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Chapter 8 Surface Waters

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Chapter 8 Surface Waters

December 2025

The Infrastructure Project Facility (IPF) is a technical assistance instrument of the Western Balkans Investment Framework (WBIF) which is a joint initiative of the European Union, International Financial Institutions, bilateral donors and the governments of the Western Balkans which supports socio-economic development and EU accession across the Western Balkans through the provision of finance and technical assistance for strategic infrastructure investments. This technical assistance operation is financed with EU funds. ***Disclaimer:*** *The authors take full responsibility for the contents of this report. The opinions expressed do not necessarily reflect the view of the European Union or the European Investment Bank.*

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8. Surface waters

8.1 Introduction

This chapter reports findings of the assessment of the impacts of the Project to the surface water environment and flood risk during both the construction and operational phases.

The study area for surface water characterisation and assessment is defined according to potential receptors that may be affected by the Project and the surface water catchment within which the project is located.

The study area typically encompasses surface water featured up to 0.5 km from the Project that have the potential to be affected directly by the proposed works associated with overland migration of pollutants (mainly considered to be sediments) directly to a surface streams. The study also includes surface water features that are in hydraulic connectivity with the study area, such as those downstream that are within 1km of the project that may be affected by indirect impacts (i.e., associated with pollutants that may be conveyed downstream via surface water features or drainage systems).

The assessment of the Project has been undertaken primarily through a desk-based study using available information relating to the existing hydrology of the subject area and potential flood risks on relevant water courses, reports on water quality of main water streams under impact, as well as results of laboratory testing of baseline water quality on samples taken relevant to the location of works. The impacts are assessed analysing the risk of direct impact of construction and operation activities and discharge of pollution in the surface waters.

Where appropriate, this chapter also identified proposed mitigation measures to minimise or control likely adverse effects arising from the project.

This chapter should be read in conjunction with the following chapters:

Chapter 1	Introduction
Chapter 2	About the Project
Chapter 3	Detailed Project Description
Chapter 4	Policy, legislative and institutional context
Chapter 5	Assessment methodology
Chapter 6	Biodiversity
Chapter 7	Ground waters
Chapter 16	Waste and materials management
Chapter 17	Cumulative impacts
Chapter 18	Residual impacts
Chapter 19	ESMP.

8.2 Baseline Conditions

8.2.1 Surface Water Hydrology

Three rivers are identified to be of the importance for the project as main surface water receptors: rivers Neretva, Tresanica and Bijela (Figure 8-1). All three watercourses in the Project area belong to the Adriatic Sea basin. The largest and most important river is Neretva, while Tresanica and Konjicka Bijela are its right and left tributaries, respectively.

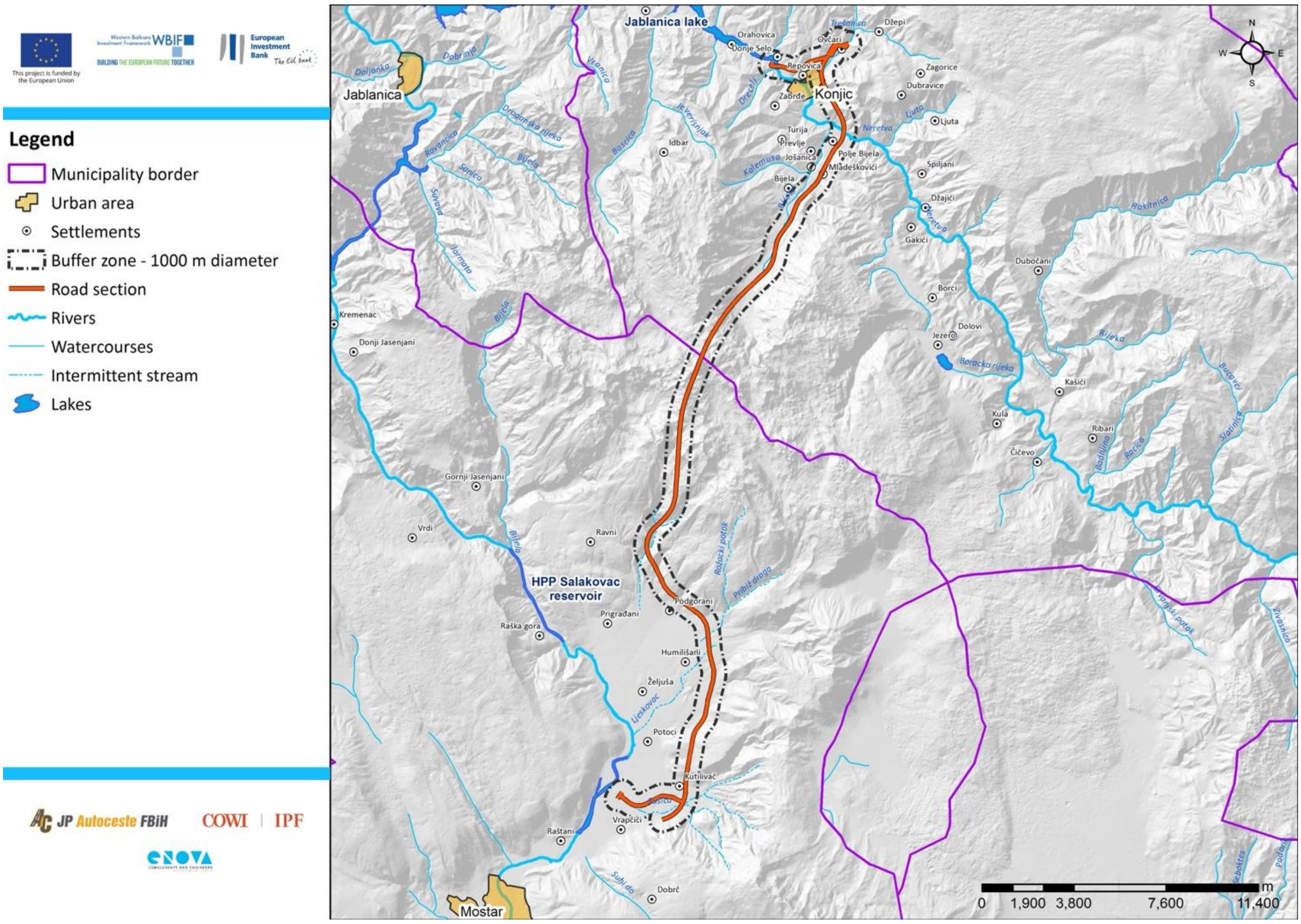

Figure 8-1: Surface streams in the Project area

Tresanica originates under the mountain Bitovnja, then flows in the direction of south toward Konjic where it drains into the Neretva River. Konjicka Bijela originates on the southeast side of the Prenj mountain and flows in the direction of north toward Konjic. After 10 km the river drains into the Neretva River at the location of Hadzica polje.

Number of smaller intermittent streams of seasonal character are identified in the project area. On the Konjic side, Suhi potok creek forms the upper stream of Konjicka Bijela. On the Mostar side Susica, Pribiz draga, Rozacki Potok, Ljeskovac are identified in the Kuti area. During the site visits, none of these watercourses were active.

The total length of Neretva River is about 225 kilometres, of which 208 kilometres are in Bosnia and Herzegovina, while the final 22 kilometres are in Croatia. It is assumed that the Neretva basin is about 11,798 km^2 in total, of which in Bosnia and Herzegovina is 11,368 km^2.

Neretva is divided into upper, middle, and lower course. The source area of the basin belongs to a high mountainous region of Bosnia. On its 90 km course, through the upstream section, the Neretva cuts two deep and narrow canyons and two wide and fertile valleys, around Ulog and then around Glavaticevo, before it reaches town of Konjic. This section is also known as the Upper Neretva and here river flows generally from east-southeast to north-northwest and covers around 1,390 km^2 with an average elevation of 1.2%. Right below Konjic, the Neretva expands into a third and largest valley which provided fertile agricultural land before it was flooded by large artificial reservoir, Jablanicko Lake, formed after construction of a Jablanica Dam near town of Jablanica. The tributaries of the Neretva joining it in its upper course from the right are Slatnica, Rakitnica, Ljuta, Tresanica, Kraljuscica, Neretvica, and Rama, while from the left it is joined by Bijela, Ladjanica, Krupac, Bukovica, Sistica, Idbar, and Draganka. In its middle course the Neretva is joined by its right tributaries of Doljanka and Drezanka, Radobolje and Jasenice, while from the left it is joined by its tributaries of Prenjska River.

The middle course begins from the confluence of Neretva and Rama between Konjic and Jablanica where Neretva suddenly takes almost 180 degrees turn toward east-southeast and flows the short leg before reaches town of Jablanica, from which point turns again towards south. From Jablanica, the Neretva enters third and the largest canyon on its course, running through the steep slopes of Prenj, Cvrsnica and Cabulja reaching 800-1,200 metres in depth. This section is characterised with steep and relatively narrow canyon, and rugged karstic geology and hydrology. Four enormous vales-size rifts appear in the mountainsides forming canyon walls, two from each side of the river, intersecting with the main canyon almost perpendicularly. The Neretva receives only four small streams in this section, all running through these side-vales, which are relatively short. Going downstream from Jablanica, first two from each side are the Glogosnica stream on the left, and the Grabovica stream on the right side. Further downstream two much larger streams appear again on each side, first on the right the stream of Drezanka and its large and steep valley, and Mostarska Bijela, as one the most pristine streams in Bosnia and Herzegovina, with its eponymous uniquely characteristic subterranean stream, embedded deep into the Prenj mountain, on the left. Although these streams are of low outflow, there are also numerous wellsprings rising on both sides of the canyon at the riverbanks, with high-capacity discharge. Three large hydroelectric power stations operate in middle section of the Neretva, between Jablanica and Mostar – Grabovica HPP, Salakovac HPP and Mostar HPP.

However, by looking at the flood risk maps and risk maps for the Adriatic Sea watershed area[1], the flood risk for the Konjic area was determined to be the highest (" danger to all").

The area where the bridge on the Konjic bypass is located, as can be seen from the hazard map, also belongs to the area of the highest degree of danger, and the designer will take into account the relevant hydrological parameters when designing the bridge according to standard design practice. Flood risk maps were never prepared for the project area.

According to the Study on Preliminary Flood Risk Assessment for the Category I watercourses[2] there is no flood risk from the Neretva River in the area of influence due to the control of the rivers from hydroelectric dams. On the other hand, historical floods are recorded on the Tresanica river in the industrial area of Konjic's Repovica settlement which indicate moderately significant flood risk in this area. Motorway will cross Tresanica river via Viaduct No. 3 at height[3] of 30 m so there is no flooding risk for the motorway structures in this area.

8.2.2 Surface Water Quality

8.2.2.1 Ecological and Chemical Status of Surface Waters Along the Main Motorway Route

A summary assessment of the state of natural water bodies and the potential of surface waters based on regular monitoring of surface waters in the period 2016-2019 is given in the Water Management Plan for the Adriatic Sea in the FBiH for the period 2022-2027. The last available report on the chemical and ecological state of surface waters in FBiH was published in 2021[4]. Two monitoring profiles, Neretva 9 (Konjic) and Neretva 10 (upstream from Konjic), were of interest for this project. However, monitoring was not performed on the Tresanica and Konjicka Bijela rivers.

The determination of ecological status/potential was made in accordance with the *Decision on the characterisation of surface and groundwater, reference conditions and parameters for the assessment of water status and monitoring of waters and biotic characteristics of rivers in the water area of the Adriatic Sea*[5], which is aligned with the EU Water Framework Directive. The assessment of ecological status/potential was carried out based on indicative biological and accompanying physico-chemical parameters.

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[1] Available at https://avpjm.jadran.ba/zastita-od-voda
[2] Hydro-Engineering Institute Sarajevo, Study on Preliminary Flood Risk Assessment for Category I Water Courses in FBiH, April/May 2013
[3] The viaduct height was determined based on the configuration of the terrain and overall motorway alignment.
[4] Report on the state of surface and groundwater quality in the water area of the Adriatic Sea in the FBiH for Year 2020 (Agency for Watershed of the Adriatic Sea, Mostar December 2021).
[5] Official Gazette of the FBiH No. 1/14

Based on the summary results of previous monitoring for the period 2016-2019. which are given in the Water Management Plan in the water area of the Adriatic Sea in FBiH for the period 2022-2027, the following was concluded:

- There are no biological indicators for the Neretva 9 profile (Konjic), however, the basic physical and chemical indicators indicate that the ecological and chemical condition is "good" and that the overall potential is "good".
- For the Neretva 10 profile (upstream of Konjic), biological and basic physico-chemical indicators indicate a high ecological level, while there is no data for the chemical condition. The overall potential was assessed as "high".

However, it is necessary to point out that the latest Results from the Report on the Chemical and Ecological Condition of Surface Waters in FBiH for 2021, which were not taken into account when creating the Water Management Plan, show that the Neretva River has maximum ecological potential in the section that passes through Konjic (Neretva profile 9) and good ecological status in the location upstream from Konjic (profile Neretva 10). This report was prepared based on the results of phytobenthos, zoobenthos, macrophytes and ichthyofauna monitoring (only on the Neretva 10 profile).

On the other hand, the same report indicates that the chemical status of the Neretva River at the location upstream from Konjic is "good," while the chemical status of the Neretva River passing through Konjic is "bad," mainly due to wastewater discharge from settlements that are not connected to the wastewater treatment plant of Konjic.

Table 8-1: Evaluation of ecological status of Neretva River

Monitoring station	**Benthic macroinvertebrates**				**Phytobenthos**				**Macrophytes**	**Fish**			**Ecological status/ potential**		
	SI (Pantie-Buck	BMWP index	SI (Zelinka-	H (Shanon	SI (Pantie-Buck	SI (Zelinka-	H (Shanon	IPS	IBMR	EFI+	CPUE	CPUE	Basic ph-ch.	Biol. Para	Total score
Neretva 9_ Konjic	1.67	125	11	2.35	1.90	1.76	2.75	18.3/4.63	10	-	-	-	MEP*	MEP	MEP
Neretva 10_ Konjic upstream	1.56	117	11	2.51	1.69	1.41	2.35	18.7/4.73	6	0.562	8.125	104.21	High	Good	Good

*Maximum ecological potential

8.2.2.2 Surface Water Quality Along the Main Motorway Route

Surface water monitoring was performed for the purpose of determining the baseline condition in the pre-construction phase. The monitoring was performed on three surface water bodies determined to be in the Project area of influence: river Neretva, river Tresanica and river Konjicka Bijela. Monitoring was performed during the wet season in March 2021 and during the dry season in July 2021.

Sampling of the river Tresanica was performed downstream of the Viaduct No. 3. Sampling of the river Neretva was performed downstream of the Viaduct No. 4 in Konjic. Sampling of the river Konjicka Bijela was performed on two locations, just before the confluence with the river Neretva and near settlement Mladeskovici. Sampling points are presented in the table and figures below.

Sampling and physico-chemical analysis were performed by accredited test laboratory ZAGREBINSPEKT Ltd., Mostar in accordance with internationally approved standard methods listed in Table 8-3.

Table 8-2: Description of sampling points

Sampling point	Description	Location
SP 1 – Neretva	Downstream from the Viaduct No. 4	N: 43° 38′ 16,53″ E: 17° 58′ 45,07″
SP 2 – Tresanica	Downstream from the Viaduct No. 3	N: 43° 39′ 32,17″ E: 17° 58′ 4,94″
SP 3 – Konjicka Bijela	Before the confluence with river Neretva	N: 43° 38′ 20,24″ E: 17° 58′ 25,23″
SP 4 – Konjicka Bijela	Near settlement Mladeskovici	N: 43° 37′ 12,20″ E: 17° 57′ 40,14″

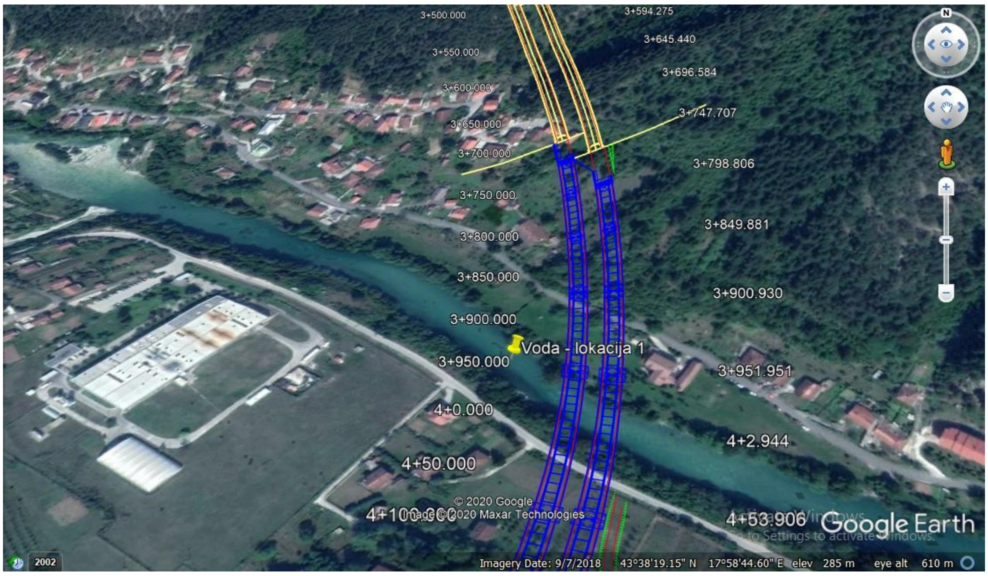

Figure 8-2: SP 1 – river Neretva, downstream from the Viaduct No. 4 in Konjic

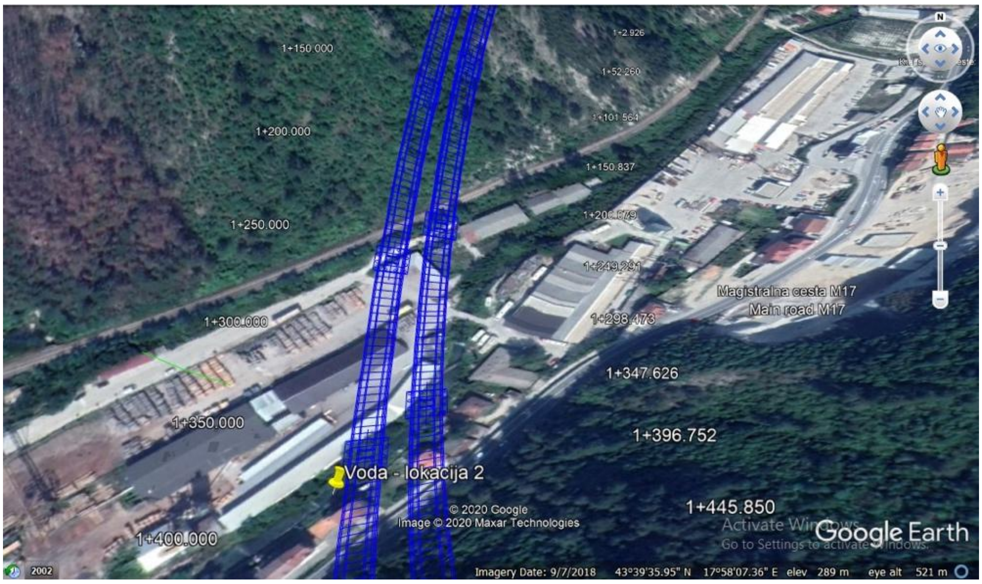

Figure 8-3: SP 2 – river Tresanica, downstream of the Viaduct No. 3 in Konjic

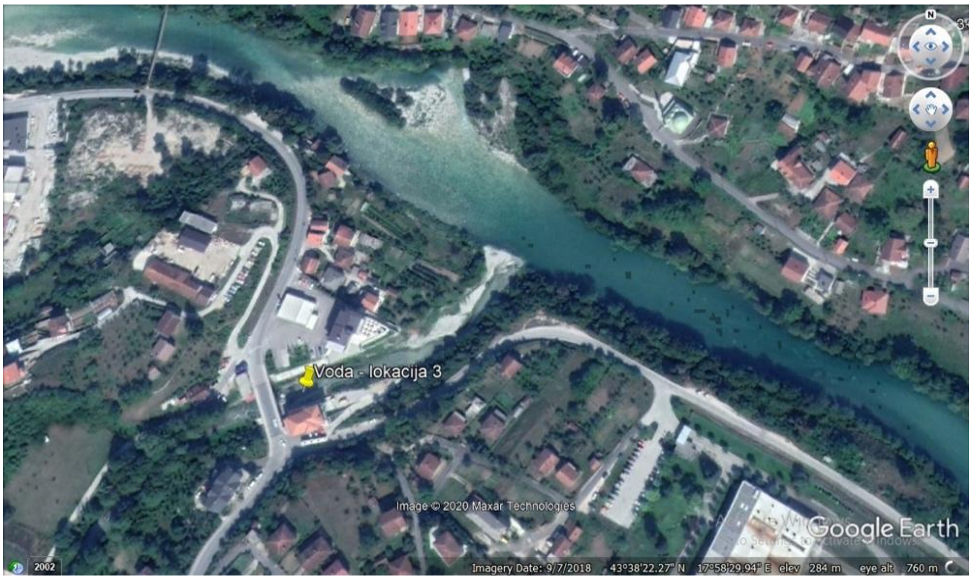

Figure 8-4: SP 3 – river Konjicka Bijela before the confluence with the Neretva

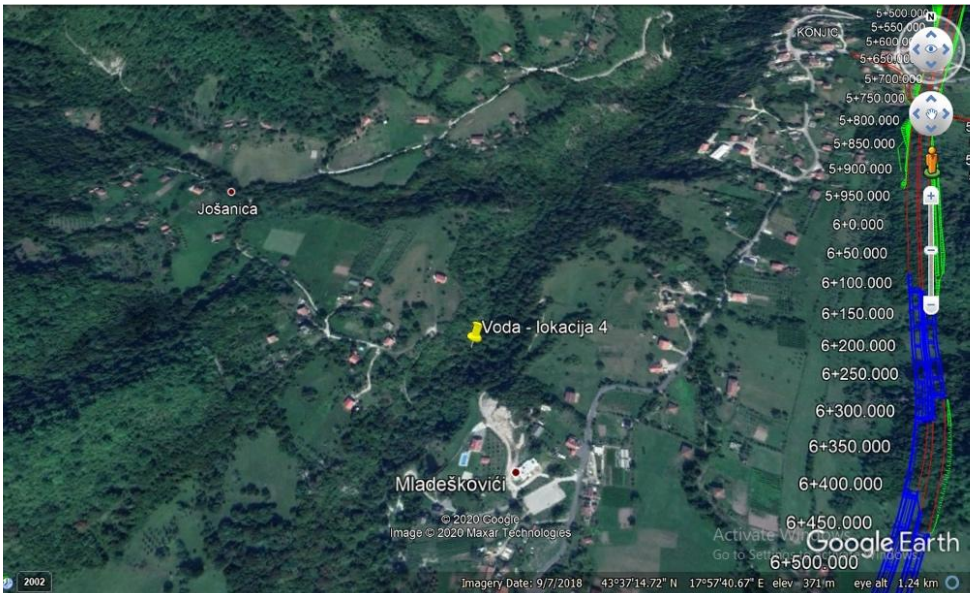

Figure 8-5: SP 4 – river Konjicka Bijela near the settlement Mladeskovici

Based on the results of physical-chemical analyses of the surface waters during the **high flow or wet season** in March 2021, in samples SP 1, SP 2 and SP 4 all tested parameters are below limit values stipulated by the *Regulation on Hazardous and Harmful Substances in Waters*[6] and the *Decree on the Classification of Waters and Coastal Seas of Yugoslavia within borders of SR BiH*[7] and meet the criteria for surface waters of class I and II. For sample SP 3, mercury (Hg) analysis is above the limit value stipulated by the *Regulation on Hazardous and Harmful Substances in Waters*[8].

Based on the results of physical-chemical analyses of the surface waters during the **low flow or dry season** in July 2021, for samples SP 1, SP 2 and SP 3, majority of analysed parameters are within the permissible values stipulated by the *Regulation on Hazardous and Harmful Substances in Waters* and the *Decree on the Classification of Waters and Coastal Seas of Yugoslavia within borders of SR BiH* and meet the criteria for surface waters of class I and II. For samples SP 1 and SP 3 the analysis for lead (Pb) below the maximum allowed concentrations and meets the criteria for surface water of III and IV class according to the *Regulation on Hazardous and Harmful Substances in Waters* and the *Decree on the Classification of Waters and Coastal Seas of Yugoslavia within borders of SR BiH*. For sample SP 2 analysis of copper (Cu) and mercury (Hg) meets the criteria for surface water of III and IV class according to the *Regulation on Hazardous and Harmful Substances in Waters*[9] and the *Decree on the Classification of Waters and Coastal Seas of Yugoslavia within borders of SR BiH*[10]. For sample SP 4, all tested parameters are within the permissible values stipulated by the *Regulation on Hazardous and Harmful Substances in Waters*[11] and the *Decree on the Classification of Waters and Coastal Seas of Yugoslavia*

[6] Official Gazette of FBiH, no. 43/07
[7] Official Gazette of SR BiH, no. 19/80
[8] Official Gazette of FBiH, no. 43/07
[9] Official Gazette of FBiH, no. 43/07
[10] Official Gazette of SR BiH, no. 19/80
[11] Official Gazette of FBiH, no. 43/07

within borders of SR BiH[12] and meet the criteria for surface waters of class I and II.

The obtained results in dry and wet seasons are presented in tables below.

The results indicate seasonal increase of heavy metals concentrations in water (mercury and lead) of which the most significant is the increase of mercury concentration in high flow season in Konjicka Bijela stream. The value exceeds the upper limit several times. On the other hand, the mercury concentration at SP 3 in low flow season are much lower and within the limits for III-IV class.

The cause of elevated mercury concentrations is not easily identified. The existing polluters in the catchment areas are one active quarry, potential activities within the shooting range and sewage pollution from individual households. All of them are located upstream from the sampling location where the monitoring results at SP 4 indicated that mercury concentrations are inside the permissible limits. Therefore, these polluters cannot be taken as a source of mercury contamination.

Moreover, the results of soil quality testing presented in Chapter 13.2 do not indicate increased concentration of heavy metals in soil.

All these uncertainties lead to a conclusion that it is mandatory to repeat baseline measurements before the start of construction.

[12] Official Gazette of SR BiH, no. 19/80

Table 8-3: Results of water quality analysis along the main alignment in the high flow season

Parameters	Unit	Method	Date	Limit value I-II Class Surface water	Limit value III-IV Class Surface water	Results SP1	Results SP2	Results SP3	Results SP4
Sampling	-	BAS EN ISO 5667-1:2008, 3:2014, BAS ISO 5667-6:2017	16.3.2021.	-	-	-	-	-	-
Mandatory parameters									
Ph		BAS EN ISO 10523:2013	16.3.2021.	6.8-8.5/5.8-8.5	6.0-9.0/6.0-9.0	7.7	7.7	7.9	7.9
Odour		RU-7.2/OV-1-31*	16.3.2021.	without/ without	Barely noticeable/-	without	without	without	without
Colour	mg Pt/l	BAS EN ISO 7887:2013 ©	17.3.2021.	-	-	2	3	2	4
Dissolved oxygen	mg/l	BAS EN ISO 5814:2014	16.3.2021.	8/6	4/3	8.2	8.7	8.1	8.3
Electrical conductivity	μS/cm	BAS EN 2788:2002	16.3.2021.	-	-	312	491	368	392
Suspended solids	mg/l	BAS ISO 11932:2002	17.3.2021.	10/30	80/100	<2	5	2	4
Chemical oxygen demand (COD)	mgO_2/l	BAS ISO 15705:2005	17.3.2021.	10/12	20/40	<15	<15	<15	<15
Biochemical oxygen demand (BOD)	mgO_2/l	BAS ISO 5815-1,2:2004	23.3.2021.	2/4	7/20	0.79	1.29	1.40	1.11
Ammonia	mg/l	BAS ISO 7150-1:2002	22.3.2021.	0.1-0.25	0.25-1.50	<0.050	<0.050	<0.050	<0.050
Nitrates – NO_3	mg/l	BAS ISO 7890-3:2002	22.3.2021.	0.5-1.5	1.5-10	0.15	0.48	0.35	0.35
Nitrites – NO_2	mg/l	BAS EN 26777:2000	17.3.2021.	0.01-0.03	0.03-0.2	<0.013	<0.013	<0.013	<0.013
Nitrogen according to Kjeldahl	mg/l	BAS EN 25663:2000	23.3.2021.	-	-	<1	<1	<1	<1
Total nitrogen, N	mg/l	Calculated from the concentrations of nitrite,	23.3.2021.	-	-	<1	<1	<1	<1

Parameters	Unit	Method	Date	Limit value I-II Class Surface water	Limit value III-IV Class Surface water	Results SP1	Results SP2	Results SP3	Results SP4
		nitrate and nitrogen according to Kjeldahl							
Total phosphorus, P	mg/l	BAS EN ISO 6878:2006	22.3.2021.	0.1-0.25	0.25-1.50	0.034	0.049	0.050	0.045
Sulphates	mg/l	Standard methods 4500-SO_4^{2-} C, izd. APHA-AWWA-WEF 2012.	19.3.2021.	-	-	<10	99	16	8
Specific parameters									
Cadmium, Cd	µg/l	BAS ISO 8288:2002	24.3.2021.	0.5	5.0	<0.5	<0.5	<0.5	<0.5
Copper, Cu	µg/l	BAS ISO 8288:2002	24.3.2021.	2-10	10-20	<1	<1	<1	<1
Chrome, Cr	µg/l	Standard methods 3111B	24.3.2021.	1-6	6-20	<1	<1	<1	<1
Zinc, Zn	µg/l	BAS ISO 8288:2002	24.3.2021.	50-80	80.200	<0.5	<0.5	<0.5	<0.5
Nickel, Ni	µg/l	BAS ISO 8288:2002	24.3.2021.	15-30	30-200	<1	2.26	<1	1.21
Iron, Fe	µg/l	Standard methods 3111B	24.3.2021.	100	1000	<1	<1	<1	<1
Lead, Pb	µg/l	BAS ISO 8288:2002	24.3.2021.	2	80	<1	<0.10	<0.10	<0.10
Manganese, Mn	µg/l	Standard methods 3111B	24.3.2021.	50	1000	<1	<1	<1	<1
TOC	mg/l	Macherey-Nagel, Nanocolour Test	17.3.2021.	-	-	4.0	6.6	3.5	4.5
Oils and fats	mg/l	BAS ISO 11349:2019	17.3.2021.	-	-	<10	<10	<10	<10
Mineral oils	mg/l	Standard methods 5520 (F) izd. APHA-AWWA-WEF2017.	-	-	-	<0.02	<0.02	<0.02	<0.02
Phenolic index	mg/l	ISO 6439:2000	-	-	-	<0.10	<0.10	<0.10	<0.10
Mercury, Hg	µg/l	AMA 254, Advanced Mercury Analyser, Operation Manual	-	0.02	1.00	<0.10	<0.10	**67.36**	<0.10
Anthracene	µg/l	EPA 610:1984	-	0.2	1	<0.012	<0.012	<0.012	<0.012

Parameters	Unit	Method	Date	Limit value I-II Class Surface water	 III-IV Class Surface water	Results SP1	Results SP2	Results SP3	Results SP4
Acenaphthylene	µg/l	EPA 610:1984	-	-	-	<0.009	<0.009	<0.009	<0.009
Flouren	µg/l	EPA 610:1984	-	-	-	<0.009	<0.009	<0.009	<0.009
Fenantren	µg/l	EPA 610:1984	-	-	-	<0.010	<0.010	<0.010	<0.010
Piren	µg/l	EPA 610:1984	-	-	-	<0.016	<0.016	<0.016	<0.016
Benzo (a) anthracene	µg/l	EPA 610:1984	-	-	-	<0.015	<0.015	<0.015	<0.015
Hrizen	µg/l	EPA 610:1984	-	-	-	<0.014	<0.014	<0.014	<0.014
Benzo (b) fluoranthenes	µg/l	EPA 610:1984	-	0.005	0.01	<0.007	<0.007	<0.007	<0.007
Benzo (k) fluoroanthene	µg/l	EPA 610:1984	-	-	-	<0.008	<0.008	<0.008	<0.008
Bezo (g.h.i) perilen	µg/l	EPA 610:1984	-	-	-	0.080	0.099	0.080	0.108
Indeno (1,2,3-cd) pyrene	µg/l	EPA 610:1984	-	-	-	0.006	0.010	0.006	0.005
Benzo (a) pyrene	µg/l	EPA 610:1984	-	0.005	0.01	<0.009	<0.009	<0.009	<0.009
Di benzo (a.h) anthracene	µg/l	EPA 610:1984	-	-	-	<0.015	<0.015	<0.015	<0.015
Naphtalene	µg/l	EPA 610:1984	-	-	-	<0.018	<0.018	<0.018	<0.018
Acenaften	µg/l	EPA 610:1984	-	-	-	<0.010	<0.010	<0.010	<0.010
Fluoroanthenes	µg/l	EPA 610:1984	-	-	-	<0.013	<0.013	<0.013	<0.013

Table 8-4: Results of water quality analysis along the main alignment in the low flow season

Parameters	Unit	Method	Date	Limit value I-II Class Surface water	Limit value III-IV Class Surface water	Results SP1	Results SP2	Results SP3	Results SP4
Sampling	-	BAS EN ISO 5667-1:2008, 3:2014, BAS ISO 5667-6:2017	1.7.2021.	-	-				
Mandatory parameters									
pH		BAS EN ISO 10523:2013	1.7.2021.	6.8-8.5/5.8-8.5	6.0-9.0/6.0-9.0	7.8	7.1	7.2	7.5
Smell		RU-7.2/OV-1-31*	1.7.2021.	without/without	Barely noticeable/-	without	without	without	without
Colour	mg Pt/l	BAS EN ISO 7887:2013 (C)	1.7.2021.	-	-	2	4	3	5
Dissolved oxygen	mg/l	BAS EN ISO 5814:2014	1.7.2021.	8/6	4/3	8.4	8.5	8.4	8.5
Electrical conductivity	µS/cm	BAS EN 2788:2002	1.7.2021.	-	-	318	452	325	314
Suspended solids	mg/l	BAS ISO 11932:2002	2.7.2021.	10/30	80/100	<2	<2	<2	2
Chemical oxygen demand (COD)	mgO_2/l	BAS ISO 15705:2005	2.7.2021.	10/12	20/40	<15	<15	<15	<15
Biochemical oxygen demand (BOD)	mgO_2/l	BAS ISO 5815-1,2:2004	7.7.2021.	2/4	7/20	0.87	1.34	1.87	1.79
Ammonia	mg/l	BAS ISO 7150-1:2002	5.7.2021.	0.1-0.25	0.25-1.50	<0.050	0.063	<0.050	<0.050
Nitrates – NO_3	mg/l	BAS ISO 7890-3:2002	5.7.2021.	0.5-1.5	1.5-10	0.18	0.44	0.34	0.31
Nitrites – NO_2	mg/l	BAS EN 26777:2000	2.7.2021.	0.01-0.03	0.03-0.2	<0.013	0.013	<0.013	<0.013
Nitrogen according to Kjeldahl	mg/l	BAS EN 25663:2000	5.7.2021.	-	-	<1	<1	<1	<1

Parameters	Unit	Method	Date	Limit value I-II Class Surface water	Limit value III-IV Class Surface water	Results SP1	Results SP2	Results SP3	Results SP4
Total nitrogen, N	mg/l	Calculated from the concentrations of nitrite, nitrate and nitrogen according to Kjeldahl	5.7.2021.	-	-	<1	<1	<1	<1
Total phosphorus, P	mg/l	BAS EN ISO 6878:2006	5.7.2021.	0.1-0.25	0.25-1.50	<0.025	<0.025	<0.025	0.096
Sulphates	mg/l	Standard methods 4500-SO_4^{2-} C, izd. APHA-AWWA-WEF 2012.	6.7.2021.	-	-	<10	124	28	24
Specific parameters									
Cadmium, Cd	µg/l	BAS ISO 8288:2002	6.7.2021.	0.5	5.0	<0.5	<0.5	<0.5	<0.5
Copper, Cu	µg/l	BAS ISO 8288:2002	6.7.2021.	2-10	10-20	1.40	3.74	<1	<0,40
Chrome, Cr	µg/l	Standard methods 3111B	6.7.2021.	1-6	6-20	<0.5	<0.5	<0.5	<0.50
Zinc, Zn	µg/l	BAS ISO 8288:2002	6.7.2021.	50-80	80.200	<0.5	<0.5	<0.5	<0.50
Nickel, Ni	µg/l	BAS ISO 8288:2002	6.7.2021.	15-30	30-200	<1	<1	<1	<0.10
Iron, Fe	µg/l	Standard methods 3111B	6.7.2021.	100	1000	<0.03	<0.03	<0.03	<0.03
Lead, Pb	µg/l	BAS ISO 8288:2002	6.7.2021.	2	80	2.96	<0.10	4.03	<0.10
Manganese, Mn	µg/l	Standard methods 3111B	6.7.2021.	50	1000	<0.01	<0.01	<0.01	<0.01
TOC	mg/l	Macherey-Nagel, Nanocolour Test	2.7.2021.	-	-	3.9	8.6	5.7	4.2
Oils and fats	mg/l	BAS ISO 11349:2019	2.7.2021.	-	-	<10	<10	<10	<10
Mineral oils	mg/l	Standard methods 5520 (F) izd. APHA-AWWA-WEF2017.	-	-	-	<0.02	<0.02	<0.02	<0.02
Phenolic index	mg/l	ISO 6439:2000	-	-	-	<0.10	<0.10	<0.10	<0.10

Parameters	Unit	Method	Date	Limit value I-II Class Surface water	Limit value III-IV Class Surface water	Results SP1	Results SP2	Results SP3	Results SP4
Mercury, Hg	µg/l	AMA 254, Advanced Mercury Analyser, Operatin Manual	-	0.02	1.00	<0.10	0.16	<0.10	<0.10
Anthracene	µg/l	EPA 610:1984	-	0.2	1	<0.012	<0.012	<0.012	<0.012
Acenaphthylene	µg/l	EPA 610:1984	-	-	-	<0.009	<0.009	<0.009	<0.009
Flouren	µg/l	EPA 610:1984	-	-	-	<0.009	<0.009	<0.009	<0.009
Fenantren	µg/l	EPA 610:1984	-	-	-	<0.010	<0.010	<0.010	<0.010
Piren	µg/l	EPA 610:1984	-	-	-	<0.016	<0.016	<0.016	<0.016
Benzo (a) anthracene	µg/l	EPA 610:1984	-	-	-	<0.015	<0.015	<0.015	<0.015
Hrizen	µg/l	EPA 610:1984	-	-	-	<0.014	<0.014	<0.014	<0.014
Benzo (b) fluoranthenes	µg/l	EPA 610:1984	-	0.005	0.01	<0.007	<0.007	<0.007	<0.007
Benzo (k) fluoroanthene	µg/l	EPA 610:1984	-	-	-	<0.008	<0.008	<0.008	<0.008
Bezo (g.h.i) perilen	µg/l	EPA 610:1984	-	-	-	<0.004	<0.004	<0.004	<0.004
Indeno (1,2,3-cd) pyrene	µg/l	EPA 610:1984	-	-	-	<0.005	<0.005	<0.005	<0.005
Benzo (a) pyrene	µg/l	EPA 610:1984	-	0.005	0.01	<0.009	<0.009	<0.009	<0.009
Di benzo (a.h) anthracene	µg/l	EPA 610:1984	-	-	-	<0.015	<0.015	<0.015	<0.015
Naphtalene	µg/l	EPA 610:1984	-	-	-	<0.018	<0.018	<0.018	<0.018
Acenaften	µg/l	EPA 610:1984	-	-	-	<0.010	<0.010	<0.010	<0.010
Fluoroanthenes	µg/l	EPA 610:1984	-	-	-	<0.013	<0.013	<0.013	<0.013

8.2.2.3 Surface Water Quality Along South Connection to the Main Road M17 (Konjic Bypass)

Surface water monitoring was also performed for the purpose of determining the baseline condition of the Neretva River at the location of the Donje Selo settlement where the works on the Konjic bypass will be performed. Donje Selo is found on the right Neretva Bank where the Konjic Bypass will cross Neretva to connect to the main road M17. The monitoring was performed in May 2022.

The sampling point is presented in the table and figures below.

Sampling and physical-chemical analysis were performed by accredited test laboratory ZAGREBINSPEKT Ltd., Mostar in accordance with internationally approved standard methods listed in Table 8-6.

Table 8-5: Description of sampling points

Sampling point	Description	Location
SP 1 – Neretva	Downstream from the bridge in Donje Selo	N: 43° 38′ 16,53″ E: 17° 58′ 45,07″

Figure 8-6: River Neretva, downstream from the location of future bridge in Donje Selo

Based on the results of physico-chemical analyses of the surface water, all tested parameters are within the permitted values stipulated by the *Regulation on Hazardous and Harmful Substances in Waters* and the *Decree on the Classification of Waters and Coastal Seas of Yugoslavia within borders of SR BiH* and meet the criteria for surface waters of class I and II.

The obtained results are presented in table below.

Table 8-6: Results of water quality analysis during the wet period at SP 1

Parameters	Unit	Result	Method	Date	Limit value I-II Class Surface water	Limit value III-IV Class Surface water
Sampling	-	-	BAS EN ISO 5667-1:2008, 3:2019, BAS ISO 5667-6:2017	30.5.2022.	-	-
Mandatory parameters						
pH		8.3	BAS EN ISO 10523:2013	30.5.2022.	6.8-8.5/5.8-8.5	6.0-9.0/6.0-9.0
Smell		without	RU-7.2/OV-1-31*	30.5.2022.	without/without	Barely noticeable/-
Colour	mg Pt/l	3	BAS EN ISO 7887:2013 ©	31.5.2022.	-	-
Dissolved oxygen	mg/l	7.5	BAS EN ISO 5814:2014	30.5.2022.	8/6	4/3
Electrical conductivity	µS/cm	66.9	BAS EN 2788:2002	30.5.2022.	-	-
Suspended solids	mg/l	<2	BAS ISO 11932:2002	31.5.2022.	10/30	80/100
Chemical oxygen demand (COD)	mgO_2/l	<15	BAS ISO 15705:2005	31.5.2022.	10/12	20/40
Biochemical oxygen demand (BOD)	mgO_2/l	0.55	BAS ISO 5815-1,2:2004	6.6.2022.	2/4	7/20
Ammonia	mg/l	<0.050	BAS ISO 7150-1:2002	3.6.2022.	0.1-0.25	0.25-1.50
Nitrates – NO_3	mg/l	<0.040	BAS ISO 7890-3:2002	3.6.2022.	0.5-1.5	1.5-10
Nitrites – NO_2	mg/l	<0.013	BAS EN 26777:2000	31.5.2022.	0.01-0.03	0.03-0.2
Nitrogen according to Kjeldahl	mg/l	<1	BAS EN 25663:2000	2.6.2022.	-	-
Total nitrogen, N	mg/l	<1	Calculated from the concentrations of nitrite, nitrate and nitrogen according to Kjeldahl	3.6.2022.	-	-
Total phosphorus, P	mg/l	<0.025	BAS EN ISO 6878:2006	6.6.2022.	0.1-0.25	0.25-1.50
Sulphates	mg/l	31	Standard methods 4500-SO_4^{2-} C, izd. APHA-AWWA-WEF 2012.	6.6.2022.	-	-
Specific parameters						

Parameters	Unit	Result	Method	Date	Limit value	
					I-II Class Surface water	III-IV Class Surface water
Cadmium, Cd	µg/l	<0.5	BAS ISO 8288:2002	10.6.2022.	0.5	5.0
Copper, Cu	µg/l	1.45	BAS ISO 8288:2002	10.6.2022.	2-10	10-20
Chrome, Cr	µg/l	1.98	Standard methods 3111B	10.6.2022.	1-6	6-20
Zinc, Zn	µg/l	5	BAS ISO 8288:2002	10.6.2022.	50-80	80.200
Nickel, Ni	µg/l	1.49	BAS ISO 8288:2002	10.6.2022.	15-30	30-200
Iron, Fe	µg/l	30	Standard methods 3111B	10.6.2022.	100	1000
Lead, Pb	µg/l	0.25	BAS ISO 8288:2002	10.6.2022.	2	80
Manganese, Mn	µg/l	<10	Standard methods 3111B	10.6.2022.	50	1000
TOC	mg/l	2.1	Macherey-Nagel, Nanocolour Test	31.5.2022.	-	-
Oils and fats	mg/l	<10	BAS ISO 11349:2019	31.5.2022.	-	-
Mineral oils	mg/l	<0.02	Standard methods 5520 (F) izd. APHA-AWWA-WEF2017.	-	-	-
Phenolic index	mg/l	0.06	ISO 6439:2000	-	-	-
Mercury, Hg	µg/l	<0.10	AMA 254, Advanced Mercury Analyser, Operatin Manual	-	0.02	1.00
Anthracene	µg/l	<0.012	EPA 610:1984	-	0.2	1
Acenaphthylene	µg/l	<0.009	EPA 610:1984	-	-	-
Flouren	µg/l	<0.009	EPA 610:1984	-	-	-
Fenantren	µg/l	<0.010	EPA 610:1984	-	-	-
Piren	µg/l	<0.016	EPA 610:1984	-	-	-
Benzo (a) anthracene	µg/l	<0.015	EPA 610:1984	-	-	-
Hrizen	µg/l	<0.014	EPA 610:1984	-	-	-
Benzo (b) fluoranthenes	µg/l	<0.007	EPA 610:1984	-	0.005	0.01
Benzo (k) fluoroanthene	µg/l	<0.008	EPA 610:1984	-	-	-
Bezo (g.h.i) perilen	µg/l	<0.004	EPA 610:1984	-	-	-
Indeno (1,2,3-cd) pyrene	µg/l	<0.005	EPA 610:1984	-	-	-

Parameters	Unit	Result	Method	Date	Limit value	
					I-II Class Surface water	III-IV Class Surface water
Benzo (a) pyrene	µg/l	<0.009	EPA 610:1984	-	0.005	0.01
Di benzo (a.h) anthracene	µg/l	<0.015	EPA 610:1984	-	-	-
Naphtalene	µg/l	<0.018	EPA 610:1984	-	-	-
Acenaften	µg/l	<0.010	EPA 610:1984	-	-	-
Fluoroanthenes	µg/l	<0.013	EPA 610:1984	-	-	-

8.3 Assessment of Potential Impacts

8.3.1 Assessment of Impacts in the Construction Phase

8.3.1.1 Type of Possible Impacts

The motorway route passes close to (or over) the Tresanica, Neretva and Konjicka Bijela rivers, where negative impacts on surface water may occur during the construction and operation phase. Here is to be noted that by polluting groundwaters, polluting substances can also reach open streams, and vice versa. Precipitation can transfer pollution from the surface to the soil and underground, while high water levels can cause polluted groundwater to flow into surface waters that are fed from these sources. For this reason, this chapter must be read in conjunction with *Chapter 7 Groundwaters*.

The impact with highest probability of occurrence during the execution of the construction works is the release of different pollutants that can cause **change in physical or chemical properties of the surface waters**. The following types of releases are possible:

- Sediment release during construction of motorway structures (land clearance, excavation, and cuts, dewatering of excavations, tunnelling, embankments, construction of viaducts and bridges in riverbed and on the banks, etc.) that temporary increases sedimentation within watercourses,
- Sediment release into river systems resulting from depositing of construction waste into the rivers,
- Release of untreated groundwater drainage generated in the process of tunnel drilling,
- Accidental spillages containing hydrocarbons within the construction site caused by e.g., change of machine oils and lubricants, spillages from storage vessels, etc.
- Concrete wash water from concrete batching plant and wastewater from asphalt mixing plant,
- Sanitary wastewaters from workers' camps, and
- Inappropriate disposal of different types of wastes on riverbanks.

Runoff with high sediment loads may have direct adverse impacts on adjacent water bodies through increasing turbidity (affecting ecological quality through reducing light penetration and reducing plant growth). By smothering vegetation and bed substrates (thus impacting on invertebrate and fish communities through the destruction of feeding areas, refuges, and breeding and or spawning areas). Organic sediment can also have indirect effects on physio-chemical properties such as dissolved oxygen demand and pH and may also contain heavy metals and other soluble pollutants that can affect chemical water quality.

Increased pollution risks from the discharge or spillage of fuels or other harmful substances associated with temporary works may also migrate to local surface water receptors. Hydrocarbons form a film on the surface of the water body, deplete oxygen levels and may be toxic to fish. If materials and activities are not stored and carried out in designated areas, runoff and washdown may enter a water body, adversely affecting the aquatic environment. Concrete and cement products can also pose a risk to the water environment and chemical water quality. These products ae highly alkaline and corrosive. For the most part, it is only when large quantities of hazardous substances are spilled, or the spillage is directly into the water body that a significant risk of acute toxicity would arise in the receiving water. The risks are likely to be grater with the construction of bridge and culverts that will cross the watercourse and may require works within the riverbed. The risk could also be associated with the discharge or runoff from concrete wastewater from potential batching plant(s).

Impacts could typically be associated with pollution risk for the discharge of sanitary waters from workers' camps. It is expected that there will be at least three main construction worker's camps along the alignment. The location of these camps will be determined by the Contractor(s) in later stages of the Project, so it is difficult to assess the risk of surface water pollution. Still the appropriate system for collection and treatment of wastewater from the camps shall be required as part of the Construction Site Organisation Plan.

This type of surface water pollution risk is temporary, it lasts as long as the construction works are active and cease after completion of works and implementation of recultivation and rehabilitation measures.

Considering the sensitivity, importance, and protection of waters around the motorway route, visual monitoring during the construction phase must be done on a daily basis. The monitoring process will involve visually detecting any improper waste disposal on the banks or in the water. Additionally, it will involve identifying any visible changes in the water's colour or appearance, which could result from an increased release of suspended solids or accidental spillage of material directly into the water course.

Other potential impacts on water resources in the construction phase include **changes in river flow and recharge** by cutting or diverting permanent and intermittent streams around the motorway structures. Temporary works within watercourses (most notably the construction of new culverts) could reduce the hydraulic capacity of the watercourse either by temporary diversion, restriction, or blockage of the watercourse to facilitate the construction of new structures. This in turn may reduce the volume of river flows downstream of the Project available for abstraction or supporting water environments. This is most likely to be greater risk to smaller watercourses and tributaries that have a low flow, such as Bijela, while the risk to larger watercourses that have a larger catchment is likely to be low. This impact is also permanent in duration and must be prevented or mitigated with engineering measures to preserve hydraulic connectivity in the area, regardless of the risk level.

According to the Flood Risk Maps for the water area of the Adriatic Sea (https://avpjm.jadran.ba/zastita-od-voda), the highest degree of flood risk has been determined for the Konjic area, therefore, when designing the bridge over the Neretva on the Konjic bypass, it is necessary to take into account taking into account the relevant hydrological parameters, which will ensure the stability and resistance of this structure to floods.

8.3.1.2 Assessment of Potential Impacts Along the Motorway Alignment

Starting from the Ovcari Interchange, motorway will be constructed on the slopes above Tresanica. During the removal of material for the construction of the open route, during the construction of the Ovcari interchange as well as the construction of the embankment on this section of the route, there is a possibility of soil erosion and liberation of sediments during heavy rainfall resulting in increased sedimentation in the water. Although the direct discharge in the river should be avoided, this type of pollution (which also happens naturally during such events) will be lasting only during the rainfall and should not have a great long term negative impact on river ecology.

At chainage km 1+300.00 the motorway will cross over the industrial zone Sipad and the Tresanica river with Viaduct 3 (L=480 m) at maximum height of 84 m (Figure 8-3). The model of Viaduct 3 is given in Figure 8-7.

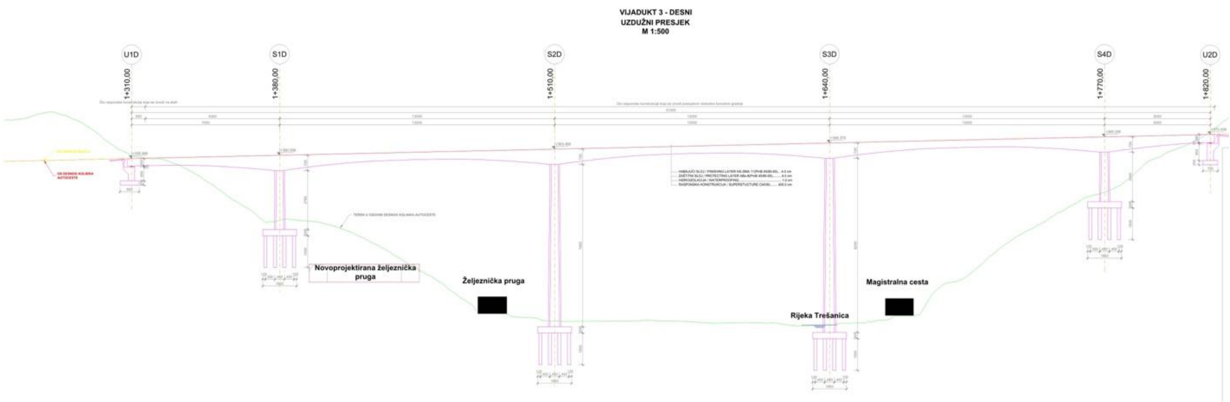

Figure 8-7: Model of Viaduct 3 over the Tresanica river

One of the viaduct pillars intersect with the riverbed due to the terrain configuration and viaduct design. In order to avoid construction of pillars inside the Tresanica riverbed, the river training in length of 140 m will be done.

The training structure will be made of stone lining laid on a 10 cm thick gravel filter layer under which a 200g/m^2 geotextile layer will be placed. The banks above the slope will be grassed over a layer of humus and fertile soil. The stone lining ends with a transition section. The typical cross-section (Figure 8-9) is trapezoidal provided to clean the riverbed and protect eroded banks and concave curves. The structure will be able to drain high waters of 1/100 years occurrence.

Therefore, the construction works on Viaduct 3 will be performed around the Tresanica riverbed with possibility of direct release of polluting substances into surface water (in the unlikely event of a spill).

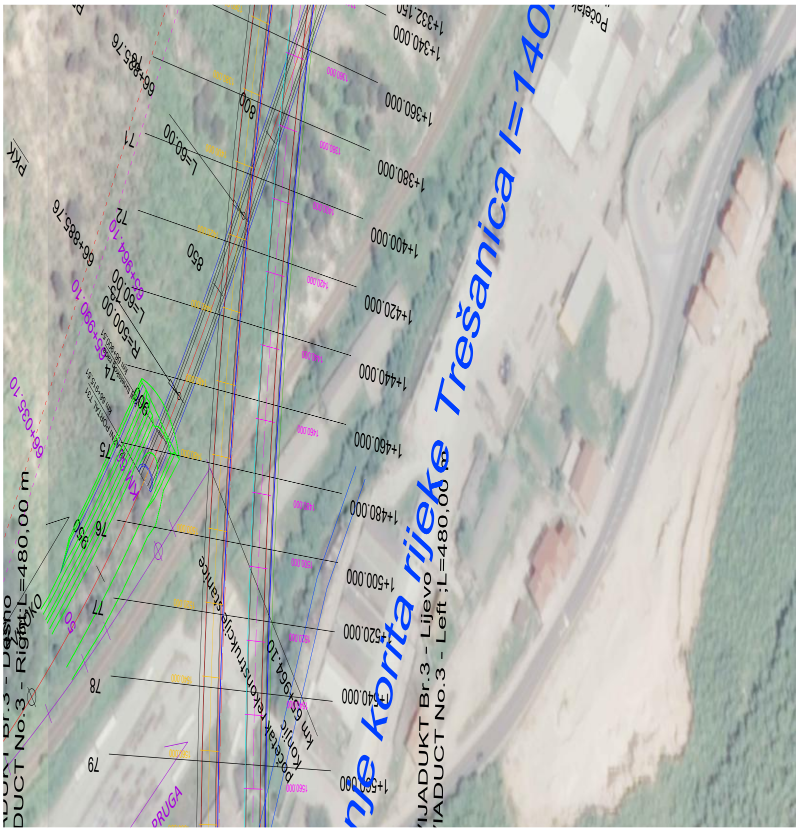

Figure 8-8 Training of the Tresanica River (L=140 m)

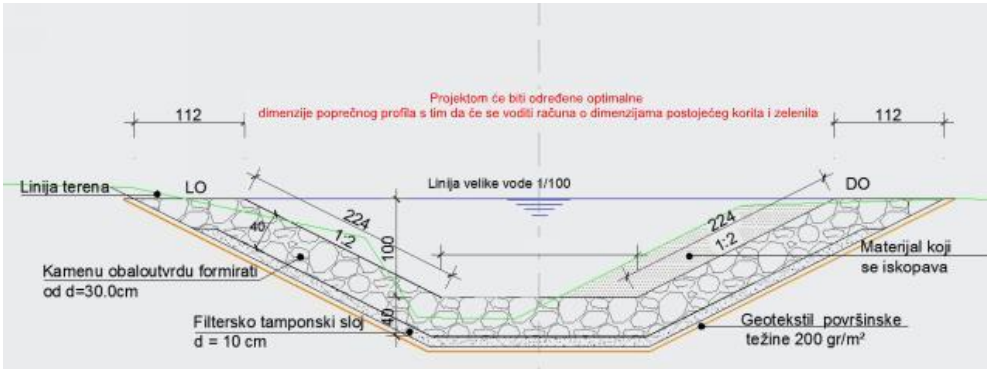

Figure 8-9: Typical cross section of training structure

Going further, the motorway will pass through the Zlatar Mountain with two tunnels T1 and T2. After exiting the Tunnel T2, the route crosses over the Neretva River with Viaduct 4 which has total length of left lane L=540 m and right lane L=605.20 m and maximum height of 77 m (Figure 8-2). Construction of pillars in the Neretva riverbed is not foreseen by the preliminary design (Figure 8-10). The construction works on Viaduct 4 will be performed around the Neretva River with possibility of direct release of polluting substances into surface water in the unlikely event of a spill.

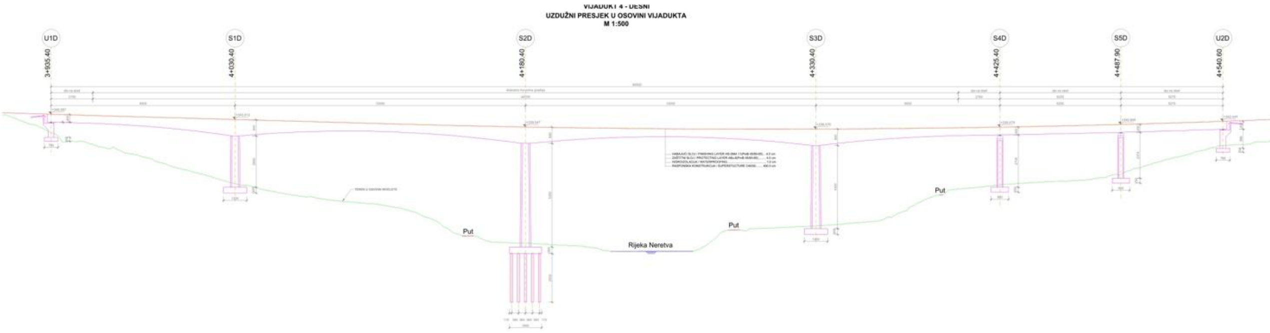

Figure 8-10: Model of Viaduct 4 over the Neretva River

Both Tresanica and Neretva are streams sensitive from the aspect of aquatic ecology as explained in Chapter 6 (e.g., salmonids spawning grounds downstream from the construction works, presence of bullhead in the Tresanica river, a species very sensitive to pollution and disturbances in the habitat). By avoiding construction in the riverbed, the sensitive river ecology will be protected. Still mitigation measures for the construction that will take place on the banks will have to be foreseen as outlined in Chapter 8.4.2.

After crossing the Neretva, the motorway enters the valley of the Bijela river. In order to avoid unstable ground for construction, the motorway has lowered from the steep upper slopes down towards the Bijela river to avoid construction in cut in the unstable terrains. However, this will require for the upper section of Bijela river, called Suhi Potok stream, to be trained just before entering the zone of the Rakov Laz shooting range (Figure 8-11).

The width of the trained riverbed in the bottom is 6.0 m with a total length of trained section of 1,280 m, together with the construction of one culvert through the motorway embankment. The dimensions of the flow profile of this culvert would be approximately b x h = 10 x 3.2 m, with total length L=95 m.

For most of the route, the newly regulated Suhi Potok stream would be excavated in full profile, which in principle represents a new canal that would be dimensioned to accept and transport 1/100 years of high water from this part of the Bijela river basin. The technical solution foresees construction of a stone lining with a level that follows the natural slope of the Suhi Potok riverbed. The same typical cross section of the structure shown in Figure 8-9 is also applicable to this case.

It is to be noted here that Suhi Potok (translated as Dry creek) is an intermittent stream and that is dry for most part of the year. The training structure can be constructed in a low flow season without negative impact on Konjicka Bijela or the springs downstream.

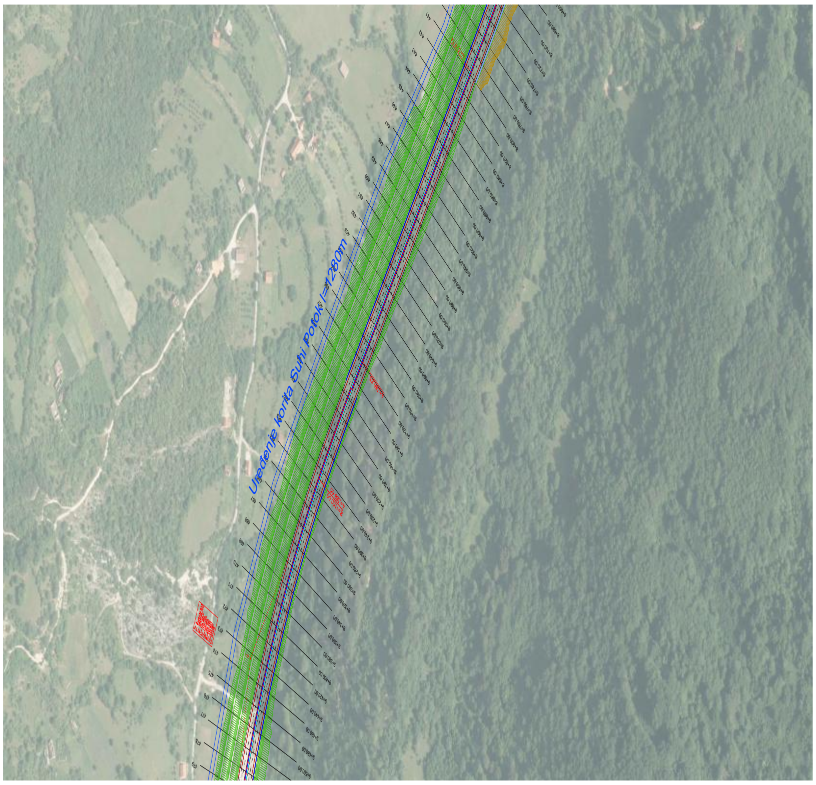

Figure 8-11: Training of the Suhi Potok stream (L=1,280 m)

For the purpose of preserving the Bijela and Gornja Bijela spring (water supply from Crno Vrelo) from the impact of high waters from the river Bijela, an additional regulation of the natural riverbed of the river Bijela over a length of approximately 600 m is planned. This will prevent the tap water supply from being endangered by potential changes in water quality in the riverbed of the Bijela river.

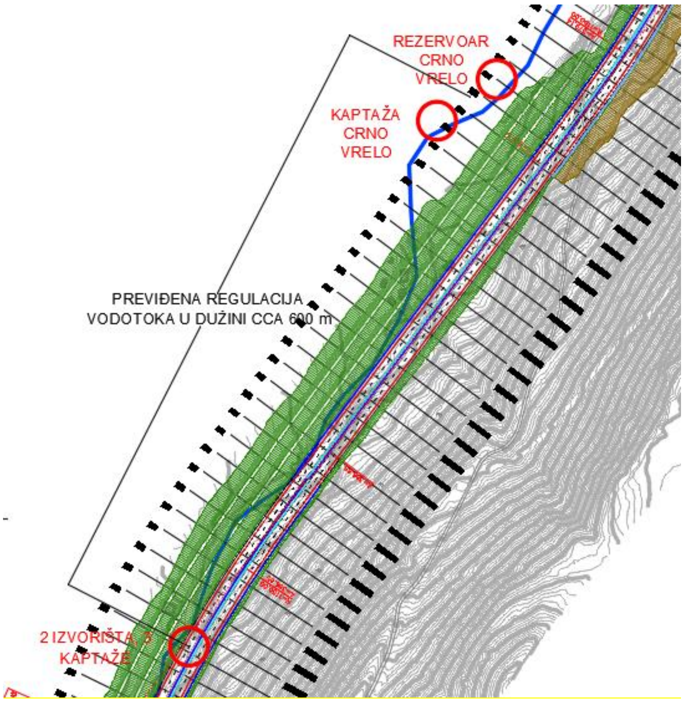

Figure 8-12: Regulation of the Bijela stream (L = 600 m)

From the exit from the Prenj Tunnel to the Mostar North Interchange, the construction works will not be performed close to the permanent surface streams. The Neretva River is located at the distance of few kilometres from the motorway alignment. However, several intermittent streams are located in the zone of the motorway that are usually dry most of the year except in the period of heavy rains or snow melting. The design has foreseen construction of culverts in embankments to allow for water to flow undisturbed. The dimensioning of the culverts is done in a way to allow for water to pass undisturbed but also to ensure the stability of motorway structures.

On the Konjic bypass side, the Neretva River will be crossed by the 387-meter-long bridge M1 at the location of the Donje Selo settlement which is located on the right Neretva Bank (Figure 8-6). The bridge crosses the existing Sarajevo-Capljina railway, the Neretva River, and the main road M17. It comprises a total of 12 pillars spaced approx. 30 meters apart, with two pillars located within the Neretva riverbed. During the summer season, the flow of the Neretva River at the bridge location is low enough to allow for work to be carried out in the nearly dry riverbed. Mitigation measures for the construction that will take place in the riverbeds will have to be foreseen as outlined in Chapter 8.4.2.

The proposed spoil disposal site (municipal landfill) on the Konjic side have been situated at a distance from surface waters. The remaining material will be used for landscaping around the embankments in the zone near the tunnel Prenj. However, the disposal site at Humilisani on the Mostar side partially intersects with an intermittent stream, which only flows during the rainy season. The stream flows to the left of the disposal plot and reappears in the upper left corner (Figure 8-13).

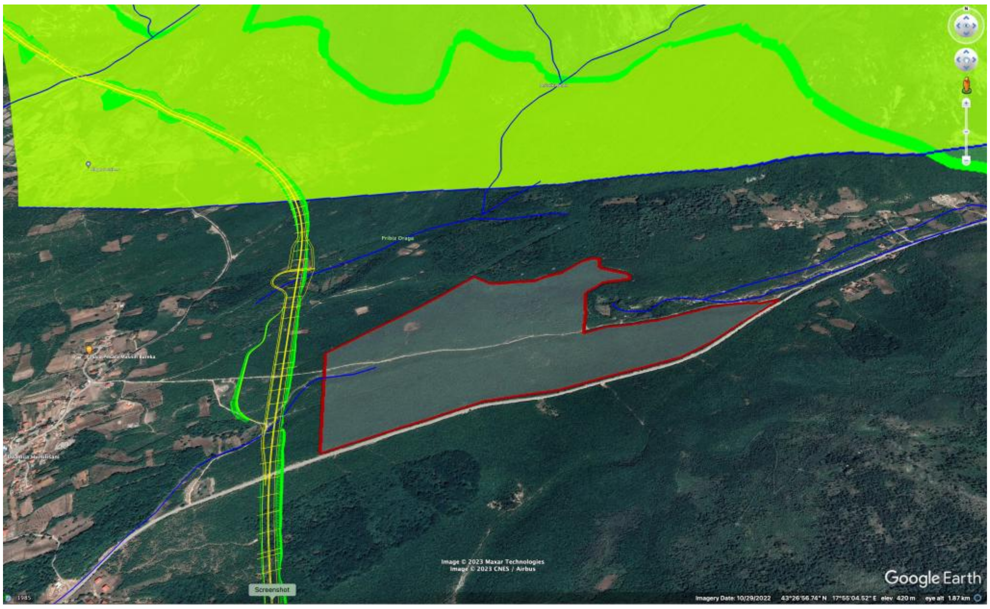

Figure 8-13: Intermittent surface streams (in blue) around the plot designated for Humilisani disposal site (in red)

To ensure the stability of the disposal site Humilisani, its design must include engineering measures to bypass or enclose the stream, thereby ensuring its connectivity and uninterrupted flow. Additionally, all disposal sites require engineering measures to prevent erosion and the release of sediment. Measures such as limiting the height of the disposal site, limiting the slope, revegetation, slope breakers, construction of run-off collection and drainage must be foreseen to ensure the stability of the landfill. The landscaping on the Konjic side will be carried out in a man-made depression, which is formed by an embankment on one side and natural terrain on the other. This depression will be filled with excavated materials, thus the erosion and sediment release is not expected. More details and mitigation measures to address this are given in *Chapter 16 Waste and Materials Management*.

8.3.2 Assessment of Impacts in the Operational Phase

In the operation phase, the impact with highest probability of occurrence is the change in quality of surface waters due to

- direct release of intercepted surface run-off which can be contaminated with fuel, oil and lubricants leakage, tyre wear, dust, wind-borne particles, different pollutants settling from the atmosphere and defrosting salts and gravel of small granulation used in winter maintenance activities,
- spillover of surface runoff not intercepted and treated by drainage system, usually occurring in case of extreme floods,
- direct release of sanitary water from toll station and rest areas, which is usually contaminated with organic pollution,
- accidental spill of hazardous material (e.g., oil and oil derivatives, hazardous chemicals, etc.) resulting from traffic accidents. This impact has been estimated as a lifelong Project impact,
- release of de-icing agents in road winter maintaining activities.

Typical pollutants in surface run-off are listed in Table 8-7[13].

Table 8-7: Pollutants in the surface run-off

Pollutants	Pollution sources
Solid particles	Pavement wearing, vehicles, atmosphere, and road maintenance
Nitrogen and phosphorus	Atmosphere and artificial fertilisers
Lead	Lead in form of tetramethyl lead from exhaust gases, tyre wearing
Zinc	Tyre wearing, motor oils and lubricants
Iron	Rust from vehicles, metal structures on the road (bridges, bump rail), movable motor parts
Copper	Metal protective coatings, bearing and motor brushes wearing, movable engine parts, brakes wearing, fungicides and insecticides
Cadmium	Tyre wearing and pesticides use
Chromium	Metal protective coatings, movable engine parts, brakes wearing
Nickel	Diesel fuel and gasoline, lubricating oils, metal protective coatings, brakes and asphalt surfaces wearing
Vanadium	Fuel additives
Titan	Pavement markings colour
Manganese	Movable engine parts
Sodium, Calcium and Chlorides	Defrosting salts
Sulphates	Pavement bed, fuel and defrosting salts
Oil and oil derivatives	Sprinkling and leakage of fuel, anti-freeze and hydraulic oils, asphalt surface moistening

The design of drainage and treatment structures is part of the Preliminary Design for all three sections, and the details are given in Chapter 3.2.8 Wastewater Treatment System.

On the Ovcari-Tunnel Prenj section, the closed surface run-off collection and treatment system is foreseen. The system will intercept all surface waters from motorway surfaces and treat it in the oil and grease separators**.** The final position of all oil and grease separators will be known after the Main Design, but the mitigation measures will require to specifically cover the two viaducts crossing Tresanica and Neretva rivers, as well as the bridge over Neretva that connects Konjic Bypass with M17 road. In the area of Konjicka Bijela springs, treatment efficiency of oil and grease separators will be 100% and effluent is to be discharged downstream from the springs. If there are accidental spills, the

[13] Adopted from different sources including http://lakes.chebucto.org/SWT/pollutants.html and https://www.cedr.eu/download/Publications/2016/CEDR2016-1-Management-of-contaminated-runoff-water.pdf

closed system will prevent the spilled material from being naturally discharged, ensuring full retention of the material until removed by authorised entities. The toll stations and rest areas will be connected to the local water supply and sewerage system that is available in the vicinity of the motorway alignment. This will provide reliable access to water and sewage services for these facilities.

All water from the asphalt surfaces at the Prenj Tunnel section, whether it is from washing the tunnel or responding to a fire, will be diverted from inside of the tunnel into a closed reservoir with a capacity of 100 m^3. One reservoir is planned for each portal. Water that is collected in the reservoir will be pumped out and treated by authorised entities. Additionally, all water collected on the tunnel plateau will be directed to drainage system on the open route and treated in oil and grease separators.

On the Prenj Tunnel-Mostar North section, according to the Preliminary Water Consent[14], all intercepted surface runoff on the section passing through the sanitary protection zones of the Salakovac and Bosnjaci springs must be contained, treated and discharged outside of this zone. The design concept proposes use of oil and grease separators without a bypass and with 100% treatment efficiency. In the event of accidental spills, the material will be fully contained until it can be removed by authorised entities. As for the remaining portion of this section, any intercepted runoff will be collected and treated in oil and grease separators. Wastewater from rest areas will be collected and treated in biological treatment units.

Tyre particles, which are non-soluble in water, will also be effectively managed within the oil and grease separators. These particles naturally segregate into layers based on their density, either floating in the oily section or settling into the sludge compartment, ensuring they are captured and prevented from entering the surrounding environment. In addition, while de-icing agents containing chlorides are used during winter, their removal is not currently possible due to the lack of efficient methods. However, chlorides are not classified as toxic, and their diffuse drainage into the environment over time reduces potential localised environmental impacts.

The concept of hydro-engineering structures on all sections will be further developed in the following stage of Main Design and implemented in order to reduce risk of pollution of surface waters to acceptable levels.

Konjic is situated in the area of modified Mediterranean climate with hot and warm summer days but cold and frosty winters. In winter months, up to 25 days with frost per month can be expected. Therefore, it is assessed that de-icing agents will be used on this section of the motorway. On the other hand, Mostar is situated in the area with Mediterranean climate. Winters are very mild; temperatures rarely go below zero and snow is not common. Therefore, it is assessed that de-icing agents will rarely be used, if ever, and this impact is

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[14] Preliminary water consent no. UP/40-1/21-2/129/21 from 15.03.2022 issued by Agency for Watershed of the Adriatic Sea

considered to be not significant on the section between exit of the Prenj Tunnel to the Mostar North Interchange.

Table 8-8 provides a summary of potential impacts and assessment of their significance.

Table 8-8: Summary of potential impacts on waters and assessment of their significance before mitigation

Phase	Type of potential impact	Adverse/ Beneficial	Magnitude	Sensitivity	Impact evaluation	Significance (before mitigation)
Water						
Pre-construction	Perform the pre-construction water quality measurements from which change can be assessed as construction works progress	Adverse	Moderate	Medium	**Moderate**	**Significant**
Pre-construction / Construction	Increased pollution risks to surface water bodies from works within riverbed	Adverse	Moderate	Medium	**Moderate**	**Significant**
Construction	Reduction in water quality of Tresanica, Neretva and Konjicka Bijela due to direct release of pollutants generated in connection with construction actives. › Release of untreated groundwater drainage generated in the process of tunnel drilling › Sediment release during construction of motorway structures (embankments, cuts, bridges) › Sediment release into river systems during viaduct construction in	Adverse	Moderate	Medium	**Moderate**	**Significant**

Phase	Type of potential impact	Adverse/ Beneficial	Magnitude	Sensitivity	Impact evaluation	Significance (before mitigation)
	riverbed and on the banks, › Sediment release into river systems resulting from depositing of construction waste into the rivers, › Accidental spillages at the construction site caused by e.g., change of machine oils and lubricants, spillages in the storage site, etc. › Wastewater from concrete batching plant and asphalt mixing plant, › Sanitary wastewaters from workers' camps, and › Inappropriate disposal of different types of wastes on riverbanks					
Pre-construction / Construction	Change in river flow and recharge by cutting or diverting permanent and intermittent streams around the motorway structures	Adverse	Moderate	Medium	**Moderate**	**Significant**
Operation	Reduction in water quality in river system resulting from: › direct release of intercepted surface run-off › direct release of sanitary water from toll station	Adverse	Moderate	Medium	**Moderate**	**Significant**

Phase	Type of potential impact	Adverse/ Beneficial	Magnitude	Sensitivity	Impact evaluation	Significance (before mitigation)
	> accidental spill of hazardous material resulting from traffic accidents > use of de-icing agents in the Ovcari Interchange - Prenj Tunnel subsection					

8.4 Mitigation and Enhancement Measures

8.4.1 Pre-construction Phase

Pre-construction monitoring

Due to the timespan between preparation of this Study and start of construction works, up-to-date information on water quality in the Project areas will be needed to determine baseline conditions. The following actions must be implemented:

- Carry out the pre-construction water quality analysis of Tresanica, Neretva and Konjicka Bijela before the construction starts.
- Use the same monitoring parameters and points as described in this ESIA (Chapter 8.2.2)
- Carry out the water quality analysis in at least two hydrological cycles (low and high flows) as with the previous sampling and testing.

Note: The measure is in line with the Preliminary Water Consent.

8.4.2 Pre-construction/Construction Phase

River crossing

Develop a River Crossing Management Plan (RCMP) that includes a Specific Method Statement for river crossing. This statement shall provide details of the methods proposed to ensure dry working conditions and minimise risks to water quality as well as to aquatic flora and fauna, during works conducted in the riverbeds and on the banks:

- Limit the clearance of vegetation on the channel banks. Where works are required on the watercourse banks, or in-channel, vegetation clearance should be restricted to the working area and should be undertaken only immediately prior to the commencement of those works. Vegetation should be re-established as soon as practicable following construction. Use seeded biodegradable fibre matting to encourage re-vegetation after works on, or near, the banks.
- Until the beginning of the in-water works (applicable to the Neretva River on the Konjic bypass), preserve at least 20 m depth of bankside vegetation from the channel bank to protect bank stability.

- Avoid works to watercourses during high flow season and during heavy rainfall to reduce the risk of fine sediment release, watercourse erosion and increased flood risk.
- Create a dry-working area for works within a watercourse channel or within the floodplain wherever possible using structures such as cofferdams.
- Use in-channel coffer dams where appropriate and or silt management systems such as silt curtains within watercourses that require diversion or in-channel construction works.
- Direct access of vehicles to watercourses and banks should be restricted to those vehicles required as part of the construction activities. If it is necessary for any vehicle to enter a watercourse, it should be inspected in advance and, if required, remedial action taken to prevent contamination from oil/fuel leakages. All drivers should be instructed in the use and safe disposal of clean up equipment and carry absorbent materials in their vehicles and be trained for spill response.
- In accordance with the conditions specified in the Preliminary Water Consent, in locations where the route is closely situated next to watercourses or intersects them, on sections that pass through areas of moderate and high risk, it is mandatory to design vertical barriers to prevent vehicles from veering off the highway corridor (such as guardrails, blocks, New Jersey barriers, etc.).

Hydraulic connectivity

- Hydraulic connectivity must be maintained.
- When cutting off or otherwise controlling the water flow, ensure appropriate dimensioning of culverts for all identified intermittent streams that are crossed by motorway on embankment.
- When watercourse diversion is required maintain a temporary channel to maintain flow and connectivity whilst the permanent channel is prepared. Preserve the natural characteristics of the riverbed morphology. Avoid to a degree possible: (1) changes in the planned and realised length of intervention; (2) spatial and temporal variation in channel morphology; (3) changes in cross-section measurements; (4) changes in hydraulic parameters.
- In case of Suhi potok and river Bijela, construction of training structures shall be performed in the low flow season when the creek bed is dry.

Collection and treatment of surface run-off from motorway surface

- Design and construct a closed surface drainage collection and treatment system.
- Treatment units (oil and grease separators) to specifically cover the two viaducts over Tresanica and Neretva and the bridge over Neretva in Donje Selo.
- Treated wastewater shall not be discharged in the III sanitary protection zone of the protected Salakovac and Bosnjaci springs, as well as Crno Vrelo, Bijela and Gornja Bijela springs.

Collection and treatment of sanitary wastewater from toll stations and rest areas

- Design and construct connections between toll stations/rest areas and local water supply and sewerage systems, wherever they are available.
- If local water supply and sewerage systems are not available, design and construct a collection and treatment system for sanitary wastewater that uses biological treatment units before discharging the treated water into the environment.
- Treated wastewater shall meet the standards specified in the Regulation on the conditions for the discharge of wastewater into the environment and public sewage systems (Official Gazette of the FBiH, No. 26/20 and 96/20)
- Treated wastewater shall not be discharged in the III protection zone of the protected Salakovac and Bosnjaci springs, as well as in the direct influence zone of the officially unprotected Bijela spring.

8.4.3 Construction Phase

- In accordance with the conditions specified in the Previous Water Consent, prepare a construction site organisation project and construction technology and schedule that should include:
  - Site boundaries that should take into account, among other things, the need to protect sensitive areas from erosion, oil spills, water pollution, etc.
  - A system for the drainage of wastewater and stormwater from the construction site.
  - The most suitable locations for workshops, machinery bases, fuel and lubricant storage, and asphalt bases. Placing these facilities in high-risk water pollution zones is prohibited.
  - The construction work plan and construction technology must completely avoid the possibility of partially or fully filling up watercourses that the route intersects with or is located alongside.

Sediment release

- Avoid the positioning of stockpiles near to watercourses (minimum 50 m) and ensure they are located outside areas at fluvial flood risk.
- Contain stockpiles with bunds or sediment fences and cover stockpiles when not in use.
- Control runoff during construction. Provide sediment barriers between earthworks and the watercourse to prevent sediment from washing into the river. Use of silt fences, silt traps, filter bunds, settlement basins and/or proprietary units such as a "siltbuster" to treat sediment laden water generated on site before discharge shall also be implemented.
- Pass any water generated by dewatering processes through silt busters or sediment tanks, prior to discharging this water to the any watercourse. Additional treatment may be required if other pollutants are present or if these measures are not effective.

- Additional measures and pre-treatment required prior to discharging potentially polluted water from tunnel dewatering to include use of non-ecotoxic additives and oil separator. Sampling may be required prior to discharge to evaluate effluent quality in line with the conditions prescribed in the *Regulation on the conditions for the discharge of wastewater into the environment and public sewage systems (Official Gazette of the FBiH, No, 26/20 and 96/20)*.
- Access roads inside the construction camp should be located 60m from watercourses as far as practicable. Site roads and approaches to watercourse crossings should be kept free from mud and cleaning water should not be discharged to the watercourse.
- It is necessary to anticipate the use of only clean material for embankments near watercourses, in accordance with the conditions specified in the Preliminary Water Consent.

Accidental pollution

- Fuels and potentially hazardous construction materials should be stored in bunded areas with external cut-off drainage and fuel should be stored in double skinned tanks with 110% capacity. No hazardous materials shall be stored within 50m of a watercourse.
- Waste fuels and other fluid contaminants shall be collected in leak-proof containers prior to removal from site to a processing facility authorised by the Cantonal ministry responsible for environmental protection in accordance with the *Rulebook on issuing a permit for small business activities in waste management (Official Gazette of the FBiH, No. 9/05)*.
- Machine repairs and oil replacement must not be carried out on the construction site but in designated areas outside the zones defined as high-risk pollution zones. Oily waters must be treated to the level prescribed by the *Regulation on the Conditions for Discharging Wastewater into Natural Recipients and the Public Sewerage System* (Official Gazette of FBiH, No. 26/20, 96/20), in accordance with the conditions specified in the Preliminary Water Consent. Fuelling and maintenance of construction vehicles and plant (including washdown) shall be done on hard standing or on haul roads, with appropriate cut-off drainage and located at least 50 m away from watercourses. Drip trays should be placed beneath static plant such as generators and plant not in use. No plant should be stored within 50 m of a watercourse and no maintenance should be undertaken within 50 m of a watercourse.
- Spill kits in the form of oil absorbent booms and other spill containment equipment to be kept on site to be deployed in the event of a spillage, and site staff trained in their use.
- Concrete mixing and washing areas should be located more than 500m from any watercourse. Wastewater from these areas shall be intercepted and hauled to a licenced disposal facility authorised by the Cantonal ministry responsible for environmental protection in accordance with the *Rulebook on issuing a permit for small business activities in waste management (Official Gazette of the FBiH, No. 9/05).*

> Set up settling tanks at the concrete batching plant to treat the wastewater before discharging it. The treated wastewater shall meet the standards specified in the Regulation on the conditions for the discharge of wastewater into the environment and public sewage systems (Official Gazette of the FBiH, No. 26/20 and 96/20).
> No surface water runoff from construction working areas or sites that may contain fuels or other harmful substances shall be discharged to surface water receptors unless first subject to robust pre-treatment (physical and chemical treatment of harmful substances).

Wastewater from construction site and worker's camps

Used water from the construction site must be safely managed through a sewage system, collected in appropriate reservoirs, and treated either on-site or at remote facilities in accordance with the *Regulation on the Conditions for Discharging Wastewater into Natural Receivers and the Public Sewerage System* (Official Gazette of FBiH, No. 26/21, 96/20) as specified in the Previous Water Consent. This includes, among other things:

> Design and construct a system for collection and treatment of drainage water and sanitary wastewater inside the camps capable of treating water to national and project standards
> No surface water runoff from construction compounds should be discharged to surface water receptors unless first subject to robust pre-treatment.
> Provide portable toilets at construction site outside the worker's camp
> For the locations of construction bases, maintenance operations, and asphalt bases, separate water permits must be requested in accordance with the conditions specified in the Preliminary Water Consent.

Waste disposal

> Develop and implement a **Detailed Construction Waste Management Plan** (DCWMP) and put in operation waste management procedures to avoid inappropriate disposal of construction waste in and around the construction site. The content of a DCWMP is prescribed by the *Rulebook on construction waste* (*Official Gazette of the FBiH, No. 93/19)*.
> Implement measures for waste management specified under Chapter 15. This includes the measure of prohibiting the disposal of excavation materials within the water pollution risk zones (along the banks of watercourses, sanitary protection zones), as specified in the issued Preliminary Water Consent.

All above listed measures to be included in a **Construction Environmental and Social Management Plan** (CESMP)[15] and implemented accordingly.

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[15] Construction Environmental and Social Management Plan (CESMP) to be developed as a part of the Construction Site Organisation Plan (CSOP), to meet the national requirements in accordance with the national *Decree on Construction Site Organisation, Mandatory Documentation on Construction Site and Construction Work Participants*, as well as the EBRD and EIB E&S requirements. The minimum content is stipulated in the ESAP.

Daily visual monitoring of surface waters during the construction phase shall be maintained. The monitoring will visually detect inappropriate waste disposal and any visible changes in water colour or appearance, caused by increased release of suspended solids or accidental material spillage into the water.

The construction phase mitigation measures summarised above will significantly reduce the risk to surface water environment during the construction of the Project. However, it will be difficult to fully prevent the risk of increased sedimentation in watercourses that are crossed by the Project and will need works to be undertaken around the watercourse. These risks will however be temporary and unlikely to have significant or long/term impact to water quality. After implementation of mitigation measures it is anticipated that effects to surface waters are a result of the Project will be minor adverse during construction.

8.4.4 Operational Phase

Collection and treatment of surface runoff

Include in the **Operational Environmental and Social Management Plan** (OESMP)[16] the measures to properly operate and regularly maintain sanitary and drainage facilities. This includes regular cleaning of the separators, and regular monitoring of effluent quality in line with the requirements from the water permit. Operational Maintenance Plan also must contain the measures for mowing/herbicide treatment of neglected areas and their impact on water (if used), in line with the Preliminary Water Consent.

In accordance with the Preliminary Water Consent, the OESMP should also include a plan for winter maintenance procedures, taking into account the type of de-icing agents that must be compatible with the designated treatment facilities. The plans should define the locations of chemical storage facilities, which need to be outside high-risk zones.

In the **Operational Emergency Preparedness and Response Plan** (OEPRP)[17] include procedures to prevent contamination of waters from accidental spills.

The operational phase mitigation measures proposed for the design of the Project are considered sufficient to manage all likely impacts to the surface water environment to negligible levels.

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[16] The purpose of the OESMP is to ensure compliance with the EBRD's Performance Requirements (PRs) and relevant national and EU legislation during the operational phase. The minimum content is stipulated in the ESAP.

[17] The EPRP sets out policies, laws, and standards related to emergency response in order to reduce harm to society or the environment. The minimum content is stipulated in the ESAP.