programme design (Article 8 and Annex V),
- operational implementation,
- data management and quality assurance,
- status assessment and reporting, and
- adaptive review and optimisation.

This phased approach is aligned with the **six-year WFD planning cycle**, ensuring a structured transition from planning to full system operation.

Bosnia and Herzegovina has made **notable progress in aligning its water management framework with the EU Water Framework Directive (WFD)**. The country is divided into two main river basin systems—the **Sava River Basin** and the **Adriatic Sea Basin**—for which River Basin Management Plans (RBMPs) have been prepared for the **2022–2027 planning cycle**. These RBMPs represent the second cycle of WFD-aligned planning instruments and provide a structured basis for water management. Institutional responsibilities are clearly defined at the entity level, with competent ministries and river basin agencies responsible for monitoring, planning, and implementation. The legal framework is broadly aligned with EU requirements, and recent strategic developments—particularly the **Water Management Strategy of the Federation of BiH 2022–2032**—provide an important foundation for improving monitoring systems and strengthening compliance with the EU acquis.

However, despite this progress, the monitoring system in Bosnia and Herzegovina remains in a **transitional and partially operational stage**, with significant implementation gaps. Monitoring programmes are not yet fully harmonised or implemented across all water bodies, resulting in incomplete and inconsistent data coverage. Biological monitoring is particularly underdeveloped, with several Biological Quality Elements (BQEs) only partially or inconsistently monitored. Chemical monitoring also remains limited, especially with regard to priority substances, biota, and sediment compartments. As a result, water status assessments are frequently based on incomplete datasets or pressure-based estimations, leading to **low confidence in ecological and chemical status classification**. Additional challenges further constrain effective implementation. Monitoring systems are characterised by **fragmented governance structures**, reflecting the highly decentralised institutional framework of Bosnia and Herzegovina. Data management remains weak, with monitoring data dispersed across institutions and the central Water Information System (CISV) not yet fully operational. Laboratory capacity and quality assurance systems require further development, and **monitoring activities are often dependent on externally funded projects**, limiting long-term sustainability. Moreover, insufficient integration between monitoring results, Programme of Measures implementation, and RBMP planning cycles reduces the effectiveness of water management.

To address these challenges, Bosnia and Herzegovina requires a structured transition to a **fully operational, harmonised, and sustainable WFD-compliant monitoring system**. The proposed roadmap outlines a phased implementation approach for the period **2026–2030**, aligned with the WFD planning cycle. Initial efforts focus on completing the monitoring system design, harmonising methodologies across entities, strengthening legal and institutional coordination frameworks, and establishing harmonised standards. This is followed by targeted capacity building, including recruitment and training of experts, upgrading of laboratory infrastructure, and expansion of monitoring networks to achieve adequate spatial coverage. Subsequent phases focus on the full implementation of monitoring programmes, including **regular and systematic data collection**, comprehensive coverage of biological and chemical quality elements, and improved consistency in sampling frequency and methods. These efforts are supported by the development of integrated data management and assessment systems, including the full operationalisation of CISV and the establishment of WFD-compliant classification and reporting procedures. This will enable the generation of reliable datasets and support preparation of **WISE-compatible reporting outputs**.

In the final phase, monitoring results are systematically integrated into the next RBMP cycle, enabling **evidence-based decision-making and optimisation of monitoring systems**. Key priorities throughout the roadmap include strengthening institutional coordination, ensuring full monitoring coverage, developing robust data systems, improving laboratory and technical capacity, and securing **sustainable long-term financing**. In conclusion, Bosnia and Herzegovina has established the **legal and planning foundations for WFD-compliant water management**, but decisive efforts are required to move from partial implementation to a fully operational monitoring system. Successful implementation of the proposed roadmap will be essential to ensure reliable water status assessments, strengthen river basin management, and support the country's progress toward EU environmental standards and accession requirements.

2. INTRODUCTION AND SCOPE

EU4Green is an important element of the continuous support by the European Union to empower and assist the Western Balkans' transition to modern, resource-efficient and competitive economies where growth is decoupled from emissions of greenhouse gases, resource use and waste generation and where climate resilience is pursued. It is the general objective of the project to support the Western Balkans in the implementation of the Green Agenda, thus in the development and transformation towards sustainability and reaching climate neutrality by 2050. Accordingly, EU4Green is a very broad initiative building on the combined expertise and cooperation within the thematic areas EU ETS MRVA, Circular Economy, Depollution Water, Depollution Air, Depollution Soil, Biodiversity, Sustainable Agriculture, Communication, Green Education, Stakeholder participation and Green Finance.

River basin management is based on monitoring of **surface water and groundwater resources** and plays a central role in any River Basin Management Plan (RBMP).

Surface water monitoring consists of ecological and chemical monitoring in accordance with the requirements of the Water Framework Directive (WFD). Ecological monitoring includes the assessment of biological quality elements (BQEs), supported by hydromorphological and physico-chemical elements, while chemical monitoring focuses on Priority Substances and other pollutants. These monitoring components are required to supplement and validate the characterization and risk assessment, to establish the status of surface water bodies (SWBs), and to evaluate the effectiveness of the measures implemented to achieve and maintain good ecological and chemical status.

In addition, surface water monitoring is needed to detect long-term trends in water quality, identify emerging pressures, and support the design and adjustment of programmes of measures under evolving environmental and climate conditions.

Sound monitoring is a fundamental instrument for good **surface water governance**. It provides all stakeholders with up-to-date and reliable information on the status and trends of surface waters within a river basin and enables informed decision-making for water management and the implementation of programmes of measures aimed at achieving the environmental objectives laid down by the Water Framework Directive (WFD).

This **Surface Water Monitoring Development Plan (MDP)** addresses the requirements for ecological and chemical monitoring of surface waters in line with the WFD. The comparison with the current situation provides the basis for identifying gaps, drawing conclusions, and formulating options for the progressive development and successful implementation of a WFD-compliant surface water monitoring system.

3. WFD COMPLIANT MONITORING

3.1. WFD monitoring principles

Article 8 of the Water Framework Directive (WFD) establishes the requirements for monitoring the status of surface waters, groundwater, and protected areas. Monitoring programmes are designed to provide a **coherent and comprehensive overview of water status** within each river basin district.

According to Annex V of the WFD, monitoring of surface waters is required to support the following objectives:

- Classification of ecological and chemical status;
- Supplementing and validating the risk assessment carried out under Annex II;
- Supporting the efficient and effective design of future monitoring programmes;
- Assessing long-term changes in natural conditions and those resulting from widespread anthropogenic activity;
- Estimating pollutant loads transferred across international boundaries or discharged into seas;
- Assessing changes in the status of water bodies identified as being at risk, particularly in response to implemented measures;
- Identifying the causes of failure to achieve environmental objectives where these are not yet known;
- Determining the magnitude and impacts of accidental pollution events;
- Supporting intercalibration exercises (comparison with neighbouring countries);
- Assessing compliance with the objectives and standards for protected areas; and
- Quantifying reference conditions for surface water bodies where these exist.

The results of monitoring programmes are reported within River Basin Management Plans (RBMPs) through **maps of monitoring networks, status assessments, and estimates of the confidence and precision** achieved by the monitoring systems.

Under the WFD, waters to be monitored are assigned to specific geographical and administrative units, in particular **river basins, river basin districts, and individual water bodies**, which form the fundamental units of assessment. Monitoring the status of these water bodies provides the basis for evaluating progress towards achieving the environmental objectives of the Directive.

Before monitoring programmes can be implemented, several preparatory steps must be completed:

- Delineation of surface water bodies;
- Identification of water body types (rivers, lakes, transitional and coastal waters);
- Definition of type-specific reference conditions for all biological quality elements.

Where such information is not yet fully available, particularly at national scale, **pressure analysis combined with expert judgement and/or modelling approaches (risk assessment)** can be used as an interim basis.

Annex V of the WFD distinguishes three main types of surface water monitoring: **surveillance monitoring, operational monitoring, and investigative monitoring**. These are complemented by additional monitoring requirements for protected areas identified under Article 6.

3.2. Recent update

Directive (EU) 2026/805 is a **recent update of the EU water policy framework** that amends the Water Framework Directive(2000/60/EC), the Groundwater Directive (2006/118/EC), and the Environmental Quality Standards Directive (2008/105/EC). It aims to strengthen protection of surface water and groundwater by updating the list of regulated pollutants, introducing stricter environmental quality standards, and enhancing monitoring and reporting requirements. The Directive places particular emphasis on emerging contaminants such as PFAS, pharmaceuticals, and microplastics, and promotes more advanced methods, including cumulative risk assessment and effect-based monitoring, in line with the EU's Zero Pollution ambition.

3.3. Precision and confidence

According to Annex V of the Water Framework Directive (WFD), monitoring results shall achieve appropriate levels of **precision and confidence**. What is considered “acceptable”, “adequate”, or “sufficient” will directly influence key design aspects of the monitoring programme, including:

- the number of water bodies included in the different types of monitoring;
- the number of monitoring stations required to assess the status of each water body; and
- the frequency at which parameters representing quality elements are measured.

The Directive does not prescribe fixed quantitative thresholds for precision and confidence. Nevertheless, it is clear that the levels achieved must be sufficient to enable **robust and meaningful assessments of water status**, both spatially and temporally.

In practice, many Member States begin by evaluating their **existing monitoring networks and datasets** to determine the level of precision and confidence that can be achieved with available resources. Monitoring system design is therefore typically an **iterative process**, involving ongoing adjustment and optimisation of networks, parameters, and sampling frequencies in order to reach levels that support reliable classification and decision-making.

In addition, **expert judgement** often plays an important role, particularly in assessing the risk of misclassification. For example, in cases where a water body may be incorrectly classified as being “at risk”, responsible authorities will typically seek to reduce uncertainty through

additional investigations before committing to costly measures. This approach helps ensure that management decisions are both **scientifically robust and proportionate**.

3.4. Biological quality elements for surface water

The basis of the classification of surface water bodies are the Biological Quality Elements (BQE) consisting of fish, macroinvertebrates, phytobenthos, phytoplankton, and macrophytes, while physico-chemistry and hydromorphology act as supporting elements.

- Biology
 - Macroinvertebrates (all rivers)
 - Phytobenthos (in small rivers only)
 - Phytoplankton (in very large rivers and lakes/reservoirs only)
 - Fish and macrophytes will be classified by expert judgment or by using local information (fishermen). If no information is available, these BQE will be included in a later phase. The same is true for macroinvertebrates and phytobenthos in lakes.
- Supporting elements
 - General physico-chemical parameters (all rivers and lakes)
 - Hydromorphology (based on a general classification of the river network)

“Supporting” means that the values of the physico-chemical and hydromorphological quality elements are such as to support a biological community of a certain ecological status, as this recognises the fact that biological communities are products of their physical and chemical environment. It is not intended that these supporting elements can be used as surrogates for the biological elements in surveillance and operational monitoring.

According to the WFD, physico-chemical quality elements include 1) general physico-chemical parameters as listed in Annex V of the directive (temperature, O₂, nutrients, salinity, pH) and 2) specific pollutants to be expected in the respective water body. These River Basin Specific Pollutants (RBSP) have to be identified and selected beforehand.

3.5. Chemical quality elements for surface water

Chemical status assessment under the Water Framework Directive (WFD) is based on a defined set of quality elements, primarily focusing on the presence and concentration of chemical substances that may pose risks to aquatic ecosystems and human health. The core elements are the Priority Substances and Priority Hazardous Substances, which are regulated at EU level and subject to Environmental Quality Standards (EQS) in water, and in some cases also in biota and sediments. These substances include heavy metals (e.g. mercury, cadmium, lead), organic pollutants (e.g. pesticides, PAHs), and industrial chemicals. In addition, River Basin Specific Pollutants (RBSPs) are included at national or river basin level to address locally relevant pressures not fully covered by the EU list.

Assessment of chemical status requires monitoring across different matrices, primarily surface water, but increasingly also biota (e.g. fish tissue) and sediments, particularly for

substances that accumulate in the food chain. The evaluation is based on compliance with EQS thresholds, with a strict “one out – all out” principle, meaning that exceedance of any single substance leads to failure of good chemical status. A key component of chemical monitoring is also the analysis of long-term trends, especially for substances that tend to accumulate or persist, in order to identify whether pollution is increasing or decreasing over time.

Together, these quality elements ensure a comprehensive assessment of chemical pressures on surface waters, enabling authorities to detect pollution, assess compliance with environmental objectives, and design targeted measures to reduce emissions and improve water quality.

3.6. Quality elements for groundwater and transitional and coastal waters

The Water Framework Directive (WFD) applies to all inland surface waters as well as groundwater and also defines quality elements for **transitional and coastal waters**. Coastal waters are defined as surface waters extending up to one nautical mile seaward from the baseline of the territorial waters. For **chemical status assessment**, the scope extends to territorial waters, which may reach up to 12 nautical miles.

For **groundwater**, EU legislation focuses on achieving **good quantitative status and good chemical status**. In addition, measures must be implemented to **prevent or limit the input of pollutants** and to **identify and reverse significant and sustained upward trends** in pollutant concentrations. (For further details on groundwater, reference is made to the document “Monitoring Development Plan – Groundwater, Bosnia and Herzegovina”.)

Healthy **surface water ecosystems** are essential not only for ecological integrity but also for ensuring the availability of clean water for drinking, agriculture, and industrial use. The status of surface waters is influenced by a combination of **hydromorphological conditions and pollution pressures**. The WFD therefore requires that inland, transitional, and coastal waters achieve both **good ecological status (or potential)** and **good chemical status**.

Transitional waters are defined as bodies of surface water in the vicinity of river mouths that are partly saline due to their proximity to coastal waters, but still significantly influenced by freshwater flows. Coastal waters extend seaward from the baseline and include waters influenced by marine processes, as defined above.

Ecological status classification is based primarily on the condition of **biological quality elements**, supported by **hydromorphological** and **physico-chemical quality elements**, and compared against **type-specific reference conditions**. Appropriate classification systems and assessment tools must therefore be developed to evaluate deviations from these reference conditions.

For **transitional and coastal waters**, the following quality elements are defined under Annex V of the WFD:

Biological quality elements

- Composition, abundance, and biomass of phytoplankton (transitional and coastal waters)
- Composition and abundance of other aquatic flora (macrophytes and phytobenthos)
- Composition and abundance of benthic invertebrate fauna
- Composition and abundance of fish fauna (transitional waters only)

Supporting hydromorphological elements

For transitional waters:

- Morphological conditions:
 - Depth variation
 - Quantity, structure, and substrate of the bed
 - Structure of the intertidal zone
- Tidal regime:
 - Freshwater flow
 - Wave exposure

For coastal waters:

- Morphological conditions:
 - Depth variation
 - Structure and substrate of the coastal bed
 - Structure of the intertidal zone
- Tidal regime:
 - Direction of dominant currents
 - Wave exposure

Supporting physico-chemical and chemical elements

- General conditions:
 - Transparency
 - Thermal conditions
 - Salinity
 - Oxygenation conditions
 - Nutrient conditions
- Specific pollutants:
 - Pollution by Priority Substances and other relevant pollutants discharged into the water body
 - Pollution by other substances identified as being discharged in significant quantities

3.7. Surface Water Surveillance Monitoring

The Water Framework Directive (WFD) requires that a sufficient number of water bodies be included in the **surveillance monitoring programme** to provide a representative assessment of the overall surface water status within each catchment and sub-catchment of a river basin district. The design of the monitoring strategy should make use of all available information on **chemical pressures and impacts**, including knowledge of substance properties (as outlined in CIS Guidance Document No. 7), emission sources and data, identified pressures, and results from previous monitoring activities.

Surveillance monitoring must be undertaken for a **minimum period of one year within each six-year River Basin Management Plan (RBMP) cycle**. The Directive specifies that monitoring should be carried out at locations where water dynamics are most relevant at the scale of the river basin district, including:

- rivers with significant flow rates, particularly large rivers with catchment areas exceeding 2,500 km²;
- large lakes and reservoirs where water volumes are significant;
- water bodies that cross Member State boundaries; and
- additional sites required to estimate pollutant loads transferred across boundaries and into the marine environment.

Within surveillance monitoring, parameters representing **all biological quality elements (BQEs), hydromorphological elements, and general as well as specific physico-chemical quality elements** must be monitored to ensure a comprehensive assessment of status.

Proposal for monitoring frequency of surveillance sites¹:

With regard to monitoring frequency, a harmonised and practical approach is recommended. For rivers, it is appropriate to sample chemical parameters monthly (12 times) over the course of one year, twice per RBMP cycle. For lakes, general physico-chemical parameters, River Basin Specific Pollutants (RBSPs), and Priority Substances (PS) may be sampled four times over one year, also twice per RBMP cycle (Table 1). Biological monitoring frequencies differ depending on the quality element and water category. In rivers, biological quality elements (BQEs) are typically monitored twice per RBMP cycle (Table 2). In lakes, phytoplankton is recommended to be sampled multiple times (e.g. four times) over a year, with sampling distributed across the vegetation period to capture seasonal variability.

¹ Recommendations are based on WFD Annex V, the CIS Guidance No. 7, as well as the Austrian experience. In practice, monitoring frequencies may differ from the minimum recommendations depending on specific approaches, available resources, and basin-specific monitoring strategies (e.g. rotational monitoring of sites or increased sampling frequency for selected biological elements). The key objective is to ensure that the status of all water bodies can be assessed, and the reliability of that assessment in terms of confidence and precision must be provided.

Table 1: Recommendations for chemical monitoring frequency at surveillance.

Monitoring	SWB	Quality Elements / Group of Parameters	Frequency within the selected year of the RBMP cycle	Intervals
Chemical Surveillance Monitoring	Rivers	General Physico-Chemical Parameters	12x	at least every 3 years
		River Basin-Specific Pollutants		
		Priority Substances		
	Lakes	General Physico-Chemical Parameters	4x	
		River Basin-Specific Pollutants		
		Priority Substances	12x	
	Transitional & Coastal Waters	General Physico-Chemical Parameters	4x	
		River Basin-Specific Pollutants		
		Priority Substances	12x	

Table 2: Recommendations for biological monitoring frequency at surveillance sites.

Monitoring	SWB	Quality Elements / Group of Parameters	Frequency within the selected year of the RBMP cycle	Intervals
Biological Surveillance Monitoring	Rivers	Benthic Invertebrates	1x	at least every 3 years
		Phytobenthos		
		Fish		
		Macrophytes		
	Lakes	Phytoplankton	4x	
		Fish	1x	
		Makrophytes		
	Transitional & Coastal Waters	Benthic Invertebrates	1x	
		Phytoplankton	4x	
		Fish	1x*	
Macrophytes		1x		

* Fish are not required in coastal waters.

Table 3: Recommendations for hydromorphological monitoring frequency at surveillance sites.

Monitoring	SWB	Quality Elements / Group of Parameters	Frequency / Intervals
Hydro-morphological Surveillance Monitoring	Rivers	Continuity	once in 6 years
		Hydrology	continuously
		Morphology	every 6 years
	Lakes	Continuity	-
		Hydrology	Monthly
		Morphology	once in 6 years
	Transitional & Coastal Waters	Continuity	-
		Hydrology	-
		Morphology	once in 6 years

3.8. Surface Water Operational Monitoring

The objectives of **operational monitoring** are to:

- establish the status of water bodies identified as being at risk of failing to meet their environmental objectives; and
- assess changes in the status of these water bodies resulting from the implementation of programmes of measures.

Operational monitoring must be carried out for all water bodies identified as being at risk of failing the relevant environmental objectives. In addition, it is required for water bodies into which **priority substances** are discharged. However, it is not necessary to monitor every individual water body, as the Directive allows for **grouping of similar water bodies** and representative monitoring, provided that the approach ensures reliable status assessment.

Operational monitoring is **targeted and pressure-specific**, focusing on those parameters and quality elements that are most sensitive to the dominant pressures affecting a water body. For example, where organic pollution is a key pressure in a river, **benthic invertebrates** may serve as the most sensitive biological indicator for assessing ecological impacts.

Proposal for monitoring frequency of operational sites:

With regard to monitoring frequency, a practical and structured approach is recommended. General physico-chemical parameters should be sampled monthly (12 times per year) in rivers and four times per year in lakes, with monitoring carried out in two separate years within the six-year RBMP cycle (Table 4). For biological quality elements (BQEs), the most indicative quality elements in relation to the present pressures must be chosen to assess the water body at risk of failing the good ecological status. BQEs are typically monitored twice per RBMP cycle in rivers, while in lakes, phytoplankton is recommended to be sampled multiple times (e.g. four sampling events) within a single year, repeated twice within the

RBMP cycle. These sampling events in lakes should be distributed across the vegetation period to adequately capture seasonal dynamics (Table 5). However, if the BQE results do not allow for a clear status assessment due to the dynamics of natural systems and unpredictable events, the monitoring period should be extended by one additional year.

Where point source or diffuse pollution is identified, suspected Priority Substances and River Basin Specific Pollutants (RBSPs) should also be monitored, following comparable frequencies (e.g. 12 times per year in rivers and four times per year in lakes, repeated twice per RBMP cycle).

Table 4: Recommendations for chemical monitoring frequency at operational sites.

Monitoring	SWB	Quality Elements / Group of Parameters	Frequency within the selected year of the RBMP cycle	Intervals
Chemical Operational Monitoring	Rivers	General Physico-Chemical Parameters	12x	at least every 3 years
		River Basin-Specific Pollutants	12x*	
		Priority Substances	12x*	
	Lakes	General Physico-Chemical Parameters	4x	
		River Basin-Specific Pollutants	4x*	
		Priority Substances	12x*	
	Transitional & Coastal Waters	General Physico-Chemical Parameters	4x	
		River Basin-Specific Pollutants	4x*	
		Priority Substances	12x*	

** If the risk assessment finds the SWB to be affected by point source or diffuse pollution, chemical analysis of the suspected substances should also be conducted. – Rivers: 12x; Lakes: 4x.*

Table 5: Recommendations for biological monitoring frequency at operational sites.

Monitoring	SWB	Quality Elements* / Group of Parameters	Frequency within the selected year of the RBMP cycle	Intervals
Biological Operational Monitoring	Rivers	Benthic Invertebrates	1x	at least every 3 years
		Phytobenthos		
		Fish		
		Macrophytes		
	Lakes	Phytoplankton	4x	
		Fish	1x	
		Makrophytes		
	Transitional & Coastal Waters	Benthic Invertebrates	1x	
		Phytoplankton	4x	
		Fish	1x**	
Macrophytes		1x		

* Choose the most indicative quality element to the present pressures to assess the status of the water body at risk.

** Fish are not required in coastal waters.

Table 6: Recommendations for hydromorphological monitoring frequency at surveillance sites.

Monitoring	SWB	Quality Elements / Group of Parameters	Frequency / Intervals
Hydro-morphological Operational Monitoring	Rivers	Continuity	once in 6 years
		Hydrology	continuously
		Morphology	every 6 years
	Lakes	Continuity	-
		Hydrology	Monthly
		Morphology	once in 6 years
	Transitional & Coastal Waters	Continuity	-
		Hydrology	-
		Morphology	once in 6 years

Choosing operational monitoring sites:

The following schemes A, B, and C (Figure 1, Figure 2, Figure 3) are adapted from a publication on implementing the Austrian Ordinance on the Monitoring of the Quality of Water Bodies (BMLFUW, 2008) illustrate the step-by-step approach on operational monitoring site selection:

Scheme A

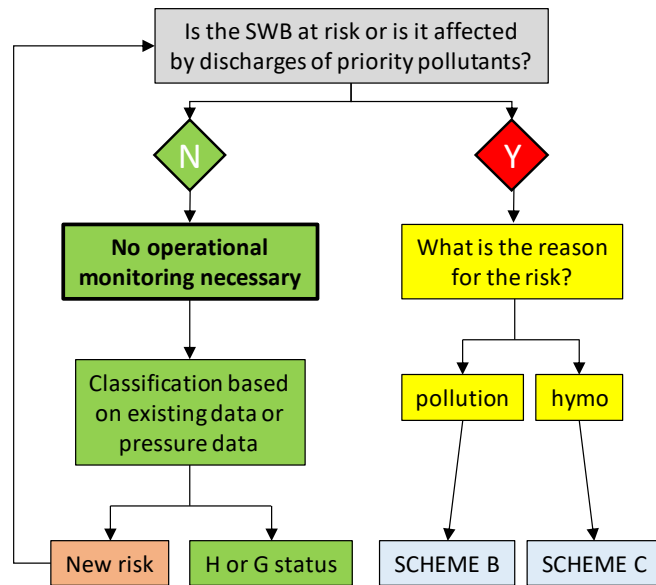


Figure 1: Scheme A of decision tree for choosing operational monitoring sites.

Scheme B

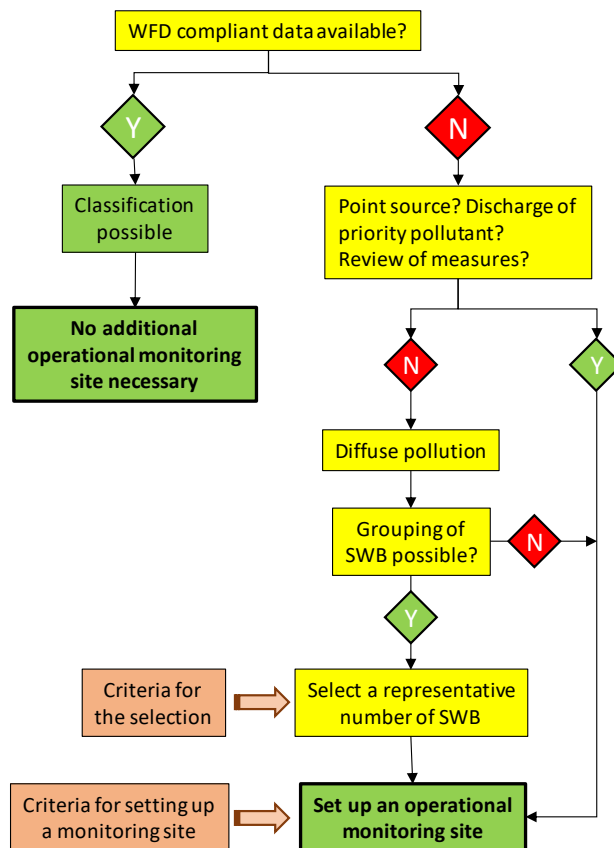


Figure 2: Scheme B of decision tree for choosing operational monitoring sites.

Criteria for the selection of representative water bodies from the group:

- Pollution from diffuse sources
- for successive SWB
 - diffuse load is uniform
 - monitoring site situated in the last SWB (most downstream)
 - Classification results can be applied to the SWB above (upstream)
- for SWB in different regions
 - diffuse load is uniform
 - SWB belong to the same type
 - SWB are comparable in terms of agricultural use
 - Affected SWB of the group are affected by the same substance or combination of substances
 - At least 25% of the SWB in a group are selected as representatives

Criteria for the setting up a monitoring site in rivers

- one site per SWB which is representative for the pollution
- Preferably at the lower end of the SWB
- Beware dilution effects of tributaries
- Distance to possible additional point sources should be at least 1 km or – if the river breadth is >100 m – at least the 10-fold of the river breadth

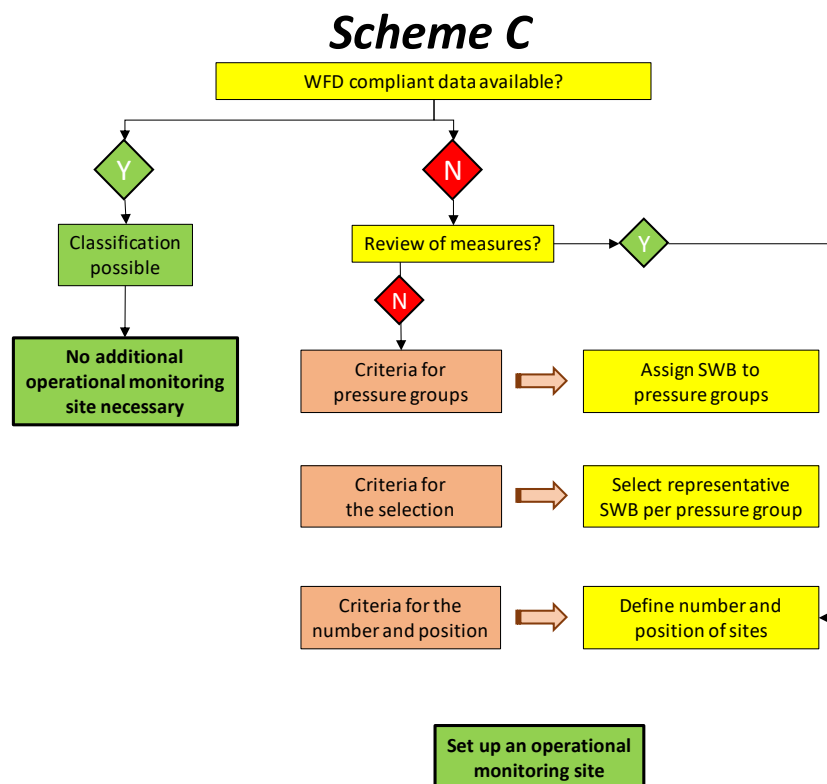


Figure 3: Scheme C of decision tree for choosing operational monitoring sites.

Criteria for pressure groups in rivers

A group of SWB

- with same river type,
- affected by the same pressure,
- which can be investigated and classified by the same indicative biological quality element

Criteria for the selection within each pressure group

- Ideally 1/3 of SWB within each pressure group
- Hydrological context: if possible, select sites within a hydrological subbasin
- No additional pressure (if possible)
- Easy to reach

Criteria for the number and position

- Morphology: one site in the longest uniform section
- Water abstraction: one site directly below the abstraction
- Continuum: one or two sites, above the weir or dam; if there is series of several weirs or dams, another one below the lowest one
- Impoundment: one site beginning (source) of the impoundment, optionally another site directly above the dam

3.9. Surface Water Investigative Monitoring

Investigative monitoring may be required in specific situations as defined in Annex V of the Water Framework Directive (WFD), including:

- where the reasons for exceedances of environmental objectives are unknown;
- where surveillance monitoring indicates that objectives are unlikely to be achieved and operational monitoring has not yet been established; or
- to determine the magnitude and impacts of accidental pollution events.

Investigative monitoring is therefore **problem-oriented and case-specific**, and its design must be tailored to the particular issue being addressed. In many cases, it involves **more intensive sampling strategies**, higher monitoring frequencies, and a focused selection of relevant water bodies, sub-areas, and quality elements.

In addition, investigative monitoring may include components of **alarm or early warning systems**, for example to protect drinking water abstractions from accidental pollution. Such systems may rely on **continuous or semi-continuous measurements** of selected parameters, including key physico-chemical indicators (e.g. dissolved oxygen) and, where appropriate, biological indicators.

Given its targeted and flexible nature, investigative monitoring is essentially an “**on-demand**” approach, triggered by specific problems or knowledge gaps. As a result, it is not possible to define standard monitoring sites, parameters, or frequencies in advance; instead, monitoring programmes must be **designed dynamically**, based on the specific objectives and pressures under investigation.

3.10. Sampling site selection in surveillance and operational monitoring

Surveillance monitoring sites should be strategically located to provide a representative and long-term overview of surface water status across the river basin district. These sites should remain **consistent across multiple RBMP cycles**, allowing for the assessment of trends and long-term changes in water quality and ecological conditions.

In contrast, **operational monitoring sites** should be applied in a more flexible manner and should not be considered part of a fixed, permanent monitoring network. Instead, their selection should directly reflect the need to assess **water bodies identified as being at risk** of failing environmental objectives.

Once the ecological status of a water body has been reliably determined through operational monitoring, it is advisable to **shift monitoring efforts to other at-risk water bodies in subsequent monitoring campaigns**. This approach allows for a more efficient use of resources and supports the progressive improvement of knowledge across the river basin district, ultimately contributing to a more comprehensive and targeted understanding of pressures and impacts.

3.11. Sampling and analysis

The representativeness of monitoring programmes begins with **careful and well-informed planning**, making full use of all available data and knowledge within the river basin. A crucial first step is to clearly define the **objectives of monitoring**—that is, the specific questions the monitoring programme is intended to answer.

An equally important aspect is the **planning and execution of sampling**. Errors introduced at the sampling stage—whether through inadequate design or improper field procedures—cannot be corrected by even the most advanced analytical methods. Therefore, it is essential to ensure the use of **appropriate equipment**, accurate selection of sampling locations, correct application of standardised methods, and the deployment of **properly trained personnel**. Effective communication with laboratories is also critical, particularly regarding sampling requirements, sample handling, preservation, and transport, in order to prevent any alteration or degradation of samples before analysis.

A number of international standards define the principles and requirements for ensuring high-quality monitoring and laboratory performance. In particular, **ISO/IEC 17025** provides a widely recognised framework for the competence of testing and calibration laboratories. This standard offers guidance on the key elements required to produce reliable and traceable results, including proper laboratory infrastructure, equipment management, and operational procedures. It

emphasises the need for **safe handling, transport, storage, and maintenance of equipment**, as well as the management of consumables to prevent contamination or deterioration.

Quality assurance (QA) is therefore a fundamental component of monitoring systems, ensuring that results are **valid, reliable, and comparable**. It must be embedded as a continuous and evolving process within laboratory operations, supporting the ongoing improvement of analytical performance and the overall quality of monitoring data.

3.12. Data management, maintenance and reporting

Purpose of monitoring is to provide sound data on the current burden of pollution of water bodies, demonstrate long term changes (as result of measures or changes of pressures) as basis for fact-based decision making. Monitoring produces a high amount of data and requires, thus, a consolidated and uniform definition of requirements and format of data. This starts with the output of raw data and their plausibility, storage and maintenance. Full power of data can only be withdrawn, when a complete and consistent set of data is available in a well-maintained database. Pre-requisite is a solid and operational network including a powerful server, which connects all involved institutions.

Collaboration between institutions and entities is key to spreading relevant information and gaining added value from data. This regards checking raw data for plausibility and interpretation of data from different users' angles.

3.13. Sustainable Budget

Any form of monitoring requires sustainable budget to guarantee a meaningful set of data. The WFD provides a concept, which needs to be adapted to the needs of every economy to best suit its demands. This encompasses resources for already existing structures in the competent authorities, Ministries and entities to coordinate and administer the concept of the WFD, but also additional expenses for sampling, analysis and data maintenance. Thus, a high degree of awareness about the tasks and obligations at high level is needed to streamline the activities related to the implementation of the WFD.

- There is need for governmental understanding of the necessity, importance and benefits of water monitoring and for strong commitment of sufficient sustainable financing of water monitoring.
- Detailed cost estimations are needed, covering all aspects of monitoring. The estimate should distinguish between
 - sufficient one-time budget to cover the investment costs like infrastructure, equipment etc.;
 - sufficient and guaranteed permanent long-term budget to cover maintenance of infrastructure and equipment; and
 - operational costs for staff, training and consumables.
- It is necessary to demonstrate the political decision makers the benefits of monitoring. The costs of monitoring should be compared with the economic benefits

gained from e.g. water industries and water related tourism. Such a comparison could strongly convince decision makers of the importance of comprehensive water monitoring.

4. WORKPLAN FOR IMPLEMENTATION

The following chapter gives an overview of prerequisites and steps that can be used as a checklist for establishing a WFD-compliant surface water monitoring system. It covers the governance structure and roles of responsible authorities, the design of the monitoring system based on river basin characterisation, and the development of monitoring programmes including selection of parameters, sites, and frequencies. The chapter further describe the implementation of field and laboratory activities, the establishment of data management and QA/QC systems, and the processes for status assessment, classification, and reporting.

4.1. Governance, Scope, and Responsibilities

4.1.1. Institutional Setup

- Designation of the **Competent Authority (CA)**
- Definition of roles:
 - Monitoring authority / agency
 - Laboratory services
 - Data management authority
 - Reporting authority
- Establish coordination mechanisms with:
 - River basin authorities
 - Nature conservation bodies
 - Stakeholders (where applicable)

4.1.2. Scope Definition

- River basin district(s)
- Surface water categories:
 - Rivers
 - Lakes
 - Transitional waters
 - Coastal waters
- Monitoring cycle aligned with the **6-year WFD planning cycle**

4.2. Phase 1 – Baseline Analysis and System Design

4.2.1. Characterisation of Surface Waters (Article 5)

- Delineation and typology of surface water bodies
- Review of existing data and monitoring programmes
- Identification of:
 - Significant pressures and impacts
 - Waters at risk of failing good status

Deliverables:

- Typology and water body register
- Pressure and impact assessment

4.2.2. Definition of Monitoring Objectives

Biological Elements:

- Establish a compliant sampling method
- Establish a compliant lab method
- Gather data on biology in a consolidated database
- Establish a pressure-response-relationship
- Define criteria for type-specific reference (benchmark) conditions (E)
- Set class boundaries (EQR)
- Compile all methods to a binding guidance document (as a basis for the monitoring)

Chemical Elements:

- Establish a pressure-response-relationship
- Which chemical pollutants and indicators are already monitored?
- Which chemical pollutants are missing?
- Establish a compliant lab method

Define objectives for each monitoring type:

- **Surveillance monitoring**
- **Operational monitoring**
- **Investigative monitoring**

Ensure consistency with:

- Ecological quality ratios (EQRs)
- Environmental Quality Standards (EQS)

Deliverables:

- Monitoring strategy document
- Type-specific EQRs
- Harmonized sampling and assessment guidances

4.3. Phase 2 – Monitoring Programme Development (Article 8 & Annex V)

4.3.1. Selection of Monitoring Types

Monitoring type	Purpose
Surveillance	Long-term trends, baseline status
Operational	Status of water bodies at risk
Investigative	Causes of failure or incidents

4.3.2. Parameter Selection

4.3.2.1. Ecological elements:

- Biological quality elements (BQEs):
 - Phytoplankton
 - Macrophytes and phytobenthos
 - Benthic invertebrates
 - Fish fauna
- Supporting elements:
 - Hydromorphology
 - Physico-chemical parameters

4.3.2.2. Chemical elements:

- Priority substances
- River Basin Specific Pollutants (RBSPs)

Deliverables:

- Parameter list by water category & monitoring type

4.3.3. Monitoring Network Design

- Selection of monitoring sites:
 - Representative sites

- Risk-based site selection
- Spatial and temporal coverage
- Sampling frequency according to Annex V

Deliverables:

- Monitoring network maps
- Sampling schedules

4.4. Phase 3 – Operational Implementation

4.4.1. Field Sampling and Measurements

- Development of Standard Operating Procedures (SOPs)
- Training of field personnel
- Implementation of sampling campaigns

4.4.2. Laboratory Analysis

- Use of accredited laboratories
- Compliance with QA/QC requirements
- Intercalibration where applicable

Deliverables:

- SOPs
- Sampling and analysis reports

4.5. Phase 4 – Data Management and Quality Assurance

4.5.1. Data Management System

- Establishment or adaptation of a central database
- Metadata documentation
- Data validation and plausibility checks

4.5.2. Quality Assurance & Quality Control

- Internal QA/QC procedures
- Participation in interlaboratory comparisons
- Audit and review mechanisms

Deliverables:

- Validated monitoring datasets

- QA/QC reports

4.6. Phase 5 – Assessment, Classification, and Reporting

4.6.1. Status Assessment

- Calculation of ecological quality ratios (EQRs)
- Status classification (high → bad)
- Chemical status compliance check

4.6.2. Trend and Pressure Analysis

- Temporal trend analysis
- Linkage with pressures and measures

4.6.3. Reporting

- Input to RBMPs and Programmes of Measures
- Reporting to the European Commission (WISE)

Deliverables:

- Status classification results
- Assessment reports
- WFD reporting datasets

4.7. Phase 6 – Review and Adaptive Improvement

- Evaluation of monitoring effectiveness
- Review of site selection, parameters, and frequency
- Integration of new methods (e.g. continuous sensors, eDNA)
- Update monitoring programme for next cycle

Deliverables:

- Monitoring programme review
- Updated workplan for next WFD cycle

4.8. Indicative Timeline (6-Year Cycle)

Year	Key activities
1	Characterisation, design, network setup
2–5	Monitoring implementation & QA
4–5	Status assessment & trend analysis
6	Reporting, review, and redesign

4.9. Key Risks and Mitigation Measures

- **Data gaps** → risk-based prioritisation
- **Resource constraints** → phased implementation
- **Method changes** → harmonisation and documentation
- **Climate impacts** → adaptive monitoring strategies

5. CURRENT WATER MONITORING SITUATION IN BOSNIA AND HERZEGOVINA

5.1. Legal and Institutional Framework – Bosnia and Herzegovina

Bosnia and Herzegovina (BiH) has a **highly decentralised water governance system**, reflecting its constitutional structure. Water management responsibilities are largely assigned to the **two entities** — the Federation of Bosnia and Herzegovina (FBiH) and Republika Srpska (RS) — as well as the **Brčko District**, rather than the state level.

The country is hydrologically divided into two main river basin systems:

- the **Sava River Basin**, and
- the **Adriatic Sea Basin**

Water management planning is thus carried out separately by entities, resulting in a system where:

- RBMPs exist at **entity level**,
- coordination occurs through international river basin bodies (e.g. ISRBC for the Sava),
- and harmonisation with the EU Water Framework Directive (WFD) remains ongoing.

5.1.1. River Basin Management Structure

The river basin management structure in BiH follows a **dual layering**:

Hydrological structure

- Two main basin districts:
 - **Sava River Basin District**
 - **Adriatic River Basin District**

Administrative implementation structure

- **Republika Srpska (RS):**

- Sava River Basin District
- Trebišnjica (Adriatic) Basin District
- **Federation of BiH (FBiH):**
 - Sava Water Area
 - Adriatic Water Area
- **Brčko District:**
 - small territory integrated into basin-level planning

This creates a **fragmented basin management structure**, where:

- each entity prepares its own RBMP or water management plan,
- cross-entity coordination is necessary but not always fully harmonised.

Additionally:

- The Sava River Basin is also covered by an international RBMP coordinated by the International Sava River Basin Commission (ISRBC), providing an important layer of integration across different administrative structures. Bosnia and Herzegovina also participates in the wider Danube River Basin framework under the International Commission for the Protection of the Danube River (ICPDR), which ensures overarching coordination at the basin scale and complements the role of the ISRBC at the sub-basin level.
- In Republika Srpska, water management planning is organised at the level of regional river basin districts (oblasni riječni slivovi – ORS), including the Sava River Basin District and the Trebišnjica (Adriatic) River Basin District. For each of these areas, separate water management plans (equivalent to RBMPs under the WFD framework) are prepared.
- While the term RBMP is used in this document for consistency with the WFD framework, it should be noted that planning documents in Republika Srpska are formally structured as plans for regional river basin districts in accordance with its legislation.

5.1.2. Institutional Responsibilities

Water management responsibilities in Bosnia and Herzegovina are predominantly decentralised and assigned to entity-level institutions, with limited coordination at the state level.

Republika Srpska (RS)

The **Ministry of Agriculture, Forestry and Water Management of Republika Srpska** is responsible for the development of water policies, preparation of legislation, and the approval of River Basin Management Plans (RBMPs). It provides the strategic and regulatory framework for water management within the entity.

The **Public Institution “Waters of Srpska”** acts as the main technical authority for water management. Its responsibilities include the preparation of RBMPs, implementation of water monitoring programmes, collection and management of water-related data, and

support in assessing the status of water bodies. In practice, RBMPs in RS are prepared by this institution and subsequently adopted by the Government of Republika Srpska.

Federation of Bosnia and Herzegovina (FBiH)

The **Federal Ministry of Agriculture, Water Management and Forestry** is responsible for the overall coordination of water management, including strategic planning, policy development, and legislative framework within the Federation.

Operational responsibilities are delegated to two river basin agencies:

- The **Sava River Basin Agency** is responsible for water management in the Sava basin area, including water monitoring, preparation of RBMPs, and implementation of water protection and management measures.
- The **Adriatic Sea Watershed Agency** performs similar functions for the Adriatic basin, particularly in the Neretva–Trebišnjica catchment, including monitoring, planning, and implementation of measures aimed at achieving good water status.

Brčko District

The **Department for Agriculture, Forestry and Water Management of the Brčko District** is responsible for water management activities at the local level. Its role primarily involves coordination with the competent institutions of both entities in relation to planning, monitoring, and implementation of measures.

State Level

At the state level, Bosnia and Herzegovina has a limited role in direct water management. State institutions are primarily responsible for coordination between entities, participation in international river basin cooperation (such as the Danube and Sava basins), and supporting the harmonisation of legislation with European Union requirements. Direct operational responsibilities for water management remain at the entity level.

5.1.3. Legal Framework

The legal framework governing water management in Bosnia and Herzegovina is characterised by a **decentralised structure**, reflecting the country's constitutional organisation. Legislative competencies are primarily assigned to the two entities—Republika Srpska (RS) and the Federation of Bosnia and Herzegovina (FBiH)—while the state level retains a limited coordinating role. Consequently, water legislation is developed and implemented separately within each entity, although both frameworks are progressively aligned with European Union (EU) requirements.

Entity-Level Legislation

In **Republika Srpska**, the legal framework is based on the **Law on Waters** (*Zakon o vodama Republike Srpske*, Official Gazette of RS, No. 50/06 and subsequent amendments), which establishes principles of integrated water management and defines river basin districts as

the primary planning units. The law mandates the preparation of River Basin Management Plans (RBMPs), regulates monitoring obligations, and incorporates the key principles of the EU Water Framework Directive (WFD), including achieving good status and preventing deterioration of water bodies. In Republika Srpska, strategic planning in the water sector is guided by the Strategy of Integrated Water Management of Republika Srpska (2015–2024), which defines long-term objectives for water resource management, institutional organisation, and sector development.

In the **Federation of Bosnia and Herzegovina**, water management is regulated by the **Water Law (F BiH)** (*Zakon o vodama Federacije BiH*, Official Gazette of FBiH, No. 70/06), which established basin-based management aligned with EU principles and introduced the requirement for RBMPs and monitoring systems. The legal framework is further supported by numerous secondary regulations (by-laws, ordinances, and decisions), developed to facilitate the transposition of EU water directives.

A key recent development is the adoption of the **Water Management Strategy of the Federation of BiH 2022–2032**, formally adopted by the Parliament of the Federation of BiH in 2023. The Strategy is legally mandated under Article 24 of the Water Law (F BiH, OG FBiH 70/06) and forms part of the Environmental Protection Strategy of FBiH (2022–2032).

Alignment with European Union Legislation

The legal framework in both entities is strongly driven by alignment with the **EU Water Framework Directive (2000/60/EC)**, which establishes an integrated river basin management approach. This includes requirements for:

- delineation and classification of water bodies,
- establishment of monitoring systems,
- preparation and periodic update of RBMPs, and
- implementation of programmes of measures.

In addition to the WFD, the framework incorporates key EU directives, including:

- **Urban Wastewater Treatment Directive (91/271/EEC)**
- **Drinking Water Directive (98/83/EC; updated by Directive (EU) 2020/2184)**
- **Groundwater Directive (2006/118/EC)**
- **Nitrates Directive (91/676/EEC)**
- **Floods Directive (2007/60/EC)**

The Water Strategy 2022–2032 highlights that **transposition is still incomplete**, with varying levels of implementation depending on the directive. While some directives are largely transposed, others remain only partially implemented.

At this point, the recently passed **Directive 2026/805** that amends the WFD, the Groundwater Directive, and the EQS Directive needs to be mentioned. Among other things, this amendment expands and revises priority substances, adds certain emerging pollutants and introduces stricter threshold values and should be considered for further implementation.

5.1.4. Observations and Considerations

The legal framework for water management in Bosnia and Herzegovina is well established and **formally aligned with EU water legislation**, particularly the Water Framework Directive. The **Water Management Strategy 2022–2032** strengthens this framework by providing a clear strategic direction and emphasising monitoring, data management, and implementation capacity.

However, key challenges remain, including:

- incomplete transposition of EU directives,
- insufficient monitoring system implementation, and
- fragmentation of legal and institutional structures.

These limitations directly affect the effectiveness of RBMPs and the achievement of environmental objectives under the WFD.

5.2. Human Resources and Capacity Requirements – Biological Monitoring

5.2.1. General Principles

To ensure successful implementation of WFD-compliant biological monitoring, **trained and experienced experts are essential**. Monitoring teams must be capable of covering all Biological Quality Elements (BQEs) and supporting hydromorphological assessments in accordance with **Annex V requirements**.

The staffing levels presented below represent **minimum requirements per sampling campaign**. Field teams should consist of **at least two persons** to ensure safety, quality control, and validation of results. Efforts should be made to promote **gender balance** in staffing.

5.2.2. Minimum Staffing Requirements per Biological Quality Element

Table 7: Minimum staffing requirements per BQE.

Biological Quality Element	Number of Staff	Prerequisites
MZB (macrozoobenthos)	3 (min. two hydrobiologists + one chemist)	Coverage of all macroinvertebrate groups at required taxonomic resolution; strong coordination between field and laboratory; chemist responsible for physico-chemical measurements
PHB / PHP (phytobenthos, phytoplankton)	1	Experienced algae specialist (especially diatoms); laboratory capacity required for chlorophyll-a analysis

MAC (macrophytes)	1	Specialist in aquatic vegetation; diving skills may be required depending on site conditions
FIS (fish)	4 (1 expert + 3 trained staff)	Expertise in river-type-specific sampling methods (e.g. electrofishing); high level of experience required, particularly in large rivers
HYMO (hydromorphology)	2	One expert in hydrology and one expert in morphology; understanding of river processes and habitat structure

Abbreviations: MZB = macrozoobenthos (invertebrates); PHB = phytobenthos (diatoms); PHP = phytoplankton; MAC = macrophytes; FIS = fish; HYMO = hydromorphology

5.2.3. Competence and Qualification Requirements

- Staff must have **relevant academic backgrounds** (e.g. hydrobiology, ecology, environmental sciences, chemistry)
- Taxonomic expertise is critical, particularly for:
 - macroinvertebrates
 - diatoms
 - macrophytes
 - fish fauna
- Laboratories must be equipped and staffed for **specialised analyses**, including chlorophyll-a and biological sample processing
- Competence must be aligned with **intercalibration requirements** and WFD classification systems

5.2.4. Training and Capacity Development

- Continuous **professional development and training programmes** are essential to maintain and upgrade skills
- Institutions should establish **formal internal and external training plans**, with proper documentation
- Regular participation in:
 - interlaboratory comparisons
 - intercalibration exercises
- Training should specifically address **RBMP-identified gaps**, including:
 - limited biological datasets
 - insufficient taxonomic resolution
 - inconsistent application of methods

5.2.5. Organisational and Institutional Requirements

- Monitoring activities should be **centrally coordinated** to avoid fragmentation and ensure consistency
- Clear **roles, responsibilities, and job descriptions** are required
- Regular communication and exchange between field teams, laboratories, and data managers is essential
- Monitoring responsibilities should not be treated as secondary tasks but require **dedicated staff and structures**

5.2.6. Staff Retention and Workforce Planning

- Adequate remuneration is necessary to attract and retain qualified staff
- High levels of motivation should be supported through:
 - clear task definition
 - recognition of expertise
 - career development opportunities
- Forward-looking workforce planning is required to:
 - ensure balanced staffing
 - avoid loss of expertise
 - promote recruitment of young professionals

5.3. Human Resources and Capacity Requirements – Chemical Status Assessment

5.3.1. Required Functions and Roles

Chemical status assessment under the WFD requires a combination of **field sampling staff, laboratory analysts, QA/QC specialists, and data experts**. Minimum functional roles include:

- **Sampling teams (2–3 persons per campaign):**
 - Trained technicians for water, sediment, and biota sampling
 - Knowledge of WFD-compliant sampling protocols and preservation requirements
- **Laboratory analysts:**
 - Chemists specialised in trace analysis of Priority Substances
 - Expertise in organic and inorganic pollutant analysis (e.g. metals, pesticides, PAHs)
- **Instrumentation specialists:**
 - Operation and maintenance of advanced analytical equipment (e.g. GC-MS, LC-MS/MS, ICP-MS)
- **QA/QC officers:**
 - Oversight of quality systems, calibration, validation, and interlaboratory comparisons
- **Data management and assessment experts:**

- Processing of analytical results
- Compliance checking against Environmental Quality Standards (EQS)
- Preparation of WISE-compatible datasets

5.3.2. Competence and Laboratory Requirements

- Laboratories must achieve and maintain **accreditation (e.g. ISO/IEC 17025)**
- Analytical methods must meet **WFD performance criteria**, including:
 - limits of quantification below EQS values
 - validated and standardised methods
- alternatively, collaboration with regional and beyond regional laboratories should be considered to overcome limitations
- Staff must be trained in:
 - trace-level chemical analysis
 - sampling and preservation techniques
 - uncertainty estimation and quality control

5.3.3. Equipment and Technical Capacity

- Adequate infrastructure is required, including:
 - advanced analytical instruments (GC-MS, LC-MS/MS, ICP-MS)
 - laboratory information management systems (LIMS)
- Capacity for **biota and sediment analysis** must be ensured, not only water samples
- Regular calibration and maintenance of equipment is essential

5.3.4. Training and Quality Assurance

- Continuous **training in analytical methods and QA/QC procedures** is required
- Mandatory participation in:
 - interlaboratory comparison exercises
 - proficiency testing schemes
- Training should target RBMP-identified weaknesses, including:
 - incomplete monitoring of Priority Substances
 - insufficient detection limits
 - inconsistent QA/QC application

5.3.5. Organisational Considerations

- Chemical monitoring should be **institutionalised and not project-based** and sustainably budgeted
- Strong coordination between:
 - sampling teams

- laboratories
- competent authorities
- Clear workflows are required from sampling to reporting to ensure **data traceability and compliance**

6. GAP ANALYSIS VS. EU REQUIREMENTS (WFD IMPLEMENTATION ROADMAP)

6.1. Purpose of the Gap Analysis

This section provides a structured comparison between the **target state defined by this MDP (Phases 1–6)** and the **current status of surface water monitoring in Bosnia and Herzegovina**.

The analysis identifies key gaps and translates them into **priority actions**, forming a practical implementation roadmap toward WFD compliance.

6.2. Phase-by-Phase Gap Overview

Table 8: General gap overview aligned with MDP phases.

MDP Phase	WFD Requirement	Current Status in Bosnia and Herzegovina	Gap Level
Phase 1 — Characterisation	Full typology, pressures, risk assessment	Largely completed through RBMPs (Sava and Adriatic); pressure analysis developed; however based on incomplete and non-harmonised datasets and methodologies	Moderate–High
Phase 2 — Programme Design	WFD-compliant monitoring (BQEs, chemicals, network)	Monitoring programmes established at entity level; strong focus on physico-chemical parameters; biological monitoring and groundwater monitoring remain limited; incomplete network coverage (~55–65%)	High
Phase 3 — Implementation	Regular, systematic monitoring campaigns	Monitoring implemented but spatially incomplete; inconsistent sampling frequency; partly project-based and dependent on external funding; not all water bodies covered	High
Phase 4 — QA/QC & Data	Accredited labs, QA/QC systems, integrated databases	Laboratory capacity exists but QA/QC systems not fully harmonised; data systems fragmented between entities; CISV under development; weak interoperability	High

Phase 5 — Assessment & Reporting	Full classification (EQR, EQS) and WISE reporting	Partial classification of water bodies; assessments often based on limited monitoring or pressure analysis; incomplete datasets prevent full ecological and chemical status classification	Very High
Phase 6 — Adaptive Improvement	Continuous optimisation of monitoring system	Improvements ongoing through strategies and EU-funded projects; system upgrades driven largely by external support rather than internal institutional processes	Medium–High

6.3. Key Systemic Gaps Identified

The gaps reveal that the challenges in implementing the Water Framework Directive (WFD) in Bosnia and Herzegovina are not isolated technical issues, but rather reflect a set of **structural and systemic deficiencies**. These gaps cut across legal, institutional, technical, and financial dimensions and significantly limit the effectiveness of river basin management and monitoring systems.

Fragmented Governance and Institutional Structure

One of the most critical systemic gaps is the **highly fragmented governance structure** of the water sector. Responsibilities are divided between the two entities, cantonal authorities in the Federation of Bosnia and Herzegovina, and the Brčko District, without a unified coordination mechanism. This fragmentation results in **inconsistent implementation of legal and technical requirements, duplication of responsibilities, and limited coordination between institutions**. As highlighted in EU-supported sector analyses, such institutional complexity represents a major barrier to harmonising policies and effectively implementing EU water legislation. In particular, the limited coordination and harmonisation between competent authorities may affect the consistent implementation of WFD requirements at river basin level..

Incomplete and Uneven Monitoring Systems

A second major systemic gap concerns **water monitoring systems**, which remain incomplete and unevenly developed across the country. Although monitoring programmes exist, they cover only a portion of water bodies and are characterised by **limited spatial coverage (approximately 55–65% of surface water bodies), insufficient groundwater monitoring, and incomplete biological and chemical datasets**. Monitoring activities are often concentrated on physico-chemical parameters, while biological quality elements—essential for ecological status classification—are not comprehensively assessed. Furthermore, differences in methodologies and monitoring practices between entities lead to reduced comparability and reliability of results. Consequently, Bosnia and Herzegovina lacks a fully **robust and harmonised monitoring system**, as required under Annex V of the WFD, and this

issue has been identified as a priority in ongoing EU-supported initiatives to strengthen monitoring capacity and data quality.

Weak Data Management and Information Systems

Closely linked to monitoring deficiencies is the **lack of integrated data management and information systems**. Water-related data are currently **fragmented across institutions, stored in separate databases, and characterised by weak interoperability**, which significantly limits their usability. While initiatives such as the Central Information System for Water (CISV) aim to improve data integration and accessibility, these systems are still under development and not yet fully operational. As a result, **data availability remains limited, reporting is inconsistent, and decision-making is frequently based on incomplete or non-harmonised datasets**. This gap directly affects compliance with WFD reporting obligations and reduces the capacity for evidence-based water management.

Limited Implementation Capacity and Financing Constraints

Despite the existence of River Basin Management Plans and clearly defined Programmes of Measures, **implementation remains limited and inefficient**. The relatively low rate of implemented measures reflects **insufficient financial resources, limited institutional and technical capacity, and a strong dependence on externally funded (donor-driven) projects**. Existing funding mechanisms are not sufficient to ensure long-term sustainability, particularly in relation to infrastructure investments and pollution control. Furthermore, weak cost recovery and financial instability within the water services sector further constrain implementation. As a result, many key measures—especially those related to wastewater treatment and reduction of pollution pressures—are either delayed, only partially implemented, or not implemented at all.

Incomplete Legal Harmonisation and Weak Enforcement

Although Bosnia and Herzegovina has made progress in aligning its legislation with EU water directives, the process remains **incomplete and uneven across entities**. Certain directives, particularly those related to groundwater protection and diffuse pollution, are only partially transposed. In addition, even where legal provisions formally exist, **their enforcement is weak due to limited administrative capacity, insufficient inspection systems, and inadequate coordination between competent authorities**. This discrepancy between legal alignment and practical implementation is a recurring finding in Chapter 27 assessments, which emphasise that environmental legislation in Bosnia and Herzegovina is often not effectively applied in practice.

Underdeveloped Water Services Sector and Pollution Pressures

The condition of the water services sector represents another major systemic challenge. The sector is characterised by **high water losses in distribution systems (often exceeding 50%), low wastewater treatment coverage, and the widespread discharge of untreated wastewater into the environment**. These shortcomings result in significant pollution pressures on surface and groundwater bodies and directly hinder the achievement of WFD

environmental objectives. It is estimated that a large proportion of collected wastewater is released without adequate treatment, highlighting the strong link between infrastructure deficits, service inefficiencies, and environmental degradation.

Weak Intersectoral Coordination

Effective implementation of the WFD requires strong integration with other sectors, including agriculture, energy, and spatial planning. In Bosnia and Herzegovina, however, **intersectoral coordination remains limited**, as policies and planning processes are often developed independently without sufficient consideration of their impact on water resources. This results in **conflicting objectives, inefficient use of resources, and reduced effectiveness of water protection measures**, particularly in areas such as hydropower development, land use planning, and agricultural practices.

Overall Assessment

Taken together, these systemic gaps indicate that Bosnia and Herzegovina faces challenges that extend beyond technical implementation and are rooted in **governance, coordination, and institutional capacity limitations**. While the legal and strategic framework is increasingly aligned with EU requirements, practical implementation remains constrained. The most critical deficiencies relate to **fragmented governance, incomplete monitoring systems, and weak implementation of measures**, all of which significantly hinder progress toward achieving WFD objective

6.4. Gap-to-Action Matrix (Priority Measures)

The gap-to-action matrix links the identified systemic gaps to targeted measures and positions them within the WFD implementation cycle. This approach ensures that recommended actions are consistent with the phased development of monitoring systems and river basin management planning.

Table 9: Gap-to-Action Matrix identifying key measures.

Gap Area	Identified Gap (Bosnia and Herzegovina)	Key Measures	Phase Link
Monitoring Programme Implementation	Monitoring programmes exist but are not fully operational; inconsistent spatial coverage and sampling frequency; partial dependence on project-based implementation	<ul style="list-style-type: none"> • Define and implement a fully operational coordinated monitoring programme aligned with WFD requirements • Ensure full coverage of all water bodies and monitoring types (surveillance, operational, investigative) • Establish consistent sampling frequencies across entities • Integrate monitoring programmes into regular institutional mandates 	Phase 2 & Phase 3

Biological Monitoring	Incomplete monitoring of Biological Quality Elements (BQEs); limited expertise and weak taxonomic capacity; biological monitoring not systematically implemented	<ul style="list-style-type: none"> • Develop harmonised standards and methods for all BQEs (fish, macroinvertebrates, macrophytes, phytobenthos) • Strengthen technical capacity through specialist training • Establish regular biological monitoring programmes • Integrate BQEs into routine monitoring and assessment 	Phase 2, Phase 3 & Phase 5
Chemical Monitoring	Limited monitoring of priority substances; lack of data for biota and sediments; inconsistent compliance with environmental quality standards	<ul style="list-style-type: none"> • Expand monitoring to all WFD priority substances and RBSPs • Introduce monitoring of biota and sediment compartments • Upgrade analytical methods to ensure EQS compliance • Harmonise monitoring approaches across entities 	Phase 2 & Phase 3
Laboratory Capacity & QA/QC	Insufficient laboratory capacity; QA/QC systems fragmented and not harmonised; lack of standardisation	<ul style="list-style-type: none"> • Strengthen laboratory infrastructure and analytical capacity • Establish a harmonised QA/QC framework aligned with EU standards • Achieve ISO/IEC accreditation • Implement interlaboratory comparison systems 	Phase 3 & Phase 4
Data Management & VIS	Fragmented data systems; incomplete integration of monitoring data; CISV not fully operational	<ul style="list-style-type: none"> • Fully operationalise the CISV (Water Information System) • Integrate all monitoring datasets into a unified structure • Ensure interoperability between entity-level systems • Develop WISE-compatible reporting • Establish pollutant and pressure registers 	Phase 4 & Phase 5
Status Assessment	Low confidence in status classification; reliance on pressure-based assessment; lack of harmonised tools	<ul style="list-style-type: none"> • Develop harmonised classification methodologies (EQR, EQS) • Improve dataset completeness and monitoring quality • Standardise assessment procedures across entities • Strengthen data-based classification approaches 	Phase 2, Phase 3 & Phase 5
Monitoring Network Design	Limited representativeness and spatial coverage; gaps in groundwater monitoring; lack of harmonisation	<ul style="list-style-type: none"> • Optimise and expand monitoring network • Ensure representative spatial coverage for all water categories • Include reference and pressure-based monitoring sites 	Phase 1 & Phase 2

		<ul style="list-style-type: none"> • Harmonise network design across Sava and Adriatic basins 	
Institutional Capacity & Coordination	Fragmented institutional structure; weak inter-entity coordination; limited human and technical capacity	<ul style="list-style-type: none"> • Establish harmonised WFD coordination mechanism • Strengthen cooperation between entities and agencies • Increase staffing and technical expertise • Define clear institutional roles and operational workflows 	All Phases (1–6)
Sustainability of Monitoring	Monitoring largely project-based; unstable financing; weak integration into public budgets	<ul style="list-style-type: none"> • Ensure long-term funding for monitoring • Integrate monitoring costs into regular budgets • Reduce reliance on donor projects • Introduce cost-recovery mechanisms linked to water services 	All Phases (1–6)

6.5. Conclusions

The gap analysis demonstrates that Bosnia and Herzegovina has made **substantial progress in establishing the formal framework required for Water Framework Directive (WFD) implementation**, particularly in terms of legal transposition, institutional structures, and the preparation of River Basin Management Plans (RBMPs). However, when assessed against the phased monitoring system development outlined in Chapter 4, it becomes evident that implementation remains uneven and constrained by systemic deficiencies.

Overall Position within the WFD Monitoring Phases

With regard to the six monitoring development phases defined in Chapter 4, Bosnia and Herzegovina can be characterised as having **partially completed the initial phases while facing significant challenges in the later stages of implementation**.

In **Phase 1 (Characterisation)**, the country has achieved a relatively advanced level of development. River Basin Districts have been delineated, and pressure and risk analyses have been carried out through existing RBMPs. Nevertheless, these assessments are often based on incomplete datasets and lack harmonisation across entities, which limits their reliability and comparability.

In **Phase 2 (Programme Design)**, monitoring programmes have been formally established, and key elements of WFD-compliant monitoring have been introduced. However, these programmes remain **only partially aligned with WFD requirements**, as they are characterised by insufficient coverage of biological quality elements, incomplete groundwater monitoring, and inconsistencies in design and implementation between administrative units.

The most critical shortcomings emerge in **Phase 3 (Implementation)**, where monitoring activities are not yet fully systematic or comprehensive. Monitoring networks do not cover all water bodies, sampling frequencies are inconsistent, and activities are often dependent on externally funded projects. This indicates that Bosnia and Herzegovina has not yet achieved the level of operational stability required for a fully functioning monitoring system.

Limitations in Data, Quality Assurance, and Assessment

Further challenges are evident in **Phase 4 (QA/QC and Data Management)** and **Phase 5 (Assessment and Reporting)**. Data management systems remain fragmented, with limited integration across institutions and incomplete operationalisation of central information systems such as CISV. Similarly, quality assurance and control procedures are not fully harmonised, and laboratory capacities require further strengthening.

As a consequence of these deficiencies, **Phase 5 represents the most critical gap**, as water status classification is often incomplete or based on indirect assessments rather than robust monitoring data. This results in low confidence in ecological and chemical status assessments and limits the ability to accurately evaluate progress toward WFD environmental objectives.

Adaptive Improvement and System Sustainability

Progress in **Phase 6 (Adaptive Improvement)** is observable, particularly through the adoption of strategic documents such as the Water Management Strategy 2022–2032 and the implementation of EU-supported projects aimed at strengthening monitoring systems and institutional capacity. However, improvements remain largely **externally driven** and are not yet fully embedded within institutional processes.

This highlights a fundamental limitation regarding the **long-term sustainability of the monitoring system**, which is currently affected by unstable financing, limited integration into regular budgets, and insufficient internal capacity for continuous system optimisation.

Key Cross-Cutting Challenges

Across all phases, three overarching issues consistently emerge as the main constraints to effective WFD implementation:

- **Fragmented governance**, which hinders coordination and harmonisation across river basins and administrative levels;
- **Incomplete and inconsistent monitoring systems**, which limit the quality and reliability of data;
- **Weak implementation capacity**, particularly in terms of financing, institutional resources, and technical expertise.

These challenges are closely interrelated and reinforce each other, creating systemic barriers that affect all stages of the monitoring and management cycle.

Final Assessment

In conclusion, Bosnia and Herzegovina can be described as being in a **transitional stage of WFD implementation**, where the foundational elements of the system are largely in place, but operational effectiveness remains limited. While progress in the early phases provides a solid basis for further development, the country must prioritise improvements in monitoring implementation, data integration, and institutional coordination to advance toward full compliance.

Without addressing these critical gaps—particularly in Phases 3 to 5—the ability to achieve the WFD objective of good status for all water bodies will remain significantly constrained. Conversely, targeted improvements in these areas, as outlined in the gap-to-action matrix, have the potential to significantly accelerate progress along the WFD implementation roadmap.

7. ROADMAP 2026–2030 (IMPLEMENTATION PLAN)

The following roadmap translates the identified gaps into a **time-bound implementation plan (2026–2030)** aligned with the WFD planning cycle and the progressive preparation of the next RBMP update cycle.

Table 10: Table of possible Roadmap 2026-2030.

Task	Time-frame	Strategic Focus	Key Actions	Expected Outputs
Task A — System Completion	2026–2027	Finalisation of monitoring design, legal alignment, and harmonised coordination framework	Establish harmonised monitoring programme across entities; define standards for monitoring (BQEs + chemicals); establish coordination mechanism at state level	<ul style="list-style-type: none"> • Adopt/update secondary legislation and monitoring guidelines • Harmonised, WFD-compliant monitoring programme defined • Harmonised QA/QC framework established • Agreed methodologies across Sava and Adriatic basins
Task B — Capacity & Infrastructure Build-up	2026–2027	Strengthening institutional, technical, and laboratory capacity	Recruit and train monitoring experts (biology, chemistry); upgrade laboratory infrastructure; expand monitoring stations (surface + groundwater); improve institutional coordination mechanisms	<ul style="list-style-type: none"> • Strengthened institutional capacity in agencies and ministries • Expanded monitoring network (surface and groundwater) • Operational monitoring teams established • Accredited or partially accredited laboratories • Improved inter-institutional coordination
Task C — Full Monitoring Implementation	2027–2028	Establishment of regular, systematic and harmonised monitoring system	Implement surveillance and operational monitoring campaigns; extend monitoring to biological quality elements and priority substances; introduce consistent sampling frequencies	<ul style="list-style-type: none"> • Monitoring of priority substances in water, sediment, and biota • Regular and harmonised sampling frequencies • Substantially improved spatial and temporal coverage • Complete datasets for ecological and chemical parameters
Task D — Data Integration & Assessment	2028–2029	Data validation, status classification,	Fully operationalise CISV; integrate monitoring data	<ul style="list-style-type: none"> • Fully operational Water Information System (CISV)

		and reporting aligned with EU standards	across entities; apply classification tools (EQR, EQS); establish reporting workflows aligned with WISE	<ul style="list-style-type: none"> • Integrated shared monitoring database • WFD-compliant status assessment (ecological and chemical) • WISE-compatible reporting datasets • Improved evidence base for RBMPs
Task E — RBMP Update & Optimisation	2029–2030	Integration of monitoring results into planning cycle and system optimisation	Use monitoring results to update RBMPs; refine monitoring networks and parameters; introduce advanced monitoring approaches where feasible; improve efficiency and financing	<ul style="list-style-type: none"> • Updated RBMPs based on robust monitoring data • Optimised monitoring network and programme design • Improved cost-efficiency and sustainability of monitoring • Strengthened link between monitoring and decision-making • Secured long-term financing mechanisms

7.1. Link to WFD Planning Cycles

The phased roadmap is aligned with the WFD six-year planning cycle and reflects the current level of development of the monitoring system in Bosnia and Herzegovina:

- **2026–2027:** System completion and capacity-building phase, including harmonisation of monitoring design, institutional strengthening, and initial expansion of monitoring networks
- **2027–2029:** Progressive implementation phase focused on systematic data generation for reliable ecological and chemical status assessment
- **2029–2030:** Consolidation phase, providing input for the next RBMP cycle and fulfilling reporting requirements

If the outlined steps are successfully implemented, Bosnia and Herzegovina could, by the next RBMP update, achieve:

- significantly improved biological and chemical datasets,
- operational and more harmonised monitoring programmes across river basin districts,
- enhanced capacity for WFD-compliant status classification and reporting.

However, achieving these outcomes will depend on addressing key systemic constraints, particularly in terms of institutional coordination, monitoring coverage, and long-term financing.

7.2. Strategic Priorities

To ensure successful implementation of the roadmap, the following strategic priorities must be addressed:

1. **Institutionalisation of monitoring systems**
Transition from project-based monitoring towards stable, institutionally embedded programmes with clearly defined responsibilities.
2. **Strengthening institutional coordination**
Improve cooperation and coordination between entities, river basin agencies, and other relevant authorities to ensure harmonised implementation of WFD requirements.
3. **Investment in human resources and laboratories**
Build technical capacity through training, recruitment, and upgrading of laboratory infrastructure to meet EU standards.
4. **Completion of monitoring coverage**
Ensure comprehensive monitoring of all water bodies, including full implementation of biological quality elements (BQEs), chemical parameters, and groundwater monitoring.
5. **Development of integrated data management systems**
Establish a fully operational and harmonised water information system (CISV), enabling data integration, sharing, and WFD-compliant reporting.
6. **Ensuring sustainable financing of monitoring systems**
Secure long-term funding mechanisms and integrate monitoring costs into regular public budgets to reduce dependence on externally funded projects.

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