



Environmental Protection of International River Basins Project
Contract No. ENPI/2011/279-666

Surface Waters Monitoring Programme
in the Akhuryan River basin

Armenia

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1. INTRODUCTION

The two key environmental objectives of the Water Framework Directive (Directive 2000/60/EC; WFD) for surface waters are:

- to prevent deterioration of the status of all bodies of surface water;
- achieving good surface water status.

The status of surface waters is determined by both its *ecological* status and its *chemical* status.

Monitoring programmes and assessment is required in order to substantiate where the objectives are achieved. The surface water monitoring programme for the pilot Akhuryan River basin covers:

- surface water categories: rivers and lakes;
- the protected areas as defined in Article 6 of the WFD;
- artificial and heavily modified water bodies.

The structure and content of this monitoring programme represents the outcome of the activities conducted under the EPIRB Project as part of the River Basin Management Plans for the Akhuryan River basin.

2. DEVELOPMENT OF A WFD COMPLIANT MONITORING PROGRAMME

The monitoring programme outlined here is designed to meet the stated requirements of the WFD and related CIS Guidance Documents. The WFD sets out three types of monitoring programmes: surveillance, operational and investigative. These programmes will be explained further in the sections below.

In the process of monitoring programme development the data and information from the JFS-I, JFS-II and national monitoring programmes conducted in the Akhuryan River basin were used. Furthermore, the Typology Report, the Pressure – Impact Analysis and Risk Assessment Reports were used as basic documents in selecting the sampling locations for the Operational Monitoring.

2.1 Surveillance Monitoring Programme of Surface Waters

The objectives of Surveillance Monitoring (SM) Programme for surface water are as follows:

- supplementing and validating the impact assessment procedure detailed in Annex II of the WFD,
- the efficient and effective design of future monitoring programmes,
- the assessment of long-term changes in natural conditions, and
- the assessment of long-term changes resulting from significant anthropogenic activities.

2.1.1 Sampling locations

The selection of sampling locations and the design of the SM programme is based on sub-networks each related to fulfil one or more of the main objectives of SM as presented above. The sub-networks of the SM programme for rivers and lakes include the following ones:

- **SM1:** to be representative of the overall surface water status;
- **SM2:** detection of long-term trends (the assessment of long-term changes in natural conditions and the assessment of long-term changes resulting from the anthropogenic activities);
- **SM3:** supplementing and validating risk assessments;
- **SM4:** Large rivers and significant cross border river and lakes water bodies.

Note: Three types of the surface water bodies were identified in the Akhuryan River basin. At least one sampling location to be representative (macroinvertebrates) for each water body type (reference conditions sampling location) is included in the SM programme (see Fig. 1).

Table 1 Surveillance Monitoring sampling locations in the Akhuryan River basin for river waterbodies

No.	River name	Character of WB	Expected status/potential	Location name	Risk category	SM sub-network
1	Eghnadjur	NWB	RC I	Garnarich Village before Lake Arpi	NR	SM1
2	Artikdjur	NWB	RC I	above Artik	NR	SM1
3	Akhuryan	NWB	RC II	above Gyumri City	NR	SM1
4	Metsamor	NWB	RC III	Gai Village	NR	SM2
5	Akhuryan	NWB	Moderate	near to Krasar Village	R	SM3
6	Tsaghkashen	NWB	Good	Saragyugh Village	NR	SM1
7	Akhuryan	NWB	Poor	below Amasia	R	SM2
8	Metsamor	NWB	Bad	Border	R	SM4
9	Lake Arpi	HMWB	High	shore and close to dam	NR	SM3
10	Akhuryan reservoir	HMWB	Good	shore and close to dam	PR	SM4

NWB means Natural Water Body

All together 10 sampling locations (8 on rivers and 2 on lakes) were identified to be monitored under the SM programme for the Akhuryan River basin and results are summarized in the Table 3. In the Akhuryan River basin there are no natural lakes. However, two sampling locations was selected for the SM programme for lakes.

The sampling locations for the SM programme of the Akhuryan River basin are shown on the Figure 1 and detailed information is presented in Appendix 1 (rivers).

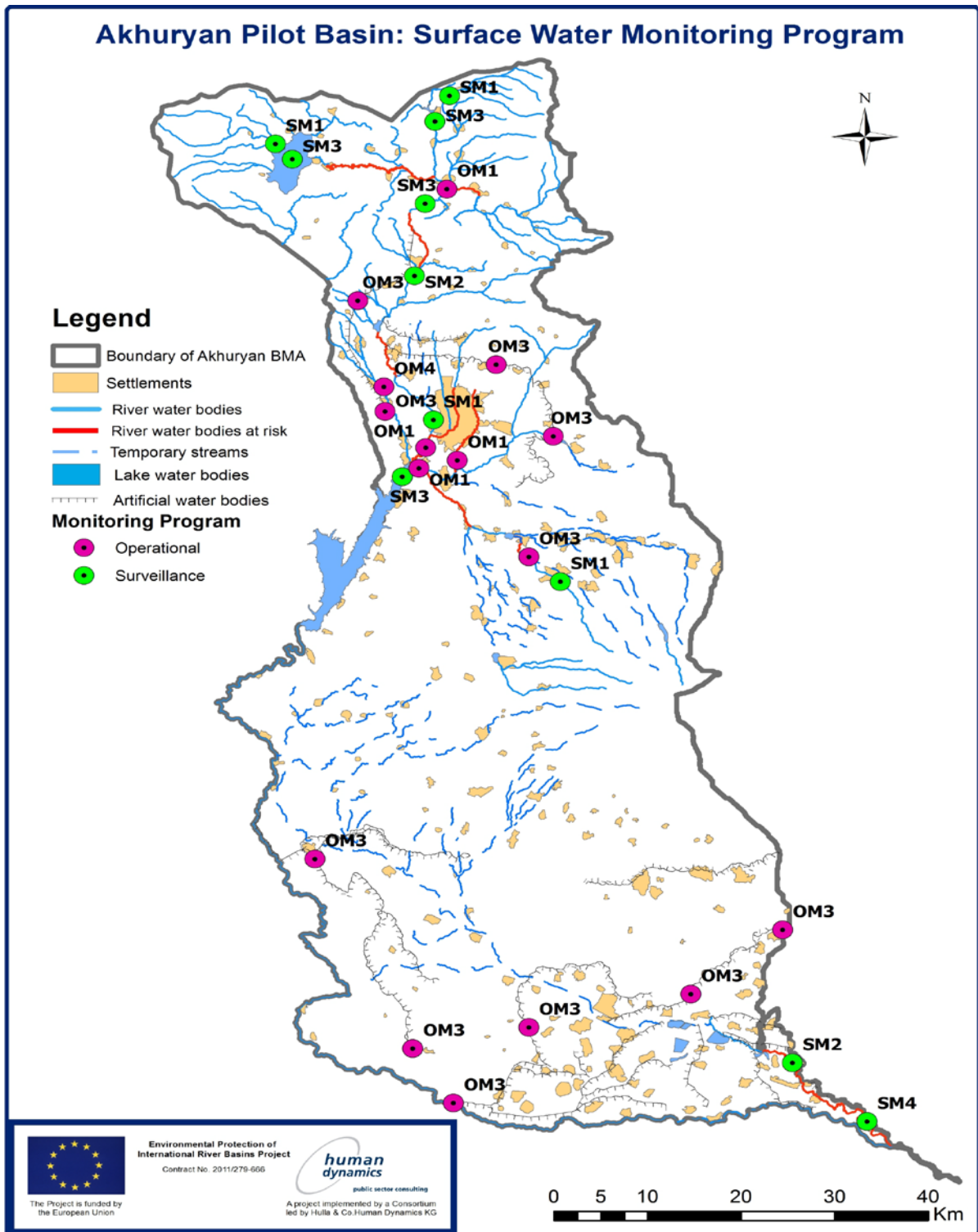


Figure 1 Sampling locations for the Surface Water Monitoring Programme in the Akhuryan pilot river basin.

2.1.2 Quality Elements

According to WFD Annex V.1.3.1, Surveillance Monitoring Programme shall be performed at each selected surveillance monitoring location for a period covered by a RBMP for (see Table 2 and Table 5 for lakes):

- parameters indicative of all biological quality elements;
- parameters indicative of all hydromorphological quality elements;
- parameters indicative of all general physico-chemical quality elements;
- priority list pollutants which are discharged into the river basin or sub-basin;
- other specific pollutants discharged in significant quantities in the river basin or sub-basin (pilot river basin specific pollutants).

Note: Quality elements of the SM programme for lakes will be the same as for the Operational Monitoring programme for lakes, only Priority Substances and Certain other Pollutants will be added.

Sampling methods and devices based on the European Standards will be used in the monitoring programmes (exception ichthyofauna).

The **biological quality elements** incorporate for rivers:

Macroinvertebrates, Phytobenthos, Macrophytes and Fish;

for lakes:

Macroinvertebrates, Phytoplankton, Macrophytes and Fish.

The water samples will be identified for the abundance and composition for all biological quality elements up to Genus/Species level. Individual metrics (indices) will be applied to the biological quality elements (for ichthyofauna only migratory fish species will be described).

The **physico-chemical quality elements** include for both rivers and lakes:

General conditions;

Specific both synthetic and non synthetic pollutants.

EN, ISO and other international standards will be applied for the analysis of the water samples.

The **hydromorphological quality elements** will incorporate the following elements:

Hydrological regime;

River continuity;

Morphological conditions.

Hydromorphological field and assessment protocols as used during the JFS in the EPIRB project will be applied.

Table 2 List of the quality elements monitored for the Surveillance Monitoring Programme in the Akhuryan River basin (rivers)

	Parameter	Unit	SM
Physico-chemical Quality Elements			
General conditions			
	Temperature	°C	X
	Dissolved Oxygen	mgO ₂ /l	X
	pH	pH units	X
	Conductivity	µS/cm	X
	Hardness	mg/l CaCO ₃	X
	Colour	visual	X
	o-Phosphate	mg P/l	X
	Nitrate	mg N/l	X
	Ammonium	mg N/l	X
	Chloride	mg/l	X
	Sulphate	mg/l	X
	Total suspended solids	mg/l	X
	Biochemical oxygen demand (BOD ₅)	mgO ₂ /l	X
	Chemical oxygen demand (COD - dichromate)	mgO ₂ /l	X
	Oil substances	visual	X
Other specific pollutants			
	Manganese	mg/l	X
	Strontium	µg/l	X
	Molybdenum	µg/l	X
	Antimony	µg/l	X
	Arsenic	µg/l	X
	Chrome	µg/l	X
	Copper	µg/l	X
Priority Substances and Certain Other Pollutants			
All 'Priority substances and certain other pollutants' that can be analysed with the existing laboratory capacity		µg/l	X
Biological Quality Elements			
	Macroinvertebrates	Metrics	X
	Macrophytes*	Metrics	X
	Phytobenthos	Metrics	X
	Fish	Migratory fish species	X
Hydromorphological Quality Elements			
	River morphological conditions and continuity	HM protocols	X
	River flow	Daily Mean Flow (m ³ /s)	X

* *Macrophytes will be only monitored in the Metsamor River sub-basin*

For more details see also the Appendix 1 of this report.

2.2 Operational Monitoring of Surface Waters

The Operational Monitoring (OM) Programme is focussed on monitoring the effect of supporting measures aimed at achieving the objectives of the WFD in the water bodies (possibly) at risk. It is designed to provide targeted information on the effectiveness of specific measures taken within the Akhuryan River basin.

The objectives of OM programme are defined as follows:

- to establish the status of those bodies identified as being at risk of failing to meet their environmental objectives;
- to assess any changes in the status of such bodies resulting from the programmes of measures.

Because the protection of high and good status from deterioration is required by the WFD, OM programme must also provide information on whether the POMs, aimed at maintaining such status, are effective. Therefore, even water bodies that are not categorized to be at risk in the Risk Assessment Report prepared are included in the OM programme because measures are required to maintain them at their current high or good status regardless of existing risk category.

Risk Assessment Analysis has identified 10 water bodies “at risk” and 4 ones “possible at risk” in the Akhuryan River basin. These results were transferred into the OM programme.

2.2.1 Sampling locations

Sampling locations for OM programme are assigned to one or more sub-networks each related to fulfil one or more of the main objectives of the OM programme.

The sub-networks of the OM programme for rivers and lakes include the following ones:

- OM1: to assess the effect of measures that have been aimed at improving the impact of individual and combined point sources (organic pollution, eutrophication impacts and priority substances);
- OM2: to assess effectiveness of the measures related to diffuse pollution sources;
- OM3: To assess effectiveness of measures to reduce hydromorphological alterations;
- OM4: To monitor high and good status sites currently not categorized to be at risk in order to assess the effectiveness of POMs aimed at maintaining high and good status water bodies;
- OM5: to monitor protected areas which are at risk.

Note: Several water bodies with the same type were identified to be “at risk” due to the same pressure type (point sources of pollution). Therefore, some of sampling locations for the OM programme were selected to be representative for the group of water bodies.

All together 18 sampling locations were identified to be monitored under the OM for the Akhuryan River basin and results are summarized in the Table 3. Ten of the sampling locations are situated in the AWBs (irrigation canals), six of them on the rivers and two on lakes (reservoirs).

Table 3 Operational Monitoring sampling locations in the Akhuryan River basin

No.	River name	Character of WB	Expected status/potential	Location name	Risk category	OM sub-network
1	Akhuryan	WB	Bad	below Gyumri City	R	OM1
2	Karmrakar	WB	Poor	below Gyumri City	R	OM1
3	Karkachun	WB	Poor	Mouth of Karkachun	NR	OM1
4	Haykavan	WB	Good	Voghchi Village	R	OM4
5	Artikdjur	WB	Poor	below Artik	R	OM3
6	Ashotsk	WB	Poor	Mouth of Ashotsk	R	OM1
7	Akhuryan main canal middle	AWB*	Poor	Near Getashen village	R	OM3
8	Akhuryan main canal end	AWB*	Poor	Near Haykavan village	R	OM3
9	Shirak main canal middle	AWB*	Poor	Near Hatzik village	R	OM3
10	Shirak main canal end	AWB*	Poor	Karnut village	R	OM3
11	Talin main canal middle	AWB*	Poor	Near Aragatsavan village	R	OM3
12	Talin main canal end	AWB*	Poor	Near Vanand village	R	OM3
13	Lower Hrazdan canal middle	AWB*	Poor	Metsamor town	R	OM3
14	Lower Hrazdan canal end	AWB*	Poor	Near Aghavnatun village	R	OM3
15	Armavir main canal middle	AWB*	Poor	Near Lenughi village	R	OM3
16	Armavir main canal end	AWB*	Poor	Near the state border	R	OM3
17	Karnut reservoir	HMWB	Moderate	shore and close to dam	PR	OM2
18	Sarnaghbyur reservoir	HMWB	Moderate	shore and close to dam	PR	OM2

* AWB – Artificial Water Body

The sampling locations for the OM programme of the Akhuryan River basin are shown on the Figure 1 and detailed information is presented in Appendix 1 (rivers) and Appendix 2 (lakes).

2.2.2 Quality Elements

In order to assess the magnitude of the pressure to which the surface water bodies are exposed in the Akuryan River basin those quality elements are monitored that are indicative of the identified pressures. The following quality elements will be monitored as relevant (see Table 4 and 5):

- parameters indicative of the biological quality elements, most sensitive to the pressures to which the water bodies are subject;
- all other specific pollutants discharged in significant quantities into the river basin or sub-basin;
- parameters indicative of the hydromorphological quality elements most sensitive to the pressure identified.

Table 4 List of the quality elements monitored for the Operational Monitoring Programme in the Akhuryan River basin (rivers)

	<i>Parameter</i>	<i>Unit</i>	<i>OM</i>
Physico-chemical Quality Elements			
General conditions			
	Temperature* – in situ	°C	X
	Dissolved Oxygen* – in situ	mgO ₂ /l	X
	pH* – in situ	pH units	X
	Conductivity* – in situ	µS/cm	X
	Hardness	mg/l CaCO ₃	X
	Colour – in situ	visual	X
	o-Phosphate*	mg P/l	X
	Nitrate*	mg N/l	X
	Ammonium*	mg N/l	X
	Chloride	mg/l	X
	Sulphate	mg/l	X
	Total suspended solids	mg/l	X
	Biochemical oxygen demand (BOD ₅)	mgO ₂ /l	X
	Chemical oxygen demand (COD - dichromate)	mgO ₂ /l	X
	Oil substances – in situ	visual	X
Other specific pollutants***			
	Manganese**	mg/l	X
	Strontium	µg/l	X
	Molybdenum	µg/l	X
	Antimony	µg/l	X
	Arsenic**	µg/l	X
	Chrome**	µg/l	X
	Copper	µg/l	X
Biological Quality Elements			

	Chlorophyll* a	mg/m ³	X
	Macroinvertebrates	Metrics	X
	Macrophytes*	Metrics	X
Hydromorphological Quality Elements			
	River flow	Daily Mean Flow (m ³ /s)	X

* For the AWBs only these parameters will be monitored

** will be monitored for Ashotsk water body

*** all other specific pollutants will be only monitored for Karkachun water body

For more details see also the Appendix 1 of this report.

Table 5 List of the quality elements monitored for the Operational Monitoring Programme in the Akhuryan River basin (lakes)

	Parameter	Unit	OM
Physico-chemical Quality Elements			
General conditions			
	Temperature	°C	X
	Dissolved Oxygen	mg O ₂ /l	X
	pH	pH units	X
	Conductivity	µS/cm	X
	Colour	visual	X
	Total Phosphorus	mg P/l	X
	Total Nitrogen	mg N/l	X
	Hardness	mg/l CaCO ₃	X
	Alkalinity	mg/l CaCO ₃	X
	Ammonium	mg N/l	X
	Chloride	mg/l	X
	Sulphate	mg/l	X
	Calcium	mg/l	X
	Sodium	mg/l	X
	Magnesium	mg/l	X
	Silica	mg/l	X
	Secchi disc	m	X
	Biochemical oxygen demand (BOD ₅)	mgO ₂ /l	X
	Chemical oxygen demand (COD - dichromate)	mgO ₂ /l	X
	Depth at site	m	X
Other specific pollutants			
	Manganese	mg/l	X
	Strontium	µg/l	X
	Molybdenum	µg/l	X
	Antimony	µg/l	X
	Arsenic	µg/l	X
	Chrome	µg/l	X
Biological Quality Elements			

	Chlorophyll a	mg/m ³	X
	Macroinvertebrates	Metrics	X
	Macrophytes	Metrics	X
Hydromorphological Quality Elements			
	River flow (inflow and outflow)	Daily Mean Flow (m ³ /s)	X

For more details see also the Appendix 2 of this report.

2.3 Investigative monitoring

The WFD includes a third type of monitoring called Investigative Monitoring (IM). The WFD states that this type of monitoring is required for situations when the surface water body is at risk with a very specific manner that causes of water bodies failing to achieve the required environmental objectives under the WFD. The list of parameters in this case will be dynamic and its validity in time should be limited, in order to respond to new information on the potential risks posed by emerging pollutants and any others alterations. However, it is not expected to conduct the IM in the Akhuryan River basin in this stage of the monitoring programme.

2.4 Frequency of monitoring programme

Sample frequency will vary depending on the monitoring programme and the individual sub-networks and the quality element. The WFD outlines the minimum requirements for frequency of monitoring, as it is presented in Table 6.

Table 6 Monitoring frequencies according to WFD Annex V.1.3.4

	Rivers	Lakes
Biological quality elements		
Phytoplankton	6 months	6 months
Other aquatic flora	3 years	3 years
Benthic invertebrate fauna	3 years	3 years
Fish	3 years	3 years
Hydromorphological quality elements		
Continuity	6 years	
Hydrology	continuous	1 month
Morphology	6 years	6 years
Physico-chemical quality elements		
Thermal conditions	3 months	3 months
Oxygenation	3 months	3 months
Salinity	3 months	3 months
Nutrient status	3 months	3 months
Acidification status	3 months	3 months
Other pollutants	3 months	3 months
Priority substances	1 month	1 month

Long-term trend monitoring locations will require high frequency sampling. The sites required for supplementing and validating the risk assessment will be monitored with

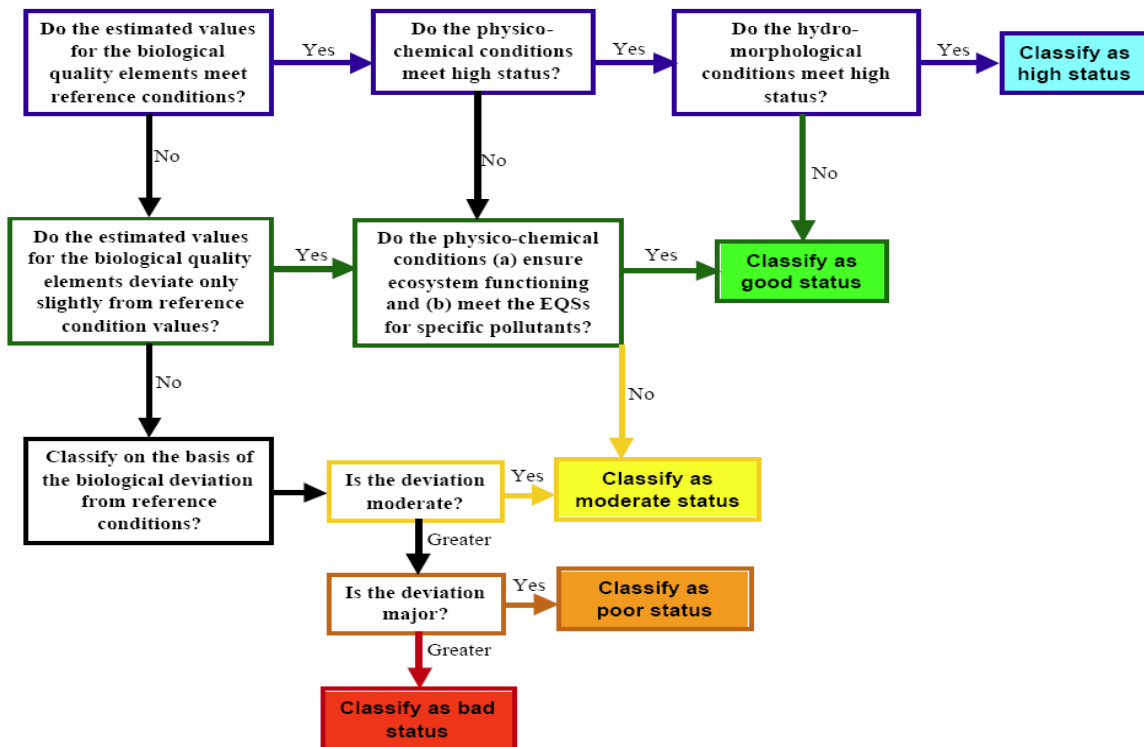
different frequencies depending on the importance of the risk, details of the frequency of monitoring required for each of the individual river sub-networks are given in Appendix 1_EPIRB_River_MP_Akhuyan.

3. QUALITY CONTROL AND QUALITY ASSURANCE

It is important for the surface water monitoring programme to ensure that data generated by WFD physico-chemical and biological monitoring parts are reliable and representative. Furthermore, as it is known a data should allow the assessment of the impacts of Programs of Measures on the water body status. Therefore, Quality Management Programme should be prepared for all steps of the monitoring programme from sampling via analysis to the data management and interpretation. It is expected that sampling and analysis (physico-chemical and biological quality elements) will be conducted in accordance with ISO Standards (other International Standards) and laboratories will meet the requirements of the ISO 17025 Standard.

4. ECOLOGICAL STATUS ASSESSMENT

The WFD defines ecological status in the high, good and moderate classes for each of the ecological quality element for each of the surface water categories (WFD Annex V, 1.2). It describes the biological, hydromorphological elements and the physico-chemical and other specific pollutants required in the overall ecological assessment. The overall ecological status assessment is shown on the scheme below.



All biological quality elements will be taken into account when assigning water bodies to any of the ecological status or ecological potential classes. For each biological element the set of the metrics (or indices) will be selected to be indicative for the given pressures. The status of

each of the biological elements for natural water bodies is determined by measuring the extent of the deviation, if any, of the observed condition from the **reference condition** established for that type of water body.

Ecological status assessment system will be expressed numerically as *ecological quality ratios* (EQR) in the range between 1 (high status) and 0 (bad status). The EQR scale for the assessment system for each surface water category will be divided into the five classes by assigning a numerical value to each of the boundaries between the classes.

The physico-chemical and hydromorphological quality elements are supporting elements of the biological assessment for the purpose of the overall ecological status assessment. Therefore, based on the existing data from the JFS and national monitoring programmes statistical analysis will be conducted to estimate the numerical boundary for the ecological status classes. This will be conducted only for the macroinvertebrates due to fact that for other biological quality elements there are not data available.

5. CHEMICAL STATUS ASSESSMENT

The chemical status of surface water bodies is linked with the WFD Annex X pollutants. The latest EU directive specifying both the pollutants ('Priority substances and certain other pollutants') and their environmental quality standards (EQS), is the Directive 2013/39/EU "amending Directives 2000/60/EC and 2008/105/EC as regards Priority substances in the field of water policy".

The Directive 2013/39/EU has defined EQSs for in total 45 (groups of) substances, comprising four metals (cadmium, lead, mercury and nickel) and a wide array of organic micropollutants.

In principle, two (complementary) environmental quality standards are defined; both EQSs are to be met in order to qualify as 'good chemical status':

- annual average – environmental quality standard (AA-EQS), applying to the arithmetic mean of one year of data, with monthly sampling presumed;
- maximum concentration – environmental quality standard (MAC-EQS), applying to the maximum concentration in the annual set of data.

Annex 1

Recommended List of Standards and Guidelines

ISO 10870: 2012 Water quality - Guidelines for the selection of sampling methods and devices for benthic macroinvertebrates in fresh waters (ISO 10870:2012).

ISO 5667-1: 2007 – Water quality - Sampling - Part 1: Guidance on the design of sampling programmes and sampling techniques (ISO 5667-1:2006)

ISO 14996: 2007 – Water quality - Guidance on assuring the quality of biological and ecological assessments in the aquatic environment.

ISO 8689-1: 2000 – Water quality - Biological classification of rivers - Part 1: Guidance on the interpretation of biological quality data from surveys of benthic macroinvertebrates. (ISO 8689-1:2000).

ISO 8689-1: 2000 – Water quality - Biological classification of rivers - Part 1: Guidance on the interpretation of biological quality data from surveys of benthic macroinvertebrates. (ISO 8689-1:2000)

ISO 16150:2012 – Water quality - Guidance on pro-rata Multi-Habitat sampling of benthic macro-invertebrates from wadeable rivers.

ISO Project AQEM, 2002. Manual for the application of the AQEM System (Asterics 3.3.1, www.aqem.de)

EC, 2003. Guidance Document No. 7 Monitoring under the Water Framework Directive, Luxembourg: Office for Official Publications of the European Communities.

ISO 15843:2010 Water quality. Guidance standard on determining the degree of modification of river hydromorphology, CEN, 2010.

ISO 14614:2004 Water Quality - Guidance standard for assessing the hydromorphological features of rivers, CEN, 2004.

ISO Water Sampling Standards 5667 (series).

Appendix 1:

EU WFD compliance monitoring for the Akhuryan River basin
List of Quality Elements for rivers
Sampling Frequency for rivers

Appendix 2:

EU WFD compliance monitoring for the Akhuryan River basin
List of Quality Elements for lakes
Sampling Frequency for lakes

EU WFD compliance monitoring for the Akhuryan Pilot Basin (Rivers)

No.	Water body number	River name	Character of water body	Expected status/potential	Location	Latitude	Longitude	Altitude	Area (km2)	Surveillance monitoring sites	Operational monitoring sites	Risk category
1		Eghnadjur	WB	RC I	Garnarich Village before Lake Arpi					1		
2		Artikdjur	WB	RC I	above Artik					1		
3		Akhuryan	WB	RC II	above Gyumri City					1		
4		Metsamor	WB	RC III	Gai Village					1		
5		Akhuryan	WB	Moderate	near to Krasar Village					1		
6		Akhuryan	WB	Bad	below Gyumri City							
7		Tsaghkashen	WB	Good	Saragyugh Village					1		
8		Karmrakar	WB	Poor	below Gyumri City							
9		Karkachun	WB	Poor	Mouth of Karkachun							
10		Haykavan	WB	Good	Voghchi Village							
11		Artikdjur	WB	Poor	below Artik							
12		Ashotsk	WB	Poor	Mouth of Ashotsk							
13		Akhuryan	WB	Poor	below Amasia							
14		Metsamor	WB	Bad	Border					1		
15		Akhuryan main canal middle	AWB	Poor	to be selected							
16		Akhuryan main canal end	AWB	Poor	to be selected							
17		Shirak main canal middle	AWB	Poor	to be selected							
18		Shirak main canal end	AWB	Poor	to be selected							
19		Talin main canal middle	AWB	Poor	to be selected							
20		Talin main canal end	AWB	Poor	to be selected							
21		Lower Hrazdan canal middle	AWB	Poor	to be selected							
22		Lower Hrazdan canal end	AWB	Poor	to be selected							
23		Armavir main canal middle	AWB	Poor	to be selected							
24		Armavir main canal end	AWB	Poor	to be selected							

Note: NR - not at risk
PR - possibly at risk
R - at risk

List of Quality Elements for rivers

			Surveillance monitoring site	Operational monitoring site	Protected Area site
Physico-chemical Quality Elements					
General conditions					
Temperature - in situ	°C	1	1		
Dissolved Oxygen - in situ	mgO ₂ /l	1	1		
pH - in situ	pH units	1	1		
Conductivity - in situ	µS/cm	1	1		
Hardness	mg/l CaCO ₃	1	1		
Colour - in situ	visual	1	1		
o-Phosphate	mg P/l	1	1		
Total Phosphorus	mg P/l				1
Total Nitrogen	mg N/l				1
Nitrate	mg N/l	1	1		
Ammonium	mg N/l	1	1		
Chloride	mg/l	1	1		
Sulphate	mg/l	1	1		
Total suspended solids	mg/l	1	1		
Biochemical oxygen demand (BOD5)	mgO ₂ /l	1	1		
Chemical oxygen demand (COD - dichromide)	mgO ₂ /l	1	1		
Oil Substances - in situ	visual	1	1		
Other specific pollutants discharged in significant quantities (basin specific)*					
Manganese	µg/l	1	1		
Strontium	µg/l	1	1		
Molybdenum	µg/l	1	1		
Antimony	µg/l	1	1		
Arsenic	µg/l	1	1		
Chromium	µg/l	1	1		
Copper	µg/l	1	1		
Priority Substances and Certain Other Pollutants					
<i>All 'Priority substances and certain other pollutants' that can be analysed with the existing laboratory capacity</i>					
	µg/l	1			
Biological Quality Elements					
Macroinvertebrates	Metrics	1	1		
Macrophytes	Metrics		1		
Phytobenthos	Metrics	1	1		
Chlorophyll "a"	µg/l		1		
Fish	Migratory fish species	1			
Hydromorphological Quality Elements					
Morphological Conditions	HM metrics	1	1		
River flow	Daily Mean Flow	1	1		1

Note: In case of AWB (irrigation canals) only macrophytes, chlorophyll "a" and general physico-chemical parameters and hydromorphological quality elements will be monitored. In case of concrete canals only general physico-chemical parameters will be measured. Priority substances and relevant pollutants will be monitored only if there is evidence that they are discharged into the water body.

* to be monitored in water bodies where are discharged in the significant quantities

Sampling Frequency for rivers

Frequencies for Physico-chemical Quality Elements

Operational Monitoring

OM1	Point Pressure	4	times per year for general parameters and other pollutants discharged in significant quantities (basin specific)
OM2	Diffuse Pressure	4	times per year for general parameters and other pollutants discharged in significant quantities (basin specific)
OM3	Hydromorphological	4	times per year for general parameters
OM4	High and Good status	4	times per year for general parameters (However, not all sites in this sub-network require physico-chemical parameters to be monitored)
OM5	Protected areas (habitat)	4	times per year for general parameters

Notes:

These are minimum sampling frequencies and more frequent sampling may be required depending on the confidence and precision required and the particular programme of measures that is being monitored under the Akhuryan Pilot river basin.

Surveillance Monitoring Network

General conditions and other specific pollutants	12	times per year for general parameters
Priority Substances	12	times per year for one year in each 6-year cycle for priority substances
Overall status Sites	12	times per year for general parameters
Long-term Trend Sites	12	times per year for general parameters
Supplementing and Validating the IA	6	times per year for general parameters
Large Rivers and Significant Cross Border RWBs	12	times per year for general parameters

Notes:

As a principle the sub-network with the most frequent requirement should be respected for the sampling frequency

Drinking Water Monitoring Point Frequencies

Frequency
12 times per year

Biological Quality Elements

Surveillance monitoring

	Minimum Frequency	
Macroinvertebrates	2	time per year in each 6-year cycle
Macrophytes	1	time per year in each 6-year cycle
Phytobenthos	1	time per year in each 6-year cycle
Fish	1	time in each 6-year cycle

Operational monitoring

Macroinvertebrates	2	time per year in each 6-year cycle
Macrophytes	1	time per year in each 6-year cycle
Phytobenthos	1	time per year in each 6-year cycle
Fish	1	time in each 6-year cycle

Hydromorphological quality elements

River flow daily	
Morphological conditions	1 time in each 6-year cycle

Note: In case of Cannals AWB, the frequency will be as follows:

General physico-chemical parameters	4	time per year in each 6-year cycle
Chlorophyll a	4	time per year in each 6-year cycle
Macrophytes	1	time per year in each 6-year cycle
Hydromorphological parameters	1	time in each 6-year cycle

EU WFD compliance monitoring for the Akhuryan Pilot Basin (Lakes)

No.	Water category	Lake name	Character of water body	Expected status/potential	Location*	Latitude	Longitude	Altitude	Area (km2)	1 Surveillance monitoring sites	SM1 Overall status	SM2 Long-term trends	SM3 Supplementing and validating IA	Stipulated lakes	Protected areas	Operational monitoring sites	OM 1 Point Source Risk	OM 2 - Diffuse Risk	OM 3 - Hydromorphology	OM 4 - Protect High and Good Status	OM 5 - Habitat Protected Areas at risk	Risk category
1		Lake Arpi	HMWB	High	shore and close to dam				20.59	1												NR
2		Akhuryan reservoir	HMWB	Good	shore and close to dam				48.39	1	1	1										NR
3		Karnut reservoir	HMWB	Moderate	shore and close to dam	43,964953	40,772766		1.64							1		1				PR
4		Sarnaghbyur reservoir	HMWB	Moderate	shore and close to dam	43,896433	40,532149		0.68							1		1				PR

Note: NR - not at risk
PR - possibly at risk
R - at risk

* - two sampling locations per water body

List of parameters to be monitored for lakes

		Surveillance monitoring si	Operational monitoring sit
Physico-chemical Quality Elements			
General conditions			
Temperature - in situ	°C	1	1
Dissolved Oxygen - in situ	mgO ₂ /l	1	1
pH - in situ	pH units	1	1
Conductivity - in situ	µS/cm	1	1
Colour - in situ	visual	1	1
Total Phosphorus	mg P/l	1	1
Total Nitrogen	mg N/l	1	1
Hardness	mg/l CaCO ₃	1	1
Alkalinity	mg/l CaCO ₃	1	1
Ammonium	mg N/l	1	1
Chloride	mg/l	1	1
Sulphate	mg/l	1	
Calcium	mg/l	1	
Sodium	mg/l	1	
Magnesium	mg/l	1	
Silica	mg/l	1	1
Secchi disc - in situ	m	1	1
Biochemical oxygen demand (BOD ₅)	mgO ₂ /l	1	1
Chemical oxygen demand (COD - dichromide)	mgO ₂ /l	1	1
Depth at site	m	1	1
Other specific pollutants discharged in significant quantities (basin specific)			
Manganese	µg/l	1	1
Strontium	µg/l	1	1
Molybdenum	µg/l	1	1
Antimony	µg/l	1	1
Arsenic	µg/l	1	1
Chromium	µg/l	1	1
Priority Substances and Certain Other Pollutants			
<i>All 'Priority substances and certain other pollutants' that can be analysed with the existing laboratory capacity</i>		µg/l	1
Biological Quality Elements			
Phytoplankton	Metrics	1	1
Chlorophyll a	mg/m ³	1	1
Macroinvertebrates	Metrics	1	1
Macrophytes	Metrics	1	1
Fish	Fish Metrics	1	
Hydromorphological Quality Elements			
Morphological Conditions	HM metrics	1	1
Inflow	m ³ /s	1	1
Water level	m	1	1

Sampling Frequency for lakes

Frequencies for Physico-chemical Quality Elements

Operational monitoring

Point Pressure	4	times per year for general parameters and other pollutants discharged in significant quantities (basin specific)
Diffuse Pressure	4	times per year for general parameters and other pollutants discharged in significant quantities (basin specific)
Hydromorphological Pressure	4	times per year for general parameters
High and Good status	4	times per year for general parameters (However, not all sites in this sub-network require physico-chemical parameters to be monitored)
Protected areas (habitat)	4	times per year for general parameters

Notes:

These are minimum sampling frequencies and more frequent sampling may be required depending on the confidence and precision required and the particular programme of measures that is being monitored under the Akhuryan Pilot river basin.

Freshwater Fish Directive Sites	12	times per year for general parameters
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Surveillance monitoring

General conditions and other specific pollutants	12	times per year
Priority Substances	12	times per year for one year in each 6-year cycle for priority substances
Overall status Sites	12	times per year for general parameters
Long-term Trend Sites	12	times per year for general parameters
Supplementing and Validating the IA	12	times per year for general parameters
Stipulated lakes	12	times per year for general parameters
Protected areas	12	times per year for general parameters

Notes:

As a principle the sub-network with the most frequent requirement should be respected for the sampling frequency

Biological Quality Elements

Operational monitoring

	Minimum Frequency	
Phytoplankton	4	times per year in each 6 years cycle as per general physico-chemical parameters
Macroinvertebrates	1	time per year in each 6-year cycle
Macrophytes	1	time per year in each 6-year cycle
Fish		not monitored

Surveillance monitoring

Phytoplankton	4	times per year as per general physico-chemical parameters
Chlorophyll a	4	times per year as per general physico-chemical parameters
Macroinvertebrates	1	time per year in each 6-year cycle
Macrophytes	1	time per year in each 6-year cycle
Fish	1	time per year in each 6-year cycle

Hyrdomorphological quality elements

Inflow and outflow	1	daily
Level of lake	1	daily
Morphological Conditions	1	time in each 6-year cycle