Updated Biodiversity Impact Assessment, Morava Corridor Motorway Project, Serbia

Final report

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Cover Photo: Image of Striped Nerite (*Theodoxus transversalis*) along Velika Morava River © Zoltán Fehér

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Executive summary

Introduction

1) This report is the updated Biodiversity Impact Assessment for the Morava Corridor Motorway Project (the Project) in the Republic of Serbia. The Project is a 112 km motorway to be developed in the West Morava River Valley. The Project is aligning with the International Finance Corporation (IFC) Performance Standards, including Performance Standard 6 (PS6) on Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC 2012), and will aim to achieve a net gain for Critical Habitat-qualifying biodiversity and no net loss for Natural Habitat.

2) This report aims to:

   (i) refine the Natural and Critical Habitat mapping undertaken in the Critical Habitat Assessment (CHA), based on additional data from field and eDNA studies to support the estimation of residual impacts;

   (ii) quantify and assess the significance of residual impacts to Critical Habitat-qualifying biodiversity, Natural Habitat, and stakeholder priority biodiversity;

   (iii) identify opportunities for further mitigation; and

   (iv) provide offset targets for achieving net gain and no net loss requirements under IFC PS6.

Refinement of the aquatic Critical Habitat map

3) The aquatic Natural and Critical Habitat map was updated for the residual impact assessment, incorporating additional data obtained from rapid field studies and eDNA studies. Further detail on the approach undertaken for the field studies is given in Appendix 1 and the memo interpreting the eDNA study results (TBC 2021).

4) Field-based habitat suitability studies for the priority species did not confirm the presence of the Striped Nerite (*Theodoxus transversalis*) in the Zapadna Morava River. Although suitable habitat exists, the species may not be present in some areas where there is suitable habitat due to deteriorating water and habitat quality. Further analysis of debris samples and community associations, and river water quality data suggests that Section 3 is unlikely to support populations of *T. transversalis*. The eDNA analysis results provided further evidence that *T. transversalis* is not present in Sections 3 and 2 as it was not picked up by the invertebrate primer used (where other small-bodied snails were) (TBC 2021). Unfortunately, the eDNA analysis was unsuccessful in Section 1 of the river, and therefore inconclusive. However, based on expert knowledge and opinion along with the other results, it is concluded that it is very unlikely that *T. transversalis* is present in any of the sections of the Zapadna. Therefore, the Zapadna Morava is considered as Natural Habitat.

5) A residual impact assessment was undertaken based on the following:

a) Suitable habitat was considered to be an appropriate proxy[1] for assessing impacts to Critical Habitat-qualifying species; permanent mesotrophic pastures and aftermath-grazed meadows was used for the Domogled Meadow Bush Cricket (*Broughtonia domogledi*), karst limestone habitat for the karst snails (*Chilostoma kollari*, *Xerocampylaea zelebori*, *Macedonica frauenfeldi*, *Agardhiella serbica*), and river habitat species of stakeholder concern. The impact assessment therefore focused on Critical and Natural Habitat[2]. The potential impact on the Gornje Pomoravljein Key Biodiversity Area (KBA) was also assessed.

b) The residual impact assessment (RIA) accounts for the main direct impacts of the Project from permanent and temporary infrastructure (infrastructure components, Table 1) to terrestrial and aquatic habitat. The main direct impacts assessed include habitat loss and fragmentation from development of the Project infrastructure; habitat degradation around the Project footprint; and the potential introduction of invasive species.

c) Impacts to river habitat originate from instream construction works which include three different river structures: river cut offs, dikes, and bank protection structures plus downstream and upstream hydrology related impacts. Each of these structures have different levels of impact, for example, the river meanders cut offs will result in total loss of river habitat as the river habitat will be converted into a wetland type habitat, while the remaining straightened sections of the Zapadna Morava River will incur a partial loss of habitat integrity. Bank protection structures and dikes will also result in a partial loss of habitat integrity.

d) The areas of terrestrial Critical and Natural Habitat impacted by the Project were calculated by overlaying the project infrastructure footprint with the CH/NH/MH map. Buffers were placed around the infrastructure components to account for habitat degradation. Under the Project footprint a total loss of habitat was assumed, while within the buffer areas a partial loss of habitat quality was assumed. The results of the analysis were converted into a Quality Hectare (QH) metric (area x quality) to provide the final residual impact and offset targets (ICMM & IUCN 2013); habitat quality was estimated based on expert opinion and a review of Project and grey literature.

[1] A proxy is an alternative measure used as a surrogate or stand in for a variable that is difficult to measure

[2] Natural habitats include; River habitat (the Zapadna Morava river system), karst limestone habitat (also Critical Habitat), riparian and gallery woodland, thermophilous deciduous woodland, permanent mesotrophic pastures and aftermath-grazed meadows (also Critical Habitat), naturalized ponds.

e) To account for the variability in current habitat quality between the various sections of the river that will be affected by river regulation work and to account for the variability in impacts created by the river regulation infrastructure, residual impacts to river habitat were quantified based on a quality and area metric ('Qkm'). Baseline Qkm was established for each river section and then a river regulation factor applied to account for the effect of each type of river regulation structure. Degradation upstream and downstream was accounted for using a similar buffer approach to terrestrial habitats and all sections added to provide an overall residual impact for river habitat.

6) A summary of the residual impacts and offset targets for terrestrial habitats is presented in the table below. The Project is estimated to result in a loss of 26 hectares (ha) (equivalent to 16 QH) of Permanent mesotrophic pastures. The largest overall impact is to riparian and gallery woodland (337 QH). There is no karst limestone habitat that will be impacted by the Project (and therefore no risk of impact on the four Critical Habitat-qualifying karst snails), (TBC 2020).

Habitat types	Impact (ha)	Residual impact (QH = area × 0.6)	Offset target
Critical Habitat			**Net Gain**
Permanent mesotrophic pastures and aftermath-grazed meadows	26.1	15.7	Greater than 15.7 QH
Natural Habitat			**No Net Loss**
Highly artificial non-saline standing waters (naturalised ponds)	9.5	5.7	Equal or greater than 5.7 QH
Riparian and gallery woodland	562.4	337.5	Equal or greater than 337.5 QH
Thermophilous deciduous woodland	390.3	234.1	Equal or greater than 234.1 QH

7) A summary of the residual impacts and offset targets for the Zapadna Morava River is presented in the table below. The Project is estimated to result in an impact to 76.5 kilometres (km) of river equivalent to 55.2 QKm of Natural Habitat.

Habitat type	Length (km) of river to be impacted	Baseline Qkm of river impacted	River regulation factor	Residual impact (Qkm)	Offset target
Natural Habitat (River regulation Sections 1, 2 and buffers)					
River	41.3	28.4	Ranging between 0.1 - 0.3	9.6	Equal or greater than 9.6 Qkm
Natural Habitat (River regulation Section 3)					
River	35.2	26.8	Ranging between 0.38 - 1	16.3	Equal or greater than 16.3 Qkm

8) Results of this assessment is an update to the ESIA (2U1K 2020), providing a precautionary approach to assessing residual impacts by accounting for habitat degradation impacts that extend beyond the infrastructure footprint. It also focuses on the Critical Habitat-qualifying biodiversity and Natural Habitat to provide targets for no net loss and net gain requirements under IFC PS6.

9) Technical modelling of downstream impacts to the Gornje Pomoravljein Key Biodiversity Area (KBA) located 13.6km downstream of river regulation works has not been undertaken. However, based on expert opinion and available information, the Project is unlikely to affect the KBA, due to its distance downstream from Section 1 where the closest instream river regulation works will take place. The effects of the river straightening in this section are expected to dissipate before reaching the KBA, and the effects of the channel straightening will likely be buffered by the increase in the hydrological capacity of the Velika Morava River downstream of the confluence of the Zapadna Morava and Južna Morava rivers.

Opportunities for additional mitigation measures

10) The residual impact analysis shows the infrastructure types that will create impacts to Natural and Critical Habitat and highlights opportunities to engage with engineers and project designers to make alterations to the layout of the infrastructure. Consultation with experts[3] on the *T. transversalis, Astacus astacus* and *Unio crassus* was undertaken to identify additional appropriate measures to minimise impacts on the stakeholder concern species. Opportunities for further mitigation measures were identified as follows:

    a) Avoidance: Relocate infrastructure components such as borrow areas, quarries, and access roads away from areas of Critical Habitat and Natural Habitat where possible. Quarry sites located in Thermophilous forest habitat for example could be reviewed for alternatives and relocated, reducing impacts to this Natural Habitat type.

    b) Minimisation: There may be further opportunity to minimise impacts though design of the new canalised sections of the river by maximising their potential to provide suitable habitat for wildlife. It is recommended that this area of design is reviewed through the ongoing design process for the river regulation by Jaroslav Ceri Institute (JCI). It may also be helpful to consult with outside resources such as The River Restoration Centre (https://www.therrc.co.uk/) who specialise in advice for river restoration activities.

    c) Minimisation: Undertake pre-disturbance surveys in mesotrophic pasture areas for the Domogled Meadow Bush-cricket by an insect specialist to confirm presence and provide additional recommendations to protect the species if present.

    d) Minimisation: Translocate *A. astacus* from impacted river sections to sections of river and tributaries (e.g. Čemernica River) that would not be impacted by the river regulation

[3] V. Djikanovic (*U. crassus, A. astacus*), K. Zoric (*A. astacus*), & Z. Fehér (*T transversalis*)

works, and to existing naturalised ponds that could potentially provide suitable habitat for populations of *A. astacus* and remove the pressure from the threat of invasive crayfish *Faxonius limosus*. If undertaken, translocation of the species would require further studies on the carrying capacity of the Zapadna Morava River and/or tributaries and should be carried out using the IUCN reintroduction and translocation guidelines (IUCN/SSC 2013). Translocation of *U. crassus* is not recommended due to the low likelihood of success of this measure for these species combined with the high cost and the level of effort required to collect and translocate the species.

e) Minimisation: Develop an Invasive Species Management Plan as part of the Biodiversity Management and Monitoring Plan detailing measures to minimize the spread of invasive species aquatic mussel and crayfish species (*Faxonius limosus, Corbicula fluminea* and *Sinanodonta woodiana*).

f) Offsets: Develop a Biodiversity Offset Strategy to support the development of biodiversity offsets to compensate for residual impacts and achieve a no net loss for Natural Habitat (riparian and gallery woodland, thermophilous deciduous woodland, Zapadna Morava River), and net gain for Critical Habitat (permanent mesotrophic pastures and aftermath-grazed meadows).

It is recommended that the Project provide an opportunity for the Institute of Nature Protection to review and agree on the additional mitigations for identified priority biodiversity, in particular for species which are listed as "strictly protected".

Recommended additional actions

g) Develop a terrestrial and river rehabilitation plan with indicators to enable the Project to track rehabilitation outcomes in terms of extent (area) of rehabilitation by habitat type and the quality or condition of those areas to support compensation of residual impacts.

h) Develop appropriate monitoring indicators and measures to assess downstream changes to instream and riparian habitat. Instream indicators would include suspended sediment and turbidity, and in situ water quality parameters such as Electrical Conductivity, Total Dissolved Solids, pH and dissolved oxygen. Riparian indicators would include percentage cover of riparian cover and riparian integrity, and geomorphology would include the monitoring of the reinstatement of the banks sections to align as closely with the form of the banks upstream and downstream. Plus, eDNA surveys to detect ongoing presence/absence of the priority species in the 3 sections. If monitoring results show a declining trend in erosion, suspended sediments, or water quality then the Project should adaptively manage the instream regulation by applying suitable management measures.

i) To date no detailed targeted studies have been conducted for the priority species under pre-disturbance conditions, and limited opportunity exists for implementation of studies before construction start due to seasonal constraints. An eDNA study was carried out to verify findings of the rapid field survey to understand the distribution and relative

abundance of priority species (*T. transversalis, U. crassus and A. astacus*) and assist the Project to track changes in these species over time (TBC 2021).

1 Introduction

This updated Biodiversity Impact Assessment (BIA) is undertaken for the Morava Corridor Motorway Project (the Project) in the Republic of Serbia (Serbia). The Project is required to align with International Finance Corporation (IFC) Performance Standards, including Performance Standard 6 (PS6) on Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC 2012).

The Project identified biodiversity risks based on a Critical Habitat Assessment (CHA) (TBC 2020) and through subsequent rapid field survey work (Appendix 1, Djikanovic *et al.* (2020)). This resulted in the identification of six Critical Habitat-qualifying species, and two species of stakeholder concern. Natural and Modified Habitat was also identified with some areas of Natural Habitat supporting populations of Critical Habitat (CH)-qualifying species, thus being identified as Critical Habitat. To align with IFC PS6, the Project will aim to achieve a net gain for Critical Habitat and no net loss for Natural Habitat.

1.1 Purpose and scope of this report

This BIA is one of four deliverables that will be prepared as part of the Supplemental Biodiversity Assessment by The Biodiversity Consultancy (TBC). This BIA will update the existing Biodiversity Impact Assessment, focusing on CH-qualifying biodiversity (including habitats and species), Natural Habitat (NH), and stakeholder priority biodiversity, by undertaking the following:

- Refine the map of aquatic Natural/Critical Habitat undertaken in the CHA, based on additional data from field studies to support the estimation of residual impacts;
- Quantify and assess the significance of residual impacts to Critical Habitat-qualifying biodiversity, Natural Habitat, and stakeholder priority biodiversity (residual impact assessment);
- Identify opportunities for further mitigation; and
- Provide offset targets for achieving net gain and no net loss requirements under IFC PS6.

1.2 Description of the Project

The Project is a 112 km motorway to be developed approximately 200 km south of Belgrade city, in the West Morava River Valley. The motorway will run from the Pojate village to Preljina near Čačak city, along a 900 metre (m) right of way.

The Project will include construction of the following permanent structures: (i) above ground structures such as bridges, and overpasses; and (ii) hydrotechnical structures, including 'cut-offs' (straightened, channelised sections of river), revetments and embankments to prevent flooding

and erosion of the Zapadna Morava River. Minor upgrades/movement to some existing high voltage power lines will be undertaken, with no new infrastructure or re-alignment required.

Temporary site facilities such as quarries and borrow areas, camp sites and storage areas, crushers, concrete batching plants and asphalt plants, and access roads will also be installed for the construction phase of the Project.

The Project is jointly designed and built by Bechtel and ENKA (BEJV) with river regulation designed by JCWI. The Project is owned by the Ministry of Construction, Transport and Infrastructure and Corridors of Serbia.

2 Refinement of the aquatic Natural and Critical Habitat map

2.1 Approach

The Zapadna Morava river system in the Area of Analysis (AoA) was classed as Critical Habitat in the CHA (TBC 2020) due to the potential presence of the Striped Nerite snail (*Theodoxus. transversalis*). However, since this time, field surveys and eDNA surveys have concluded that *Theodoxus. Transversalis* is very unlikely to be present in the Zapadna Morava river system. Therefore, the Zapadna River is classified as Natural Habitat.

Rapid field and eDNA studies were undertaken to:

- Verify the desktop habitat classification of the Zapadna Morava River in the AoA using the Index of Habitat Integrity methodology (IHI – Kleynhans, 1996).
- Scope suitable habitat for priority species (*Theodoxus transversalis*, *Unio crassus* and *Astatus astacus*) in sections of the Zapadna Morava River and major tributaries that will be directly impacted by the Project.
- Identify presence or absence of the three priority aquatic species using eDNA analysis in the three Sections of the river.

The aquatic Natural and Critical Habitat map was subsequently updated for the residual impact assessment, incorporating additional data obtained from rapid field studies and eDNA survey results. Further detail on the approach undertaken for the field studies is given in Appendix 1 (Djikanovic *et al.* 2020) and in the interpretation of the eDNA results (TBC 2021).

2.2 Findings

The field-based habitat suitability studies for the priority species did not confirm the presence of *T. transversalis* in the Zapadna Morava River. Based on initial analysis of debris samples and community associations, it appears very unlikely that *T. transversalis* is currently present in the Zapadna Morava River in Section 3. Debris samples were not able to be taken in Sections 1 and 2. Water quality data from the Environmental Protection Agency (Ministry of Environmental Protection, Republic of Serbia) in 2018 (http://www.sepa.gov.rs/index.php) and the Project ESIA

further shows that the Zapadna Morava is impacted by suspended sediments, nutrients and some heavy metals. *T. transversalis* reportedly does not tolerate water which contains increased suspended particles that deposit on substrate, or eutrophic waters (Solymos & Feher 2011). The eDNA analysis results provided further evidence that *T. transversalis* is not present in Sections 3 and 2 as it was not picked up by the invertebrate primer used (where other small-bodied snails were) (TBC 2021). Unfortunately, the eDNA analysis was unsuccessful in Section 1 of the river, and therefore inconclusive. However, based on expert knowledge and opinion along with the other results, it is concluded that it is very unlikely that *T. transversalis* is present in any of the sections of the Zapadna. Therefore, the Zapadna Morava is considered as Natural Habitat.

U. crassus was confirmed in Sections 1 and 3 of the river regulation works through field verification and was confirmed as present in all three sections of the river from the eDNA analysis (TBC 2021). *A. astacus* was not sampled (due to dangerous water levels) in the field studies, and not picked up in the eDNA results. It is thought that this is due to very low amounts of crayfish DNA in the river water at this time in the year[4]. However suitable habitat was reported, and stakeholders confirm their presence in the Zapadna Morava River, therefore based on expert opinion and stakeholder knowledge *A. astacus* is likely to occur along the length of the Zapadna Morava River and is assumed to be present.

3 Residual Impact Assessment

3.1 Scope of the assessment

Project scope

Residual impacts were estimated for the permanent structures and temporary site facilities (infrastructure components) of the Project (Table 1). Information on the infrastructure components were based on the ESIA design (2U1K 2020) and additional more up-to-date information on river regulation structures provided by Bechtel-Enka Joint Venture (BEJV).

This assessment does not include any high voltage power lines, as this work was identified as minor upgrades with no new components or re-alignment[5].

Table 1. Project components included in this residual impact assessment.

Project component	Description
Motorway	A c.112km highway running from Pojate village to Preljina near Čačak city. The width of the road corridor was calculated as the 30m wide motorway, the 5m emergency zone on

[4] Not crayfish species were picked up by the eDNA analysis, and it is known that a number of crayfish species definitely are present in the river. In colder temperatures, crayfish tend not to shed, and therefore are less likely to be picked up in eDNA samples.

[5] In the E&S action tracker (Ramboll 2020), planned high voltage power lines were originally identified as a potential impact to birds from collision with the lines. However, this was resolved by the understanding that only a minor re-alignment of existing high voltage lines at a single location was required. This was subsequently assessed as having no additional impact from the Project.

Project component	Description
	each side, and a construction corridor of 20m. Total habitat loss is expected within this road corridor.
River regulation structures	Hydrotechnical structures on the Zapadna Morava River include river (meander) cut offs, dikes and bank protection to support river regulation and drainage control. Eighteen hydrotechnical structures are planned in total, the largest being an area of river regulation in Section 3 of the Zapadna Morava River between Adrani and Preljina totaling 35.2 km (see Appendix 2 for full list). Each type of structure will have different impacts to the river habitat; these differential effects are described and accounted for in the approach to the assessment (see Section 3.2.4)
Asphalt plant	Facilities to produce or support the production of asphalt, subbase, beams and batching to construct the motorway foundation and subbase/base.
Subbase plant	
Concrete batching plant	
Beam Plant	
Screen-wash plant	
Crusher	Machine designed to reduce the size of rocks and stones extracted from quarries and borrow areas.
Quarry	Areas for the extraction of primary road construction materials (sand, gravel, clay).
Borrow area	
Camp Area	Campsites to accommodate a maximum of 3,800 workers.
Precast Yard	Areas to store precast concrete for construction of the motorway.
Temporary access roads	Temporary access roads to connect existing local/national roads to access construction areas. The width of the access road corridor was considered as 10m, the general width of a standard two-way road

Biodiversity scope

The residual impact assessment focuses on Critical Habitat-qualifying biodiversity and Natural Habitat identified in the CHA at risk of Project impact (TBC 2020), as these are subject to net gain and no net loss requirements under IFC PS6.

The species that qualify for Critical Habitat are dependent on a particular habitat type for their survival, this makes habitat a good proxy for assessing impacts to these species as well as for wider biodiversity values. The Domogled Meadow Bush Cricket (*Broughtonia domogledi*) requires permanent mesotrophic pastures and aftermath-grazed meadows, the karst snails (*Chilostoma kollari, Xerocampylaea zelebori, Macedonica frauenfeldi, Agardhiella serbica*) require karst limestone, *T. transversalis* (and species of stakeholder concern) requires river habitat with good water quality, oxygenation and a hard substrate. The residual impact assessment therefore assesses impacts to habitat as a proxy for all biodiversity impacts including to Critical Habitat-qualifying biodiversity.

A summary of the habitats assessed and the CH-qualifying species they act as proxies for is presented in Table 2 below.

Table 2. Summary of Critical and Natural Habitats assessed and the CH-qualifying species they act as proxies for.

Habitat type	CH-qualifying species associated with the habitat type	Critical Habitat	Natural Habitat
River habitat, Zapadna Morava River	None (species of stakeholder concern Noble Crayfish (*Astacus astacus*), and Thick Shelled River Mussel (*Unio crassus*) [6]		√
Karst limestone	*Chilostoma kollari, Xerocampylaea zelebori, Macedonica frauenfeldi, Agardhiella serbica*	√	
Permanent mesotrophic pastures and aftermath-grazed meadows	*B. domogledi*	√	
Riparian and gallery woodland	None		√
Thermophilus deciduous woodland	None		√
Highly artificial non-saline standing waters (naturalised ponds)	None		√

Internationally recognised areas of high biodiversity value

The CHA included the Gornje Pomoravljein Key Biodiversity Area (KBA) which is situated c.13.6km downstream of the final river regulation works within the on the Velika Morava River in the AoA. The KBA was included in the impact assessment as concerns were raised that it may be impacted by river regulation works upstream.

Impact scope

The residual impact assessment accounts for the main direct impacts of the Project based on our review of the ESIA (2U1K 2020) and the PS6 ESDD Tracker (Ramboll 2020), and is summarised in Table 3.

During the construction phase of the Project, workers will be accommodated in camps close to urban settlement areas. The construction phase is not anticipated to result in any population influx beyond these urban settlements and therefore indirect impacts to biodiversity are not anticipated during the construction phase. During the operational phase of the Project, people are predicted to migrate out of the area due to loss of their agriculture land, while the improved connectivity, greater mobility and better rural-city connections as a result of the Project is expected to attract people into the area. The ESIA does not provide information on where any impacts may occur. It is more likely that any influx would be associated with urban areas and therefore have a minimal impact on natural resources. To provide assurance that indirect impacts are minor, the Project may consider monitoring changes to the extent of Natural Habitat across the landscape.

[6] *T. transversalis is confirmed not to be present in the Zapadna Morava River and therefore not impacted by the river regulation works.*

Indirect impacts to freshwater biodiversity and river habitats e.g. increase to fishing or other pressures on river habitats, are not anticipated and have therefore not been included in the assessment. Downstream changes resulting from river regulation are included and are based on anticipated changes to downstream hydrology, habitat, and functionality of the Zapadna Morava River in Sections 1 – 3. Hydrological modelling of downstream impacts has not yet been completed (currently undergoing and due to be completed in mid 2021), and therefore the assessment is based on information available and expert opinion. The downstream effects are anticipated to include hydrological and water quality changes, a decrease in habitat heterogeneity and changes to ground-surface water interactions for approximately 2km downstream of Section 3, and 1km downstream of Section 2 and Section 1.

Table 3. Summary of key Project impacts included in this residual impact assessment

Key Project impacts	Terrestrial Natural Habitat	Terrestrial Critical Habitat	River Natural Habitat	River Critical Habitat
Habitat loss and fragmentation due to development of infrastructure components	√	√	√	√
Habitat degradation due to reduction in air quality (e.g. dust)	√	√		
Habitat degradation due to reduction in water quality and changes in hydrology			√	√
Wildlife disturbance due to noise and vibration	√	√		
Introduction of invasive species	√		√	√

3.2 Approach to the assessment

3.2.1 Use of a static baseline

The Project is located in a dynamic landscape where people have been living for centuries, as a result there are multiple existing towns and roads and ongoing development activities from industrial activities (e.g. mining and metals) to agricultural activities (e.g. growing of grain crops such as maze, wheat, and barley). Approximately 72% of land in the area immediately under and around the Project infrastructure is now Modified Habitat (Table 4). Although habitat conversion rates have not been assessed, it is likely that there is an ongoing background rate of conversion.

As a result of human activities, river habitat is degraded particularly in sections of the river close and downstream to existing towns where there is a lower water quality compared to sections further away (Appendix 1) (Djikanovic *et al.* 2020); quality is likely to continue to decline as populations and industrial activities continue. Despite the likely ongoing background declines to

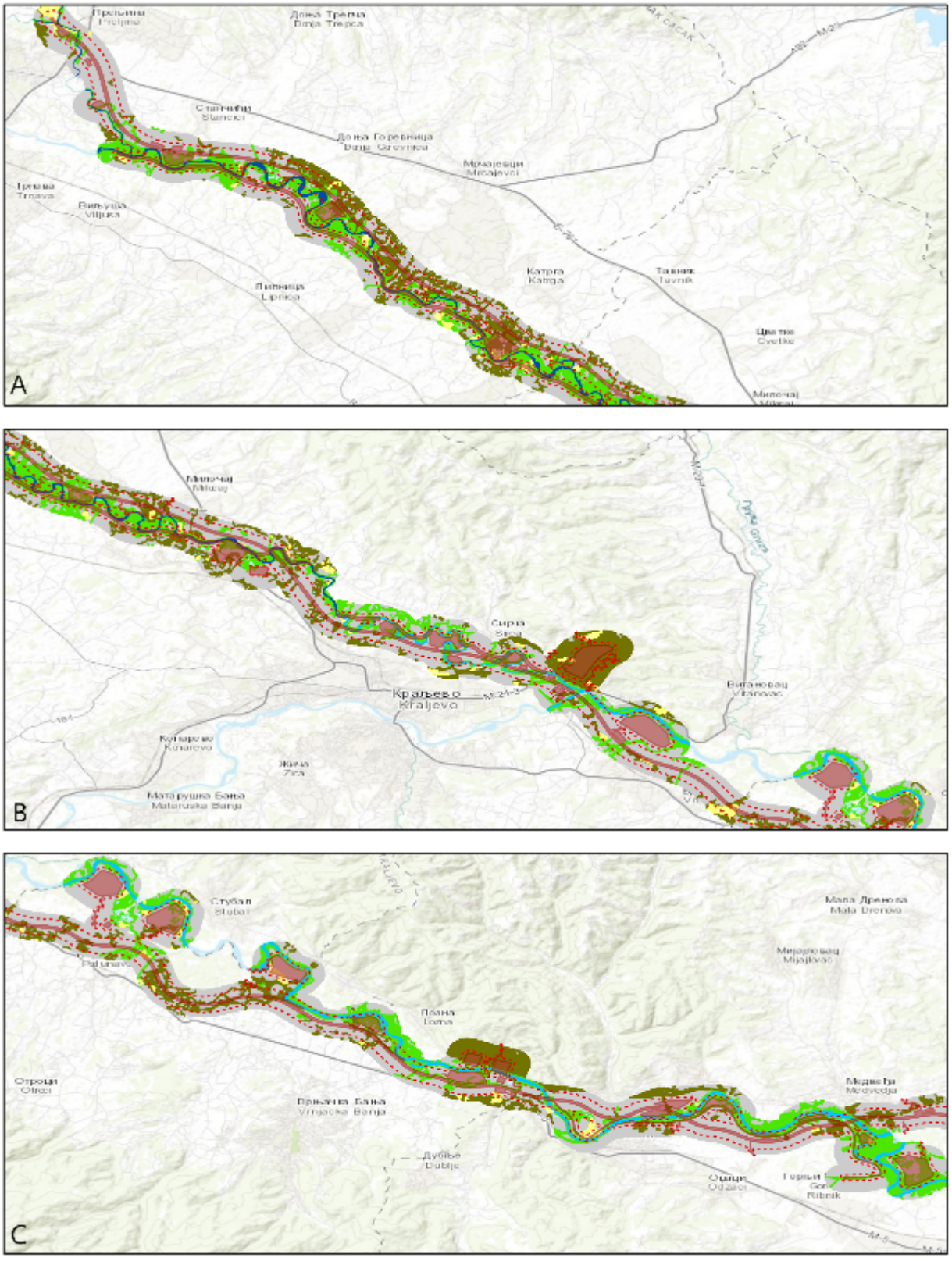
terrestrial and river habitat quality, a static baseline has been used in the quantification of residual impacts; this is considered to be a precautionary approach.

Table 4. Area (ha) of the terrestrial habitat types in the Project footprint and buffers

Habitat type (EUNIS)	Area in Project footprint and buffers (ha)
Highly artificial non-saline standing waters (naturalised ponds)	46
Modified Habitat	6804
Permanent mesotrophic pastures and aftermath-grazed meadows	90
Riparian and gallery woodland	1508
Thermophilous deciduous woodland	961
Total	**9409**

3.2.2 Calculation of residual impact for terrestrial habitats

The direct footprint of all infrastructure components of the Project (Table 1) was based on the spatial data from the ESIA. The impact to terrestrial habitat (Critical and Natural) was calculated by overlaying the Project footprint layer with the habitat map. To account for habitat degradation arising from the construction activities, buffers were defined and applied around the Project footprint (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Total loss of habitats was assumed to occur under the direct footprint. Within the buffer area, it is expected that there will only be habitat degradation, hence a partial and not total loss of habitat occurring. Where the buffers overlapped for terrestrial infrastructure components, they were merged to form a single buffer area. Where buffers for terrestrial infrastructure overlapped with buffers for the river regulation structures, the river regulation degradation affect was applied as this a more significant effect.

The buffer sizes and percentage of the habitat loss applied, and rationale for selection is presented in Table 5 below.

Table 5. Buffer sizes and proportion of the total habitat loss applied to the Project footprint, and rationale for selection

Project component	Buffer sizes (m)	% of the habitat loss in buffer	Rationale for selection and any additional notes
Terrestrial infrastructure components			
Motorway	250 (each side of road)	10	Reasonable representation of the extent of construction and operational-phase noise and dust impacts to wildlife, for e.g. the extent of noise emissions between c.50-55 dBA derived from the Project's noise modelling results was considered (2U1K 2020).
Asphalt plant	100	10	Reasonable representation of extent of dust impacts to vegetation, and the rapid reduction of dust impacts away from the source.
Subbase plant	100	10	
Concrete batching plant	100	10	
Beam Plant	100	10	
Screen-wash plant	100	10	
Crusher	100	10	
Quarry	100	10	
Borrow Area	100	10	
Precast Yard	100	10	
Camp Area	20	10	Reasonable representation of the limited extent of impact due to appropriate controls in place, e.g. the camp area will be fenced-off thus limiting impact along the boundary of the facility.
Temporary access roads	50 (each side of road)	10	Reasonable representation of extent of dust impacts to vegetation, and the rapid reduction of dust impacts away from the source.
Infrastructure components associated with river regulation but with impacts to terrestrial habitats			
River regulation structures (river cut offs, dikes and bank protection)	Lateral buffer: 100m (each side of riverbank)	60 (within the first 50m closest to structure) 20 (within the next 50m furthest from structure)	The buffer accounts for the reduction in impacts to riparian habitat away from the source with the biggest disturbance expected to occur close to the source. Disturbance will be more intensive closest to the structure due to the movement of heavy machinery, construction of temporary platforms etc and of lower intensity further away.

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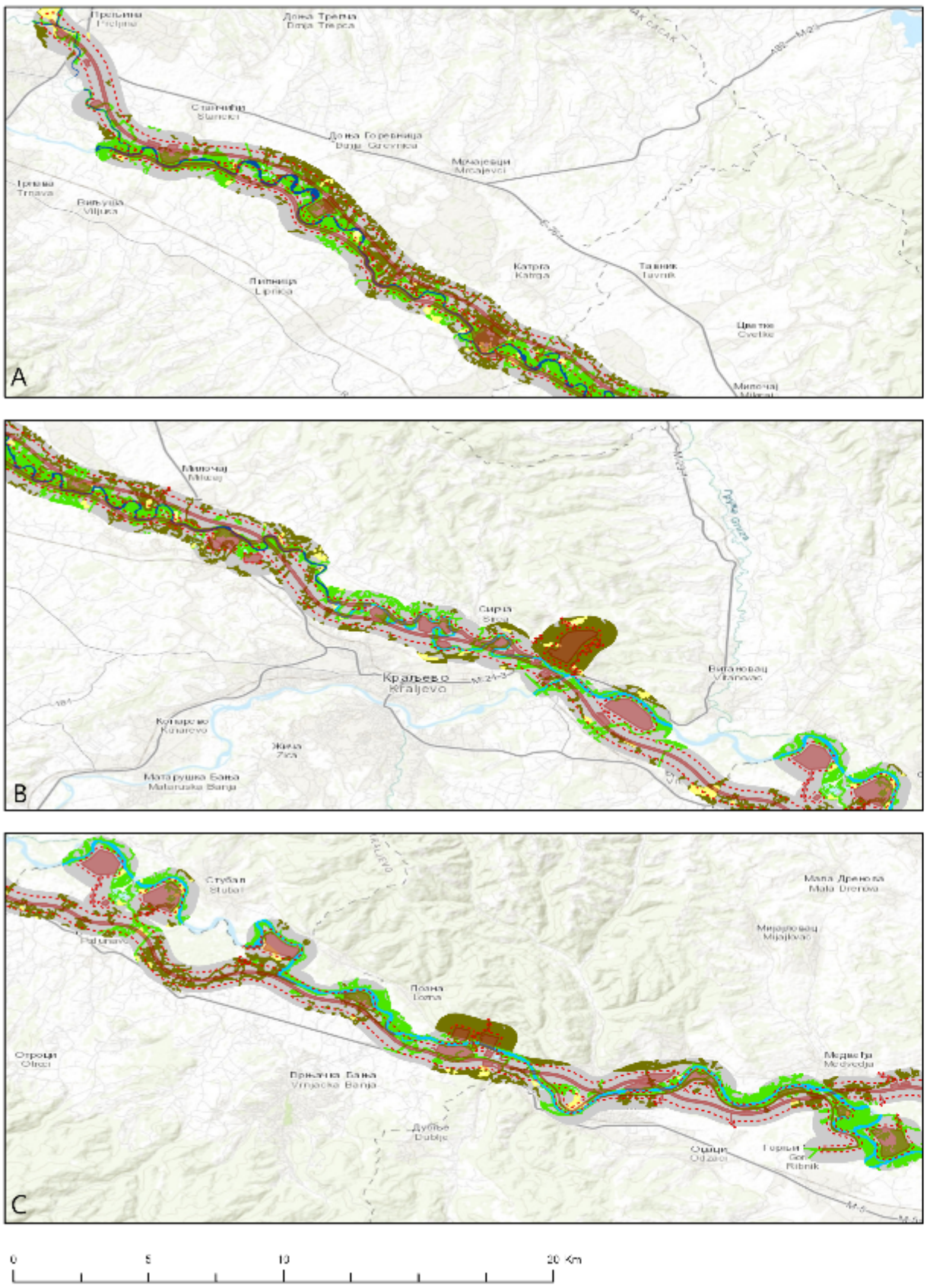

Figure 1. Extent (area) of Critical Habitat and Natural Habitat impacted by the Project

3.2.3 Application of a quality hectare metric for terrestrial habitats

Residual impacts are usually expressed not just in terms of area but also in terms of quality or condition. Adding a measure of quality ensures that when habitat losses are exchanged for gains through restoration and offset activities there is a fair and equivalent exchange. Habitat 'area × condition' metrics or quality hectares (QH), is a common and widely accepted means to account for habitat complexity through a standardised approach (e.g. Parkes *et al.* (2003); Temple *et al.* (2012)).

The QH approach uses a combination of two measures: area (refer to Section 3.2 for how to calculate this area) and condition (or quality). In this metric, a theoretical "benchmark" habitat is considered the highest quality, at 100% condition. A degraded habitat is then considered at a lower percent condition. For example:

- 10 ha of highest possible condition habitat (100% quality) = 10 × 1 = 10 QH
- 10 ha of degraded habitat at 50% quality = 10 × 0.5 = 5 QH
- 10 ha of highly degraded habitat at 25% quality = 10 × 0.25 = 2.5 QH

The majority of habitat (c.72%) in the Project footprint and buffers is Modified Habitat comprising agricultural areas and areas heavily modified by human activities (Table 4) (TBC 2020). Natural habitat is restricted to small patches in the West Morava Valley and is under pressure from agricultural, commercial and residential activities. As the terrestrial habitats are highly fragmented and have undergone historic, long-term degradation (Ministry of Environment and Spatial Planning 2011; Republic of Serbia 2014), the condition/quality of the habitat is precautionarily estimated to be **60%** of the benchmark quality for all terrestrial habitat types and naturalised ponds.

3.2.4 Calculation of residual impacts for river habitat

The new river sections will be reinstated to include riverbeds with specific bed material that is characteristic of the natural environment, and vegetated banks that resemble the features of the natural reaches of river. The management measures for the new river sections and the river rehabilitation will be part of the BMP. To account for the variability in current habitat quality between the various sections of the river that will be affected by river regulation work and to account for the variability in impacts created by the river regulation infrastructure, the following approach was applied to assess residual impacts:

1. Baseline river habitat quality was calculated for each of the river sections where river regulation works will be undertaken, and this quality was used to calculate the Quality Kilometre (Qkm) for each river section;

2. The effect of river regulation was estimated for each of the three types of river regulation structure (cut off meanders, dikes and river-bank protection);

3. Upstream and downstream buffers were added in each section of the river to account for instream degradation from the river regulation works;

4. For each section the baseline habitat quality was multiplied by the effect of the river regulation or the effect of upstream or downstream degradation to provide a residual impact figure for each section and these were then added together to provide a total river habitat residual impact (divided into Critical Habitat and Natural Habitat).

1. Baseline habitat quality and QKm

A semi-quantitative assessment of river habitat was undertaken under baseline conditions at each river section along the road alignment in October 2020. The assessment categorised riparian habitat quality and instream habitat quality in each section using the Index of Habitat Integrity (IHI – Kleynhans 1999). Habitat quality classes are based on signs of disturbance, and ranged from "natural" to "critically disturbed" (Table 6). The baseline IHI (quality) of freshwater habitat in the upper AoA is rated **"moderately modified"** (Table 7) i.e. it has lost some of its Natural Habitat qualities mainly due to the loss of riparian vegetation.

Table 6: Ecological categories, key colours and category descriptions presented within the habitat assessment which were used indicate habitat quality for the RIA calculation (adapted from Kleynhans, 1996)

Category		Description	Score (%)
A	Natural	Unmodified, natural.	90-100
B	Largely Natural	Few modifications, small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately Modified	A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely Modified	Large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously Modified	The losses of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Critically Modified	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	<20

Table 7: Habitat classification summary for rivers in the AoA, October 2020 (Djikanovic et al. 2020)

River Section (aligned with Project Sections)	Ecological category for river section based on field results (IHI – Kleynhans (1999)	Habitat integrity (IHI %)
Section-1: Pojate – Kruševac (Koševi)	C category	68
Section-2: Kruševac (Koševi)-Adrani	C category	69

River Section (aligned with Project Sections)	Ecological category for river section based on field results (IHI – Kleynhans (1999)	Habitat integrity (IHI %)
Section-3: Adrani-Preljina	C category	76[7]
Downstream section (from Section 1 start to most downstream point in AoA on the Velika Morava)	C category	67
Tributaries	C category.	66

Application of Quality Kilometer (QKm) Metric

The QKm metric combines the length of river affected by the river regulation (km) and quality as indicated by the IHI% calculated as:

QKm = Length of river affected by each river structure (**L**) x Habitat Integrity (**IHI%**)

2. *Effect of the river regulation works*

The nature of the various river regulation structures (i.e. river cut offs, dikes and bank protection) are variable in terms of their direct impact and upstream/downstream degradation. The differing effects were assessed and accounted for and are summarised in Table 8 to provide a river regulation factor for each structure that can be used to quantify the residual impacts.

Table 8: River regulation effects and factors defined for the various structural elements of the river regulation

Structures[8]	Description/Activity	River regulation effect (IHI ratings (Kleynhans, 1996)	River regulation factor
River regulation – remaining channel (Structures 1, 13-18)	Re-routed and straightened sections of remaining Zapadna Morava River	**Serious** – some integrity will be retained however hydrology and habitat will suffer a large to serious residual loss	Section 1 – 0.38 Section 2 – 0.37 Section 3 – 0.45
River regulation – meander cut offs (Structures 1, 13-18)	Cut off river meanders which will be disconnected from the remaining Zapadna Morava River and drained on the downstream section. Some structures will be infilled	**Critical** – the cut off of the meanders will result in a complete loss of functionality for these river features	1
Dike construction and upgrades (Structures 3, 5-8)	Hard engineering structures including concrete, gabions and reno mattresses on banks that have a high risk of erosion	**Low/Moderate** – the structure will affect one bank in most cases and will have a moderate residual impact	0.2

[7] Although Section 3 contains poor water quality (and therefore cannot support the Striped nerite), the IHI includes other aspects of habitat quality, and Section 3 scores highly for riparian habitat quality.

[8] See Appendix 2 for further detail on the river regulation structures

Structures[8]	Description/Activity	River regulation effect (IHI ratings (Kleynhans, 1996)	River regulation factor
	and require significant stabilization		
Bank protection (Structures 2-4, 9-12)	Use of natural interventions such as rip-rap, stone, reno mattresses, grassing and soft engineering structures to stabilize section of bank that are vulnerable to moderate erosion	**Low** – interventions will be consisting mostly of natural features such as stone and grassing and will allow higher functionality to be retained in the river	0.1
Downstream	Changes to flow and habitat downstream	**Low/Moderate –** changes to the instream structure of the river will result in downstream impacts to habitat and flow	0.3

3. Upstream and downstream buffers to account for habitat degradation

Upstream and downstream buffers were added in each section of the river to account for instream degradation from the river regulation works Table 9.

Table 9: Upstream and downstream river buffers

Buffer size	% degradation	Justification
Upstream buffer: 100m (all sections) **Downstream buffer**: Section 1 & 2: 1000 m each Section 3: 2000m	30	The downstream buffers for river Section 3 are more extensive due to the intensive instream works that this Section of river will experience. The hydraulic intricacy of river meanders (which would be lost after straightening) control the pressure along the riverbed and create surface water downwelling into the streambed and groundwater upwelling into the channel, which is an process important for species and water quality (hyporheic exchange) – (Zhou & Endreny 2020). Degradation was based on the average of the river regulation factors for dikes and riverbank protection as established by scenario-based instream changes for the various structures.

4. Quantification of river habitat residual impact

The difference in IHI integrity between baseline IHI and scenario-based reduction in IHI for each type of river structure was considered the **River regulation factor**. The length of the **residual impact (RI)** on the river was then calculated as follows:

Residual Impact (RI) = QKm x River regulation factor

3.2.5 Assumptions and limitations

This residual impact assessment makes a number of broad assumptions about the scale of impacts, and responses of CH-qualifying biodiversity and NH to these impacts. Assumptions and limitations related to the identification of residual impacts are presented below:

- This assessment is based on infrastructure plans provided by BEJV. Any changes to Project design after this assessment (October 2020) may change the outcomes of this assessment and either increase or decrease the scale of residual impacts.
- This assessment did not take into account cumulative impacts. These are not expected to be significant, as no known large industrial projects are planned in the Project area at the time of this assessment.
- The assessment assumes that all avoidance and minimization actions as outlined in the ESIA (2U1K 2020), and environment and social management plan are implemented as planned.
- This assessment does not factor in potential positive impacts as a result of active or passive or active restoration efforts as these measures have varied success, and details on the extent or effort of restoration is not provided in the ESIA to enable it to be factored into the accounting approach (recommendations are made in Section 5).
- To date the project has not undertaken hydrological modelling of the downstream impacts of the river regulation on the Zapadna Morava and Velika Morava rivers, therefore downstream buffers are based on expert opinion.

3.3 Results

3.3.1 Terrestrial habitat

The Project is estimated to impact 26 hectares (ha) of permanent mesotrophic pastures and aftermath-grazed meadows, equivalent to 16 QH of Critical Habitat. A total of 962 ha of terrestrial Natural Habitat, equivalent to 577 QH, is estimated to be impacted by the Project, of which the largest impacts are expected to areas of riparian and gallery woodland.

Biodiversity offset targets to deliver an overall net gain in biodiversity is indicated for the respective habitat types. Permanent mesotrophic pastures and aftermath-grazed meadows will require a target of >16 QH to achieve a net gain in Critical Habitat. For Natural Habitat, a target of ≥ 6 QH, 337 QH, and 234 QH is required for highly artificial non-saline standing waters (naturalized ponds), riparian and gallery woodland, and thermophilous deciduous woodland, respectively.

The residual impacts to, and offset targets for, terrestrial areas containing Critical Habitat and Natural Habitat are summarised in Table 10 below.

Table 10. Summary of residual impacts to terrestrial habitats and ponds and offset targets

Habitat types	Area under the direct footprint of all infrastructure components	Area within the buffers around all infrastructure components		Total impact area (ha)	Residual impact (QH = area × 0.6)	Offset target
		Total area	Degradation area in buffer			
Critical Habitat						**Net Gain**
Permanent mesotrophic pastures and aftermath-	16.5	73.5	9.6	26.1	15.7	Greater than 15.7 QH

Habitat types	Area under the direct footprint of all infrastructure components	Area within the buffers around all infrastructure components		Total impact area (ha)	Residual impact (QH = area × 0.6)	Offset target
		Total area	Degradation area in buffer			
grazed meadows						
Natural Habitat						**No Net Loss**
Highly artificial non-saline standing waters (naturalized ponds)	4.8	41.4	4.7	9.5	5.7	Equal or greater than 5.7 QH
Riparian and gallery woodland	366.1	1141.9	196.3	562.4	337.5	Equal or greater than 337.5 QH
Thermophilous deciduous woodland	321.6	639.1	68.7	390.3	234.1	Equal or greater than 234.1 QH

3.3.2 River habitat

The Project is estimated to impact to 76.5 kilometers (km) of river, equivalent to 55.2 QKm of Natural Habitat of the Zapadna Morava River.

The river cut-off structures will cause the largest impact to freshwater Natural Habitat (c. 47.5km), particularly in Section 3 of the river regulation works (Appendix 2). Based on information provided by the project engineers, the meanders with be cut off on the upstream side and connected on the downstream side of each meander cut off in order to facilitate draining of the meanders for flood control purposes. As the meanders need to be drained for the purpose of flood control it is not possible to keep the meanders open at the upstream end and therefore the RIA assesses the meanders cut offs as complete loss of river habitat. The dike construction will affect c. 21.4km of Natural Habitat, and the bank protection will have the lowest impact affecting c. 3.7km of Natural Habitat. The residual impacts to, and offset targets for, Natural river habitat are presented in Table 11 below.

Table 11. Summary of residual impacts and offset targets for river habitat

Habitat type	Length (km) of river impacted	Baseline Qkm in sections that will be impacted	River regulation factor	Residual Impact (Qkm)	Offset target
Natural Habitat (River regulation Sections 1, 2 and buffers)					
River	41.3	28.4	Ranging between 0.1 - 0.3	9.6	Equal or greater than 9.6 Qkm
Natural Habitat (River regulation Section 3 and buffers)					
River	35.2	26.8	Ranging between 0.38 - 1	16.3	Equal or greater than 16.3 Qkm

3.3.3 Protected areas and Internationally recognised areas

Gornje Pomoravlje KBA

No hydrological modelling of downstream impacts has been undertaken for the Project to date. There is 2D modelling of the river currently being undertaken by the Jaroslav Ceri Institute (JCI) who are also the designers of the river regulation, however it is not yet completed and will not be available until later in 2021. Based on best currently available information and expert opinion, the downstream impacts are unlikely to affect the Gornje Pomoravlje KBA on the Velika Morava River as it is c. 13.6km downstream of the final instream river works in Section 1. The effects of the river straightening in this Section are expected to dissipate before reaching the KBA, and impacts will likely be buffered by the distance to the KBA and increase in the hydrological capacity of the Velika Morava River downstream of the confluence of the Zapadna Morava and Južna Morava rivers. This assumption will be verified by modelling work that has been commissioned by the Project.

Osredak Special Nature Reserve

The Osredak Special Nature Reserve (SNR) covers a section of the Zapdana Morava river as well as adjacent wetland habitat. There will be one borrow area located upstream of the reserve (approx. 1 km) and one borrow area located downstream, (approx. 0.5 km). The nearest river regulation is the reconstruction of a dike approximately 5 km upstream. Direct impacts to the connectivity of the reserve to the river are therefore unlikely but any increases in sediment load in the river as a result of erosion from the borrow area and associated stock-piles may result in degradation effects.

Particular attention should be paid to applying standard good practice mitigation measures to construction areas upstream of the reserve (i.e., the borrow area and the dike reconstruction) to minimise erosion and sedimentation risks (e.g., silt fences and traps, bunding of stockpiles, reinstatement of banks or sections close to the river). Likewise, noise impacts from the construction and operation of the motorway should be managed using noise reduction options (e.g., acoustic/noise barriers at point sources and motorway section, installing silencers or mufflers on construction equipment).

3.4 Significance of residual impacts to Critical and Natural Habitats

3.4.1 Terrestrial habitat

A total of 26 ha of terrestrial Critical Habitat (permanent mesotrophic pastures and aftermath-grazed meadows) is estimated to be impacted by the Project (Table 10). This represents a loss of c.0.1%, and ≤0.6% of this habitat type within the Area of Influence, and AoA respectively. Project impacts to terrestrial pasture and meadow habitat is not considered to be significant at a local or landscape level. However, as the CH-qualifying species *B. domogledi* is dependent on this habitat, mitigation measures should be designed to achieve a net gain of this habitat. Measures

to minimise impacts to this species where it occurs, in addition to those presented in the ESIA, are in Section 4 (and will be included in the Biodiversity Management Plan (BMP) tracker).

The Project will result in 952 ha of terrestrial Natural Habitat impacted, of which the majority is riparian and gallery woodland (562 ha), and thermophilous deciduous woodland (390 ha). This represents a loss of c.6.0% of riparian and gallery woodland, and c.4.1% of thermophilous deciduous woodland within the Project footprint and buffer area. These habitat types are widespread across Serbia and in the central and northern parts of Europe. Thermophilous deciduous woodland are commonly found in the lowland and hilly regions of Serbia, and throughout the warmer parts of Europe (the Balkans, Iberia and the Apennines). Riparian and gallery woodland typically colonize the banks of large rivers across Serbia, such as along the rivers Danube, Sava, Tisa, Ibar and Morava, and across most of Europe. Hence, Project impacts to these terrestrial Natural Habitat features are unlikely to be significant at the landscape level. Measures to further avoid, minimise and restore impacts to these habitat types are recommended in Section 4.

In the case of the Natural Habitat feature, naturalised ponds, only 10 ha of this habitat is expected to be impacted. This represents a loss of c.0.1% and ≤0.4% of Natural Habitat within the Project Area of Influence and AoA respectively. The Project could consider quantifying the gains created for this habitat type as a result of the management of cut-off meanders and unfilled borrow areas to compensate for this impact (see Section 4).

3.4.2 River habitat

In total, 76.5km of the Zapadna Morava River are estimated to be impacted (with a residual impact of 25.9 Qkm). The Zapadna Morava River is 184 km in length, meaning the Project will result in alterations to ~42% of the main river stem. However, the longitudinal or lateral connectivity of the river will not be affected and the reaches of the Zapadna Morava River that will be impacted by the river regulation are of lower quality, retaining on average approximately 70% of their integrity. The remaining river will retain a degree of functionality after the implementation of the mitigation (as detailed in the ESIA). The Project in coordination with the authorities will identify offset measures that are in alignment with existing initiatives to compensate for residual impacts. These may include for example, measures to protect and improve freshwater habitat quality of the Zapadna Morava River; this type of offset action would need to be developed with the Serbian EPA and be in alignment with the Water Framework Directive and the development of any other national water management plans. Additional mitigation measures are described in Section 4.

4 Opportunities for additional mitigation measures

The Project's ESIA has presented numerous measures to avoid and minimise impacts to biodiversity in general which will also support the management of impacts to Critical Habitat-qualifying biodiversity, and Natural Habitat. However, there are potential opportunities to further avoid/minimise significant impacts as predicted by the residual impact assessment.

The percentage of each habitat type located within the infrastructure footprint and buffer area was calculated from the results of the residual impact assessment to provide an indication of where the largest impacts are expected, to help inform the development of additional mitigation measures (Appendix 3). The rapid ground-truthing field survey, eDNA surveys and consultation with experts on their proposed recommendations was also undertaken to further identify additional appropriate measures to minimise impacts on the stakeholder concern species (Appendix 1, Djikanovic *et al.* (2020)).

4.1 Avoidance measures

Impacts can be avoided by relocating infrastructure components such as borrow areas, quarries, and access roads away from areas of Critical and Natural Habitat where possible. This will serve to reduce loss and fragmentation of these areas. Further opportunities to reduce impacts on terrestrial Critical Habitat and Natural Habitat from the motorway alignment and river regulation structures are now likely limited due to the advanced nature of the Project.

4.2 Minimization measures

4.2.1 Additional investigation into minimization efforts from river regulation design

Discussions with Jaroslav Ceri Institute (JCI) around the current river regulation design have concluded that there is limited avoidance of impacts that can be done through infrastructure design, as the primary reason for the current design is to protect the motorway from flooding, and structural changes would compromise the main function of the design. However, there may be further opportunity to minimise impacts though design of the new canalised sections of the river by maximising their potential to provide suitable habitat for wildlife. It is recommended that the new river construction design is reviewed through the ongoing design process for the river regulation by JCI. This could also include a review of the restoration plans for the new sections of river, where additional actions may provide further benefits to biodiversity. It may also be helpful to consult with outside resources such as The River Restoration Centre (https://www.therrc.co.uk/) who specialise in advice for river restoration activities.

4.2.2 Pre-disturbance surveys for the Domogled Meadow Bush-cricket

The Project will impact upon permanent mesotrophic pastures and aftermath-grazed meadows which are areas of Critical Habitat where they support populations of the Domogled Meadow Bush-cricket. Pre-disturbance surveys by an insect specialist are recommended prior to undertaking any development activities to assess for the presence of this species. If encountered, mitigation actions should be provided by the expert to minimize impacts to the species.

4.2.3 Minimize the spread of invasive species

Invasive aquatic mussel and crayfish species such as *Faxonius limosus*, *Corbicula fluminea* and *Sinanodonta woodiana* are invasive competitors of *A .astacus* and *U. crassus* as identified by the experts (Appendix 1, Djikanovic *et al.* (2020)). These species were found in Section 1 and 2 of the Zapadana Morava River and the Velika Morava River. It is recommended that an Invasive Species Management Plan as part of the Biodiversity Management and Monitoring Plan be developed to include measures to minimize the spread of these species.

4.2.4 Translocate the Noble Crayfish from impacted river sections

The Noble Crayfish (*A. astacus*) is a species of stakeholder concern, experts recommended (Appendix 1, Djikanovic *et al.* (2020)) that it is translocated where possible, to minimise impacts. These species should be collected in pre-disturbance surveys using the appropriate techniques and translocated from portions of Zapadna Morava River that will be impacted by river regulation works and released in areas of suitable habitat (e.g. Čemernica River) that will not be directly impacted by the river regulation works. Translocation of this species would require further studies on the carrying capacity of the Zapadna Morava River and tributaries, and existing naturalised ponds that could provide suitable habitat for populations of *A. astacus* and remove the pressure from the threat of invasive crayfish *Faxonius limosus* and would need to be carried out using the IUCN reintroduction and translocation guidelines (IUCN/SSC 2013). Translocation of the Thick-shelled river mussel (*U. crassus*) is not recommended due to the low feasibility of success of this measure for this relatively immobile species.

It is recommended that the Project provide an opportunity for the Institute of Nature Protection to review and agree on these additional mitigations for identified priority biodiversity, in particular for species which are listed as "strictly protected". Where strictly protected species are potentially affected by a project, there is a requirement to consult with the Institute of Nature Protection and agree mitigation measures (*Rulebook on the designation and protection of strictly protected and protected wild species of plants, animals and fungi ("Official Gazette of RS", No. 5/ 2010, 47/2011, 32/2016 and 98/2016).*

4.3 Offset measures

Biodiversity offsets will be necessary to compensate for residual impacts and achieve a no net loss for Natural Habitat (riparian and gallery woodland, Zapadna Morava River, thermophilous deciduous woodland, and naturalised ponds), and net gain for Critical Habitat (permanent mesotrophic pastures and aftermath-grazed meadows). An Offset Strategy should be developed to assess the offset options available in collaboration with the Project, specialists, expert stakeholders, and relevant government organizations. Offset options for the Project should be identified based on internationally accepted best practice approaches and using the precautionary principle. The strategy should include high level loss/gain accounting and order of magnitude costs for the priority offset options. Input from stakeholders should be sought to identify any key risks to offset success, as well as any enabling conditions that will support successful outcomes.

5 Recommended additional actions

Additional actions are recommended to enable the Project to better assess their impacts and develop further appropriate mitigation measures to align with PS6. These are outlined in Table 12 below.

Table 12. Recommended additional actions to align with PS6

Recommended action	Impacted biodiversity feature	Description
Develop a terrestrial and river rehabilitation plan, including indicators to track contributions towards offset targets	Critical Habitat and Natural Habitat	The Project will create biodiversity gains through planned rehabilitation work. These biodiversity gains can contribute towards compensation for the residual impacts; to account for the gains created, estimates of gain based on the size of area of rehabilitation and activities should be undertaken and then indicators identified that enable the Project to track the outcomes of rehabilitation in terms of extent (area) of rehabilitation by habitat type and the quality or condition of those areas. Whilst the meanders that will be cut-off by the river regulation work will no longer be natural river habitat, they will be a different type of habitat akin to the existing naturalised ponds in the Project area. The extent and quality of these created pond areas could also be assessed and monitored to compensate for the 10ha/6QH of impacts to naturalised ponds resulting from the Project.
Monitoring of downstream impacts	River habitat and the Gornje Pomoravlje KBA	The Project is undertaking a modelling assessment to assess downstream impacts but more generally, monitoring should be undertaken downstream of river regulation works to assess changes in water quality, suspended and riverbank/riverbed erosion. If monitoring results show a declining trend in parameters, then the Project should adaptively manage the instream regulation by applying suitable management measures.
Conduct an eDNA study to understand presence of the Striped Nerite (and species of stakeholder concern)	Priority freshwater aquatic species	Targeted eDNA studies have now been conducted for the priority species under pre-disturbance conditions (TBC 2021). The eDNA study supports the findings of the rapid field survey to confirm the presence *U. crassus* and adds supportive evidence of the absence of *T. transversalis* in the Zadapna Morava River. Presence of *A. astacus* from the eDNA results was inconclusive, but it is assumed that they are present in all parts of the river from other published and stakeholder information.

6 Next steps

To fully align with PS6, the following next steps are recommended:

1. Collate the on-site mitigation measures already identified in the ESIA and the additional recommended mitigation measures (Section 4) into the **Biodiversity Management Plan** (BMP).

2. Based on the BIA findings, develop a **Biodiversity Offset Strategy** to offset residual impacts to Natural and Critical Habitats. This will serve as the Project's framework for offset design and implementation considerations including broad actions that will be taken to achieve necessary offset gains.

3. Undertake the recommended actions (Section 5) to support Project alignment with PS6.

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Appendix 1: Freshwater habitat verification and scoping survey for targeted field studies

See separate report: Djikanovicć, V., Zorić, K. & Fehér, Z. (2020). Morava Corridor Motorway Project: Freshwater habitat verification and scoping survey for targeted field studies. A report prepared for The Biodiversity Consultancy Ltd.

Appendix 2: River regulation structures

Based on the technical documentation (PD HTR & DCP HTR 2020), 18 hydrotechnical regulation structures are planned along the Zapadna Morava River for the Project. The length of each structure was measured in km using spatial data provided by river engineers which was cross referenced with information on construction elements noted in the hydrotechnical report (Table 13).

Table 13: Footprint and description of river regulation structures and buffer in river regulation Sections 1 - 3

Structures		Length (km) footprint before regulation (Zapadna Morava River)	Length (km) of meander cut off	Length (km) of river remaining after regulation
Section 1: Pojate - Kruševac (km 0+229,75 - km 27+600)				
Structure 1	River cut-off	2.4	1.67	0.73
Structure 2	Bank protection	0.6	-	0.6
Structure 3	Dike reconstruction	8	-	8
Structure 4	Bank protection	0.83	-	0.83
Downstream buffer	Buffer	1	-	1
Section 2: Kruševac (Koševi) - Adrani (km 27+600 - km 81+476.66)				
Structure 5	Dike reconstruction	10.2		10.2
Structure 6	Dike reconstruction	2.76		2.76
Structure 7	Dike construction (new)	0.235		0.235
Structure 8	Dike construction (new)	0.23		0.23
Structure 9	Bank protection	0.55		0.55
Structure 10	Bank protection	0.52		0.52
Structure 11	Bank protection	0.65		0.65
Structure 12	Bank protection	0.5		0.5
Structure 13	River cut-off	2.07	0.96	1.11
Structure 14	River cut-off	3.78	1.56	2.22
Structure 15	River cut-off	1.98	1.32	0.66
Structure 16	River cut-off	2.04	1.15	0.89
Downstream buffer	Buffer	1	-	1
Section 3: Adrani - Mrčajevci (km 79+000 - km 97+000) and Mrčajevci – Preljina (97+000 - km 109+663.80)				
Structure 17 + 18	River cut-off	35.2	24.9	10.3
Downstream buffer	Buffer	2	-	2
Total		76.5	31.6	45.0

Appendix 3: Percentage of each terrestrial habitat type located within the Project footprint and buffer area

The development of the motorway is estimated to result in the largest impact to Critical Habitat and Natural Habitat. Most of the impact (c.90%) to areas of permanent mesotrophic pastures and aftermath-grazed meadows (Critical Habitat) is attributed to the development of the motorway, river regulation structures and borrow areas. A similar trend is shown in areas of highly artificial non-saline standing waters (naturalized ponds), and riparian and gallery woodland (Natural Habitat). For areas of thermophilous deciduous woodland (Natural Habitat), the development of the motorway, quarry areas, and access roads will result in the largest impact.

A breakdown of the percentage of each habitat type located within the infrastructure footprint and buffer area is given in Table 14 below.

Table 14. The percentage of each habitat type located in the infrastructure footprint and buffer area

Habitat type	Infrastructure component	% of habitat type in Project footprint and buffer
Critical Habitat		
Permanent mesotrophic pastures and aftermath-grazed meadows	Motorway	53.52
	River regulation structures	21.61
	Borrow area	14.14
	Access roads	5.84
	Quarry	2.44
	Camp area	1.20
	Batch plant	0.70
	Crusher	0.55
Natural Habitat		
Highly artificial non-saline standing waters (naturalised ponds)	Motorway	53.05
	Borrow area	19.39
	River regulation structures	15.65
	Access roads	10.30
	Precast yard	0.67
	Beam plant	0.54
	Batch plant	0.34
	Subbase plant	0.05
	Camp area	0.01
Riparian and gallery woodland	Motorway	39.50

Habitat type	Infrastructure component	% of habitat type in Project footprint and buffer
	River regulation structures	31.23
	Borrow area	21.25
	Access roads	5.97
	Batch plant	0.80
	Precast yard	0.39
	Quarry	0.35
	Camp area	0.15
	SW plant	0.12
	Subbase plant	0.09
	Asphalt plant	0.08
	Beam plant	0.08
Thermophilous deciduous woodland	Motorway	46.96
	Quarry	29.07
	Access roads	9.06
	Borrow area	7.16
	River regulation structures	3.32
	Crusher	3.05
	Batch plant	0.77
	Asphalt plant	0.22
	Subbase plant	0.15
	Precast yard	0.11
	Beam plant	0.09
	Camp area	0.02
	SW plant	0.01