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Public Water Management Company "Srbijavode"

European Bank for Reconstruction and Development

Environmental and Social Impact Assessment, Climate Change Assessment and Technical Assessment for Pambukovica Dam in Serbia

Habitat Management, Enhancement and Offset Plan

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Abbreviation	Definition
BNG	Biodiversity Net Gain
BN	Bern Convention
BMWP	Biological Monitoring Working Party
CES	Candidate Emerald Site
CHA	Critical Habitat Assessment
CH	Critical Habitat
CR	Critically Endangered
DAFOR	Dominant, Abundant, Frequent, Occasional, Rare
DD	Data Deficient
EAAA	Ecologically Appropriate Area of Analysis
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EN	Endangered
EOO	Extent of Occurrence
EP	Environmental Protection
ESIA	Environmental and Social Impact Assessment
EU	European Union
EUNIS	European Nature Information System
FL	Flora and Fauna
GN	Guidance Note
HD	Habitats Directive
HMP	Habitat Management Plan
IBA	Important Bird and Biodiversity Areas
IFC	International Finance Corporation
INNS	Invasive Non-Native Species
IUCN	International Union for Conservation of Nature
LC	Least Concern

Abbreviation	Definition
LIFE	Lotic-invertebrate Index for Flow Evaluation
LR	Lower Risk
MAFWM	Ministry of Agriculture, Forestry and Water Management
NT	Near Threatened
NTAXA	Number of Taxa
PCR	Polymerase Chain Reaction
PBF	Priority Biodiversity Features
PR	Performance Requirement
RS	Republic of Serbia
SP	Strictly Protected
SPAs	Special Protection Areas
TSM	Thick Shelled Mussel
VU	Vulnerable
WMD	Water Management Directorate

1. Executive Summary

The Pambukovica Dam and Reservoir Project will improve drought resilience and reduce flood risk in the Ub River catchment by storing water and releasing it in a controlled way. An Environmental and Social Impact Assessment (ESIA) has been prepared in line with EBRD requirements and Serbian law, including extensive biodiversity baselining and subsequent Biodiversity Impact Assessment. Field surveys have shown a mixed landscape of farmland, woodland and river corridors with some sensitive species and habitats. Even after avoiding and minimising impacts, creating the reservoir will permanently change some areas.

To address this, the project commits to a clear programme of habitat restoration and creation to deliver Net Gain in line with EBRD PR6. This will be delivered both 'on-site' within the expropriation area (see Section 4), and downstream of the proposed reservoir 'off-site' within land owned by Srbijavode located adjacent to Tamnava River the (see Section 5). In line with international good practice and the mitigation hierarchy, opportunities to deliver on site enhancements (i.e. within the expropriation area) have been prioritised, however, to deliver Net Gain additional off-site habitat creation and enhancement will also be required.

This document describes the baseline habitat losses that need to be offset and demonstrates the feasibility of delivering this offset upstream of the proposed reservoir, within the expropriation area, and at off-site locations within land owned by Srbijavode. The design of the offset and a subsequent update to the Net Gain analysis will be undertaken at the next design phase, in line ESAP commitments.

Terrestrial habitat creation and enhancement

Baseline habitat losses from the inundation have been quantified using the Quality Hectares (QH) methodology, which combines both habitat area and ecological condition to provide a weighted measure of biodiversity value (see Table 2). Habitat losses were calculated using the 145 m reservoir water line, which represents the maximum normal operating level for Phase 2.

Following QH analysis a total of 42.24 ha of land was required to deliver Net Gain through habitat creation and enhancement.

A total of 15.55 ha will be delivered on-site within the expropriation area, through enhancement of *Robinia pseudoacacia* woodland to riparian and gallery woodland (2.99 ha) and restoration of arable land above the 145 m contour (14.03 ha) to riparian and gallery woodland.

The remaining 26.72 ha will be delivered off-site within land plots owned by Srbijavode (see Appendix A). The required compensation (off-site) includes: Mesic grasslands (E2) – 5.59 ha, sparsely wooded grasslands (E7) – 5.92 ha, *Fagetum moesiace submontanum typicum* woodland (G1.69) – 2.46 ha and *Quercetum frainetto-cerris* woodland (G1.76811) – 12.75 ha. In Autumn 2025, site visits were conducted for the proposed off-site locations. These surveys aimed to validate ecological conditions and assess the feasibility of offset implementation. Off-site plots identified for enhancement were shown to be degraded and under strong anthropogenic influence, thus, suitable for the proposed habitat enhancement and creation.

Aquatic habitat enhancement

Baseline habitat losses of riverine habitat (5.30 km) from within the inundation have been quantified using the QH methodology (Q River Units), which combines both river length and ecological condition to provide a weighted measure of biodiversity value (see Table 2). Riverine habitat losses were calculated using the 145 m reservoir water line, which represents the maximum normal operating level for Phase 2. The loss of riverine habitat (5.30 km) within the footprint of proposed reservoir is of moderate (0.6) condition, equating to 3.18 Q River Units. A target of 20% Net Gain for river habitat has been set which equates 3.82 Q River Units. This net gain will be achieved through enhancement and uplift in the 'condition' of existing rivers upstream of the dam, in the River Ub downstream of the dam, and at off-site locations adjacent to the Tamnava River (within land owned by Srbijavode, where terrestrial habitat creation / enhancement is proposed adjacent to the river).

Increased drought resilience (through delivery of the Serbian minimum flow, which will safeguard a minimum summer flow during the fish spawning season) and a reduction in 'ecologically damaging' floods

downstream of the proposed reservoir are considered the most beneficial measures for riverine habitats, delivering the significant habitat gains through improved 'condition'. These enhancements will be realised within River Ub (~28km) downstream of the proposed reservoir to the Ub-Tamnava confluence.

Additional riparian and in channel measures, that will be delivered both upstream of the proposed reservoir and within the expropriation area, include riparian buffer strips, in-channel improvements and riverbank clean-up and stabilisation. Additional riverine gains will also be achieved off-site, adjacent to the Tamnava River, as a secondary benefit of proposed terrestrial habitat works required to offset terrestrial habitat losses. This terrestrial mitigation, which will occur immediately adjacent to the River Tamnava, will deliver riverine gains through improved riparian structure and buffering capacity.

2. Introduction

2.1 Background

The European Bank for Reconstruction and Development (the "EBRD") is considering providing finance to the Republic of Serbia (the "Borrower", or the "Client"), represented by the Ministry of Finance to enable construction of a water resources reservoir near Pambukovica, Serbia. The Project will be implemented by the Public Water Management Company Srbijavode ("Srbijavode"), the national body responsible for water management, including water use and protection from pollution. Srbijavode is also responsible for management of risks associated with water bodies (such as flood risk) and the Project would increase flood downstream through water retention in the reservoir. Srbijavode operates under the Water Management Directorate (WMD), which in turn is an administrative authority of the Ministry of Agriculture, Forestry and Water Management (MAFWM). The Loan is expected to finance the construction of a new impoundment dam and reservoir infrastructure at Pambukovica including associated works such as upstream sediment traps and road realignment (vertical realignment over the reservoir).

2.2 Project Context

The Pambukovica Dam is being developed as part of Serbia's national strategy for integrated water management, with dual objectives of flood protection and climate adaptation. The Ub River catchment has been identified as highly vulnerable to seasonal droughts and flash flooding, both of which are expected to intensify under projected climate change scenarios. By regulating water flow and creating additional storage, the project aims to improve drought resilience for downstream users, including agriculture, and provide a reliable source for irrigation in Phase 2. At the same time, the reservoir will contribute to regional flood management by capturing peak flows and releasing them in a controlled manner, thereby reducing risks to downstream communities. The Project involves the construction of a new impoundment dam and reservoir infrastructure, including sediment traps and road realignment.

The Biodiversity Impact Assessment identified a range of habitats and species of conservation concern within the project area, including Priority Biodiversity Features (PBFs) and Critical Habitats (CHs). These include broadleaf woodlands, riparian corridors, mesic grasslands, and aquatic habitats supporting amphibians, bats, birds, and freshwater mussel. Even when avoidance and the mitigation hierarchy is fully applied, the very nature of dam construction means that some habitats will inevitably be lost or altered; therefore, active management of remaining habitats and the creation of new ones through an offset strategy are essential to ensure commitments set out in the Biodiversity Management Plan (BMP) and Environmental and Social Management Plan (ESMP) in the are delivered in practice.

2.3 Purpose of the Habitat Management, Enhancement and Offset Plan

This Habitat Management, Enhancement and Offset Plan (HMEOP) has been developed to support the implementation of biodiversity mitigation and enhancement measures identified in the Environmental and Social Impact Assessment (ESIA) for the Pambukovica Dam Project. It builds upon the biodiversity baseline and impact assessment conducted in 2023–2025 and is aligned with the requirements of the European Bank

for Reconstruction and Development (EBRD) Performance Requirement 6 (PR6), Serbian national legislation, and international conservation standards.

The HMEOP describes how commitments relating to the delivery of Net Gain through habitat enhancement (including increased resilience) and habitat creation, as set out in the project BMP and ESMP, will be achieved and the mechanism for delivery. This includes the roles and responsibilities for Srbijavode, their partners and the contractors (during construction phase).

The HMEOP outlines the strategy for managing, enhancing, and offsetting impacts on habitats and species within the Biodiversity Study Area and its Zone of Influence (ZoI). It aims to ensure that the project achieves No Net Loss (NNL) for Priority Biodiversity Features and Net Gain (NG) for Critical Habitats in line with PR6 requirements. Typically, PBF or Critical Habitat has been assigned based on the species present within a typical habitat type; as such NNL or NG should be delivered at a species level through enhancement and/or creation of habitats supporting the trigger species. It should be noted that all habitats qualifying as PBF for some species, also trigger CH for others; therefore, NG is the benchmark for habitats discussed.

The primary objectives of this plan are to:

- Offset significant residual Project impacts that could not be fully mitigated through application of avoidance and/or minimization/mitigation.
- Enhance ecological conditions in degraded or modified habitats within the project footprint and surrounding areas.
- Restore and manage habitats to support long-term ecological resilience and species conservation.
- Implement offset measures where residual impacts cannot be mitigated on-site, ensuring compliance with PR6 and national biodiversity laws.
- Monitor and adapt management actions based on ecological performance indicators and stakeholder feedback.

2.4 Ecological Overview

2.4.1 Legally Protected or Internationally Recognized Areas of Biodiversity Value

There are no Legally Protected or Internationally Recognized Areas of Biodiversity Value areas (as defined by EBRD) in the vicinity of the proposed Project area. The closest legally protected areas to the Project site are the Obedska Bara (Swamp) Nature Reserve / Candidate Emerald Site (CES), located 19 km away, and the Klisura Reke Gradac (Gradac River Gorge) CES, located 18 km away. The Project area is not considered to have significant ecological / functional linkage to any Legally Protected or Internationally Recognised Areas of Biodiversity Value (as defined by EBRD) in the vicinity of the proposed Project area. Based on the current Project design and mitigation measures, no adverse effects on these areas, or the species for which they are designated, are anticipated.

2.4.2 Project Area

The project area is characterized by a mosaic of land uses, including intensive agriculture, natural forests, riparian corridors, and aquatic ecosystems associated with the River Ub and its tributaries. Whilst the habitats within the project area are not particularly unique in the landscape or in Serbia, some have been classified as PBF and/or Critical Habitat according to EBRD criteria.

Field surveys confirmed the presence of the following species/habitats that triggered PBF and/or Critical Habitat:

- Bird: Middle Spotted Woodpecker (*Dendrocoptes medius*), Little Egret (*Egretta garzetta*), Red-backed Shrike (*Lanius collurio*), Grey-headed Woodpecker (*Picus canus*), European Turtle Dove (*Streptopelia turtur*)

- Bats: various microbats listed on Annex II and Annex IV of the Habitats Directive, some of which are also assessed as Near Threatened (global) and VU (Europe) by IUCN.
- Reptiles: Common Wall Lizard (*Podarcis muralis*), European Green Lizard (*Lacerta viridis*), Sand Lizard (*Lacerta agilis*), Dice Snake (*Natrix tessellata*) and Aesculapian Snake (*Zamenis longissimus*)
- Amphibians: Yellow-beilled Toad (*Bombina variegata*), Common Spadefoot Toad (*Pelobates fuscus*), Greek Stream Frog (*Rana graeca*) and Fire Salamander (*Salamandra Salamandra*).
- Fish: Balkan Loach (*Cobitis elongata*), Spined Loach (*Cobitis taenia*), and Balkan Barbel / Large-spot Barbel / Danube Barbel (*Barbus balcanicus).*
- Aquatic Invertebrates: Green Hawker (*Aeshna viridis*), Green Snaketail (*Ophiogomphus Cecilia*) and River Clubtail (*Stylurus flavipes*).
- Aquatic mussel: Thick-shelled River Mussel (*Unio crassus*)

Natural habitats recorded included *Fagetum moesiace submontanum typicum* and *Quercetum frainetto-cerris* woodlands, mesic grasslands, and Balkan riverine willow scrub. These habitat types are listed in Resolution 4 of the Bern Convention so qualify as PBF according to EBRD.

Modified habitats included arable land, low-density buildings, and transport infrastructure.

Invasive species: *Amorpha fruticosa* and *Ambrosia artemisiifolia* were recorded in riparian zones and disturbed areas.

None of the habitats recorded conform to descriptions of those listed in Annex 1 of the EU Habitats Directive, but some are listed in Resolution 4 of the Bern Convention. However, none qualify as IUCN Red List EN or CR ecosystems. Therefore, Balkan riverine willow scrub, *Fagetum moesiace submontanum typicum* woodland, and *Quercetum frainetto-cerris* woodland are listed as PBF.

The methodology and results of the PBF and Critical Habitat Assessment are detailed in Section 7 of ESIA Volume 1 Book 4 – Biodiversity Impact Assessment. The results are summarised in the Table 1 below.

Table 1 – Summary of PBF and Critical Habitats and PR6 requirements

EUNIS code	EUNIS habitat name	Critical Habitat Assessment Results[1]	PR6 Requirement
E2	Mesic grasslands	CH/PBF via suitable species (Criterion 2) using this habitat (e.g., herpetofauna)	Create 5.59 ha of habitat so that project losses are fully offset and a minimum 10% Net Gain is achieved; avoidance first, targeted enhancement/compensation, monitoring.
E7	Sparsely wooded grasslands	CH/PBF via suitable species (Criterion 2) using this habitat (e.g., Turtle Dove, herpetofauna).	Create 5.92 ha of habitat so that project losses are fully offset and a minimum 20% Net Gain is achieved; retain/restore structure, timing of works, like-for-like replacement.
G1.69	*Fagetum moesiace submontanum typicum* woodland	CH/PBF (Criterion 1) — Bern Convention Resolution 4.	Create 2.46 ha of habitat so that project losses are fully offset and a minimum 35% Net Gain is achieved; avoidance/retention priority, restoration planting, long-term management & monitoring.

[1] It should be noted that all habitats qualifying as PBF for some species, also trigger CH for others; therefore, NG is the benchmark for habitats discussed. For example, CH/PBF = habitat triggers both criteria. CH = only CH triggered (see Critical Habitat Assessment in Section 7 of ESIA Volume 1 Book 4 – Biodiversity Impact Assessment).

EUNIS code	EUNIS habitat name	Critical Habitat Assessment Results[1]	PR6 Requirement
G1.768 11	*Quercetum frainetto-cerris* woodland	CH/PBF (Criterion 1) — Bern Convention Resolution 4.	Create 12.75 ha of habitat so that project losses are fully offset and a minimum 35% Net Gain is achieved; avoid, restore/compensate, manage, monitor.
G1.1	Riparian and gallery woodland, with dominant *Alnus glutinosa/Populus nigra/Salix alba*	CH/PBF via suitable species (Criterion 2) (e.g., bats/woodpeckers/riparian birds).	Create 10.26 ha of habitat so that project losses are fully offset and a minimum 20% Net Gain is achieved; (retain riparian belts, sensitive felling, roost protection, replacement planting).
G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	CH/PBF via suitable species (Criterion 2) (e.g., bat roost/foraging, woodpeckers, nesting birds).	Create 3.73 ha of habitat so that project losses are fully offset and a minimum 20% Net Gain is achieved; pre-felling checks, timing constraints, like-for-like tree replacement, roost mitigation.
C3	Littoral zone of inland surface waterbodies	CH via suitable species (Criterion 2) (e.g., odonates, amphibians).	Net Gain of 20%; protect shallow margins, water-quality safeguards, habitat creation, monitoring.
C2: C2.31 C3.55	Surface running waters: Epipotamal streams Sparsely vegetated river gravel banks	CH due to the confirmed presence of thick shelled mussel and host fish species. River Ub supports some PBF fish species also/	Net Gain of 20% by enhancing condition of existing habitat for the species triggering Critical Habitat

3. Methodology

Even after avoiding and minimising impacts, creating the reservoir will permanently change some areas. To address this, the project commits to a clear programme of habitat restoration and creation to deliver Net Gain in line with EBRD PR6. This will be delivered both 'on-site' within the expropriation area (see Section 4), and downstream of the proposed reservoir 'off-site' within land owned by Srbijavode located adjacent to Tamnava River the (see Section 5) adjacent. In line with international good practice and the mitigation hierarchy, opportunities to deliver on site enhancements (i.e. within the expropriation area) have been prioritised, however, to deliver Net Gain additional off-site habitat creation and enhancement will also be required. As set out in the BMP, on site opportunities in the vicinity of the dam (and upstream) have been and will continue to be prioritised for habitat creation and enhancement, however Srbijavode has identified significant areas of ecologically-connected (via river/riparian corridor) land adjacent to River Tamnava (immediately downstream of the Ub-Tamnava confluence to the confluence with the Kolubara) to deliver off-site offsets downstream of the dam. This additional off-site land is required to deliver NG.

The methodology is designed to ensure that biodiversity mitigation, enhancement, and offset measures are evidence-based, ecologically sound, and aligned with regulatory and lender requirements. It builds upon the biodiversity baseline established through the ESIA and integrates findings from previous field surveys (2023–2025), stakeholder engagement, and critical habitat screening and follow up site visits and surveys (Autumn 2025) of off-site locations proposed by the Srbijavode further downstream of the location.

Plots proposed are owned by Srbijavode and there are no 3rd parties / tenants using / benefiting from maintenance of this area. Srbijavode rights are defined by the Law on Waters and include management, maintenance and protection under a public mandate, including tree planting.

To ensure that the areas proposed for habitat enhancement and creation (offsets) are ecologically viable, all identified areas were subject to ground-truthing through targeted site visits, covering both land within the expropriation zone and 'off-site' parcels located outside of it. These visits confirmed the ecological characteristics, level of degradation, and restoration potential of each site, allowing for an accurate assessment of suitability for offset measures as well as baseline habitat quality. In parallel, all potential offset sites were mapped using GIS, with habitat polygons delineated and their acreage calculated to provide a transparent and quantifiable metric. This integration of field validation with spatial mapping ensures that the HMEOP is based on verified ecological data and that offset commitments can be implemented in a measurable / repeatable and traceable manner.

3.1 Data Sources and Integration

The development of this HMEOP is grounded in a robust, multi-layered evidence base. The primary source of ecological data is contained within the baseline sections of the Biodiversity Impact Assessment conducted as part of the ESIA process, which included three years of field surveys (2023–2025) across terrestrial and aquatic ecosystems. These surveys were designed to capture seasonal and spatial variations in species presence, habitat condition, and ecological processes.

In Autumn 2025, a site visit was conducted for the newly proposed 'off-site' locations, outside the expropriation zone, during to the Disclosure process. This visit aimed to validate ecological conditions and assess the feasibility of offset implementation. The fieldwork was complemented by a desk study, reviewing national and international conservation databases. This enabled the identification of species of conservation concern and the classification of habitats using European Nature Information System (EUNIS) codes.

Hydrological modelling was integrated to delineate the inundation area of the proposed reservoir and assess ecological implications of altered water regimes. This informed the spatial definition of impact zones and helped identify areas suitable for habitat enhancement or offsetting.

As part of the offset planning process, PWMC Srbijavode was assigned the responsibility of identifying and delineating potential areas suitable for biodiversity offsets. Following the initial mapping exercise, a detailed review of these areas was undertaken to evaluate their ecological relevance, connectivity, and alignment with the mitigation requirements outlined in the ESIA.

To validate the suitability of the mapped zones, targeted biodiversity surveys were conducted. These surveys focused on confirming the level of habitat degradation and performing comprehensive habitat mapping. The objective was to determine the current baseline habitat condition and whether the ecological characteristics of each area met the criteria for effective offset implementation, particularly in terms of restoration potential and current (and potential) conservation value.

3.2 Habitat Typology

The classification of habitats followed a structured and hierarchical framework that supports consistent identification and mapping of ecological features. This system provides an approach to habitat categorization, designed to inform ecological assessments, biodiversity metrics, and spatial planning across terrestrial, freshwater, and transitional ecosystems. The classification system applied in this project is aligned with the European Nature Information System (EUNIS), ensuring compatibility with broader conservation and regulatory frameworks.

The EUNIS framework is organized into five levels of increasing specificity. At the broadest level, major ecosystems are distinguished, such as terrestrial, freshwater. These are further refined into ecosystem types aligned with international typologies, followed by broad habitat categories, detailed habitat types, and finally specific subtypes, including those recognized under European conservation directives (Figure 1). For the purposes of this project, habitat mapping was conducted at the level of detail corresponding to a resolution classification that distinguishes habitats based on characteristic vegetation structure, species composition, hydrological regime, and substrate conditions. This level of resolution allowed for the identification of priority habitats and supported alignment with national and international conservation frameworks.

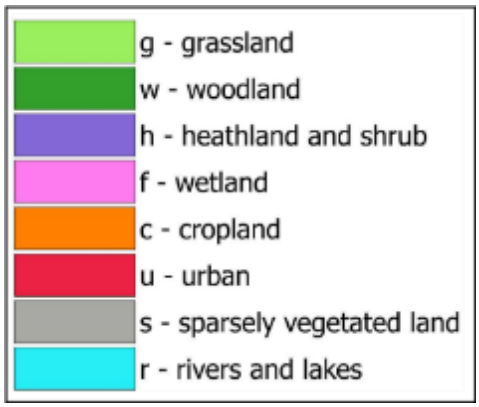


Figure 1 - Example of a broad habitat categories

Each habitat polygon was assigned a primary classification code, with additional descriptors applied where necessary to capture environmental conditions, land management practices, habitat mosaics, and origin. These supplementary codes provided essential context for interpreting habitat condition and restoration potential, particularly in areas where ecological complexity or historical land use influenced habitat structure.

Habitat boundaries were delineated based on observable changes in vegetation structure, species composition, and environmental features. A minimum mapping unit of 25 square meters was applied for fine-scale mapping, especially in areas characterized by high habitat heterogeneity or ecological sensitivity.

In addition to typological classification, each habitat was assessed for its ecological condition. Condition criteria are habitat specific and considering parameters such as:

- Dominance of native vs. invasive species
- Vegetation structure and stratification
- Evidence of human/anthropogenic disturbance
- Hydrological connectivity and soil characteristics

Habitats were categorized into five condition classes:

- Good Condition: High ecological integrity, with ⩾ 80 % cover of native species, < 5 % invasive species, and minimal visible disturbance (e.g. bare soil < 2 %, no erosion or trampling).
- Fairly Good Condition: Generally intact habitats with 60–79 % native species cover, 5–10 % invasive species, and only localized or early-stage disturbance.
- Moderate Condition: Noticeable degradation, 40–59 % native species cover, 10–25 % invasive species, and evident signs of stress such as partial canopy gaps or moderate erosion.
- Fairly Poor Condition: Heavily disturbed or fragmented habitats with 20–39 % native species cover, 25–50 % invasive or ruderal vegetation, and high disturbance (erosion, trampling, waste, cutting).
- Poor Condition: Severely modified habitats with < 20 % native species cover, > 50 % invasive or non-native vegetation, strong physical disturbance, and minimal ecological function.

Riverine habitats were mapped separately to capture the linear nature and ecological variability of aquatic systems. Mapping was conducted along the River Ub and its tributaries, including upstream and downstream reaches of the proposed reservoir, with habitats classified under EUNIS codes such as C2 (surface running waters), C2.31 (epipotamal streams), and C3.55 (sparsely vegetated river gravel banks). River segments were delineated based on channel morphology, substrate composition, flow characteristics, and associated riparian vegetation.

In addition to typological classification/ mapping, riverine habitat condition was assigned under baseline and post-development condition based on a number of condition criteria:

- Field data (e.g. aquatic invertebrate condition metrics and water quality class).
- Riparian condition assessment.
- Hydrological regime (informed by operations phased modelling).

These riverine condition criteria were used to assign a number of River Quality Unit (Q River Units) to lost or enhanced lengths of river. This approach ensured that the mapping outputs could be directly integrated into the Biodiversity Net Gain calculations presented later in this report, allowing a clear link between baseline condition, predicted impacts (adverse and beneficial), and offset planning requirements.

This typological and condition-based classification informed the prioritization of habitats for enhancement and offsetting, with emphasis placed on moderate condition habitats that offer feasible restoration opportunities.

3.3 Biodiversity Net Gain Calculation

The calculation of required habitat creation and enhancement for the Pambukovica Dam Project follows the Biodiversity Net Gain (BNG) approach as set out in the ESIA Biodiversity Impact Assessment. Habitat losses from the inundation were quantified using the Quality Hectares (QH) methodology, which combines both habitat area and ecological condition to provide a weighted measure of biodiversity value (Table 2 Table 3). Table 3 sets out potential routes to delivering a 20% net gain in river units, through river condition uplift, based on improving condition of given lengths a river. A worked example, specific the River Ub catchment, is included in Section 5.3 (Table 9).

The ESIA presents detailed loss–gain calculations across multiple inundation water levels (see ESIA Volume I Book 4: Biodiversity Impact Assessment, Tables 67–70), alongside spatial mapping of baseline and offset habitats (see ESIA Volume I Book 4: Figures 34–37, Appendix 9). These outputs identify both the extent of critical habitats lost (34.26 ha of terrestrial and riparian habitats and 5.3 km of riverine habitats) and the gains achievable through a combination of on-site and off-site offsets.

Within the HMEOP, these results provide the baseline for defining the offset strategy and priority actions. Post-development scenarios indicate that habitat transformation, restoration, and creation can deliver a net positive outcome, with an estimated 42.27 ha of terrestrial and riparian habitat gains, plus 128.79 ha of standing water habitats, subject to long-term management. Woodlands (*Fagetum moesiace submontanum*

typicum and *Quercetum frainetto-cerris*) are treated more conservatively, with a 35% are net-gain factor applied to account for slower maturation and precautionary assignment of moderate post-development condition.

Riverine habitat gains to offset the losses within the impoundment are addressed through quality enhancement rather than spatial expansion, targeting a 20% uplift in ecological value via a combination hydrological improvements and enhancements. These include riparian restoration, bank stabilisation, water quality improvements through introduction of buffer zones, as described in BMP Action 7 Aquatic Enhancement Plan and water quantity improvements / drought resilience delivered through a sustainable E Flow (see Section 5.3 for further detail).

The methodology and results of the BNG analysis therefore underpin this HMEOP, ensuring that offset commitments are measurable, consistent with lender standards, and ecologically robust.

The condition thresholds applied are consistent with the following criteria:

- 0.2 – Poor condition: Channel heavily modified or canalised; bed dominated by silt or fine deposits; riparian vegetation sparse or absent; >50 % bank length affected by erosion, litter or waste; invasive species (Robinia pseudoacacia, Ailanthus altissima, Amorpha fruticosa) dominant; little hydraulic or habitat diversity.
- 0.4 – Fairly poor condition: Partial bank vegetation, but discontinuous and frequently mown; moderate litter accumulation; some woody debris present; limited shading and substrate variation; invasive species cover 25–50 %; periodic water quality deterioration during low flow.
- 0.6 – Moderate condition: Natural planform largely retained; alternating shallow and deep sections; >60 % of banks vegetated with native species (Salix alba, Alnus glutinosa); invasive cover < 25 %; occasional litter; fair invertebrate and fish diversity; QH index between 0.55–0.65.
- 0.8 – Fairly good condition: Channel and riparian corridor structurally intact; diverse substrates (gravel, sand, cobble); continuous native gallery vegetation on both banks providing >70 % shading; invasive species < 10 %; water clear with low suspended solids; litter rare; good representation of indicator taxa (odonates, mussels, rheophilic fish).
- – Reference / excellent condition: Natural, self-sustaining morphology; full riparian canopy continuity and regeneration; negligible invasive species or litter; high substrate heterogeneity and stable hydrology; strong biotic integrity with balanced fish and macroinvertebrate assemblages.

Table 2 - Habitat net-gain calculation for 145 m

EUNIS code	EUNIS habitat name	Baseline			Required offset, to be delivered through onsite and off-site habitat enhancement / creation			Analysis	
		Area (ha)	Condition	QH Unit Baseline	Area (ha)	Condition	QH Post-Dev (ha)	% Net Gain QH	Net Gain (ha)
E2	Mesic grasslands	5.08	0.8 - Fairly High	4.06	5.59	0.8 - Fairly High	4.47	**10.04**	0.51
E7	Sparsely wooded grasslands	4.93	0.6 - Moderate	2.96	5.92	0.8 - Fairly High	4.74	**60.11**	0.99
G1.69	Fagetum moesiace submontanum typicum woodland	1.82	0.8 - Fairly High	1.46	2.46	0.6 - Moderate	1.48	**1.37**	0.64
G1.76811	Quercetum frainetto-cerris woodland	9.47	0.8 - Fairly High	7.58	12.75	0.6 - Moderate	7.65	**0.98**	3.28
G1.1	Riparian and gallery woodland, with dominant Alnus glutinosa/Populus nigra/Salix alba	8.55	0.6 - Moderate	5.13	10.26	0.6 - Moderate	6.16	**20.00**	1.71
G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	3.11	0.4 - Poor	1.24	3.73	0.6 - Moderate	2.24	**79.00**	0.62
C3	Littoral zone of inland surface waterbodies	1.3	0.6 - Moderate	0.78	1.56	0.6 - Moderate	0.94	**20.00**	0.26
C2: C2.31 C3.55	Surface running waters: Epipotamal streams Sparsely vegetated river gravel banks	5.30**	0.6 - Moderate	3.18***	See Table 3 and Table 9				
C1	Surface standing waters	0	See chapter on freshwater habitats		128.79	0.6 - Moderate	77.27		128.79

The total amount of critical **habitats lost** due to flooding is **34.26 ha and 5.3 km river**. The total amount of critical **habitats gained**, excluding areas with standing water, is **42.27 ha**, while the standing water gain is 128.79 ha.
10% 'area' net gain has been targeted for habitats with a short time to target condition period, while a 20% gain has been applied to habitats with a longer time to condition period. 35% 'area' net gain has been applied to G1.69 *Fagetum moesiace submontanum typicum* woodland and G1.76811 *Quercetum frainetto-cerris* woodland habitats; this is to account for the precautionary post-development 'moderate' condition for this habitat type and provide a 'Quality Hectares' net gain. These 'area' gains are presented in the table as Post-Development QH gains. Hectares net gain may be greater should these woodland habitats achieve a higher condition than 'moderate'
** Only the surface running water habitat (river) is measured in kilometres.
*** Quality River Units (defined by River Length x Condition)

Table 3 sets out potential routes to delivering a 20% net gain in river units, through river condition uplift, based on improving condition of given lengths a river. A worked example, specific the River Ub catchment, is included in Section 5.3 (Table 9).

Table 3 - Potential River habitat net-gain calculation

EUNIS code	EUNIS habitat name	Baseline				Potential Offset		
		River Length (km)	Condition	Q River Length Unit Baseline	Q River Length Unit Offset	From Condition	QRiver Length Post-Dev (km)	Targeted % Net Gain
C2: C2.31 C3.55	Surface running waters: Epipotamal streams Sparsely vegetated river gravel banks	5.30	0.6 - Moderate	3.18	3.81	0.2 - Poor ↓ 0.4 – Fairly Poor ↓	19.08 km at 0.2 Up 1 condition classes	20
						0.6 – Moderate ↓	9.54 km at 0.4 Up 2 condition classes	
						0.8 - Fairly Good ↓ 1 - Good	3.31 km at 0.6 Up 3 condition classes	

Table 4 summarizes the area-based offsets by EUNIS habitat and shows where they will be delivered on-site (within the expropriation zone) versus off-site (priority parcels downstream). It aggregates the BNG/QH outputs from Table 2 and Table 3 indicating that 42.27 ha of terrestrial and riparian habitats require offset, of which 15.55 ha can be delivered on-site (e.g., conversion of 14.03 ha arable land and 2.99 ha Robinia to riparian/gallery woodland, littoral creation, and small woodland features) and 26.72 ha will be secured off-site.

Note that surface running waters (C2/C2.31/C3.55) are addressed through condition uplift. A worked example, specific the River Ub catchment, is included in Section 5.3 (Table 9).

Table 4 - Onsite – Off-site summary

EUNIS Code	Habitat	Required Offset (ha) - - Condition	On-site (ha)	Off-site (ha)
Terrestrial Habitat				
E2	Mesic grasslands	5.59 - Fairly High	0	5.59
E7	Sparsely wooded grasslands	5.92 - Fairly High	0	5.92
G1.69	Fagetum moesiace submontanum typicum woodland	2.46 - Moderate	0	2.46
G1.76811	Quercetum frainetto-cerris woodland	12.75 - Moderate	0	12.75
G1.1	Riparian & gallery woodland (Alnus/Populus/Salix)	10.26 - Moderate	10.26	0

EUNIS Code	Habitat	Required Offset (ha) - - Condition	On-site (ha)	Off-site (ha)
G5	Lines of trees / small anthropogenic woodlands & coppice	3.73 - Moderate	3.73	0
C3	Littoral zone of inland surface waterbodies	1.56 - Moderate	1.56	0
TOTAL	Critical habitats	42.27	15.55	26.72

Aquatic Habitat

C2: C2.31 C3.55	Surface running waters: Epipotamal streams Sparsely vegetated river gravel banks	3.81	0	3.81

4. Habitat Creation and Enhancement (On-Site)

The on-site habitat management program is designed to mitigate and enhance habitats directly affected by the Pambukovica Dam construction and operation. Measures focus on terrestrial, aquatic/riparian, and species-specific interventions, complemented by a robust biosecurity plan to address invasive non-native species (INNS). Prescriptions are adaptive and will be updated based on monitoring results and ecological performance indicators.

4.1 Terrestrial Habitat

In this chapter, references to the 138 m water line correspond to the minimum operational reservoir level, while the 145 m water line represents the maximum normal operating level (Phase II), as defined in the ESIA hydrological and engineering design. Although vegetation between these two contour lines will not be cleared during Phase I, meaning existing woodland, grassland and scrub will remain in place, the biodiversity assessment and offset calculations treat this entire band as lost under a precautionary, worst-case scenario. Because Phase II will occur later, the habitats created through the Phase I offset programme will have already reached their target condition by the time the 145 m operating level is implemented.

The expropriation zone includes a combination of invasive-dominated stands, arable land, and natural habitats that will be transformed to offset losses caused by reservoir inundation. A total of 17.02 ha will be restored or created, ensuring Net Gain (NG) objectives (Figure **2**).

To enhance the ecological integrity of the area, these habitats will be incorporated into the expansion of the lake's border zone. Establishing riparian and gallery woodland at the water line will offer multiple benefits as a Nature-based Solution (NbS). These habitats will play a crucial role in stabilizing the soil, preventing erosion and landslides, and enhancing bank resilience against flooding events. Additionally, they contribute to water quality improvements within the reservoir and downstream by filtering pollutants, reducing nutrient runoff, and enhancing sediment retention.

Robinia pseudoacacia Woodland (2.99 ha) to riparian and gallery woodland

Current state: Invasive black locust stands bordering riparian and gallery woodland, low biodiversity value, high dominance of non-native species.

Action required: Systematic clearance of *Robinia pseudoacacia*, including root and stump removal to prevent regeneration. Implement an Invasive Species Management Protocol during works.

Target transformation: Replanting with native riparian species *Alnus glutinosa*, *Populus nigra*, and *Salix alba*.

Expected outcome/condition: Transition into riparian/gallery woodland of moderate to fairly high condition within 10–15 years, providing critical habitat and ecological connectivity (Figure 2).

Area: 2.99 ha.

Arable Land above the 145 m Contour (14.03 ha) to riparian and gallery woodland

Current state: Anticipated 8.55 ha of riparian woodland loss due to flooding. Existence of active or recently abandoned agricultural plots between the future waterline (145 m) and the expropriation boundary in the amount of 14.03 ha.

Action required: Cessation of agricultural use. Soil preparation, seeding, and planting with native communities based on slope and hydrology. Direct compensation by establishing riparian woodland on parts of the 14.03 ha arable land strip

Target transformation: Create riparian/gallery woodland dominated by *Alnus glutinosa*, *Populus nigra*, and *Salix alba* along reservoir shoreline.

Expected outcome/condition: Functioning riparian habitat of moderate condition, improving over time as hydrological regime stabilizes (Figure **2**).

Area: 14.03 ha

Figure 2 shows the baseline situation with the future 145 m operating water level overlaid. Its shows the habitats above the waterline that will be transformed (notably arable plots and INNS/Robinia stands). Figure 3 shows the proposed/created habitats that will replace those habitats above the water line post-development (e.g., conversion of 14.03 ha of arable land and 2.99 ha of Robinia to G1.1 riparian/gallery woodland, plus establishment of a C3 littoral fringe along the new shoreline).

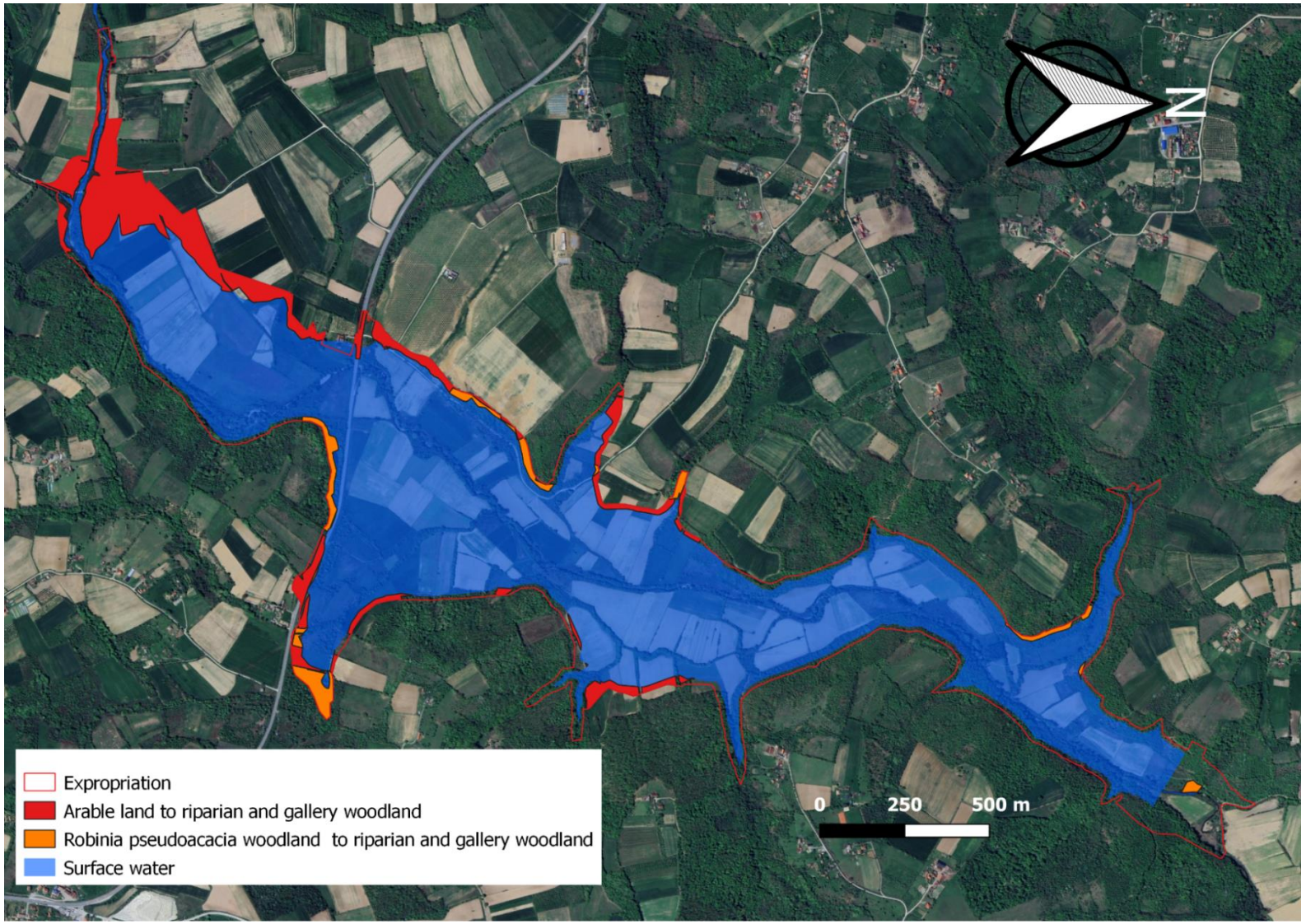


Figure 2 – On-Site Terrestrial Habitats **(under b**aseline **conditions)** with **145m – II Phase Water Level overlaid**

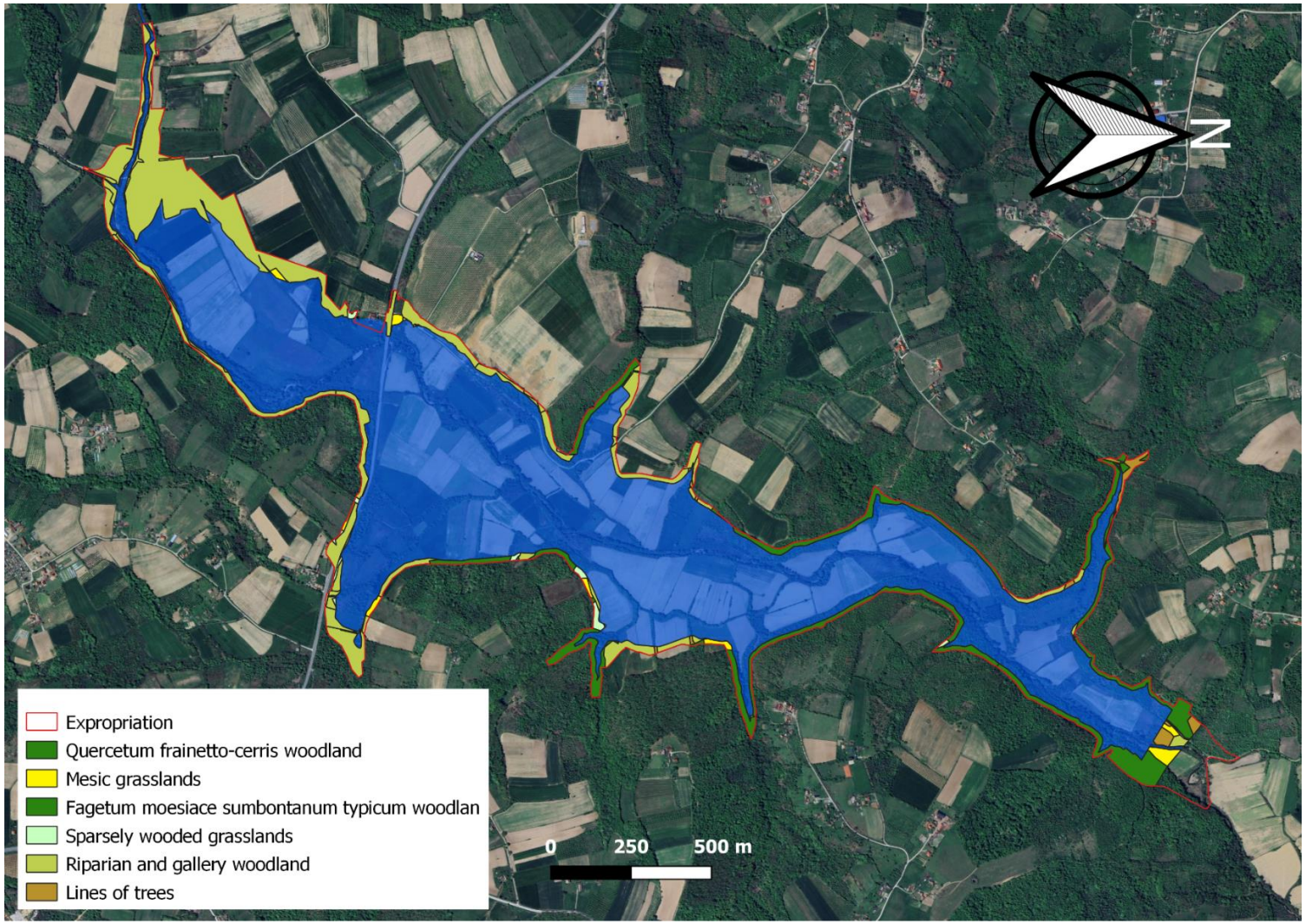


Figure 3 – Proposed habitat creation (on site)

4.2 Aquatic/Riparian Habitat

The aquatic and riparian habitats inside the expropriation zone (on site) will undergo significant transformation as a result of reservoir formation. Approximately 5.3 km of lotic riverine habitats (epipotamal streams and sparsely vegetated river gravel banks) will be inundated and replaced by lentic conditions.

Measures to offset this loss will predominantly be implemented outside the expropriation area and are covered in Section 5.3 and Table 9. Reservoir measures discussed here are not counted as part of the riverine net gain calculation.

However, measures within exploration area that will affect the aquatic environment and riparian (reservoir-side) habitats and species are covered in this section, including shoreline measures to improve water quality, and the creation of functional habitats that support aquatic biodiversity and aquatic dependant species such as birds, bats and amphibians. When discussing habitat measures around the reservoir it is important to consider the anticipated construction phasing and location. The following is anticipated:

1. In advance of Phase 1 (138 m water line) all habitats below 138 m will be removed. Land between 138 m and 145 m will be retained.
2. No interventions or habitat creation / enhancement will be made between 138 m and 145 m, as this section will eventually be flooded at the start of phase 2 operation. However, it is anticipated that during Phase 1 the land between 138 m and 145 m will naturally vegetate / re-wild forming a riparian zone next to the reservoir. The habitat that develops here will need to withstand some level of flooding as the land between 138 m and 145 m will flood intermittently (flood storage). During Phase 1 habitat here will provide buffering capacity for aquatic biodiversity and offer a functional corridor for aquatic dependant species such as birds, bats and amphibians.
3. During Phase 1 habitat measures above 145 m (namely enhancement of *Robinia pseudoacacia* woodland to riparian and gallery woodland and restoration of arable land to riparian and gallery woodland) will occur above the 145 m level (see Figure 3).
4. Theses habitats will become riparian (reservoir-side) habitats for Phase 2 (145 m) operation. They may undergo change associated with periodic inundation.

4.3 Species-Specific Management

Species-specific management measures are captured in the Biodiversity Management Plan (Chapter 8 of ESIA Volume I Book 4 Biodiversity Impact Assessment). Elements of this plan that relate to habitat clearance, enhancement and creation are included here.

Species-specific management measures within the expropriation zone are designed to minimize direct mortality during construction and inundation, while ensuring that newly created habitats provide continuity for sensitive species until they mature. These safeguards complement the terrestrial and aquatic habitat transformations described earlier, but focus only on actions within the project footprint.

For bats, retained mature trees within the expropriation zone will be veteranised to provide roosting cavities. As these woodlands will take time to develop structural complexity, artificial bat boxes will be installed to provide interim roosting opportunities. Timing restrictions will apply to any felling of trees within the zone to avoid maternity and hibernation periods, reducing the risk of disturbance or colony loss.

For birds, vegetation clearance inside the footprint will be scheduled outside the breeding season to avoid destruction of nests or chicks.

For amphibians and reptiles, individuals found within the inundation zone will be relocated under a supervised rescue protocol before reservoir filling.

For fish, the main risks within the expropriation zone are linked to the dam infrastructure. The reservoir E Flow outlet will be equipped with protective screening to minimize entrainment of reservoir fish. The

ecological flow regime, maintained above baseline drought conditions, will increase the drought resilience of downstream river habitat and safeguard the connectivity between the reservoir and downstream sections, ensuring that on-site aquatic habitats support heathy fish and mussel populations.

Collectively, these actions (Table 5) ensure that bats, birds, amphibians, reptiles, and fish are protected from the most severe on-site risks, while providing transitional safeguards until restored habitats in the expropriation zone reach maturity.

Table 5 - Summary of Habitat Management Measures

Habitat / Species	Key Management Actions	Timing	Responsibility
Robinia pseudoacacia woodland	Phased eradication of black locust; replanting with *Alnus glutinosa, Populus nigra, Salix alba*	Construction and early operation	EPC Contractor (implementation); Biodiversity Specialist (supervision)
Arable land (steep slopes)	Conversion to *Fagetum moesiace* and *Quercetum frainetto-cerris* woodland; soil stabilization	Pre-impoundment, early operation	EPC Contractor; Forestry Authority oversight
Arable land (flat plots)	Restoration into mesic and sparsely wooded grasslands; mowing/grazing regimes	Early operation	EPC Contractor; Biodiversity Specialist
Mesic & sparsely wooded grasslands	Controlled mowing; prevention of overgrazing; invasive species removal	Ongoing (post-construction)	Contractor (maintenance); Biodiversity Specialist (monitoring)
Riparian and littoral habitats	Establish native buffer strips; bank stabilization; litter and debris removal	During impoundment and operation	EPC Contractor; Srbijavode (oversight)

Note: Corresponds primarily to BMP Actions 3, 4, 5 and 7: Terrestrial Habitat Restoration, Invasive Species Management, Sensitive Site Clearance, and Aquatic Enhancement Plan

The habitat offsets are primarily required because of trigger species that define Priority Biodiversity Features (PBF) and Critical Habitat (CH) status in the ESIA. While area-based habitat creation/restoration secures the physical resource, NG is ultimately tested at the species level for those triggers. Table 6 therefore summarises the species-focused safeguards that run in parallel with habitat measures to minimise near-term construction/impoundment risks, bridge the time lag until created habitats reach target condition, and verify that offsets are delivering for the actual PBF/CH trigger taxa. Full details of species-specific mitigation measure are captured in the BMP, which forms part of ESIA Volume 1 Book 4 – Biodiversity Impact Assessment. A summary of BMP mitigation measures relating to loss or creation of sensitive habitats and so relevant to the HMEOP are provided in Table 6.

Table 6 - Summary relevant Species Management Measures

Habitat / Species	Key Management Actions	Timing	Responsibility
Bats	Retain/veteranise mature trees; install roost boxes; monitor roost success	Pre-clearance & operation	Biodiversity Specialist; Contractor (installation)
Birds	Schedule clearance outside breeding season	Pre-construction & early operation	EPC Contractor; Biodiversity Specialist

Habitat / Species	Key Management Actions	Timing	Responsibility
Amphibians / reptiles	Rescue & relocation from inundation zone	Pre-impoundment	Biodiversity Specialist; Licensed specialists
Fish	Install anti-entrainment screens; maintain sustainable ecological flows and enhance riparian structure to deliver instream and riparian gains	Construction & operation	EPC Contractor (infrastructure); Fisheries Authority / Specialist
Invasive species (general)	Machinery cleaning protocols; soil/material control; operational monitoring & rapid response	Throughout project life-cycle	EPC Contractor (implementation); Biodiversity Specialist (oversight)

Note: Corresponds to BMP Actions 2, 5, 7, 8 and 9: Ecological Monitoring Plan, Sensitive Site Clearance, Aquatic Enhancement Plan, Species Monitoring Plan, and Biosecurity Protocols

5. Habitat Creation and Enhancement (Off-Site)

5.1 Site Selection Criteria

Off-site habitat enhancement areas were identified through a structured process combining ecological surveys, GIS mapping, and land tenure analysis. The criteria applied included:

- Ecological baseline: sites were selected where they were degraded and had been subject to anthropogenic impacts; this mean site of low biodiversity value could be enhanced providing material uplift in biodiversity value and function.
- Ecological suitability: Sites had to support the restoration or creation of habitats equivalent to those lost in the inundation zone, with soils, slope, and hydrology compatible with target habitat types.
- Hydrological linkage: Priority was given to parcels connected to the Ub–Tamnava–Kolubara river system, ensuring functional connectivity along riparian corridors and facilitating dispersal of species dependent on aquatic and semi-aquatic habitats.
- Tenure and access: Only land under the jurisdiction of PWMC Srbijavode or adjacent state/public land was considered suitable, to ensure feasibility of implementation and long-term management.
- Implementation feasibility: Sites with manageable levels of degradation, limited urban encroachment, and no competing land use claims were prioritized to maximize restoration success.

These criteria were applied in a stepwise manner, starting with desk-based screening (Appendix A.9 of ESIA Volume I Book 4) and refined through site visits and ground-truthing in 2025.

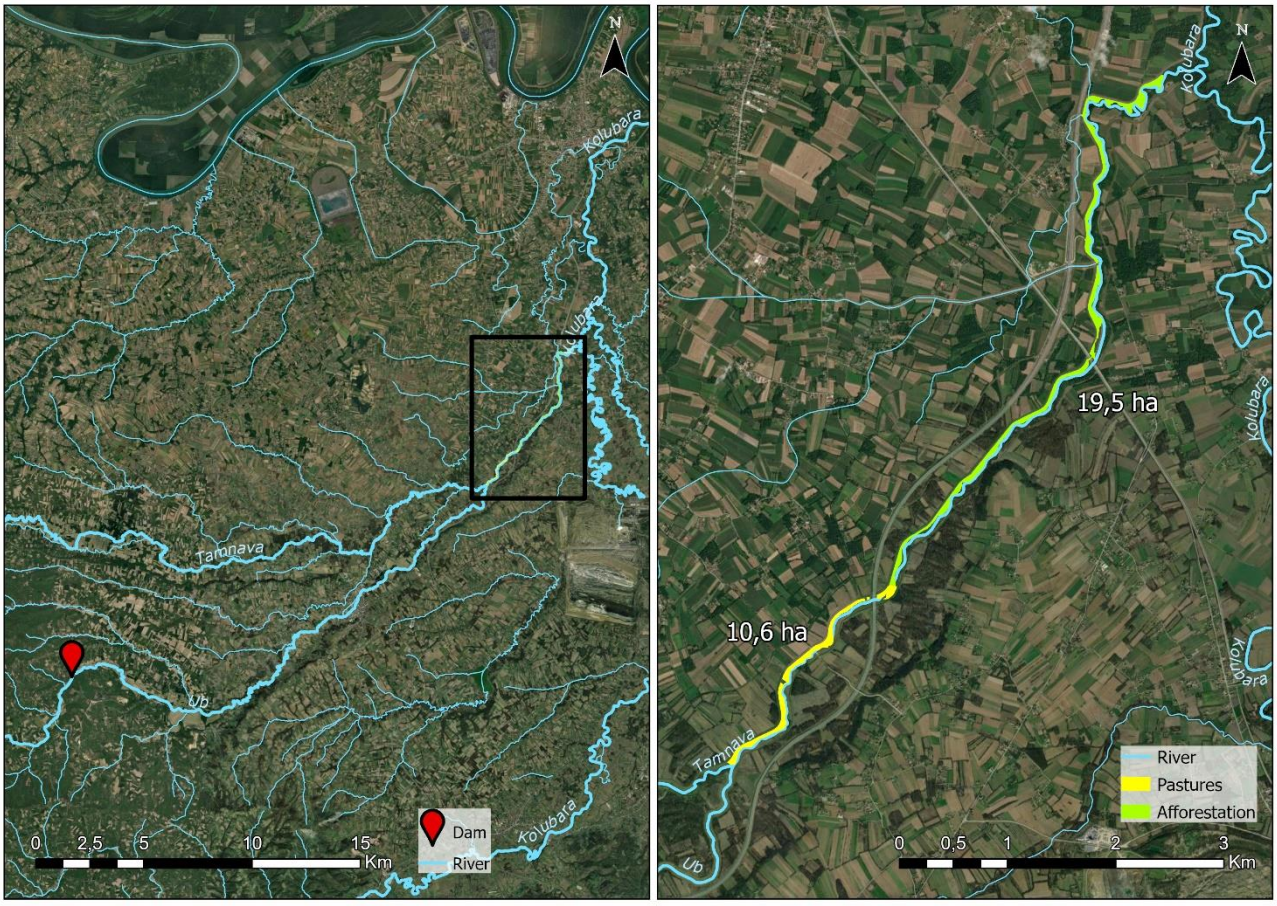


Figure 4 - Offset Habitat Creation Areas – Location of areas in catchment (black square, left). Land available for enhancement adjacent to River Tamnava (right).

All proposed off-site parcels designated for biodiversity offsets are under the ownership and management of PWMC Srbijavode. As evidence, Srbijavode provided formal land-ownership documentation, including the extract titled „Izvod iz baze podataka katastra nepokretnosti“ issued by the Republic Geodetic Authority (Republički geodetski zavod) on 7 July 2025. This cadastral extract confirms that the Brović, Piroman and Veliko Polje plots are registered as state-owned land under Srbijavode's mandate. These areas are currently maintained by Srbijavode through periodic mowing and shrub removal to ensure access to riverbanks and prevent overgrowth, and there are no third-party users or tenants. Srbijavode also confirmed that the intended long-term use of these parcels is fully aligned with the restoration and habitat-creation measures proposed in this HMEOP, and that the land is reserved for implementation and maintenance of the Project's biodiversity offsets.

5.2 Terrestrial

The off-site plots identified for habitat enhancement are within the land portfolio of Srbijavode, which currently manages them through routine cutting of grasses and shrubs to maintain access and prevent overgrowth. This management regime has resulted in habitats of low ecological quality, with limited structural diversity / sward height and frequent anthropogenic disturbance, including littering. Additionally, *Robinia pseudoacacia* (black locust) is widespread across the plots, in some areas forming dense stands of seedlings that suppress native regeneration.

As summarised in Table 4, the balance between on-site restoration and residual habitat loss identifies the areas requiring off-site compensation. Residual losses not offset within the expropriation zone (on site) amount to 26.72 ha. The required compensation (off-site) includes:

- Mesic grasslands (E2) – 5.59 ha
- Sparsely wooded grasslands (E7) – 5.92 ha
- Fagetum moesiace submontanum typicum woodland (G1.69) – 2.46 ha
- Quercetum frainetto-cerris woodland (G1.76811) – 12.75 ha

To meet these needs, degraded grassland and woodlands downstream of the Ub–Tamnava confluence were identified as priority habitat creation zones. These parcels in Brović, Piroman, and Veliko Polje sub-municipalities, are directly adjacent to the Tamnava River and therefore ecologically connected (via the Ub-Tamnava watershed) to the impacted system (i.e. in and around the proposed reservoir area).

Appendix A.1 shows the locations where the required habitat creation and enhancement will be undertaken. The exact location and habitat types for each plot are to be determined later. However it should be noted that the ~30 ha (29.1 ha of heavily degraded grassland and 1.5 ha of invasive scrub) of degraded land is available to deliver the 26.72 ha.

Baseline Condition

Off-site plots identified for enhancement are currently under strong anthropogenic influence, with regular mowing and removal of shrubs, through maintenance by Srbijavode, clearance preventing natural succession. Plots are owned by Srbijavode and there are no 3rd parties / tenants using / benefiting from maintenance of this area. Nevertheless, field surveys confirmed the presence of small oak and beech seedlings scattered throughout these parcels (Table 7). These saplings are unable to reach maturity under current management but demonstrate the natural regeneration potential of the sites once active disturbance ceases. In the Veliko Polje sub-municipality, signs of localized fires were recorded, which have further degraded the habitat and reduced its natural regeneration capacity.

During fieldwork, the Srbijavode tractor operator responsible for routine maintenance was also interviewed, confirming that he conducts mowing and vegetation clearance exclusively for Srbijavode and that no third-party users or tenants manage or utilise these parcels.

Table 7 –Brović, Piroman, and Veliko Polje Site Photos

Picture 1 – Detected litter

Picture 2 – Degraded habitat after regular mowing

Picture 3 – Oak seedlings with litter nearby

Picture 4 -Signe of fire at the Veliko Polje

Picture 4 – Dense black locust seedlings

Picture 5 – Typical mowed land with litter and black locust

Creation of Mesic Grasslands (5.59 ha)

Degraded or mown fields will be restored into mesic grasslands. Intervention will include stopping intensive mowing, reseeding with native grasses, and implementing controlled mowing and / or sensitive sheep grazing once per year to maintain structure. The expected outcome is stable, species-rich grassland providing forage and nesting grounds for pollinators and farmland birds.

Creation of Sparsely Wooded Grasslands (5.92 ha)

Grassland plots with scattered shrub encroachment will be selectively planted with native tree saplings (oak, hornbeam, or fruit-bearing species), creating a mosaic of open grass and light woodland. Management will ensure tree density remains low to preserve grassland character. The expected outcome is a semi-open

habitat that combines foraging opportunities for birds with structural diversity for reptiles and small mammals.

Creation of *Fagetum moesiace submontanum typicum* Woodland (2.46 ha)

On suitable terrain, primarily steeper slopes, enrichment planting with beech (*Fagus sylvatica*) will be undertaken to recreate natural submontane forest stands. Soil preparation, seedling protection, and weed control will be applied in the first years. The expected outcome is woodland of moderate condition within 15–20 years, enhancing slope stability and providing roosting potential for bats.

Creation of *Quercetum frainetto-cerris* Woodland (12.75 ha)

Flatter sites and degraded broadleaf stands will be reforested with a mix of *Quercus cerris* and *Quercus frainetto*. This will directly offset the woodland communities lost to inundation. The expected outcome is the creation of structurally diverse oak woodland of moderate ecological condition, which will gradually mature and may achieve high ecological condition in the longer term.

Following the implementation of terrestrial habitat management and offset measures, the expected outcome will be the establishment of continuous woodland habitats expanding along both banks of the River Tamnava (Figure 5). Over time, these restored woodlands will develop into structurally diverse ecosystems that provide ecological connectivity between fragmented areas and offset the habitats lost to inundation. Importantly, this expansion will secure long-term accommodation for species that triggered Critical Habitat designation, while simultaneously reinforcing riverbanks against erosion and improving the resilience of the riparian corridor.

During habitat mapping of the proposed offset areas, in the surrounding area, several species of conservation value were recorded, including Middle Spotted Woodpecker (*Dendrocoptes medius*), Little Egret (*Egretta garzetta*), Grey-headed Woodpecker (*Picus canus*), European Turtle Dove (*Streptopelia turtur*), Common Wall Lizard (*Podarcis muralis*), and European Green Lizard (*Lacerta viridis*). These species are consistent with those triggering PBFs and Critical Habitats in the baseline study / project area, thereby validating the ecological suitability of the offset areas as extensions of existing habitats.

Figure 5 - Example of Developed Woodland on One Side of River

5.3 Aquatic/Riparian

Baseline Condition

Field assessments confirmed that river segments downstream of the Ub–Tamnava confluence (~9.6 km length) exhibited fairly poor (value 0.4) ecological condition. Key issues identified included evidence of historic modification for flood defence (i.e. over-widening and over-deepening), litter accumulation, regular disturbance from mowing of banks, and widespread presence of invasive woody species such as *Robinia pseudoacacia* and *Ailanthus altissima*. In Veliko Polje, additional degradation was recorded due to localized fires, which reduced riparian vegetation cover and left exposed, erosion-prone banks.

At baseline, the project results in the loss of approximately 5.3 km of surface running water habitats (3.18 Q River Length Units). These losses must be offset through condition upgrades in existing upstream and downstream habitats, aiming at a 20% NG in QH units. Riverine NGs will be achieved through a combination of hydrological enhancement (improved drought and flood resilience) and localised habitat enhancement. The majority of riverine gains will be achieved as a result of increased drought resilience resulting from delivery of the Serbian minimum flow and the effects of reservoir flood attenuation. Further details on these hydrological measures and additional habitat improvement are outlined below.

Increased Drought Resilience

Increased drought resilience is considered the most beneficial measure for riverine habitats, delivering significant habitat gains. This will be achieved through delivery of the Serbian minimum flow resulting in increased habitat condition. This minimum compensation flow is legally mandated downstream of new reservoirs in Serbia and is designed to deliver sustainable summer flows for fish spawning. Hydrological modelling undertaken for the River Ub (see Section 8 of ESIA Volume 1 Book 4 – Biodiversity Impact Assessment) has shown the Serbian minimum flow to have a significant water quantity benefit, particularly in dry years. The effect of summer drought is considered a significant pressure on the River Ub and the aquatic receptors it supports; this hydrological pressure will be reduced during operation of the reservoir. This enhancement will be realised within the length (approximately 28km) of the River Ub downstream of the proposed reservoir to the Ub-Tamnava confluence.

Increased Flood Resilience

Increased flood resilience is a second hydrological measure that will deliver benefits for downstream river habitats, delivering additional riverine gains. Modelling has shown that a natural regime will exist during operation, delivering naturally fluctuating and dynamic flows required to create and maintain/clean habitats (see Section 8 of ESIA Volume 1 Book 4 – Biodiversity Impact Assessment). However, the reservoir is designed with capacity to store water and reduce the magnitude of major flood events, safeguarding human communities downstream, including in the town of Ub (see Technical Assessment Report Appendix 7 – Operational Rules). The attenuation of the most extreme ‘ecologically damaging’ floods will also offer benefit for the notable aquatic features (fish and thick-shelled mussel). This enhancement will be realised within the length (approximately 28km) of the River Ub downstream of the proposed reservoir to the Ub-Tamnava confluence.

Riverbank Clean-up and Stabilisation

Systematic removal of litter dumped household/agricultural and other forms of anthropogenic waste. Care will be taken to ensure woody debris offering habitat heterogeneity and fluvial geomorphological benefit and process will be left. Bioengineering stabilisation measures (live staking, fascines, coir rolls) will be applied on eroded banks. The expected outcome is structurally stable banks with reduced sediment loading to the river channel. The

Riparian Buffer Restoration

Clearance of invasive black locust stands and enrichment planting with native species (*Alnus glutinosa*, *Populus nigra*, *Salix alba*). Establishment of continuous vegetated buffer strips will filter runoff, provide

shading, and restore connectivity between aquatic and terrestrial ecosystems. Buffer strip represent and low-cost, but effective measure to separate areas of agricultural enrichment and the river corridor. Confirmation on the locations (upstream of the reservoir) where this intervention will be implemented will be confirmed as part of the technical design of upstream sediment control measures proposed for upstream rivers. These include; double living wicker, afforestation in/or adjacent to the river, Ilofilters (forest grass belts) and improved agricultural practices and prohibition on poor agricultural practices to reduce bank erosion and sediment ingress. Location downstream, adjacent to the Tamnava River, will be confirmed at part of the terrestrial offset design; however, it should be noted that ~10 km river length is available within land owned by Srbijavode located adjacent to Tamnava River.

In-Channel Habitat Improvement

Targeted addition of heterogeneous substrates (gravels, sands, woody debris) to diversify aquatic habitats and support spawning/feeding grounds for fish and benthic invertebrates. Combined with E-flow regulation, this will upgrade channel sections up one class of ecological condition under the Q River Length Unit Offset framework.

Following the implementation of aquatic and riparian enhancement measures, the expected outcome will be the restoration and improvement of surface running water habitats within and downstream of the project area. By stabilizing riverbanks, re-establishing riparian vegetation, and removing litter and invasive species, the Ub–Tamnava system will gradually regain ecological complexity and resilience. These actions will not only offset the loss of riverine habitats within the inundation zone but will also strengthen hydrological and biological connectivity across the river corridor.

The creation of improved riparian buffer zones, coupled with minimum ecological flow releases, will provide refugia for sensitive taxa and sustain critical ecological processes such as fish migration and spawning, mussel reproduction, and invertebrate dispersal. Over time, these measures will create a functionally connected riverine landscape that supports CH species while enhancing resilience against droughts and floods. The attenuation of major floods by the new reservoir will also offer ecological resilience; whilst flood events that are very important for the lifecycles of numerous species and the maintenance / flushing of river habitats will occur during operation (see ESIA Volume 1 Book 4 – Biodiversity Impact Assessment), the most significant and ecologically damaging flood events will be reduced as a result of the reservoir.

Field surveys in one of the tributaries, in the off-site area, demonstrated that where continuous woodland and structurally intact riparian habitats are present on both banks, water quality is markedly higher, with clear flow and no visible turbidity (Figure 7). This observation confirms the strong relationship between healthy riparian vegetation and aquatic ecological condition. By applying similar restoration interventions in the targeted offset area, a comparable outcome is expected, with improved water clarity, reduced sedimentation, and enhanced suitability for species of conservation concern.

Figure 6 - Tamnava River Photos

Picture 1 – Degraded / modified riverbank habitat

Picture 2 – Litter in the river

Figure 7 – Example of Water Quality in Tributary with Intact Riparian Woodland

River Net Gain Calculation

Table 8 shows the river habitat losses associated with the reservoir inundation, based on the 145 m operating level (5.3 km and 3.18 Q River Units), and the number of net gain units (Net Gain Q River Units) required by the Project to achieve a 20% net gain (3.82 units).

Table 9 shows a worked example of how river condition improvements outlined in this section can be used to achieve 4.10 Net Gain Q River Units across 27 km of the River Ub and 7 km of River Tamnava. The example assumes improved flood and drought hydrology in the River Ub downstream of the dam and improved riparian structure in the River Tamnava, as a result of riparian planting / improved structure adjacent to off-site restoration areas.

This worked example shows that 4.10 Net Gain Q River Units can be achieved through improvement of existing river (i.e. enhancement rather than creation on new river channel) downstream of the proposed dam. This calculation is considered precautionary, as it does not consider proposed restoration measures (including buffer zones) upstream of the proposed dam, which will be developed later and only considers 7 km of the 9.6 km of the River Tamnava available for improvement. This calculation will be updated as part the next design phase, in line ESAP commitments, where it will include all proposed measures, both upstream and downstream of the proposed dam.

Table 8 – River habitat losses associated with the reservoir inundation area and required net gain (Q River Units)

EUNIS code	EUNIS habitat name	Baseline			Required offset, to be delivered through onsite and off-site habitat enhancement / creation			Analysis			
		Length (km)	Condition	Q River (units)	Length (km)	Condition	Q River (units)	Net Gain Q River (Units)	Net Gain Length (km)	% Net Gain Q River (Units)	Description / Comments
C2: C2.31 C3.55	Epipotamal streams Sparsely vegetated river gravel banks	5.30	0.60	3.18				3.82		20	River Ub – Natural and Semi-Natural

Table 9 – River habitat gains (Q River Units) associated with enhancement (condition uplift) in the River Ub downstream of the reservoir and River Tamnava

EUNIS code	EUNIS habitat name	Baseline			Required offset, to be delivered through onsite and off-site habitat enhancement / creation			Analysis			
		Length (km)	Condition	Q River (units)	Length (km)	Condition	Q River (units)	Net Gain Q River (Units)	Net Gain Length (km)	% Net Gain Q River (Units)	Description / Comments
C2: C2.31 C3.55	Epipotamal streams Sparsely vegetated river gravel banks	22.00	0.60	13.20	22	0.70	15.4	2.20	0	20	River Ub – Natural and Semi-Natural (improved drought and flood hydrology / regime)
C2: C2.31 C3.55	Epipotamal streams Sparsely vegetated river gravel banks	5.00	0.40	2.00	5.00	0.50	2.5	0.50	0	20	River Ub – Modified (concrete lined channel) ((improved drought and flood hydrology / regime)
C2: C2.31 C3.55	Epipotamal streams Sparsely vegetated river gravel banks	7.00	0.40	2.80	7.00	0.60	4.2	1.40	0	20	Tamnava – Improved Riparian Structure / Planting adjacent to off-site areas
							Total Net Gain Q River (units)	4.10			

6. Implementation Framework and Preparatory Actions

Successful delivery of the HMEOP depends on how effectively its measures are translated from design into practice. Implementation is therefore not only a procedural step between planning and monitoring, but the phase in which ecological intent becomes tangible through coordinated field actions, documentation, and data management.

The implementation framework provides the bridge between the technical design of habitat offsets and the performance monitoring that follows. Its purpose is to ensure that every restoration, planting, and offset activity is executed under clear ecological logic, using verified baseline and reference data, and that all actions are traceable for future evaluation of Net Gain performance.

All habitat management and offset activities will be synchronised with the engineering design and construction phasing of the Pambukovica Dam, ensuring ecological works are embedded within the programme rather than added retrospectively. Activities such as woodland planting, riparian buffer establishment, and invasive-species clearance will be scheduled alongside site preparation and reservoir impoundment to minimise re-disturbance and achieve early vegetation establishment. Measures defined in this HMEOP are consistent with the ESIA Environmental and Social Management Plan (ESMP) and the Invasive Species Management Plan (ISMP, BMP Action 4) and will be reflected in the Contractor's Construction Environmental Management Plan (CEMP). Implementation will follow method statements prepared under Table 10. All restoration and offset interventions is designed to meet ecological indicators defined in Table 4 and linked to Net Gain performance metrics (Quality Hectares and Q-km).

Table 10 - Method Statements for Habitat Implementation

Method Statement	Scope and Objectives	Key Technical Steps / Methods
1. Riparian and Gallery Woodland Establishment	Restore *Alnus glutinosa*, *Populus nigra*, *Salix alba* woodland along reservoir edge and Tamnava offsets.	- Remove existing *Robinia pseudoacacia* and *Amorpha fruticosa*. - Prepare soil and stabilize banks (live staking, coir rolls). - Plant native riparian species in 3-m spacing strips within hydrologically suitable zones. - Water during first two years, if needed during dry.
2. Woodland Conversion (Robinia / Arable to Oak–Beech)	Convert degraded or invasive stands to native *Fagetum moesiace* and *Quercetum frainetto-cerris* woodland.	- Clear invasive trees in phases; stump removal and spot herbicide if re-sprouting. - Ripping and soil scarification on compacted soils. - Use mixed-age planting to accelerate structure. - Install tree guards; replant mortality > 20%.
3. Grassland Restoration and Management	Create and maintain mesic and sparsely wooded grasslands on gentle slopes and offset parcels.	- Cease mowing to allow natural regeneration. - If sward sparse, reseed with local mix (*Festuca rubra, Dactylis glomerata, Trifolium* spp.). - Spot remove *Robinia* seedlings.
4. Aquatic / Littoral Habitat Formation	Stabilise new reservoir margins and improve aquatic habitat heterogeneity.	- Where needed, grade shorelines 1:3–1:5 to form shallow littoral benches. - Install bioengineering materials (coir rolls, fascines). - Leave deadwood and stones for refugia. - Maintain 20 m no-machinery buffer during establishment.

Method Statement	Scope and Objectives	Key Technical Steps / Methods
5. Invasive Species Management (ISMP)	Prevent, control, and monitor invasive non-native species during all phases.	- Follow ISMP protocol for machinery cleaning and soil/material control. - Map invasive populations; treat mechanically or with selective herbicide. - Re-inspect treated plots annually. - Transition responsibility to Srbijavode post-construction in line with national invasive-species regulations.

The quality/condition determination of habitats follows that described in Chapter 3 and Table 2 and Table 3 where condition scores (0.2–1.0) are assigned according to a series of criteria. Newly created or restored habitats within the expropriation zone (on-site) are expected to reach moderate to fairly high condition (0.6–0.8) within 10 years, depending on habitat type and establishment success. Off-site offsets—particularly woodland and grassland restorations in the Tamnava corridor—are anticipated to start at low to moderate condition (0.4–0.6) and progressively improve through sustained management to at least 0.6–0.8. These assumptions underpin the Net Gain factors (10–35 %) applied in the ESIA and HMEOP, ensuring that the projected uplift in ecological condition is realistic, measurable, and traceable against the benchmarked scoring framework.

7. Monitoring, Evaluation and Adaptive Management

7.1 KPIs and Indicators

The effectiveness of the Habitat Management, Enhancement and Offset Plan will be tracked through a set of Key Performance Indicators (KPIs) that measure both ecological outcomes and management performance (Table 11). These indicators are designed to provide clear, quantifiable evidence of progress toward Net Gain (NG) objectives. They cover habitat condition, survival of restoration plantings, control of invasive species, recovery of riparian structure, and the status of key species groups identified as Priority Biodiversity Features (PBFs) or Critical Habitats (CHs). Monitoring will combine field surveys, GIS analysis, and species-specific assessments, with results compared against baseline conditions established in the ESIA. The following table outlines the KPIs, their definitions and methods of measurement, thresholds or targets, and proposed monitoring frequency.

Table 11 - Key Performance Indicators

KPI	Definition & Method of Measurement	Target / Threshold	Monitoring Frequency
Quality Hectares (QH) Uplift	Change in habitat ecological value, calculated as area × condition class. Condition assessed using EUNIS habitat typology, vegetation surveys, and ecological scoring (0.2 = poor, 1.0 = pristine).	≥ targeted % net gain for each habitat type (10–35% depending on typology).	Baseline, then every 3 years (up to 10 years).
Tree/Plant Survival Rate	% of planted individuals alive after a set period, verified through fixed plot surveys and GPS-tagged trees.	≥ 80% survival after 3 years; ≥ 60% survival after 5 years (with replanting if lower).	Year 1, Year 3, Year 5, then adaptive.
Invasive Species Cover Reduction	% of invasive species cover (Amorpha, Robinia, Ailanthus, etc.) measured using quadrat sampling and GIS mapping.	≥ 50% reduction within 5 years; ≤ 10% cover after 10 years.	Annual, post-treatment.
Riparian Vegetation Cover	% of riverbank length with ≥70% cover of native riparian species (Salix alba, Alnus glutinosa, Populus nigra).	≥ 70% of restored riverbank within 5 years.	Annual visual and GPS transects.
Water Quality Indices	Key metrics: DO, turbidity, nutrients (N, P), suspended solids. Measured against national and EU WFD standards.	Maintain/improve relative to baseline; no exceedance of legal limits.	Quarterly (construction & early operation); annually thereafter.
Species (general)	Composite indicator across taxa: standardised surveys to be implemented and monitored under BMP Action 2: Develop and implement an Ecological Monitoring Plan (terrestrial).	Stable or increasing presence/occupancy of targeted species relative to baseline.”	Year 1, Year 3, Year 5, then adaptive.
Water / Sediment Quality Parameters	Suspended solids / water quality in Water and Environmental Management and Monitoring Plan (WEMMP), particularly Actions 3 will involve pre-	As per WEMMP criteria	As per WEMMP

KPI	Definition & Method of Measurement	Target / Threshold	Monitoring Frequency
	construction, construction and operations phase monitoring.		
Disease-Free Woodland Stands	% of monitoring plots free of Beech Leaf Disease (BLD) or other emerging pathogens.	≥ 95% of offset plots free from infection; rapid response in case of detection.	Annual survey, with contingency inspections.

7.2 Survey Design & Frequency

Monitoring surveys will follow a structured design to capture seasonal dynamics, construction-related impacts, and long-term ecological recovery. During the construction phase, surveys will be conducted monthly between April and October, covering the active ecological season. These will focus on vegetation condition, invasive species regrowth, faunal activity (birds, bats, amphibians), and aquatic quality indicators.

During the operation phase, surveys will transition to a lower frequency but broader scope. Annual surveys will be conducted for general habitat condition, supplemented by biannual surveys (spring and autumn) for priority taxa such as fish, mussels, and bats, ensuring both breeding and non-breeding seasons are represented. These we be developed and implemented under BMP Action 2 (Develop and implement an Ecological Monitoring Plan: terrestrial) and BMP Action 3 (Develop and implement a Freshwater Ecological Monitoring Plan).

Additionally, event-based surveys will be undertaken following specific management actions or disturbance events (e.g., sediment flushing, severe floods, fire outbreaks, or invasive species treatments). These rapid-response assessments will ensure that unplanned or episodic impacts are captured, and adaptive measures can be promptly applied.

Survey design will apply a stratified approach, combining permanent sample plots for vegetation monitoring, transects for faunal surveys, and fixed water quality monitoring points. Standardized protocols will ensure comparability with ESIA baseline data and alignment with EBRD PR6 and national monitoring frameworks.

7.3 Adaptive Management Triggers

The adaptive management framework is designed to ensure that the Habitat Management, Enhancement and Offset Plan remains effective in practice. It is based on clear thresholds, corrective actions, and a decision-tree process to guide timely responses. Habitat specific thresholds/tiggers for adaptive management will be defined further in future iterations of this document, based on condition criteria.

Thresholds will include measurable deviations from targets, such as:

- Tree or shrub survival below 80%; determined through annual /seasonal monitoring as appropriate.
- Invasive species cover exceeding 20% of a restored plot after treatment.
- Water quality parameters (DO, turbidity, nutrients) exceeding baseline levels or national standards as a result of project activities (construction and operation).
- Lack of occupancy in bat or bird boxes after three years of deployment.
- Declines in CPUE/eDNA indices for priority fish or mussel species compared to baseline.
- Adverse changes in aquatic invertebrate metrics.

Corrective actions will be proportionate to the deviation observed. Examples include supplementary planting and irrigation, repeat invasive species control, reinforcement of riparian vegetation, modification of flow regulation, or targeted species reintroduction.

A decision tree will be developed to guide responses, beginning with detection of non-compliance (through KPIs), assessment of cause (e.g., climatic event vs. management failure), and escalation of actions (minor adjustment, major corrective action, or redesign of restoration approach).

All responses will be fully documented through monitoring reports, reviewed annually by the Project Biodiversity Specialist, and submitted to EBRD and relevant national authorities. This process ensures transparency, accountability, and continuous improvement throughout the project lifecycle.

8. Roles, Responsibilities and Institutional Arrangements

Effective delivery of the HMEOP requires clearly defined institutional roles, transparent responsibilities, and structured coordination among all parties. The arrangements reflect the commitments made in the ESIA and follow EBRD PR1 and PR6 requirements for biodiversity management. The structure ensures that offset measures are implemented correctly, monitored consistently, and adapted where required.

8.1 Srbijavode

PWMC Srbijavode is the overall owner of the Project and is therefore ultimately responsible for the successful delivery of the HMEOP. As the implementing authority under the Ministry of Agriculture, Forestry and Water Management, Srbijavode has the legal mandate to manage water and associated land, and to ensure that biodiversity offsets are consistent with the Law on Waters and related environmental regulations. In practice, Srbijavode will oversee all biodiversity-related activities, approve method statements and offset proposals prepared by specialists, and coordinate with both contractors and state authorities. It will also ensure that sufficient resources, financial, technical, and human, are allocated to achieve the commitments. In addition, Srbijavode will act as the main interface with EBRD and other lenders, providing periodic compliance reports and facilitating monitoring visits.

During the operational phase, PWMC Srbijavode will assume responsibility for all long-term maintenance actions specified in the HMEOP, including periodic inspection and control of invasive species such as Robinia pseudoacacia in accordance with the ESIA's ISMP (BMP Action 4).

8.1.1 Biodiversity Specialist

A qualified Biodiversity Specialist will provide technical oversight of all habitat management, enhancement, and offset works. This role is critical to ensuring that ecological considerations are embedded in project execution and that mitigation measures are not only designed but also implemented effectively. The Biodiversity Specialist will review detailed method statements covering habitat restoration, invasive species control, woodland planting, and river corridor enhancement on behalf of Srbijavode to ensure they meet the BMP, HMEOP and ESIA commitments. They will be present during key construction and offset activities to supervise works, conduct compliance checks, and provide immediate advice on sensitive issues. The Biodiversity Specialist is also responsible for ecological sign-off before reservoir filling, confirming that mitigation and offset measures have been implemented to a standard consistent with ESIA commitments. The Biodiversity Specialist will also oversee the monitoring of the habitat management and creation sites and ensure integration with wider species-specific monitoring and mitigation outlined in the BMP.

8.2 EPC Contractor & Subcontractors

The Engineering, Procurement and Construction (EPC) Contractor, supported by subcontractors, is responsible for integrating biodiversity requirements into day-to-day construction management, including habitat enhancement and creation outlined in the HMEOP. In addition to the Construction Environmental Management Plan (CEMP), the EPC contractor will be responsible for developing and implanting habitat creation and enhancement. This includes site-specific offset plans and method statement for habitat creation sites. The Contractor will conduct toolbox talks for workers on biodiversity-sensitive practices, keep detailed records of vegetation clearance, offset planting, and site restoration, and ensure that any deviations from agreed methods are reported immediately to the ECoW. Subcontractors will be contractually bound to follow the same environmental standards and will be monitored by both the EPC Contractor and the ECoW.

8.2.1 EPC Biodiversity Specialist / ECoW (construction)

A qualified Biodiversity Specialist, acting as the EPC biodiversity advisor and Ecological Clerk of Works (ECoW), will provide technical oversight of all habitat management, enhancement, and offset works. This role is critical to ensuring that ecological considerations are embedded in project execution and that mitigation measures are not only designed but also implemented effectively. The ECoW will prepare detailed

method statements covering habitat restoration, invasive species control, woodland planting, and river corridor enhancement, under the supervision of Srbijavode's Biodiversity Specialist. They will be present during key construction and offset activities to supervise works, conduct compliance checks, and provide immediate advice on sensitive issues.

8.3 Monitoring and Reporting Responsibilities

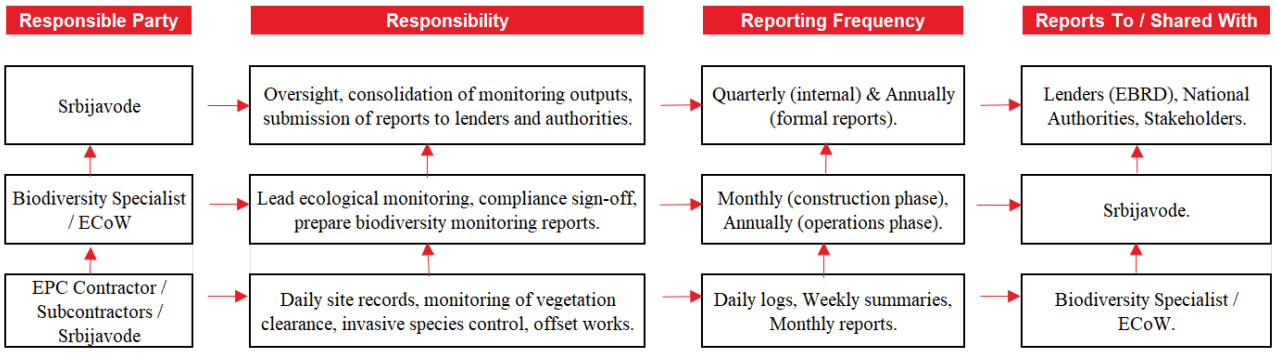
The monitoring and reporting framework is designed to ensure transparency, accountability, and adaptive management throughout the implementation of the HMEOP. Monitoring responsibilities are shared across parties, with clearly defined reporting lines to Srbijavode and onward to lenders and regulatory authorities.

The Biodiversity Specialist / ECoW will lead the ecological monitoring program, preparing periodic reports that document progress against agreed biodiversity indicators, the success of habitat enhancement measures, and compliance with species protection requirements. These reports will be submitted to Srbijavode, which will review, validate, and integrate them into consolidated environmental and social monitoring reports required under the ESIA.

The EPC Contractor and subcontractors will be responsible for collecting primary monitoring data during construction, including records of vegetation clearance, offset planting, invasive species control, and restoration works. They will submit weekly or monthly logs to the ECoW, ensuring that field evidence aligns with the commitments outlined in the HMEOP and CEMP. Any non-compliance or incidents must be reported immediately.

Srbijavode will consolidate all monitoring outputs into formal reports for submission to lenders (e.g., EBRD) and relevant national authorities. These reports will include a clear summary of compliance status, biodiversity performance against Gain targets, and any adaptive measures triggered. Annual monitoring reports will be shared with stakeholders, while internal progress reviews will occur quarterly.

Figure 8 - Monitoring and Reporting Responsibilities Diagram



Note: The EPC Contractor will be responsible for implementing and monitoring habitat creation and management measures for a period of 24 months following project completion and handover. After this period, the responsibility for continued monitoring, maintenance, and adaptive management will transfer to Srbijavode, as part of its long-term operational obligations. This approach ensures continuity in ecological management while maintaining clear accountability across project phases.

The table below outlines the sequence of key implementation tasks required to deliver the biodiversity mitigation, restoration, and enhancement commitments identified in the ESIA and HMEOP. It defines the activities for both terrestrial and aquatic habitats, their indicative timing across project phases, and the responsible parties. The reporting hierarchy is shown using arrows to illustrate the flow of responsibility and supervision, ensuring clear accountability from field implementation through to long-term operational management.

Figure 9 - Implementation Tasks and Responsibilities

Task	Description	Implementation Phase	Responsible Party (with reporting flow)
Sensitive Site Clearance & Species Protection	Ecologist-led vegetation clearance, translocation of fauna, and protection of nesting/roosting species before works.	Pre-construction	EPC Contractor → ECoW → Supervision Engineer → Srbijavode
Invasive Species (IS) Eradication & Monitoring	Implement biosecurity, cleaning, and inspection of all machinery; mechanical/manual removal of Robinia pseudoacacia, Ailanthus altissima, etc.; long-term monitoring and adaptive management.	Pre-construction → Operation	EPC Contractor → ECoW / Biodiversity Specialist → Supervision Engineer → Srbijavode
Litter Clearing & Restoration	Remove fly-tipped and agricultural waste from riparian corridors and offset lands; restore disturbed sites with native vegetation.	Pre-construction → Operation	EPC Contractor → Supervision Engineer → Srbijavode
Habitat Creation & Enhancement	Establish mesic and sparsely wooded grasslands, oak-beech woodlands, riparian and riverine habitats within offset and expropriation zones using native species.	Construction → Early Operation	EPC Contractor → ECoW → Supervision Engineer → Srbijavode → EBRD
Revegetation & Buffer Strip Establishment	Create woodland and shrub buffer zones around the future reservoir and inflow areas to reduce erosion and improve water quality.	Construction → Operation	EPC Contractor → Supervision Engineer → Srbijavode
Riverine / Riparian Enhancement	Implement Aquatic Enhancement Plan: riparian planting, bank stabilization, channel re-profiling, sediment and litter removal.	Construction → Operation	EPC Contractor → Supervision Engineer → Srbijavode
Long-term Monitoring & Adaptive Management	Track habitat recovery, IS recurrence, and effectiveness of NbS; adjust measures as needed.	Operation	EPC Contractor → Srbijavode → Local Inspectorate / EBRD

9. Implementation Schedule

The successful delivery of the Habitat Management, Enhancement and Offset Plan (HMEOP) requires clear phasing of activities, defined milestones, and robust funding arrangements. Implementation will span pre-construction, construction, and operational phases, with monitoring and adaptive management running throughout the Project life cycle.

9.1 Phasing

Pre-Construction / Final DesignThis phase includes all preparatory and enabling activities that must be completed before vegetation clearance and reservoir works begin, including development of the final design. Key actions include detailed site marking, ecological clerk of works (ECoW) induction. Early litter clearing, removal of agricultural waste, and establishment of pilot planting plots within future offset and buffer areas will be undertaken where access allows. Where feasible, early establishment of grassland and riparian vegetation will be prioritised to provide immediate ecological benefit and to compensate for habitats that will be lost during later works.

Early construction

Activities in this phase will focus on preparatory works that must precede vegetation clearance and inundation. These include advanced planting of key woodland areas to accelerate habitat establishment, invasive species removal, and initial stakeholder engagement with local forestry and water management institutions. Where possible, early creation of riverine and grasslands will be prioritised to provide immediate ecological benefit and compensate for habitat loss once clearance begins.

Construction phase

During construction, emphasis will be placed on strict adherence to timing constraints to avoid impacts on breeding birds, bats, amphibians, fish and mussels. Rescue and relocation protocols will be implemented in inundation areas in line with BMP Action 5 (Develop and implement a Sensitive Site Clearance Strategy), and biosecurity measures will be applied to prevent the spread of INNS. Habitat management tasks within the expropriation zone, such as planting and slope stabilisation, will run in parallel with dam and reservoir works. Toolbox talks, weekly compliance checks, and ongoing ecological clerk of works (ECoW) oversight will ensure all actions are fully integrated into the construction process.

Operation and early reservoir filling

In the initial years of operation, habitat enhancement and offsetting actions will continue, with emphasis on riparian woodland establishment, grassland management, and aquatic habitat creation. Adaptive management will be triggered by monitoring results, with corrective actions applied if thresholds (e.g., tree survival rates, invasive species cover) are not met. Long-term funding mechanisms will support continued management of offset areas, particularly in downstream plots (Brović, Piroman, and Veliko Polje).

9.2 Gantt / Milestones

A Gantt chart (Figure 10) is showing the sequence of tasks, their duration, and responsible parties. Key milestones include:

- Year 0 (pre-construction / design): Finalisation of HMEOP, baseline monitoring, invasive species clearance, advanced planting of woodland offsets.
    - Year 1–2 (construction): Vegetation clearance (timed outside breeding season), rescue of amphibians and reptiles, initiation of terrestrial and aquatic habitat creation, establishment of bat and bird boxes.
    - Year 3 – 5 (early operation): Verification of habitat establishment, performance against KPIs (e.g., ⩾80% survival of planted trees at Year 3), reduction of invasive species cover by ⩾50%.

- Year 6–10 (long-term): Habitat condition reassessment, achievement of targeted Quality Hectares (QH) uplift, monitoring of fish and mussel populations, evidence of functioning ecological connectivity.

This milestone-based approach provides checkpoints for lenders, regulators, and stakeholders, while ensuring accountability and adaptive management.

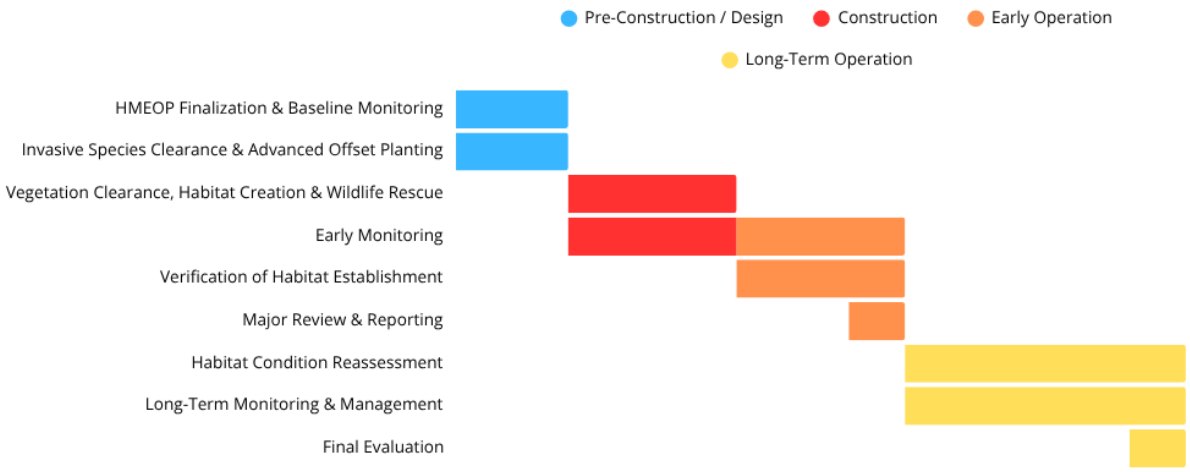


Figure 10 - HMEOP Gantt Chart

10. Risk Management and Contingency Planning

The implementation of the HMEOP faces several risks that could undermine its long-term objectives if left unmanaged. These risks stem from both ecological and operational factors, ranging from climate variability to biological threats and land management challenges. Anticipating these risks, and embedding robust contingency measures, is essential to ensure that the project achieves its Net Gain commitments.

10.1 Key Risks

Climatic risks represent one of the most significant uncertainties. Extended droughts may limit the establishment of newly planted woodlands and grasslands, while periods of flooding could damage young vegetation or alter soil stability. Biological risks are also prominent, including the potential failure of planted stock, pest outbreaks, and the spread of invasive alien plants such as *Robinia pseudoacacia*, *Amorpha fruticosa*, and *Ailanthus altissima*. Emerging tree diseases, particularly Beech Leaf Disease, present an additional long-term threat to woodland resilience.

Operational risks include legacy pollution in riparian zones, which may suppress ecological recovery, and sediment management challenges linked to the dam's flushing system. Collectively, these risks underscore the need for flexible and adaptive management throughout the project's lifecycle.

10.2 Mitigations & Contingencies

To address these risks, the HMEOP adopts a layered mitigation strategy. For climatic extremes, measures such as pre-planting irrigation, mulching, and seasonal planting schedules will be applied to improve survival rates. In the event of planting failure, replanting guarantees and nursery reserves will ensure continuity. Where drought conditions persist, ecological flow releases above baseline thresholds will be prioritized to safeguard aquatic connectivity and protect mussel and fish populations.

To counter biological risks, planting palettes have been deliberately diversified, reducing reliance on any single species and increasing ecosystem resilience. All nursery stock will be sourced locally (native strains) from certified disease-free suppliers, with monitoring programs established to detect early signs of stress or infection. Should invasive species re-establish, rapid response protocols, including mechanical removal and selective herbicide use, will be activated. In line with the ESIA Invasive Species Management Plan (BMP Action 4), the risk of *Robinia pseudoacacia* and other invasive species suckering will be managed through phased eradication and periodic re-inspection of restored sites. During the operation phase, these activities will transition to the responsibility of PWMC Srbijavode, which will oversee ongoing monitoring and retreatment where regrowth is detected. Following transfer, all invasive-species management will be implemented in compliance with national legislation and bylaws governing invasive alien species, ensuring alignment with state obligations and maintaining long-term ecological integrity of restored habitats. This ensures continuity of invasive-species management beyond construction and secures long-term ecological integrity of restored habitats.

For operational risks, sediment traps will be monitored regularly, and flushing will be timed outside of fish spawning seasons. In areas affected by pollution or waste, litter removal and soil restoration will be prioritized before planting. Land access risks are mitigated by limiting restoration activities to parcels already under the tenure of PWMC Srbijavode, ensuring long-term feasibility of management.

By combining prevention, monitoring, and rapid response measures, the project ensures that setbacks can be effectively managed without undermining the overall objective. These contingency provisions are embedded within the monitoring framework and are directly linked to the Key Performance Indicators (KPIs) outlined in Chapter 7.

The measures described above are directly tied to the residual impacts identified in the ESIA and are summarized in Table 12. This table aligns each impact with its corresponding HMEOP section, defines the corrective or compensatory action, and sets measurable indicators and schedules. By linking risks to explicit responsibilities and monitoring mechanisms, the table provides an operational roadmap for risk management, ensuring accountability and timely interventions.

Table 12 - Residual Impacts Mapping Matrix

Residual Impact (from ESIA)	Relevant HMEOP Section	Planned Measure / Action	KPI / Monitoring Indicator	Schedule	Responsible Party
Permanent loss of woodland habitats (Fagetum moesiace submontanum, Quercetum frainetto-cerris) due to inundation	5.1 Terrestrial Management; 7 Offset Strategy	Advance planting of native woodland; transformation of Robinia pseudoacacia stands; selective thinning & veteranisation	% of offset woodland reaching condition class 0.8; survival rate of planted trees	Pre-construction (advance planting); monitoring 1/3/5/10 yrs	Srbijavode overall ownership and lead. Srbijavode managing and monitoring during pre-construction and construction phase. Implementation and monitoring during operations phase. Contractor – implementation during pre-construction and construction phase. Task dependant.
Loss of mesic & sparsely wooded grasslands	5.1 Terrestrial Management; 7 Offset Strategy	Modified grazing/cutting regimes; restoration of meadows in Tamnava parcels	Area of grassland in ≥0.6 condition; % reduction in invasive species cover	Establishment pre-construction; annual monitoring	Srbijavode overall ownership and lead. Srbijavode managing and monitoring during pre-construction and construction phase. Implementation and monitoring during operations phase. Contractor – implementation during pre-construction and construction phase. Task dependant.
Loss of ~5.3 km surface running waters (C2.31, C3.55)	8 Aquatic Enhancement Plan	Riparian planting, bank/litter clean-ups, erosion/sediment control, ecological e-flows	% uplift in QH/km; water quality indices; % native riparian cover	Construction + operations; annual surveys	Srbijavode overall ownership and lead. Srbijavode managing and monitoring during pre-construction and construction phase. Implementation and monitoring during operations phase.

Residual Impact (from ESIA)	Relevant HMEOP Section	Planned Measure / Action	KPI / Monitoring Indicator	Schedule	Responsible Party
					Contractor – implementation during pre-construction and construction phase. Task dependant.
Habitat severance for fish & mussels (dam barrier)	8.3 Downstream Connectivity; 5.3 Species Mgmt.	E-flows > baseline in drought years; monitoring of host fish species for Unio crassus; potential fishpond breeding program	Presence/abundance of mussel populations; fish migration surveys	Ongoing during operation	Srbijavode
Disturbance of bats & birds (clearance, lighting, nesting loss)	5.3 Species-Specific Mgmt.	Artificial bat boxes, bird nest boxes, timing of clearance outside breeding season	Occupancy rate of bat/bird boxes; compliance with clearance windows	Pre-construction and during construction	Srbijavode overall ownership and lead. Srbijavode managing and monitoring during pre-construction and construction phase. Contractor – implementation during pre-construction and construction phase.
Spread of invasive alien plants (Amorpha, Robinia, Ailanthus)	5.4 Biosecurity Plan	Eradication program; replacement with native species; contractor biosecurity protocols	% decrease in invasive cover over 5 yrs; compliance with biosecurity checks	Continuous from construction through operation	Srbijavode overall ownership and lead. Srbijavode managing and monitoring during pre-construction and construction phase. Implementation and monitoring during operations phase. Contractor – implementation during pre-construction and construction phase. Task dependant.

Residual Impact (from ESIA)	Relevant HMEOP Section	Planned Measure / Action	KPI / Monitoring Indicator	Schedule	Responsible Party
Risk from emerging tree diseases (e.g. Beech Leaf Disease)	12 Risk Mgmt. & Contingency	Diversify planting palettes; source from certified nurseries; monitor for disease symptoms	% of offset stands disease-free; response time for any outbreak	Planting & ongoing monitoring	Srbijavode overall ownership and lead. Srbijavode managing and monitoring during pre-construction and construction phase. Implementation and monitoring during operations phase. Contractor – implementation during pre-construction and construction phase. Task dependant.
Sediment management (7 traps + flushing)	8 Aquatic Enhancement Plan; 9 Monitoring	Time sediment flushing to avoid spawning season; monitor bathymetry	Sediment load metrics; fish spawning success indicators	Operation (every 3–5 yrs or as required)	Srbijavode

Appendices

A.1 Off-Site Habitat Maps (baseline)

The off-site habitat creation areas shown on the map will be used for the implementation of terrestrial biodiversity offsets required for the Project. Across the Brović, Piroman and Veliko Polje parcels, 29.1 ha of heavily degraded grassland and 1.5 ha of invasive scrub are available for restoration. This land will be used to deliver the 26.72 ha of required terrestrial offsets. The available area therefore exceeds requirements by roughly 4 ha, providing sufficient spatial flexibility to optimise habitat layout, avoid sensitive micro-sites, and ensure successful long-term establishment.

Additional riverine gains will also be achieved off-site, adjacent to the Tamnava River, as part the terrestrial habitat works required to offset terrestrial habitat losses. This terrestrial mitigation, which will occur immediately adjacent to the River Tamnava, will deliver riverine gains through improved riparian structure and buffering capacity. There is approximately 9.6 km of the River Tamnava flowing through the off-site area available for enhancement.

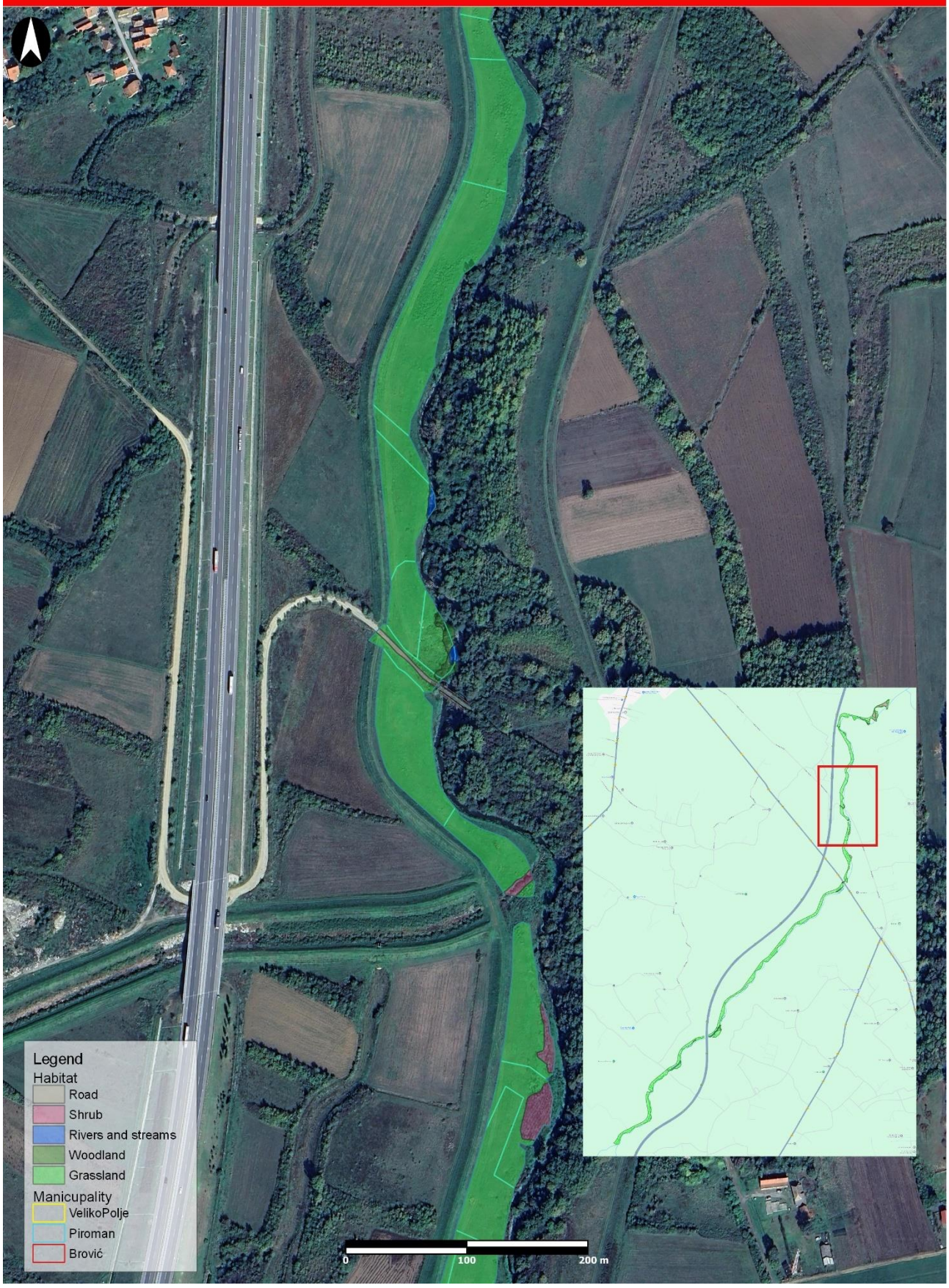
The off-site habitat map presented here illustrates the spatial distribution of current habitat types within the proposed offset areas downstream of the Ub–Tamnava confluence. The landscape is dominated by grassland habitats, which, although mapped as such, are under strong anthropogenic influence resulting from regular mowing, shrub clearance, and the accumulation of household litter. These pressures have reduced the ecological integrity of the grassland mosaic and limited its capacity for natural succession. The same pattern of disturbance and degradation is evident across adjacent parcels and transitional zones toward woodland corridors.

Despite this modification, the degraded grasslands demonstrate clear restoration potential. Field observations recorded the presence of oak and beech seedlings, particularly along river margins and within unmown micro-patches, indicating natural regeneration processes already in progress. With the implementation of habitat creation and management measures described in Section 5.2 (Terrestrial Habitat Enhancement)—notably cessation of intensive mowing, invasive-species removal, enrichment planting, and establishment of structured mowing or grazing regimes—these areas can progressively transition into native woodland or semi-natural grassland of improved ecological condition.


Off-Site Habitat Map 1
ARUP
Legend
Habitat
Road
Shrub
Rivers and streams
Woodland
Grassland
Manicupality
VelikoPolje
Piroman
Brović
0
100
200 m

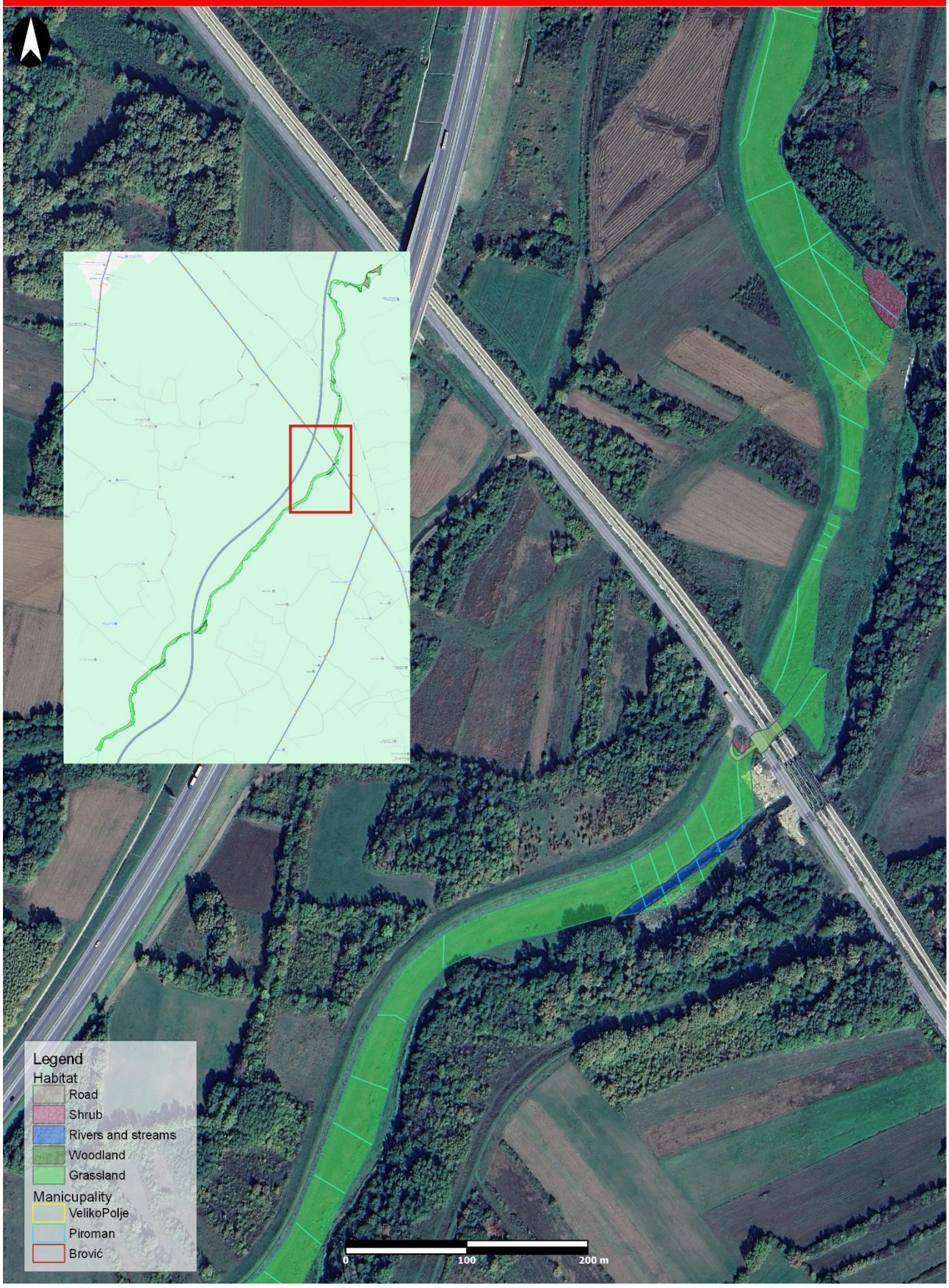
Off-Site Habitat Map 2

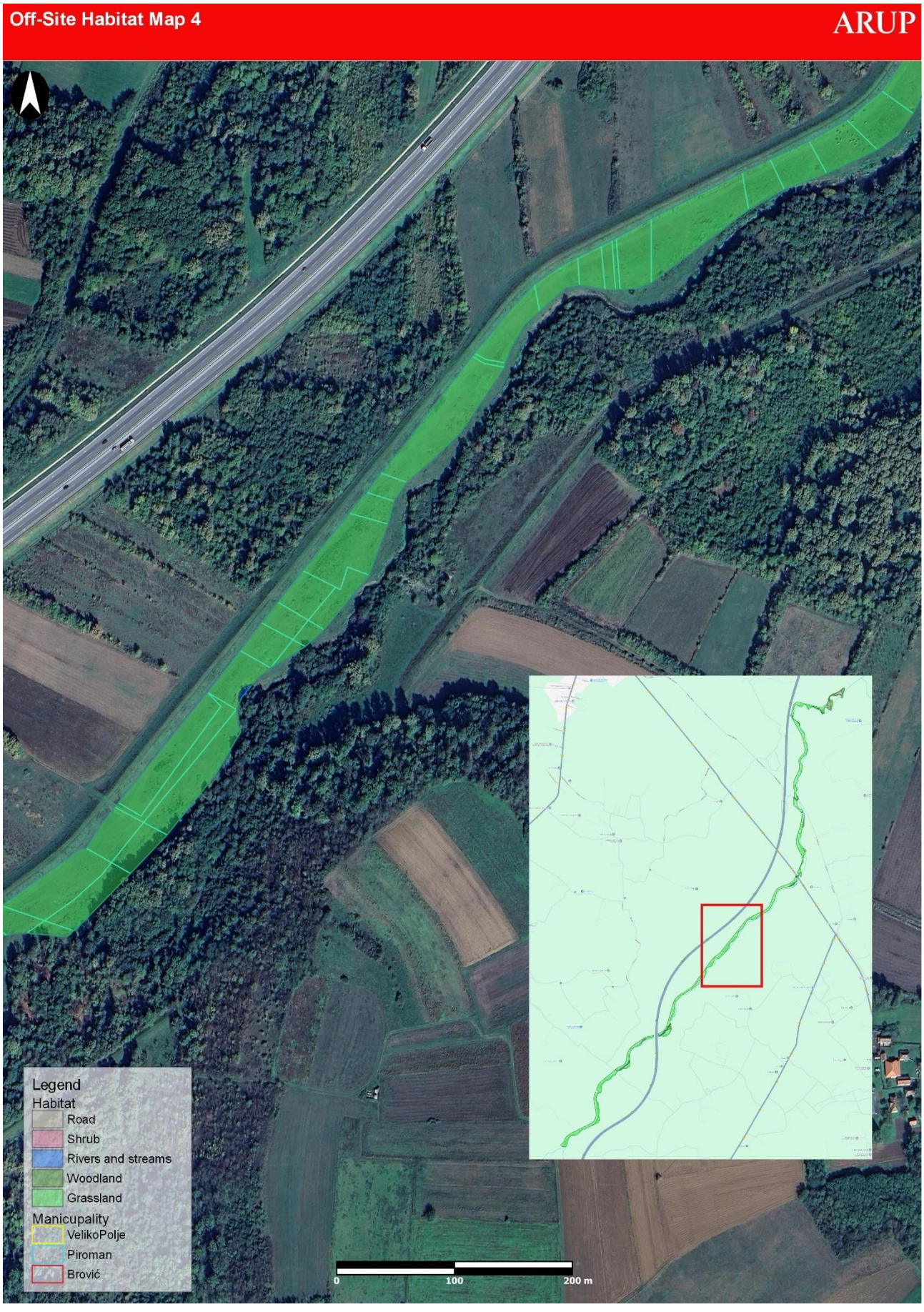
ARUP



Off-Site Habitat Map 3

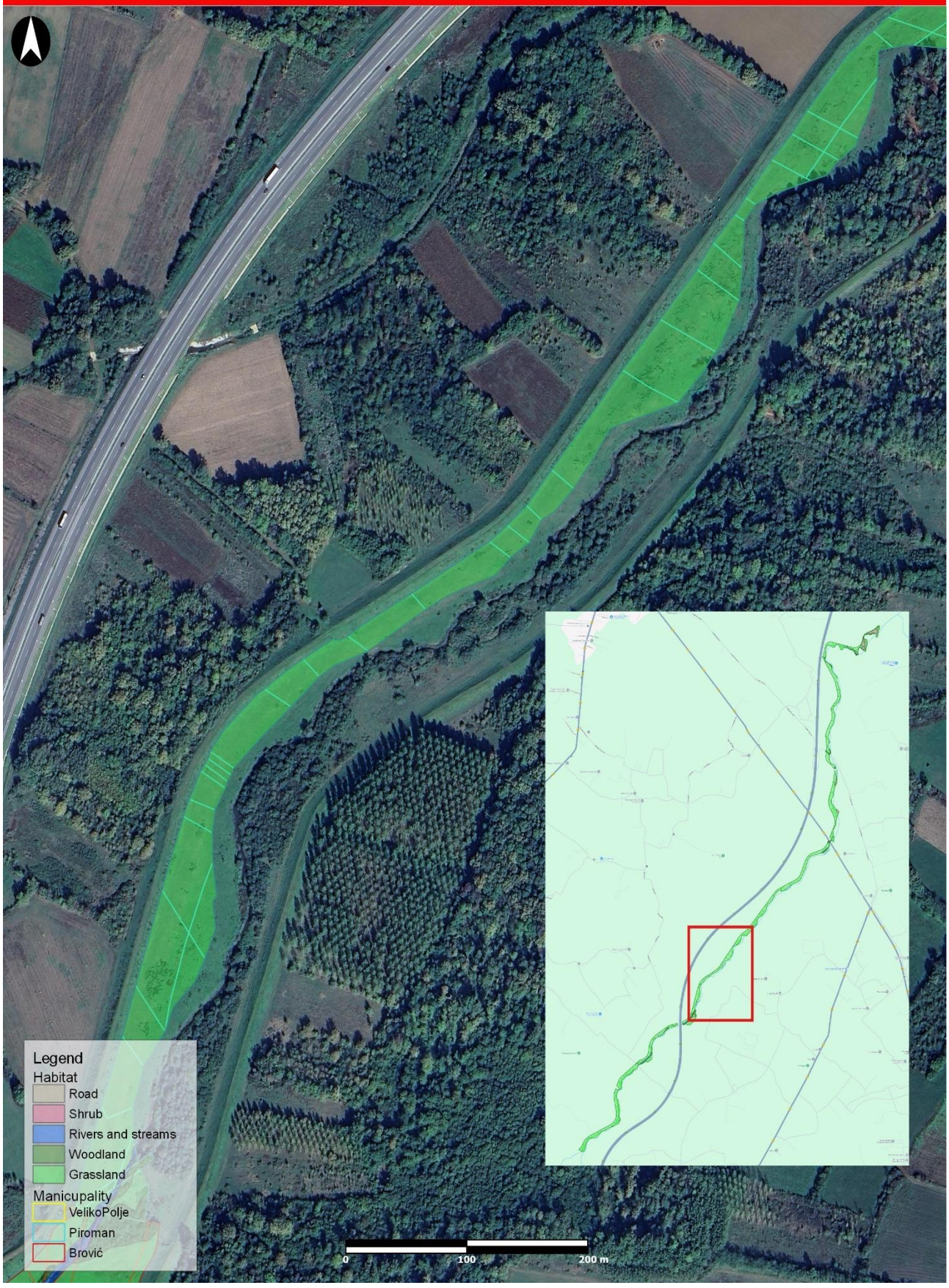
ARUP




Off-Site Habitat Map 4
ARUP
Legend
Habitat
Road
Shrub
Rivers and streams
Woodland
Grassland
Manicupality
VelikoPolje
Piroman
Brović
0
100
200 m

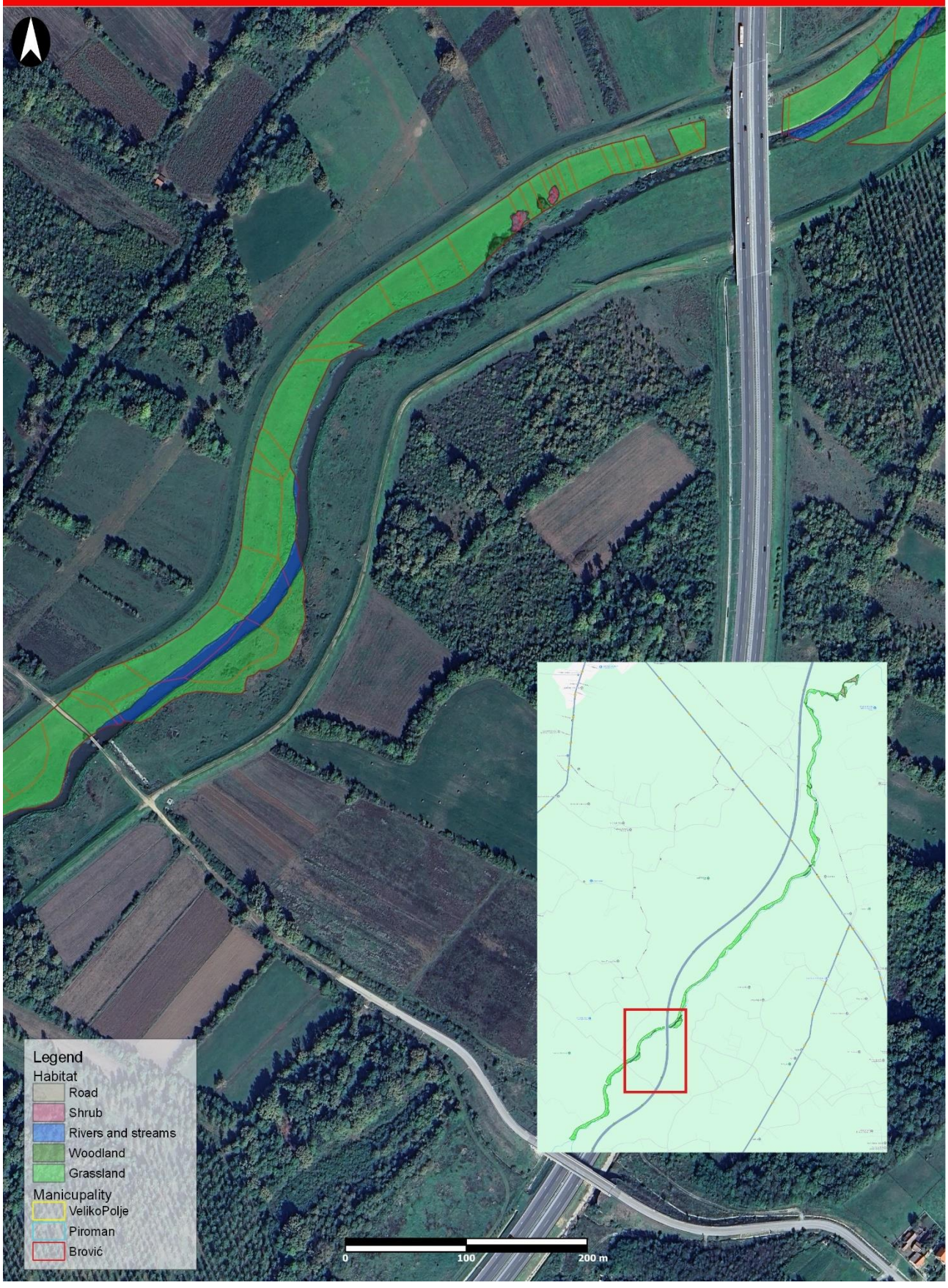
Off-Site Habitat Map 5

ARUP



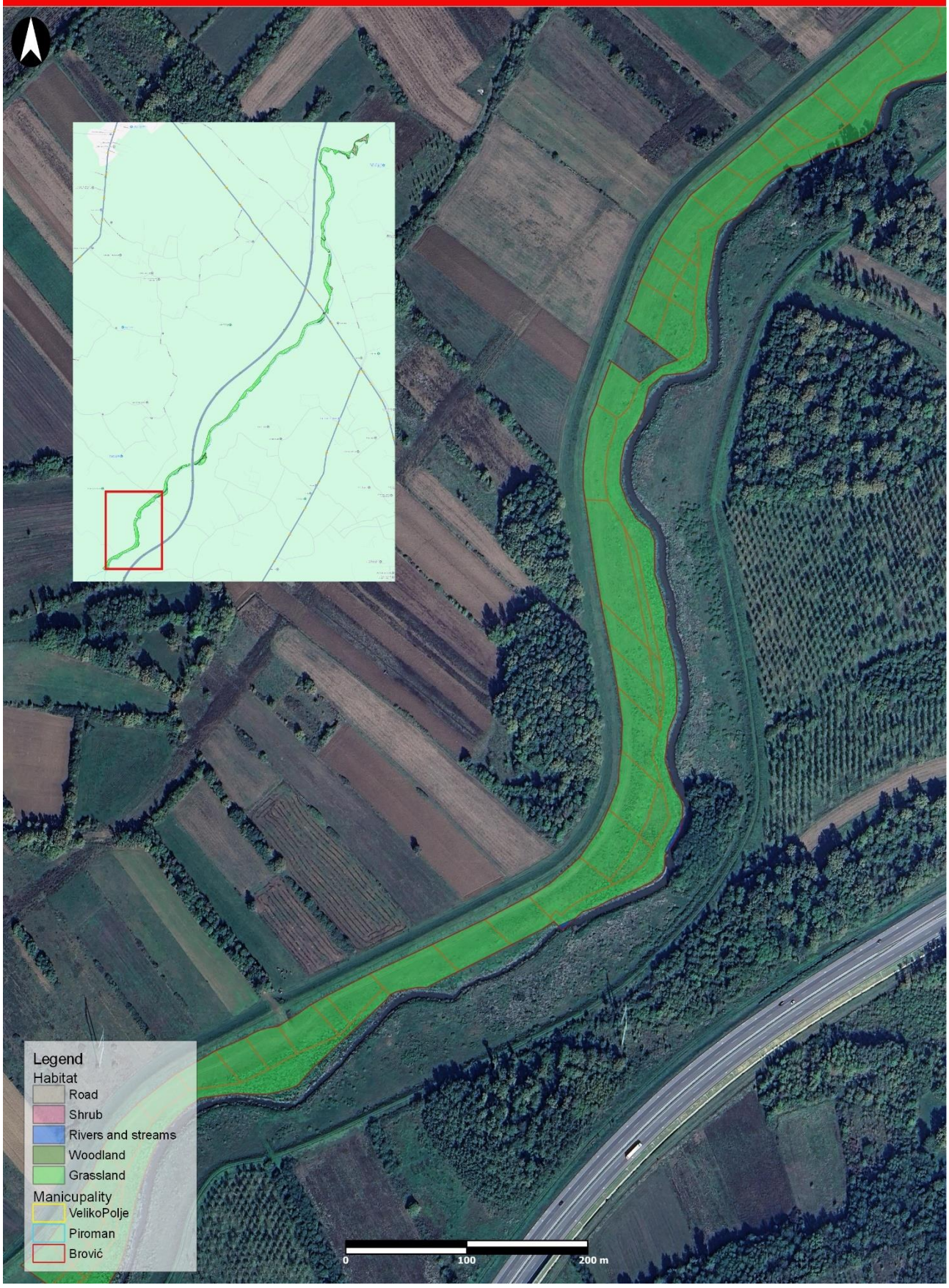
Off-Site Habitat Map 6

ARUP



Off-Site Habitat Map 7

ARUP



Off-Site Habitat Map 8

ARUP