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BIODIVERSITY MANAGEMENT PLAN

Information for Habitats Directive Assessment and Biodiversity Management Plan for HEP Ombla Hydropower Project Impacts on the Proposed Paleoombla-Ombla Natura 2000 Site

For HEP and the EBRD

14/03/2013

FINAL VERSION

Quality Management

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	First Draft for HEP / EBRD review	Draft Final	Final (excluding updated figures)	Final for Public Disclosure
Date	January 2013	February 2013	February 2013	March 2013
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Project number	33209	33209	33209	33209
Report number	Draft Version 1	Draft Final	Draft Final	Final
File reference	E09\projects\2012	E09\projects\2012	E09\projects\2012	E09\projects\2012

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14/03/2013

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Executive Summary

Background

WSP Environmental UK Ltd (WSPE) and its contracting partners have been commissioned by Hrvatska Elektroprivreda d.d. (HEP) to undertake an Appropriate Assessment and Biodiversity Management Plan for the proposed Ombla Hydropower Project (HPP). This project is being undertaken for the construction and operation of a 68MW hydropower plant located at the Ombla Spring, Dubrovnik, Croatia. Ombla Spring emerges from an extensive karst system, which is itself part of the Dinaric Alps mountain range which runs along the Croatian coast of the Adriatic Sea and then extends into Bosnia and Herzegovina, Slovenia, Croatia, Serbia, Albania and Montenegro. The design includes installing a 'grout curtain' within the karst to create a dam to generate sufficient head of water for the HPP. The project will also supply potable water to Dubrovnik.

This project builds on previous relevant work undertaken by HEP that has included an Environmental Impact Assessment (EIA) and a bat fauna study. The EIA has been approved with subsequent permits issued. However, in order to establish current baseline conditions, HEP has commissioned further work including analysis of existing data and conducting baseline ecology surveys, with the key aim of establishing an appropriate assessment baseline. The baseline ecology surveys have been undertaken by a number of specialist Croatian bat, fish and biospeleology survey organisations, coordinated by Elektroprojekt (a Croatian consultancy), and the survey data have been used with to undertake this Appropriate Assessment and Biodiversity Management Plan that is intended to achieve the goals of the Habitats Directive.

This project is also being carried out in part because the European Bank for Reconstruction and Development (EBRD) has been requested to consider financing the Ombla HPP. The EBRD has adopted a set of Performance Requirements that clients are expected to meet, covering key areas of environmental and social impacts and issues. Of relevance to this report is Performance Requirement 6 (Biodiversity Conservation and Sustainable Natural Resource Management) which requires amongst others, that clients adopt a precautionary approach to the conservation and sustainable use of biodiversity and the management of impacts, and that project activities in protected areas be legally permitted, follow the mitigation hierarchy (avoid, minimise, mitigate, offset), and implement appropriate programmes to promote and enhance the conservation objectives of the protected area.

Croatia is preparing to become a member state of the European Union (EU) and as part of those preparations has developed a series of proposed Sites of Community Importance (SCI). When Croatia becomes a member of the EU, and if the proposed SCIs are accepted by the European Commission, then the SCIs will become part of the Natura 2000 network of protected sites established under the EU Habitats Directive. The Ombla HPP is located within the proposed Paleoombla-Ombla SCI, therefore the EBRD have required that an assessment of the project is carried out so that it meets the objectives of the Habitats Directive, even though at present there is no legal obligation under Croatian law to do so.

Objective of this Study

The overall aim of this project is to undertake an assessment of likely significant effects from the Ombla HPP upon the proposed Paleoombla-Ombla SCI, in accordance with the requirements of Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (as amended), known as the 'Habitats Directive'.

Approach

The Study has been undertaken in accordance with the guidelines and principles of European Commission (EC) methodological guidance on the provision of Article 6 (3) of the Habitats Directive concerning the assessment of plans and projects significantly affecting Natura 2000 sites and provides the following:

- An overview of the Ombla Hydropower Project, including details of the location of the scheme, the existing cave system, proposed scheme construction and operation and the benefits of the scheme.
- Background to reasons that the proposed Paleoombla-Ombla SCI has been put forward by the Croatian Government including details of the habitat and species relevant to the designation and the SCI's specific Conservation Objectives which form the focus of the assessment underpinning the required data collection and assessment process.
- A summary of baseline studies relevant to the proposed SCI and its designated habitats and species including the findings of relevant ecological surveys and the characteristics of the SCI interest features.

- A staged analysis of the impacts of the project on the proposed SCI through:
  - 1) Identification of any Likely Significant Effects – by identifying any changes that could be brought about by the scheme that could undermine the Conservation Objectives of the SCI;
  - 2) Undertaking an Appropriate Assessment of significant effects and identifying potential mitigation measures to avoid, reduce or offset those effects;
  - 3) Consideration of whether, in spite of the mitigation, the scheme will have an impact on the integrity of the proposed SCI with respect to its structure and function and its Conservation Objectives and identification of potential compensation in line with an element of Article 6 (4), where mitigation is not sufficient to reduce likely effects to insignificant levels.
- The production of a Management and Monitoring Programme, summarising proposed measures for mitigation, monitoring and contingency planning to be incorporated into the comprehensive biodiversity management plan.

Findings

The Ombla HPP scheme is situated almost exclusively underground within the border mountain ridge behind the Ombla Spring, Dubrovnik, Croatia; extending from the spring for about 0.5 km into the mountain, with a lessening effect on water levels for an additional 8 kilometres into the mountain, into Bosnia and Herzegovina. The project will provide a maximum output of 68MW of power and will also substantially improve the quality and increase the quantity of drinking water to the city of Dubrovnik and surrounding areas. The construction of the project will take 5 years and is designed to raise the water table by 130m within the permeable limestone by blocking the natural flow of water with a watertight grout curtain (underground dam). The grout curtain will stretch across and within the permeable limestone from 280m below sea level to 135m above sea level, at a maximum width of 1500m. By creating this underground accumulation of groundwater the project will create enough water pressure to generate power by passing a controlled amount of water through a network of newly created artificial tunnels that will feed a number of turbines. The creation of the grout curtain requires extensive tunneling to create three grouting galleries set at different heights from where boreholes will be drilled at 4m spacing (that is, four meters apart, across the 1500-meter width of the limestone). The boreholes will then be injected with cement and clay to seal the cracks and fissures in the rock. A number of cave passages will also be plugged with concrete. The project will also divert the main underground flow of water from a natural cave that carries water from within Bosnia and Herzegovina, and that reaches some 130m below sea level, through newly excavated and lined tunnels to an enlarged natural cave, known as the Spring Cave, before discharging back into the external Ombla Spring Pond through a new opening into the Pond.

The Ombla HPP scheme will be developed within a karst limestone rock mass that contains over 3060 surveyed metres of dry, temporarily flooded and permanently flooded caves and conduits known as the Vilina Cave-Ombla Spring system. The explored system has three main components, Ombla Spring Cave, Vilina Cave, and the Great Hall, and the system can also be divided into three levels; the terrestrial upper and middle caves and lower aquatic caves. The majority of the explored system is located in Croatia, although it extends into Bosnia and Herzegovina where most of the karst rock mass and matrix of unexplored caves and conduits that feed the Ombla Spring lies.

The Vilina Cave-Ombla Spring system is recognised as one of the most biodiverse cave habitats in Croatia, a fact recognised by its designation as part of the proposed Paleoombla-Ombla SCI for the following features (as defined in the Habitats Directive):

- Caves not open to the public (supporting very specialised and highly endemic cave dependent fauna, including terrestrial and aquatic invertebrate species).
- Five species of bat (found within the Vilina Cave) including Schreibers' bat; lesser mouse-eared bat; Geoffroy's bat Mediterranean horseshoe bat and greater horseshoe bat.

The proposed SCI is also designated for Eastern sub-Mediterranean Dry Grasslands (Scorzoneratalia villosae), which is reported to be found extensively within the wider boundary of the SCI but not within the direct footprint of the project.

Recent surveys by Croatian specialists of bats, fish and cave fauna undertaken within the cave system during 2012 have confirmed the importance of the site for both bats and endemic cave invertebrate species. These surveys provided information of where the species are found within the cave system and what physical and ecological aspects (water supply, microclimate and association with other species) are important to maintain them.

Recent (2012) and historic surveys of the Ombla cave system have recorded 9 species of fungi, 139 species of invertebrate, 1 species of amphibian[1], 1 species of fish and 6 species of mammal (5 of which are species of bat). The surveys in 2012, recorded 14 distinct karst cave habitats types and 9 species of fungi, 105 species of invertebrate, 1 species of fish and 5 species of bat.

The surveys and historic records show that the Vilina Cave - Ombla Spring system has hosted up to 36 species which are only found (endemic) in the south Dinaric karst region. The Ombla system is the only location where 32 of these species have been recorded in Croatia and it is the only location in the world where 14 of these species have been recorded. The recent 2012 surveys identified 12 of these as new species.

Review of the surveys and historical studies have also identified that there remains significant scientific uncertainty over the life cycle, populations, distribution and identification of cave invertebrates both within the site, the wider Ombla hydrogeological catchment (mainly within BiH) and the southern Dinaric karst biogeographic region. The use of the cave system is better understood, due to a longer and more complete set of surveys at the site, although the external use of the site and the use of the caves in winter is still uncertain.

Through review of the changes that the construction and operation of the Ombla HPP will bring, a number of significant effects have been identified as having the potential to adversely affect the Conservation Objectives of the proposed SCI. These effects have been subject to Appropriate Assessment and additional mitigation and risk management measures have been formulated to address them, where it is possible to do so. These significant effects, associated mitigation and residual effects and risks are summarised in the Table below.

[1] This relates to record of one juvenile olm *Proteus anguinus*, recorded in 1986. The olm was included in an earlier version of SCI feature list but was subsequently removed from the SCI following the failure of 2012 surveys and records since 1986 to confirm its presence.

Table of Summary of Significant Effects, Mitigation and Residual Effects

Identified Significant Effects	Mitigation	Residual Effects / Risks
■ Direct, permanent and long term effects on the cave habitat that supports rare and endemic cave fauna due to: • loss of 15m of cave passage to the footprint of the grout curtain and the permanent flooding of 800m of cave passage in the middle level cave habitat under the operation of the HPP.	Provision of artificial permanent offset habitat in two of the grouting galleries. This will provide 1750m of equivalent terrestrial subterranean habitat. 1300m of this new habitat will be available to cave fauna for a minimum of 12 months in advance of the flooding of middle cave habitat. Monitoring of this new habitat will be carried out to ensure it provides the suitable habitat for specialised cave species. Water levels will be raised slowly and monitored over a minimum of 30 days to allow for movement of cave fauna to higher drier areas.	Flooding of dry caves and loss of 15m of passage to grout curtain filling and plugs remains. There is residual uncertainty regarding speed of colonistation and the efficacy of the new artificial habitat in replicating the structure and function of the naturally flooded cave habitat.
■ Drainage and enlargement of the Spring Cave during construction and a change in the water regime of the Spring Cave during operation.	Creation of a new artificial cave adjacent to the Spring Cave which will act as a refuge to existing aquatic cave fauna during construction and provide permanent habitat that will partly offset change in habitat in the Spring Cave, although the area will be substantially reduced. Flooding of the middle cave habitat will provide 800m of new aquatic cave habitat.	As above.
■ Potentially direct, permanent and long term adverse effects on cave habitats and associated species due to: • increased risk in the introduction of alien species of bacteria, fungi and animals (cave fauna are vulnerable) due to construction (movement of personnel and machinery).	Implementation of a construction bio-security management plan and measures to ensure risk is reduced to an acceptable level in line with good practice guidelines.	No significant adverse effect.
■ The risk of accidental flooding of the higher level Vilina Cave that supports bat species and cave fauna due to uncontrolled water flow through unexplored cave connection.	Avoidance of the impact by gradual raising and monitoring of water levels and potential connection points to the Vilina Cave; directional drilling from the grout curtain galleries will be undertaken to seal any connections. Where not effective, operational water levels will be reduced to avoid flooding.	No significant adverse effect.

Identified Significant Effects	Mitigation	Residual Effects / Risks
■ Disturbance and change in microclimatic conditions caused by the installation of drainage pipes in the Vilina Cave (as specified by the Croatian Ministry of Environment (2009)).	Drainage holes will be drilled outside Vilina Cave to avoid direct disturbance and fitted with one way valves to avoid risk of changing air flow within the Vilina Cave.	No significant adverse effect.
■ Uncertain changes in the flow of water, drifting aquatic cave species and nutrients through the system due to permanent diversion of flows in construction and operation, from the deep main water channel and the permanent raising of water levels by 130m within the middle cave system.	Install a small diameter flexible perforated pipe connecting the main channel inflow at the intake structure and the flooded cave system to provide continued inflow of species and nutrients and provide mixing to all parts of the water column.	Due to the scale of change, there remains a degree of residual uncertainty over how aquatic cave fauna will respond to the changes. Monitoring of the use of aquatic habitat by cave fauna will be undertaken and changes to water flow and mixing adjusted, as appropriate.
■ Potentially indirect, temporary and short to medium term effects on bat species during the maternity roosting period due to the drainage of the Spring Pond during reconstruction of the Komolac Weir at the downstream extent of the Spring Pond.	Undertake the works necessary to drain the Spring Pond during the period 31st November to 1st April, if winter flow conditions allow. If works to the drain the Spring Pond are required outside of this period due to high flows in the winter, provide a constant water surface area of $25m^2$.	There is uncertainty over the reliance/importance of the bat population on the Spring Pond. Monitoring will be undertaken to ensure drainage of the Spring Pond is avoided during important periods of use by bat species.
■ Potentially direct, short term and temporary effects on bats species due to the possible risk of disturbance of winter roosting bats during works within 50m of the Vilina Cave.	Undertake preconstruction surveys and pre works checks and cease work if >10 individual roosting bats are found with 50m proximity until a bat specialist has evaluated the risk and confirmed that works can continue.	No significant adverse effect.

Following the development of mitigation measures to avoid, reduce, and offset, an Appropriate Assessment of the Ombla HPP impact on the proposed SCI has been undertaken, adopting a precautionary approach. The precautionary principle is a central part of the requirement of Article 6 (3) of the Habitat Directive and of EBRD PR 6. This suggests there must be certainty that the Ombla HPP will not adversely affect the integrity of the protected area. Where sufficient uncertainty remains, then it cannot be concluded that the scheme will not have an adverse effect. In light of these requirements the study has made the following conclusions:

- Based on the assessment of the potential impacts of Ombla HPP on the Vilina Cave, it can be concluded that there will be no adverse effect on integrity for bat species, subject to the successful implementation of all mitigation measures and appropriate implementation of adaptive management measures based on monitoring results.
- Due to uncertainty regarding the of the scale of the change in water regime and short term impacts upstream and downstream of the grout curtain, and the loss of extent of natural cave habitat it is not possible to conclude that there will be no adverse effect on the “Caves not open to public” habitat feature.

However, Ombla HPP scheme will provide extensive, adjacent man-made habitat to offset adverse effects associated with habitat change. As a result the following points should be noted:

- The scheme will lead to a potential long term increase in subterranean habitat that is intended to provide the structure and function to support terrestrial invertebrate species recorded in the existing explored upper and mid level cave system.
- The scheme will potentially provide for the creation of an additional 400m of subterranean passages that will be enhanced to provide habitat for roosting bats.

The scheme will lead in the long term to a significant increase in aquatic cave habitat, due to the raising of normal water levels from sea level to 130 metres above sea level for the majority of the time. (It should be noted that current water levels fluctuate between 0 and 50 metres above sea level for short periods of time during high flows. After project implementation, levels will also fluctuate for short periods of time, falling from 130 metres above sea level to 75 metres above sea level when flows are low. The provision of offset habitat (identified in the bullet points above) in combination with an extensive Monitoring and Management Programme has the significant potential to reduce adverse effects on the “Caves not open to public” habitat feature. This will potentially allow for the populations of terrestrial and aquatic endemic cave fauna to be sustained with the boundary of the proposed SCI.

The study has identified a number of potential compensatory measures that could be adopted by HEP and the Croatian Government to ensure the continued coherence of the Nature 2000 network. In summary these include measures to:

1. Extend the level of protection to similar sites not presently proposed for inclusion within the Natura 2000 network in Croatia;
2. Close or restore caves or sections of caves which are or have been exploited for tourism within the Natura 2000 network;
3. Restore caves that support endemic cave fauna that are exploited for use, other than tourism and extend the level protection provided.

There are a three cave sites within boundaries of the southern Dinaric karst in Croatia where these measures could be applied. These sites and the measures (1, 2 or 3) that could be applied are listed below:

- Močiljska cave (1 & 3)
- Špilja za Gromačkim vlakom cave (2)[2]
- Šipun Cave (1& 3)

In addition, further sites have been identified outside of the southern Dinaric karst where similar measures could be undertaken to protect some of the species of cave fauna found at Ombla.

[2] This could be potentially considered as mitigation because it is inside the boundary of the proposed SCI.

A Monitoring and Management Programme during the project development has been produced to provide a summary of measures and monitoring requirements set out by the study that will need to be implemented to meet the requirements of the Habitats Directive and EBRD's PR6.

1 Overview of the Ombla Hydropower Project

1.1 Introduction

WSP Environmental UK Ltd (WSPE) and its contracting partners have been commissioned by Hrvatska Elektroprivreda d.d. (HEP) to undertake a biodiversity assessment, which will provide information for a Habitats Directive Assessment and produce a Biodiversity Management Plan for the proposed Ombla Hydropower Project (HPP). The HPP comprises the construction and operation of a 68 MW hydropower plant located at the Ombla Spring, Dubrovnik, Croatia. The project will also supply potable water to the City of Dubrovnik and surrounding areas.

This project builds on previous relevant work undertaken by HEP that has included an Environmental Impact Assessment (EIA) issued in 1998, an EIA Summary Report in English prepared by Elektroprojekt d.d. (a Consulting Engineering company used by HEP) in 1999, a bat fauna report issued in 2008 and correspondence from the competent authorities regarding bats in 2009.

As part of potential financing arrangements with the European Bank for Reconstruction and Development (EBRD), HEP in 2011 re-disclosed for public review and comment all the previous documentation, and also a Non Technical Summary that described potential impacts in plain language. This Summary noted that the previous EIA met the requirements of Croatian environmental protection law at the time of its preparation and was approved with subsequent permits issued. Because the project is on-going, these permits remain valid, as there is no time limitation restriction under Croatian law, from when these documents were first prepared. However, it was considered that some parts of the EIA reports were no longer representative of the current baseline conditions, and therefore may need to be reviewed and updated. In this regard, HEP agreed that further work should be undertaken that included analysis of existing data and conducting baseline ecology surveys, with the key aim of establishing an appropriate assessment baseline. As such, HEP commissioned Elektroprojekt in 2012 to conduct a study on the impact on the ecological network of Ombla. This work was done to build on the existing EIA information, as, although it met the Croatian legislative requirements at the time and is approved by the competent authorities, it would not meet the new Croatian legislative requirements which have since been strengthened or the EU EIA Directive. In addition to the new Elektroprojekt work, HEP also commissioned this current study to meet the goals of the Habitats Directive. Although Croatia is not in EU member state yet and the Croatian regulations that transpose the Habitats Directive requirements do not legally apply to this project, HEP is undertaking the study to ensure the project is consistent with the goals of the Habitats Directive.

Also disclosed for public review and comment in 2011 was an Environmental and Social Action Plan (ESAP) with actions to be undertaken by HEP to manage – that is, to plan and implement specific measures to avoid, reduce, control, or otherwise mitigate – potential environmental, occupational health and safety, and social impacts during construction and operation. The EBRD financing is conditional on compliance with its Performance Requirements and of relevance to this report is the Performance Requirement 6 (PR6) on Biodiversity Conservation and Sustainable Natural Resource Management which requires amongst others, that clients demonstrate that any proposed development in protected areas will not lead to a reduction in the population of any endangered or critically endangered species or a loss in area of the habitat concerned and that appropriate measures are put in place to avoid this. Croatia is preparing to become a member state of the European Union (EU) and as part of those preparations has developed a series of proposed Sites of Community Importance (SCI). When Croatia becomes a member of the EU, and if the proposed SCIs are accepted by the European Commission, then the SCIs will become part of the Natura 2000 network of protected sites established under the EU Habitats Directive. The Ombla HPP is located within the proposed Paleoombla-Ombla SCI, therefore the EBRD have required that an assessment of the project is carried out in accordance with the requirements of the Habitats Directive as a requirement of meeting PR6.

The specific details of the work, the approach and the structure of this report are provided below.

1.2 Purpose of this Report

Ombla Spring emerges from an extensive karst system that extends along the Croatian coast of the Adriatic Sea and landwards into Bosnia and Herzegovina (BiH). The spring emerges at sea level in two main locations: 'Spring Cave' which is just inside the karst system; and 'Spring Pond' which is located immediately in front of the cliff face of the karst system (Plate 1). Spring Pond, which also feeds the entire length of the Ombla River, flows over Komolac weir after some 30 metres into Rijeka Dubrovačka (Plate 2) and then the Adriatic Sea.

As previously discussed, this biodiversity assessment is being carried out in part because the EBRD has been requested to consider financing the Ombla HPP. The EBRD has adopted a set of ten Performance Requirements that clients are expected to meet, covering key areas of environmental and social impacts and issues. Performance Requirement 6 (Biodiversity Conservation and Sustainable Natural Resource Management) requires amongst others, that clients demonstrate that any proposed development in protected areas will not lead to a reduction in the population of any endangered or critically endangered species or a loss in area of the habitat concerned and that appropriate measures are put in place to avoid this from occurring. Further details of the specific requirements of PR6 in relation to the Ombla HPP and the relevance of the Habitats Directive are provided in Section 2.7, EBRD Performance Requirements.

Croatia is preparing to become a member state of the European Union (EU) and as part of those preparations has developed a series of proposed Sites of Community Importance (SCI). When Croatia becomes a member of the EU, and if the proposed SCIs are accepted by the European Commission, then the SCIs will become part of the Natura 2000 network of protected sites established under the EU Habitats Directive. The Ombla HPP is located within the proposed Paleoombla-Ombla SCI. Therefore the EBRD requires that an assessment of the project is carried out in accordance with the requirements of the Habitats Directive.

This report provides the information required to 1) inform an assessment of the effects of the Ombla HPP against the EU Habitats Directive in relation to the proposed SCI, and 2) develop a biodiversity management plan for the scheme. The aims and requirements of the Habitats Directive, as well as details of the Habitats Directive Assessment requirements are provided in Section 2.6.

In addition, as part of this project, the scope of work has also included the construction of a digital three-dimensional (3D) model of the underground features of the karst from the Ombla Spring back to beyond the dolomite barrier into Bosnia and Herzegovina, with suitable identification of features. Analytical review of data has been undertaken to construct the 3D model to gain an understanding of subsurface features and the underground complex including an assessment of the potential impact on water levels from the Ombla Spring up-gradient into Bosnia and Herzegovina, including beyond a dolomite barrier that controls underground water flows into Croatia and ultimately to the Ombla Spring. Figures from the 3D model are presented throughout this report.

Lastly, this report also provides a plan for information disclosure and stakeholder consultation with the regard to the findings of this report and other relevant work that has been conducted concurrently by HEP.

This report is divided into ten chapters as follows:

1. Overview of the Ombla Hydropower Project – provides details of the location of the scheme, the existing cave system, proposed scheme construction, and the benefits of the scheme.
2. Regulatory System – provides details of the Croatian and EU laws in relation to ecological protection (including the Habitats Directive), as well as relevant EBRD Performance Requirements and other relevant standards including those of the International Finance Corporation (IFC).
3. The proposed Paleoombla-Ombla SCI – provides details of the habitat and species interest features for which the site is proposed to be designated, as well as the site's conservation objectives (against which the assessment of scheme effects is made).
4. Baseline Studies – including details of the findings of relevant ecological surveys and the characteristics of the SCI interest features.
5. Assessment of Likely Significant Effects – assessment of scheme effects upon the conservation objectives for the SCI interest features.

6. Appropriate Assessment and Counteracting Mitigation Measures – identification of mitigation and enhancement measures that could be incorporated, and the likely influence of these on potential effects of the scheme upon the conservation objectives for the SCI interest features.
7. Assessment of Effect on Site integrity – determination of effects, taking into account site integrity.
8. Compensatory Measures – identification of potential compensation, where mitigation is not sufficient to reduce likely effects to insignificant levels.
9. Management and Monitoring Programme – summary of proposed measures to be incorporated into the Biodiversity Management Plan
10. Information Disclosure and Stakeholder Communications – provides details of the communications and disclosure process that will be undertaken as part of this assessment.

Plate 1: Ombla Karst

Plate 2: Ombla Spring and Komolac Weir in Flood

1.3 Existing Cave System

1.3.1 Ombla Spring's Catchment Area and Hydrology

Ombla Spring is one of the largest karst springs in Croatia. It drains an area of between 600 and 900[3]km^2 mainly in Bosnia and Herzegovina (Figure 1.1). Ombla Spring's catchment area contains the Trebisnjica River, the Trebinje (Mokro) Polje, the area to the north east of Popovo Polje and the polje itself.

Culver and Pipan (2009) note that the Trebisnjica River had a surface water course of between 35 and 90km, depending on the water flow, which under natural conditions sinks in the Popovo Polje. Poljes are spring fed large karst depressions with flat floors that are commonly covered by river sediments. During the heavy rains (usually in autumn) a temporary lake forms in the bottom of the polje due to flooding of the river. Some of the flow of the Trebišnjica River drained through its river bed as it crossed Popovo Polje and hence entered the Ombla drainage system. Along the side of the Popovo Polje there are a number of caves, including the Vjetrenica, one of the most diverse caves in the world. Many of these caves were periodically flooded, providing organic material necessary for the survival of many endemic aquatic cave invertebrate species.

[3] The uncertainty in the exact catchment is because the catchment is an underground one based on the underground geological structure rather than on the visible surface topography. The assessment of area is based on limited dye tracing of groundwater flows and the understanding of the geology.

To provide hydro power and to control flooding, the government of the former Yugoslavia constructed a dam and channelised the Trebisnjica River (by concrete lining) in 1979. Following completion of the Trebišnjica Hydroelectric Power Plant and concrete lining of the Trebišnjica's riverbed, the flooding from the Trebisnjica River has been significantly reduced, impacting on the frequency and volume of flood water recharged to the Ombla groundwater catchment and reducing the input of nutrients to the catchment area and the surrounding caves.

The average annual rainfall in the catchment varies from 1238mm on the coast at Dubrovnik to 2037mm at Hum (Bosnia and Herzegovina) which is at the centre of the catchment area.

The outflow from Ombla has been recorded at Komolac Weir (30 metres downstream of Ombla Spring) from 1968 to present day (except for around the time of the Siege of Dubrovnik during 1991-2). A number of hydrological studies have been undertaken over the last two decades. Assessment of flows from the latest (Tractebel Engineering, 2011) for the period 1981 to 2009 are presented below, (flows prior to 1981 have not been presented, to eliminate conditions prior to the influence of concrete lining of the Trebišnjica River upon flows):

Average flow ....23.1 m^3/s

Lowest monthly average flow............................... 4.5 m^3/s (September 1990)

Highest monthly average flow.............................66.3 m^3/s (February 1986)

95% exceedance flow... 5.94 m^3/s

50% exceedance [4]flow ....15.1 m^3/s

10% exceedance flow...61.9 m^3/s

Maximum annual floods range between..............76 and 109 m^3/s

1 in 100 year flood...110 m^3/s

1 in 10,000 year flood ....130 m^3/s

Highest recorded flood ....109 m^3/s (November 1985)

The pre-1981 average flow was assessed as 28 m^3/s (Tractebel Engineering, 2011). The 1 in 100 and 1 in 10,000 floods have been assessed on the whole record (1968 to 2009). The design for the HPP has used similar flows (+/- 5% approx.). It is not considered appropriate to use the shorter time period (1981 to 2009) as it will be difficult or impossible to distinguish whether the different figures produced are a result of the real effect of the lining of the Trebišnjica River or the great uncertainty due to using a shorter dataset.

In general, the figures from various hydrological assessments typically agree with each other within about 5%, which is appropriate for this assessment.

[4] A 95% exceedanceflow is the flow that is exceeded 95% of the time

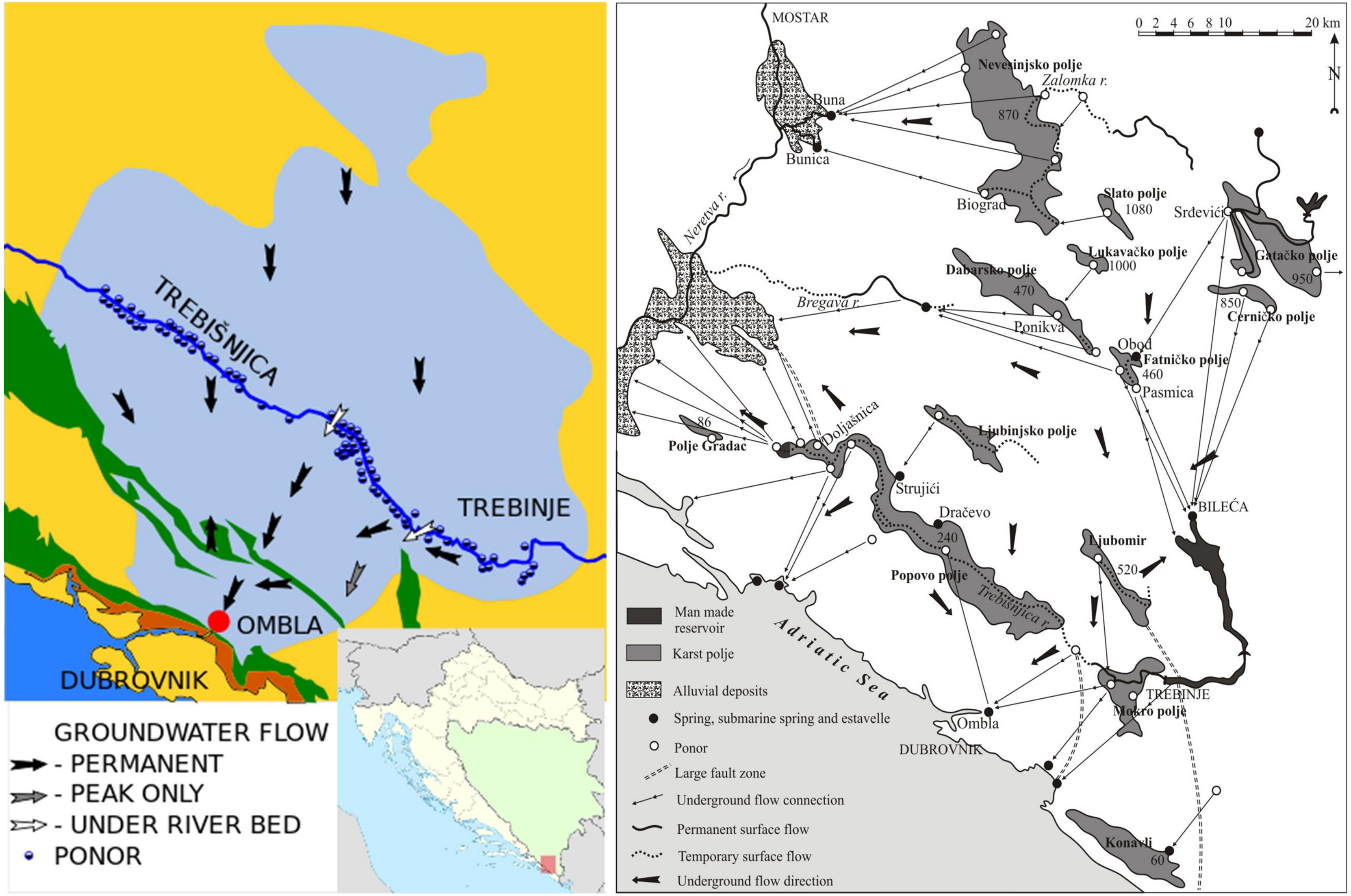

Figure 1.1: a) Ombla Catchment Area (shown in blue) with limestone shown in orange, dolomite shown in green and flysch shown in red. Note: the limestone (orange) extends under the catchment area (blue) except where there is dolomite (green). Inset map shows location in Croatia; **b) Location of Popovo Polje and Trebinje (Mokro) Polje** from Milanovic 2010.

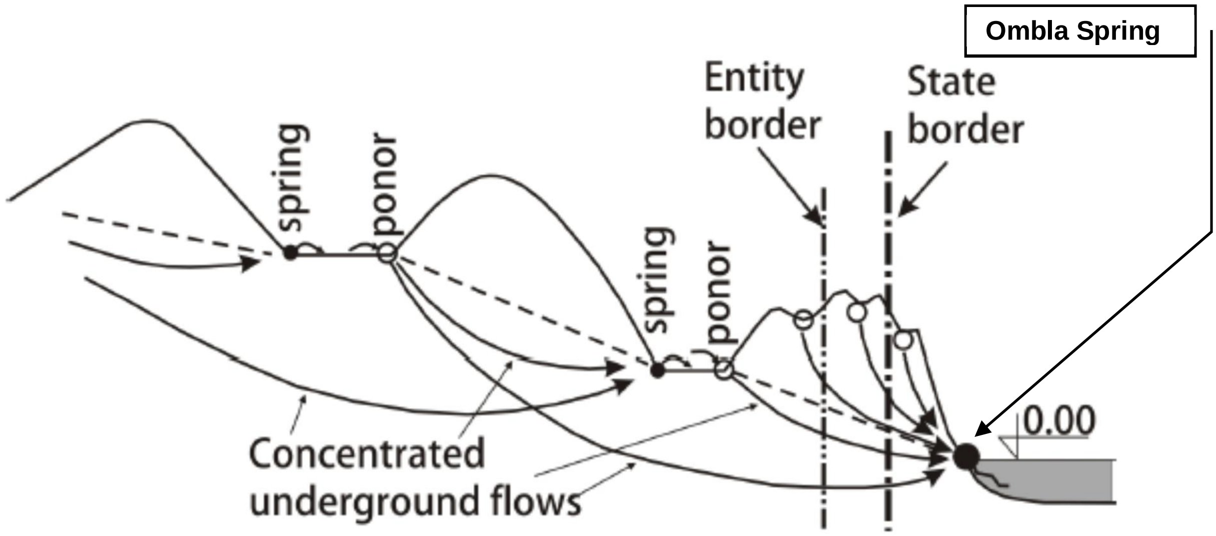

Figure 1.2: Simplified Geomorphology of Ombla Spring Hydrological System (after Milanović, 2010)

The monthly average flows at Komolac Weir (30 metres downstream of Ombla) are shown in Figure 1.3. The lowest flows are experienced in August, with the highest flows recorded in December.

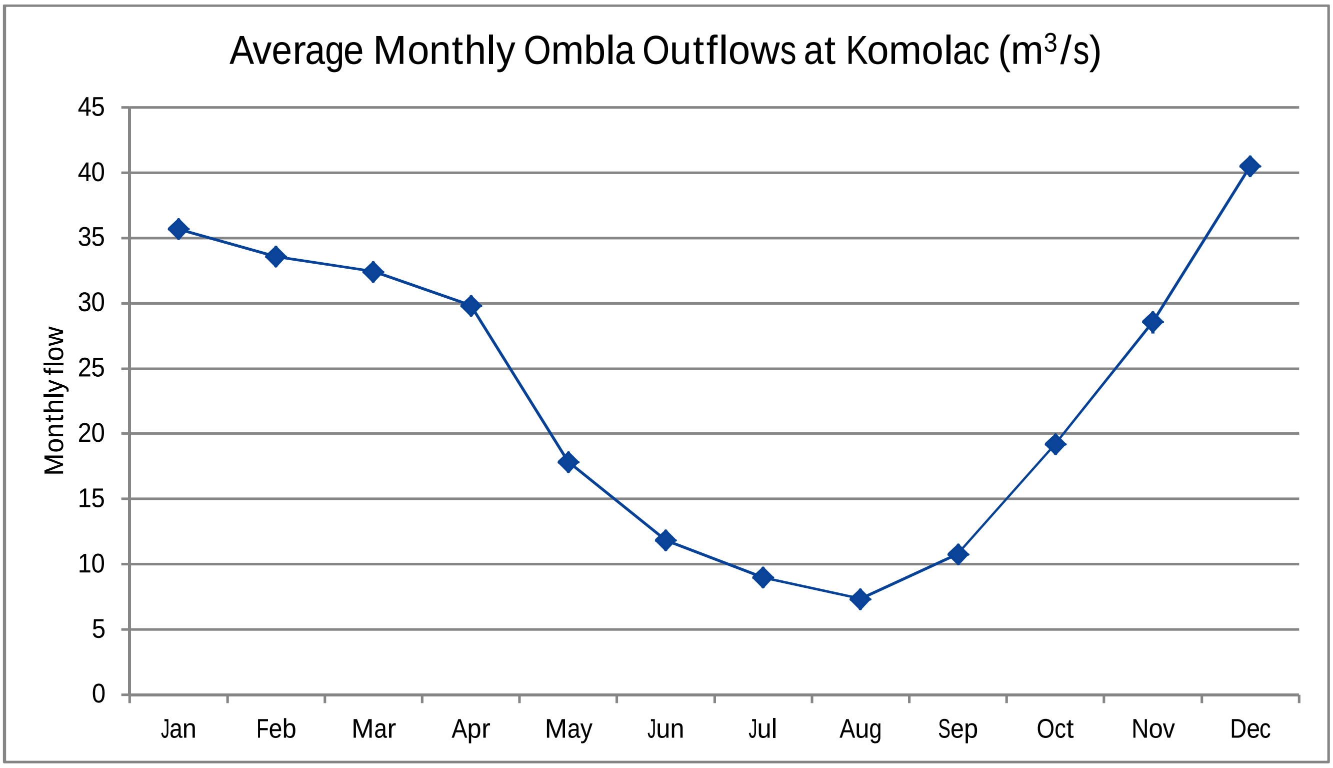

Figure 1.3: Average Monthly Outflows from Ombla (m^3/s)

1.3.2 Cave System

The Vilina Cave-Ombla Spring system, with approximately 3060m of surveyed passage over a vertical difference of 192m, is the 13th longest cave in Croatia. The majority of the known cave passages are located in Croatia although parts lie within Bosnia and Herzegovina and parts are still unexplored due to limited access.

The system has three main components, Ombla Spring Cave, Vilina Cave, and the Great Hall, which are described below. The cave can also be divided into three levels with regard to altitude (i.e. terrestrial upper and middle caves and lower aquatic caves) – see Figure 1.4.

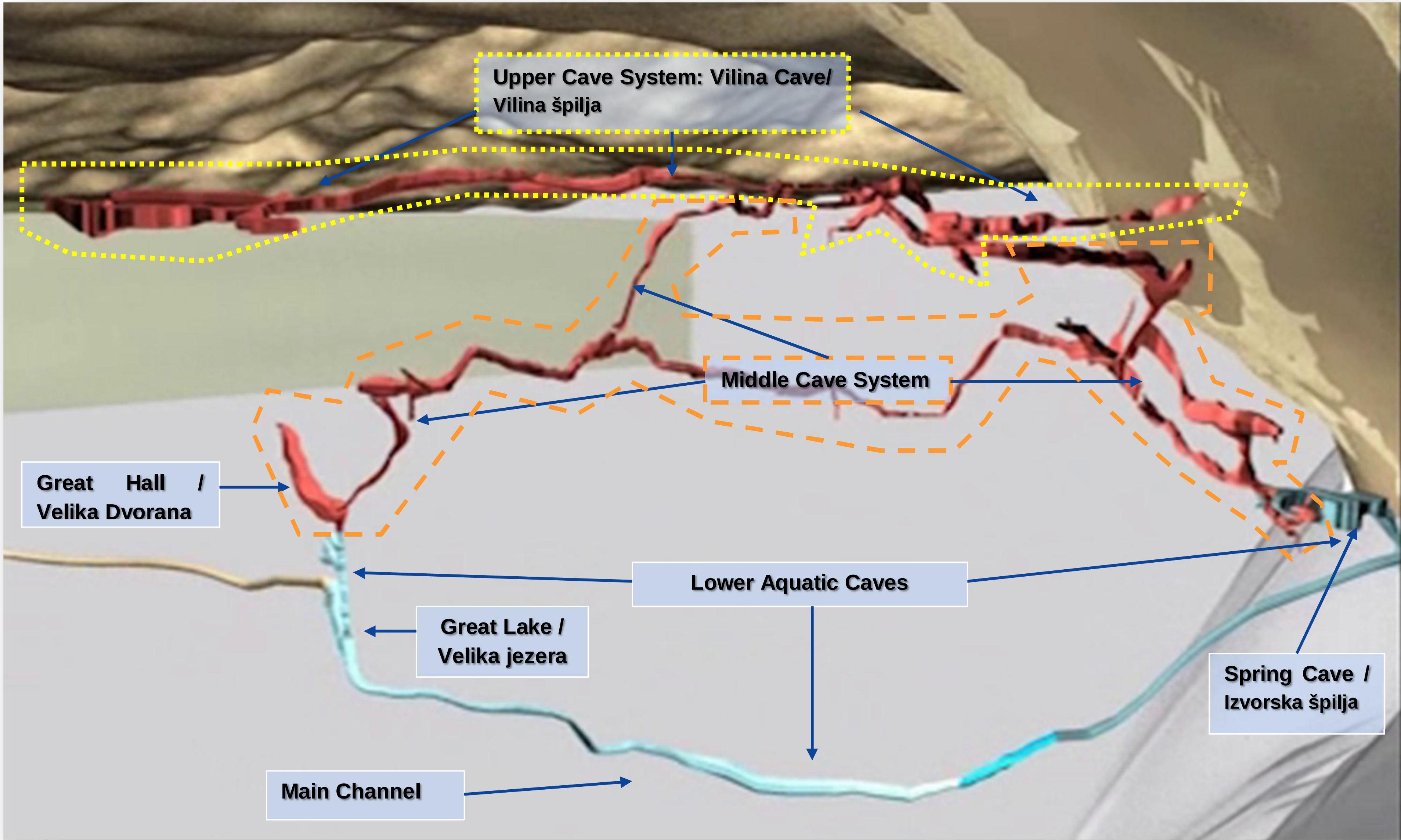

Figure 1.4a: *3D Visualisation of the Vilina Ombla Cave System within the limestone rock structure (Looking from the west).*

Vilina Cave [Vilina špilja] is located at an elevation of 137.66m asl. During investigations in 1986, 1987 and 1988, more than 2500m of cave passage were discovered. Two connected levels of cave passage have been extensively explored. The higher (upper level) is at an altitude of between 130-150m and accessed from the Vilina Cave entrance. The lower (middle level) is located at an altitude of between 50m and 80m and is accessed via a connecting passage from the upper level some 250m from the cave entrance. This cave consists of a well dissected fossil passage with a sediment or boulder floor. The lower portions flood intermittently (typically only a few days in a year).

Ombla Spring Cave [Izvorska špilja] was discovered in 1985 when cave divers dived into it from the Spring Pond. It is about 80m long, about 40 m wide and about 8m high above the normal water surface.

Great Hall [Velika Dvorana] was explored from the Vilina Cave and is connected to the middle level. It is a large sloping chamber about 40m high containing a lake (Great Lake) in the bottom. The water level of this lake is only slightly (about 0.15m) higher than the level in the Spring Pond. Great Lake has been explored underwater to reach a large (about 10m high) cave passage with a significant flow in it. Where the almost vertical passage from the Great Hall meets this flowing passage, its base is at -54m asl. It has been explored downstream for about 40m to a depth of about -61m.asl. Upstream, it has been explored from about 20m to a depth of about -33m asl. At this point, it continues to descend. Two almost horizontal inlet passages have been identified in the passage descending from the Great Hall at elevations of -11m.asl and -18.8m.asl. The main flowing cave passage below the third and deepest cave level is the main route for water from the catchment in Bosnia-Herzegovina to the Ombla Spring. This flow has been confirmed by dye tracing and the main deep channel has been located at -130m asl by boreholes drilled from the exploratory tunnel. The Great Hall has also been intercepted by exploratory tunnels constructed in 1989.

It is highly likely that there are further unexplored cave passages just to the north of the known passages described above. These would be within Bosnia and Herzegovina. Bonacci (1995)[5] hypothesizes, that based on the evidence from boreholes (denoted as O9, O8 and O18 in HEP records), there are two main cave conduits extending 8km or more from Ombla Spring; a higher larger one of about 10m^2 rising to about 110m.asl (at 8km from Ombla) and a lower smaller one of about 3m^2 at around sea level. In the existing situation, the lower would be permanently flooded with the upper being only being submerged in times of high flows.

The passage lengths of the cave levels at the three different altitudes (upper, middle and lower) have been calculated based on maps of the cave and other information. The calculated passage lengths summarised following review of Grasic (1999) are shown below in Table 1.2. Key features are illustrated in Figure 1.4 above.

Table 1.2: Cave Passage Lengths

Cave Altitude Level	Description	Passage Length (m)
Upper	*Fossil[6] cave accessed from entrance of Vilinia cave and remains at a broadly similar level to the entrance*	1660
Middle	*Fossil cave only accessible from Upper level or via exploratory tunnel. Parts of this level intermittently flood (typically only a few days in a year)*	1400
Lower	*Active[7] cave typically between approximately 0m and -130m asl; includes Ombla Spring Cave, Great Hall and the main active conduit (passage)*	920

Source: After Garašic, 1999

[6] Fossil is the speleological adjective to describe a passage which has been abandoned by the strean or river that formed it.

[7] Active is the speleological adjective to describe a passage which still contains the stream or river that is responsible for its formation

1.3.3 HPP Infrastructure Introduction

The Ombla Hydropower Project (HPP) will involve the construction and operation of a 68MW hydropower plant located underground in the border mountain ridge behind the Ombla Spring, Dubrovnik, Croatia; extending from the spring to about 250m into the mountain.. The project will also substantially increase the supply of drinking water and also will increase the quality of water to the city of Dubrovnik and surrounding areas.

The project is designed to raise the water table within the permeable limestone behind the Spring Cave to create an underground accumulation of water. By creating this underground accumulation, enough water pressure (head) will be created to be used to generate power by passing a controlled amount of water through a number of turbines. The accumulation will be created by blocking and impounding the natural flow of water with a 3m wide watertight grout curtain that stretches across the permeable limestone from impermeable sections of rock which sit underneath and to either side. The grout curtain will be constructed by first drilling boreholes and then injecting a mixture of cement and clay into the boreholes at regular intervals (typically 4m spacing) to seal the cracks and fissures in the rock and plugging a number of cave passages with concrete. The grout curtain will stretch from 280m below sea level to 135m above sea level. The length of the top of the grout curtain will be approximately1500m.

1.3.4 Components

The proposed HEP infrastructure consists of the key components described below in Table 1.3 below, which describes each component and its function. Figure 1.5 below provides a schematic diagram of the key components.

Table 1.3: HEP Infrastructure Components

Component	No on Figure 1.4	Under-ground	Intersects cave passage	Description
Water Intake & Water intake boreholes	1 & 2	✓	✓ (boreholes intersect)	The water intake is a chamber immediately adjacent to the 'Great Hall' cave chamber about 500m into the mountain from Ombla Spring. It provides two separate intakes via four 3m diameter boreholes from the main channel at -50 masl; for the water supply system and for the hydropower plant.
Water Supply System	5	✓	✓	From the water intake, a separate tunnel containing a 1200mm diameter pipe links into the existing Dubrovnik water supply system to provide additional water to the existing water system. Importantly, the water supply is also connected to middle level of the cave at 55m asl via the vertical shaft (item 10 on Figure 1.5). The actual connection is not shown on the figure
Headrace Tunnel	4	✓	×	This 8m diameter tunnel is the main intake for the hydropower plant. It links the water intake to the bottom of the vertical shaft.
Vertical Shaft	10	✓	×	This 6m diameter vertical shaft is located about 250m from Ombla Spring on the upstream side of the grout curtain and extends from +1m asl to +135m asl. At its base, it is fed by the headrace tunnel and has outlets to the turbines, the bottom outlet and the ecological acceptable flow tunnel. At its top, it is linked by a tunnel containing a weir at +130m asl to the swirling spillway (downward direction of flow) vertical shaft.

Component	No on Figure 1.4	Under-ground	Intersects cave passage	Description
Turbines (and tailrace tunnels)	12 & 17	✓	×	The turbines are fed by a tunnel from the base via a valve chamber to the four turbines. There are two smaller 6m^3/s turbines and two larger 24m^3/s turbines which discharge via tailrace tunnels into the enlarged Spring Cave. Above the turbines are underground chambers containing the generating sets (connected to each turbine below) and associated equipment.
Bottom Outlet	13,14,15	✓	×	The bottom outlet connects the base of the vertical shaft to discharge into the Rijecka Dubrovačka just downstream of the Komolac weir. Flow through this tunnel is controlled by two Howell-Bunger valves. Its prime purpose is to provide an alternative route for the water during maintenance. During construction it will form the diversion route for all flows.
Swirling Spillway	9	✓	×	This is a vertical shaft designed to allow water to fall downward in a swirling pattern and hence allow air to pass up the centre. It is connected to the top of the vertical shaft by a weir at +130m asl and is located just downstream of the grout curtain. It provides an overflow for when the inflow into the system exceeds the amount being taken by the combination of the turbines and the ecologically acceptable flow tunnel. From its base, it is linked by a tailrace tunnel to the enlarged Spring Cave chamber.
Ecologically Acceptable Flow Tunnel	not numbered	✓	×	This tunnel is fed from the base of the vertical shaft and flow through it is controlled by a butterfly valve. Its outlet is to the base of the swirling spillway and hence to the enlarged Spring Cave chamber. Its function is to provide the ecologically acceptable minimum flow of 4m^3/s (when this flow is not being passed through the turbines) into the enlarged Spring Cave chamber and hence the Spring Pond.
Spring Cave and Outlet Structure	17,18	✓	✓	The existing Spring Cave chamber will form the outlet for the turbines, the swirling spillway and the ecologically acceptable flow tunnel. To perform this function, it will be substantially enlarged and linked to the Spring Pond by a new outlet structure.

Component	No on Figure 1.4	Under-ground	Intersects cave passage	Description
Grouting Galleries and Grout Curtain	23 (grouting galleries) Grout curtain not shown for clarity	✓	✓	There are three grouting galleries that run between the impermeable rock on either side of the site. These are at +4.8m, +66.5m and +135.7m asl, numbered I, II and III respectively and typically around 1.5km long. From these galleries, grout (a mixture of clay and cement) is injected at typical 4m spacing along each tunnel to form an impermeable barrier to the water. Where cave passages pass through the line of the grout curtain, these will be plugged using concrete. The upper part of the Vilina Cave passes through the grout curtain at +126m asl. At this location, the cave passage will not be plugged and the top of the grout curtain will only be at +126m asl rather than +135m asl for the remainder. If necessary, additional grouting works will be undertaken to prevent water entering the upper cave.
Access Tunnel	3	✓	✓	A tunnel provides access to the water intake and other underground locations. Also, the grouting galleries will be used for permanent access to some underground locations (e.g. top of the vertical shaft).
Access Roads	not shown	×	×	Access roads on the mountain slopes on both sides of the site provide permanent access to the upper two grouting galleries.
Control Buildings	not shown	×	×	The hydropower plant (and water supply system) will use the existing buildings and one new control building on the western bank of Rijecka Dubrovačka.

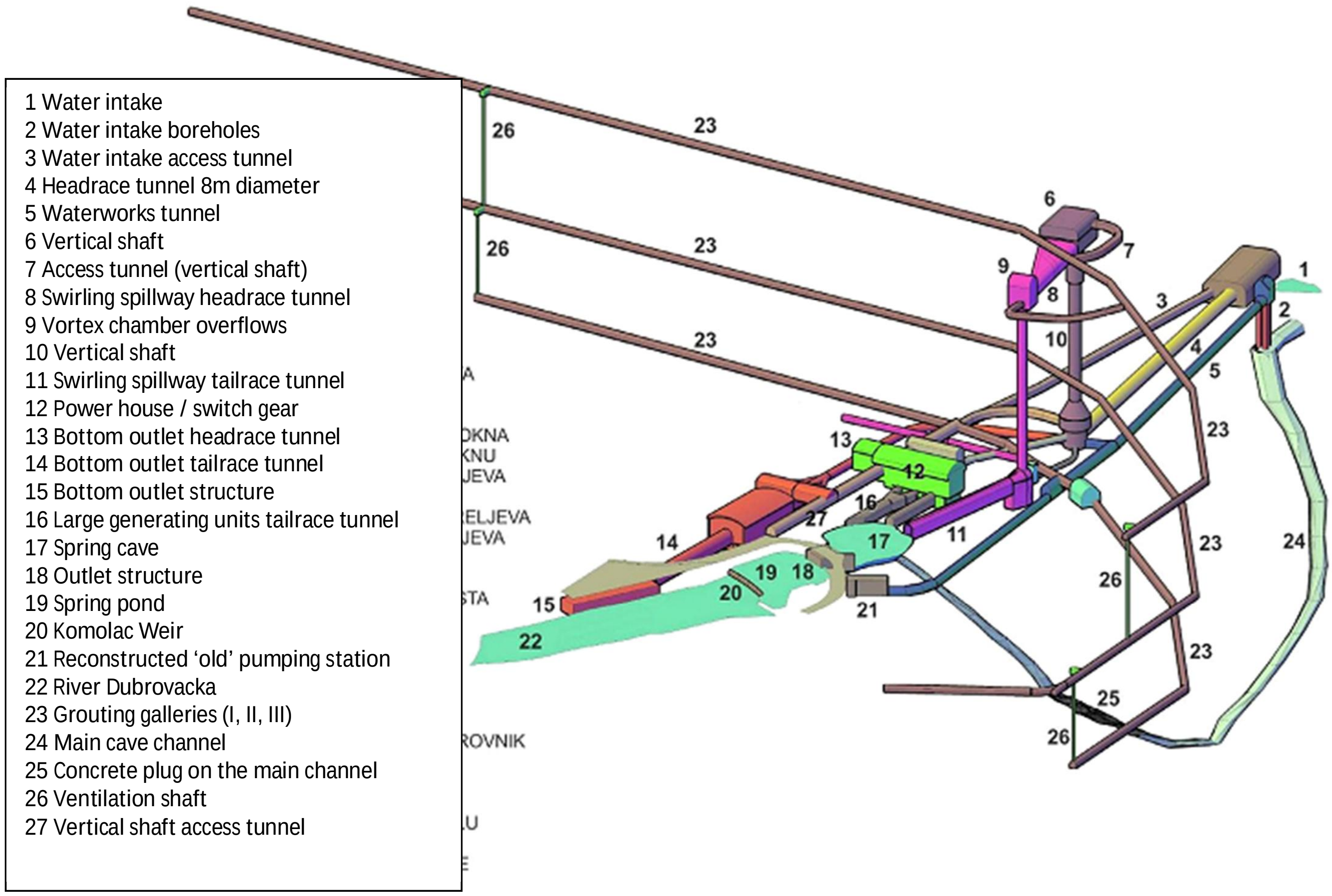

Figure 1.5: Schematic Diagram of Key Components

1.3.5 Principles of Operation

With regard to the controls on water levels and flows, the key principles of operation are as follows:

- At all times, an ecologically acceptable minimum flow of 4m^3/s will be maintained via the headrace tunnel and then either through the turbines or through the ecologically acceptable flow tunnel when the turbines are not operating. The ecologically acceptable minimum flow has been set by the Croatian authorities and is less than the 5.94m^3/s 95% exceedance flow (i.e. the natural flow that is exceeded for 95% of the time). To put this into context, the mean flow (23.1 m^3/s) will be exceeded about one third of the time and the median flow of 15 m^3/s will be exceeded 50% of the time.
- If possible, the water level in the vertical shaft will be maintained at +130m asl and the flows through the turbines and the ecologically acceptable flow tunnel will be balanced with the inflow into the system to achieve this. However, in dry periods where the inflow is less than 4m^3/s, the water level will drop. The predicted minimum level is around +75m asl.
- When the inflow exceeds the flow being taken by the turbines and the ecologically acceptable flow tunnel, the excess flow will overflow over the weir at +130m at the top of the vertical shaft and hence down the swirling spillway.
- The bottom outlet is available as an alternative flow route and is designed to discharge 113m^3/s, which is sufficient to discharge the 1 in 100 year flood peak.
- The system is designed to able to discharge the 1 in 10,000 year flood using the bottom outlet and the vertical shafts.

1.3.6 Effect on Water Levels

The operation of the HPP was modelled (Jović, 1999) using 13 years of observed rainfall and flow data. The model output demonstrated that the water level remains at 130m asl behind the grout curtain; only dropping below this level for between about 30 and 80 days of any one year. The lowest modelled water level was 75m asl and for half of the years modelled, the minimum level was above 100m asl. Based on the above modelling and observed levels in boreholes, Figure 1.6 below shows the indicative water levels behind Ombla Spring at present and with the HPP.

This figure shows the indicative water levels at boreholes O9, O8 and O18 as well as the proposed grout curtain for the HPP. Borehole O18 is located in Bosnia and Herzegovina 7.4km from Ombla spring near the village of Hum. Boreholes O8 and O9 are located in Bosnia and Herzegovina between Ombla Spring and borehole O18 and are 4.7km and 1.6km respectively from the spring. The Ombla Spring is approximately 520m from the border with Bosnia and Herzegovina and approximately 5.5km from the border with the political entity Republika Srpska.

The existing levels shown are based on the recorded water levels for each borehole with the normal being the typical level for most of the year and the flood levels being the maximum observed. For the water levels with the HPP, the low and flood levels are taken from the modelling referred to above and the normal water level is simply taken as 130m asl.

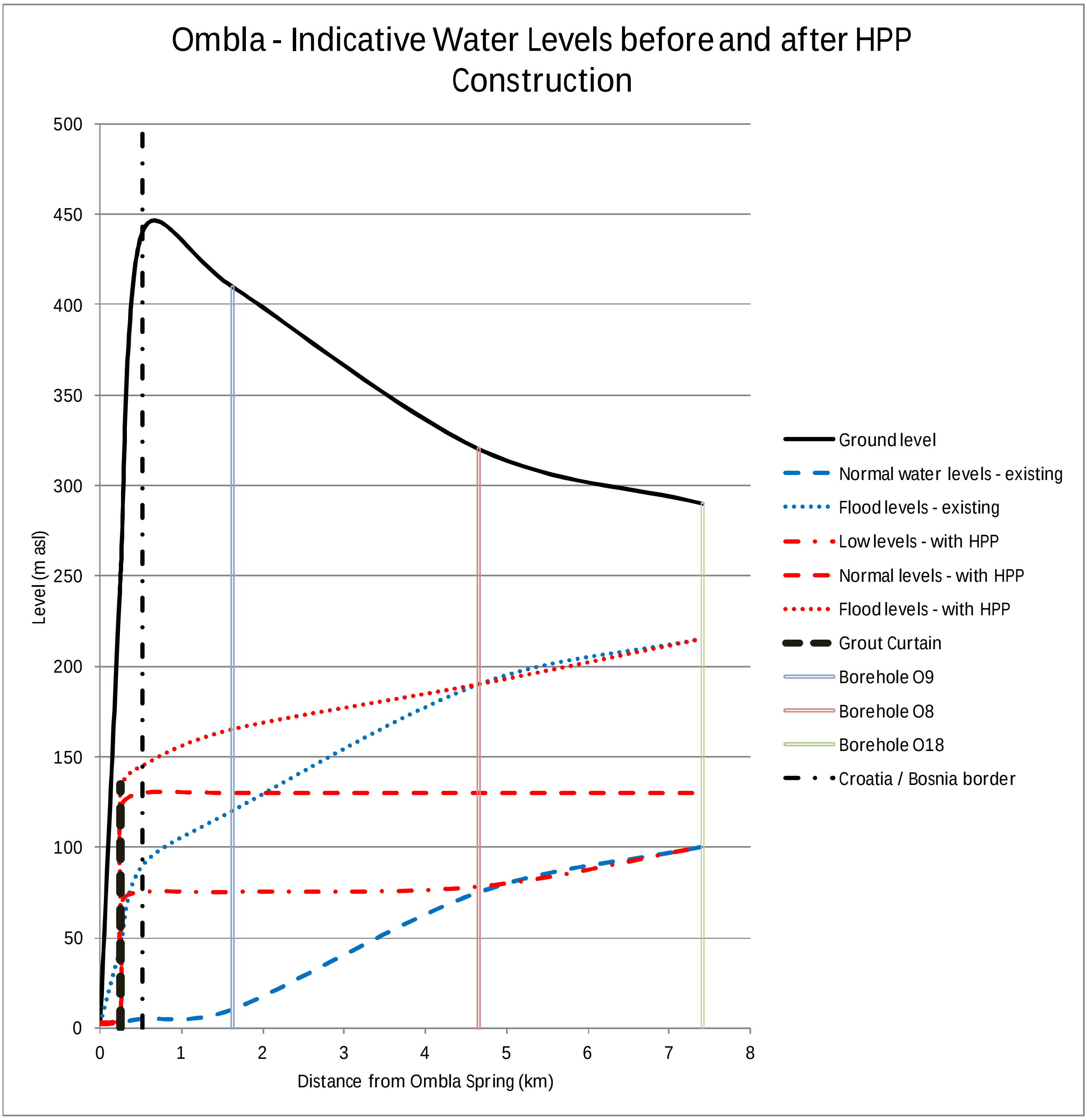

Figure 1.6: Indicative Water Levels Before and After HPP Construction

As Figure 1.6 above shows that flood levels are more than 50m below ground level and that the flood levels with and without the HPP become broadly similar from about 5km from Ombla. It is not envisaged that the proposed HPP increases flood risk in Bosnia and Herzegovina based on the available data.

1.3.7 Effects of Ombla HPP on Water Levels and Flows within Caves

Construction of the HPP and the proposed change in water levels during operation will affect the water levels and flows in the Vilina Cave-Ombla Spring system. Table 1.4 below describes the existing environments and the impacts on the three levels of the caves, as defined in Section 1.3.2.

Table 1.4: Effects– Of Ombla HPP on Water Levels and Flows within Caves

Cave Level	Existing situation	Scheme Effect on Water Levels
Upper (typically between about 120m and 150m asl)	This upper level is virtually dry apart from some percolation water entering the cave from above (as a result of rainfall on the Croatian side of the mountain ridge). There are some static pools such as Milky Lake [Mliječni jezero] in this upper level fed by this percolation water.	The scheme design is intended to avoid flooding of the upper level of the Vilina Cave by locally lowering the grout curtain level, whilst the installation of drainage pipes (as required by the Ministry of Culture) will reduce additional collection of percolation water due to the general raising of water levels within the system. The upper level will not be blocked or otherwise intercepted by the grout curtain. The permeable nature of limestone karst systems, which have relatively low porosity within the matrix of the rock, but greater hydraulic connectivity through fractures and dissolution conduits within the rock, presents a risk that the increase in the wider phreatic level to 130m.asl will lead to flooding in the Vilina Cave through unknown (unmapped) fractures and conduits, if not controlled.
Middle (typically between 130m and 0m asl)	The middle level is also virtually dry with some static pools. Lower parts of this level flood occasionally (once a year or every couple of years) when the flows through the Ombla Spring system are high.	The middle level will be divided during the construction of the HPP as impermeable concrete plugs that will be constructed at three locations where the cave crosses the grout curtain. The portion of cave behind the grout curtain will be flooded when the HPP is operating at its normal water level of 130m al. After sustained periods of low flows some of the upper parts of this level will be dry (as modelling predicts that the operating level will drop to 75m asl), but this is likely to be only for a few days or weeks a year. Due to the water intake at 55m asl on the vertical shaft which connects to this cave level, there will be a small flow through this cave. The portion of the cave in front of the grout curtain will remain relatively unchanged although there is likely to be a change in air flow and intermittent drainage of water from the Vilina Cave within this area. The grout curtain may also restrict the amount of percolated water that reaches this level intersecting fissures that feed percolation water from the mountain behind it.

Cave Level	Existing situation	Scheme Effect on Water Levels
Lower (typically between about 0m and -130m asl)	The lower level currently consists of the main cave passage that takes the majority of the flow and several chambers containing lakes such as Great Hall [Velika Dvorana] and Spring Cave. Both the Spring Cave and Great Lake are fed by upwelling of water from the main underground channel. The Great Lake is fed from the main channel flow from the hinterland some -54m.asl, whilst the Spring Cave is fed as a backwater by an offshoot channel connected to the Main Channel at approximately -25m.asl. The Main Channel discharges directly to the Spring Pond, whilst there is no identified direct connection between the Spring Cave and Spring Pond other than via the Main Channel connection described.	After the construction of the HPP, there will cease to be any significant flow in the main cave passage. This may impact the water chemistry or biology (e.g. reduce the amount of dissolved oxygen or nutrients etc.). The Great Hall will be permanently flooded. The HPP construction involves substantially enlarging (two or three-fold) the Spring Cave and diverting virtually all of the flow through this enlarged chamber. The impact will therefore be to significantly increase the water velocities and replace the natural cave features with a uniform artificial system. The new main flow route will be through the headrace tunnel and then onwards via the various HPP components. As this tunnel is smaller and smoother than the natural cave passage, the velocities experienced in the headrace, tail race and enlarged Spring Cave will be higher under normal flow conditions.

As the upstream terrestrial and aquatic cave passages connected to the Vilina Cave-Ombla Spring system have not been explored or mapped, it is difficult to assess the impacts on these. However, the raising of the normal water levels for 8km or more from Ombla Spring means that some currently dry passages will inevitably be flooded. With two levels of fossil cave passages in Croatia, it is reasonable to assume that there will be similar upper levels of fossil cave passages in Bosnia and Herzegovina; however there is considerable uncertainty about their dimensions and locations and also the portions of these underground cave passages that would be flooded.

1.4 Construction Approach

1.4.1 Timeline

Construction of the Ombla HPP is proposed to last five years followed by start-up and full operation. HEP is the developer and will tender for the use of contractors for the construction phase. The Ombla HPP will be operated by HEP. The proposed construction timeline is shown in Table 1.5 below.

Table 1.5: Proposed Construction Programme

Year	Proposed Works
1	• **Project start** • Water supply filter plant • Water intake for Dubrovnik water supply • Access roads • Access tunnels • After completion of access roads: o Grouting galleries (III and II) at 135m and 65m asl • Vertical shaft (part)

2	• Completion of water supply system, followed by:
	  o Bottom outlet
	  o Water intake for hydropower station
	• Completion of upper two grouting galleries, followed by:
	  o Swirling spillway
	  o Concrete floors to galleries, then:
	    ▪ Grouting from these galleries
	• Lower grouting gallery (I)
	• Valve chamber
	• Upper part of power chamber

3	• Installation of Howell Bunger valves in bottom outlet
	• Installation of valves at +18m asl in vertical shaft
	• Completion of grouting from upper two galleries (II and III) and left and right flanks from lower one (I), followed by:
	  o Plugging of main underground conduit at -130m asl
	• Towards end of year:
	  o Grouting of central part of grout curtain from lower gallery
	  o Power house
	  o Swirling spillway

4	• Grout curtain complete
	• Swirling spillway
	• Concrete works in power house
	• Towards end of year:
	  o Concrete work on swirling spillway
	  o Equipment installation in power house

5	• Completion of swirling spillway • Connection to Croatian electricity network • **Project complete**

1.4.2 Raising Water Levels

The water levels behind the grout curtain will be raised in three phases and supported by extensive monitoring. The activities within the three phases are shown in Table 1.6 below. The change in water levels and flows in the three cave levels will start with impacts on the lower cave level, which will be affected from year three of construction, with the other levels being affected from the second half of year four.

Table 1.6: Phases in Water Level Raising

Phase	Time Period	Water Raising
1	Year 3 and first half of Year 4	Once the main underground conduit is plugged, it will be possible to raise water levels to about +9m asl by closing bottom outlet valves during low flows.
2	Second half of Year 4	During small inflows, the water levels will be raised to +20m asl, then monitored for a period of time followed by raising to +50m asl and monitoring. At any time, the water levels can be returned to the pre-construction levels by fully opening the bottom outlet.
3	Year 5	In this final phase, once the swirling spillway is complete, water levels will be raised to +130m asl and monitored and the HPP will be tested. Again, at any time, the water levels can be returned to the pre-construction levels by fully opening the bottom outlet.

1.4.3 Flow Diversion

During construction, the main flow of the water through the system will be diverted from the intake in the Great Hall (Velika Dvorana) via the headrace tunnel, the base of the vertical shaft, the bottom outlet and into the Rijeka Dubrovačka. This will be enabled by construction of a temporary weir immediately downstream of the existing Komolac weir with a crest level of +3m asl. This will mean that this diversion route becomes the preferential route (over the natural route via the main underground conduit, Spring Cave and Spring Pond). It will allow the water level in Spring Pond and Spring Cave to be lowered to facilitate construction. It will also reduce the flow in the main underground conduit to allow the construction of a grout injected plug in the same vertical plane as the grout curtain. This work will be carried out when the inflow is below 13 m^3/s, which is the median flow[8] (i.e. the flows exceeded on 50% of the days in a year).

1.5 Benefits of the Scheme

The importance and benefits of the Ombla HPP project have been summarised by HEP and they include the following:

- Security of the public drinking water supply to the wider Dubrovnik area with an increase in the capacity of drinking water from the current level of 500 l/s to 1,500 l/s.
- Pollution protection and improvement of drinking water supply including addressing the occasional problems associated with increased turbidity during heavy rainfall. Filtration will be used.
- Cost effective scheme for water supply that will eliminate the need to pump water from further afield. Savings of €1,500,000/year can be realised from pumping costs alone, as water will be transferred by means of gravity
- Security of electricity supply to the wider Dubrovnik area. Production of an inexhaustible supply of renewable electricity, with production for the average hydrological year of around 220 GWh to the Croatian National Grid. There are currently interruptions to the delivery of electricity in the Dubrovnik area which should be reduced.
- Renewable electricity with minimal pollution to the environment or emissions causing potential harm to human health.
- The scheme will be a continuous and steady operation, unlike other forms of renewables e.g. solar, wind power. Furthermore, this scheme is considered cost effective compared to the other forms of renewables (wind and solar) and will not require as large a footprint as these other forms of renewables.

[8] There is a difference in median flow stated in a) Tractebel's Technical Due Diligence Report and b) HEP's tender documents.

- Under the Directive on Renewable Energy (Directive 2001/77/EC of the European Parliament and of the Council of 21 September 2001), Croatia is obliged to increase the share of electricity production from renewable energy sources and this project will help to move towards these targets.
- A reduction in greenhouse gas emissions will be achieved. For the total production of about 220 GWh, approximately 198,000t of CO_2 will be saved annually. Avoided cost of emission allowances which at current market conditions and costs (€8 / t CO_2) amounts to an annual savings of about €1.6 million
- The scheme will contribute to achieving the goals of reducing emissions of air pollutants (LRTAP Convention) – acid gases i.e. oxides of nitrogen and sulphur
- The scheme will reduce the dependence on imported electric energy. Restoration and upgrade of the network will require time and significant investment and there is also the need to construct new facilities to replace obsolete existing thermal plants, meaning greater dependence potentially on imported energy. The scheme will provide underlying savings which will amount to about €15.5 million / year from savings achieved from reduced imported energy.
- Long term sustainable economic development of the Dubrovnik area in relation to the vital tourism industry from the security of supply (of both water and electricity).
- Economic development in terms of employment from the Ombla HPP, specifically over the 5 year construction period, there will be some 550 persons employed of which a third will be from the wider Dubrovnik area, both direct and indirect jobs. During operation there will 24 new jobs created.
- HEP has started to upgrade the electricity network in the Dubrovnik area including the construction of new substations in anticipation of the new Ombla HPP.

2 Regulatory System

2.1 Croatian Governance of Protected Sites

The main legislation covering nature protection in Croatia is the Nature Protection Law (NPL) (O.G. No. 70/05, 139/08). Although Croatia is not currently a member of the European Union (EU), the NPL has already implemented many mechanisms that transpose provisions of the EU Habitats Directive. The main such mechanisms are the National Ecological Network (Ordinance on establishment of national ecological network, NN 109/07) and the Nature Impact Assessment (NIA) procedure (Ordinance on nature impact assessment, NN118/09). The NIA procedure is applied to all planned projects that may have the potential to have a significant impact on the ecological network from the August 2007. It is understood that the NPL and the NIA, do not make specific provision for retrospective application of the NIA procedure to projects consented prior to 2005.

The Ministry of Environmental and Nature Protection, is the competent authority for the NIA procedure and administers it in most cases. The Croatian State Institute for Nature Protection (SINP) provides expertise in nature conservation. During the NIA process the SINP provides expert advice to the competent authority. The SINP also has a wider remit, including: providing information about the boundaries of the ecological network and sites' target features; organising and implementing biodiversity inventorying and monitoring; evaluation of management plans for protected areas; preparation and implementation of projects and programmes in the field of nature protection and organisation; and implementation of educational and promotional activities.

2.2 Croatian National Ecological Network

The process of developing a network of protected sites in Croatia began in 2002, with the creation of a National Ecological Network (NEN) confirmed by Ordinance NN109/07, adopted in October 2007. To be consistent with the EU Habitats[9] and Birds[10] Directives, the NEN is divided into internationally important areas for birds and areas important for other species and habitats. Conservation objectives have been outlined for each area including a list of species and habitat types for which the area was included in the NEN. Guidelines for protection measures are also given for each area[11]. The Ombla HPP project has the potential to affect three areas designated within the NEN:

- HR2001010, The Ombla
- HR2000186, Vilina Špilja (Fairy Cave)
- HR2000187, the system of Vilina Špilja – the Ombla Spring

2.3 Croatian Natura 2000 Network

Croatia is in the process of developing a series of Sites of Community Importance (SCI) to be put forward to the EU for inclusion in the Natura 2000 network (see Section 2.4) when Croatia joins the EU. The Ombla HPP project has the potential to affect one of these proposed sites:

- HR2001010, Paleoombla–Ombla.

The proposed SCI area includes the three previously identified NEN sites around Ombla spring, and also one other NEN site, the Špilja za Gromačkom vlakom (Cave of Gromacka train, NEN code HR2000169). In addition

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[9] Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora

[10] Directive 2009/147/EC on the on the conservation of wild birds (codified version of Directive 79/409/EEC as amended)

[11] SINP website: http://www.dzzp.hrecological-networks/national-ecological-network/national-ecological-network-339.html; , http://www.dzzp.hr/eng/ecological-networks/national-ecological-network/national-ecological-network-339.html).

another NEN site lies close to the boundary of the proposed SCI but is not presently included within the designation: Močiljska špilja (Močiljska cave, NEN code HR2000090). The project will not affect either of these sites.

Figure 2.1 below provides the boundary of the proposed Paleoombla-Ombla SCI and the location of the Ombla HPP scheme.

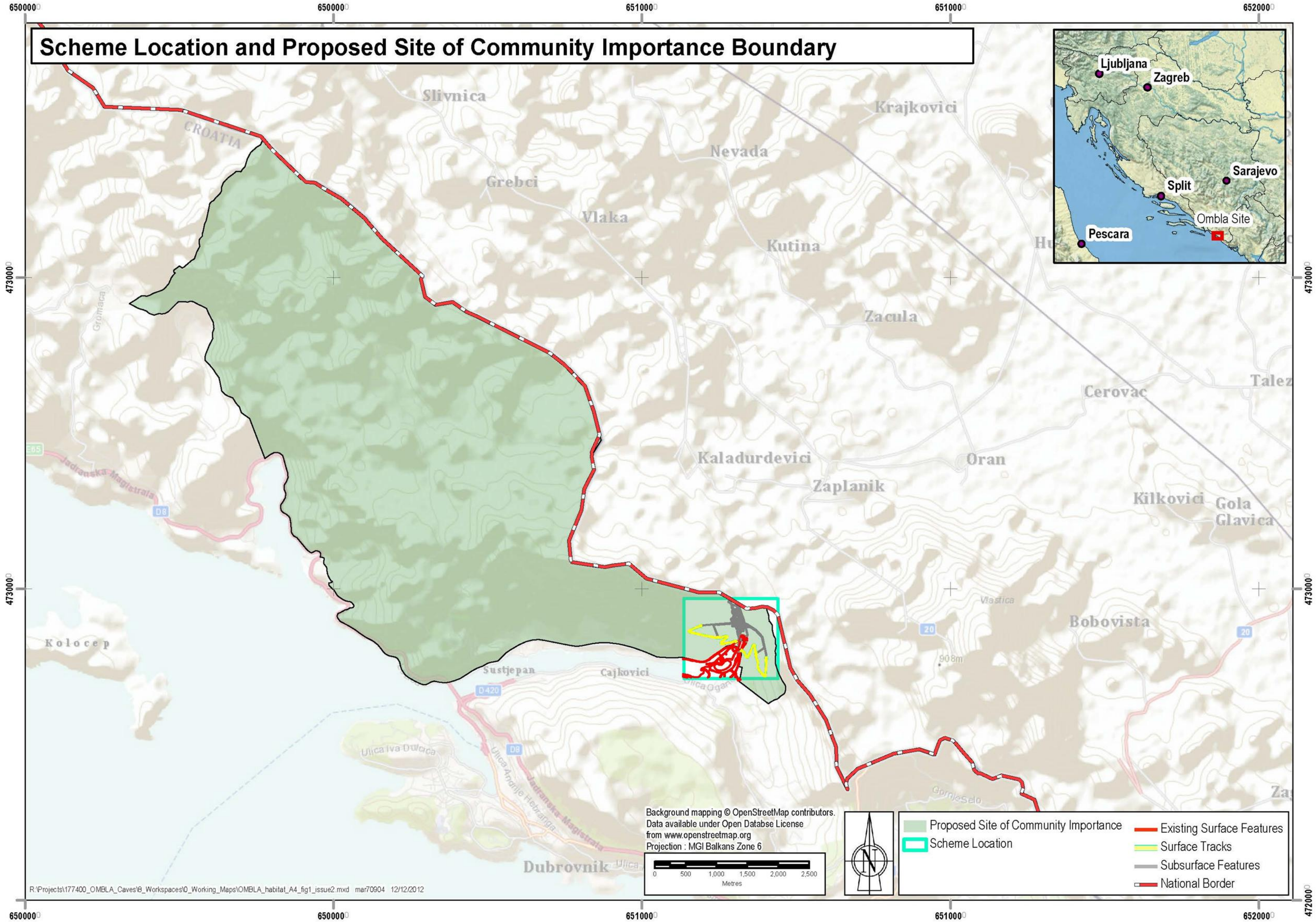

Figure 2.1: The Boundary of the Proposed Paleoombla-Ombla SCI and Location of the Ombla HPP Scheme

2.4 Decisions to Date Related to the Ombla-Paleoombla SCI

2.4.1 Environmental Impact Assessment and Development Permits

An Environmental Impact Assessment (EIA) for the Ombla HPP was prepared and issued in 1998. The EIA met the requirements of Croatian environmental protection law at the time of its preparation and was approved with subsequent permits issued. The "Decision on acceptability of construction for the environment" was issued by the Ministry of Environmental Protection, Physical Planning and Construction on 30th November 1999.

The permits issued for the scheme cover the various design and construction stages of schemes. There are three permitting phases in the design process:

1. Preliminary design - gives the basic functional and technical solutions of the building and the placement in the space. Depending on the project it can consist of various blueprints and documents. This is the basis for issuing the Principle permit.
2. Final design - gives technical solutions for the buildings, the placement of the buildings and infrastructure in the space. The final design provides the evidence to demonstrate that the project will fulfill all of the remaining permitting, legal and regulatory requirements before construction can commence. This is the basis for issuing the Building permit.
3. Working design - works out the technical solution provided in the final design. It has to be done in accordance with the final design. This is the basis for construction of the project facilities.

Following this, the project facilities cannot be used without prior issue of the Using Permit. After the technical inspection which determines that the facilities were built according to the final design, the Using Permit is issued by the Ministry. In the case of Ombla HPP after the construction works have been completed one Using Permit will be issued.

Following the Principle permit, HEP will be required to obtain seven Building permits for each part of the building complex. In the documentation that HEP provided, six of the seven final designs that are needed for the issue of Building permits have been finished and at this stage two of the seven Building permits have been obtained (permits for roads and the HPP approach).

There is no time limitation restriction on these permits as long as a project remains active. Therefore, as work on the project has been on-going since 1999, these permits remain valid under Croatian law. Similarly, under Croatian law, the Ordinance on Nature Impact Assessment, NN118/09, transposing the EU HD Article 6 into Croatian law, does not retrospectively apply to development consents that have already been approved, and therefore NIA is not legally required for the Ombla HPP project.

2.4.2 Ministry of Culture Opinion on the Influence of Ombla HPP on the Bat Fauna in Vilina Cave

In December 2008, the Biology Department (Zoological Institute) of the University of Zagreb prepared the document "Influence of HPP Ombla on the bat fauna in Vilina Cave and protection measures". The document aimed to set out the 'expert base' for the bat fauna of Vilina Cave and to recommend measures to protect bats from the potential effects of Ombla HPP.

The Ministry of Environmental Protection, Physical Planning and Construction referred the document to the Ministry of Culture for their opinion on the expert base document. On 6th March 2009, the Croatian Ministry of Culture issued their opinion and, based on the recommendations in the report, asked that the following protection measures be fully implemented:

- Construction of drainage of the lowest part of the cave system used by bats (~lowest part of High Hall) in accordance with the maps in Appendices 1 & 2 of the expert base "Influence of HPP Ombla on the bat fauna in Vilina Cave and protection measures".

- The diameter of the drainage pipes need to be sufficient for draining of possible waters and due to the possibility of filling and narrowing of pipes with sediment, the pipes need to be maintained to retain sufficient diameter.
- From April to November all the works in Vilina Cave are forbidden.
- From April to November all visits or any other means of use of Vilina Cave during Ombla HPP construction are forbidden.
- There is a need to monitor the state of bat fauna during construction.
- There is a requirement to submit a proposal for a construction phase bat fauna monitoring program to the Ministry of Culture for their consent.
- There is a requirement to deliver to the Ministry of Culture and the State Institute for Nature Protection the results of the construction phase bat monitoring, which will include eventual additional protection measures and proposals for monitoring of the state of bat fauna once the HPP is operational.
- The results of construction phase bat monitoring will be the basis for eventual additional protection measures and for defining the monitoring of bat fauna needed after the HPP is put into operation, which will be the obligation of the developer and user of Ombla HPP to carry out i.e. HEPs full responsibility as both the developer and operator of Ombla HPP.
- There is a requirement to submit a proposal for an operation phase bat fauna monitoring programme to the Ministry of Culture for their consent.
- After the Ombla HPP is put into operation, there is a requirement to ensure implementation of the program for monitoring the state of bat fauna.
- There is a requirement to regularly deliver results of monitoring of the bat fauna after Ombla HPP is put into operation to the Ministry of Culture and to The State Institute for Nature Protection.

The opinion of the Ministry of Culture states that by incorporating the protection measures from the expert base, the nature protection measures regulated by "Decision on acceptability of construction for the environment", dated 30th November 1999, would be fulfilled and the legal conditions which were in power in time of declaration of Decision would be satisfied.

2.5 Croatian Requirements on Public Participation in Decisions

This Habitats Directive Assessment is going through the information disclosure and stakeholder engagement process in accordance with the Aarhus Convention (and EBRD's PR 10 - discussed further in Section 2.7.3). In 2007, Croatia ratified the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (UNECE). The convention is designed to improve the way ordinary people engage with government and decision-makers on environmental matters. Consequently, citizens of Croatia are entitled to be informed about all environment related issues pertaining to the project and it is the responsibility of public authorities, local authorities, or government departments to reveal such environmental information. This is reflected in the Law on Environmental Protection (Official Gazette No. 110/07), currently in force in Croatia. In addition, as HEP is a state owned company, its operations fall under the requirements, specified in the Law on Freedom of Information (Official Gazette No. 172/03, 144/10).

2.6 Habitats Directive

2.6.1 Aims and Requirements

The main aim of the Habitats Directive (the Council Directive 92/43/EEC May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, as amended) is to promote the maintenance of biodiversity. European Union Member States are required to take measures to maintain or restore natural habitats and wild species at a favourable conservation status and to introduce robust protection for those habitats and species of

European importance. In applying these measures Member States are required to take account of economic, social and cultural requirements and regional and local characteristics.

Natura 2000 is a network of areas designated to conserve natural habitats and species that are rare, endangered, vulnerable or endemic within the European Union. The Natura 2000 network includes Special Areas of Conservation (SACs) designated under the Habitats Directive for their habitats and/or species of European importance and Special Protection Areas (SPAs) designated under the Birds Directive for rare, vulnerable and regularly occurring migratory bird species and internationally important wetlands.

Under Article 6 of the Habitats Directive, an Appropriate Assessment is required where a plan or project will give rise to a likely significant effect upon a Natura 2000 site, either alone or in combination with other plans or projects.

Article 6(3) of the Habitats Directive states that:

"*Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to paragraph 4 (see below), the competent national authority shall agree to the plan or project only having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public*".

Article 6(4) of the Habitats Directive states that:

"*If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of social or economic nature, the Member State shall take all compensatory measures to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.*

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest."

The Croatian Ministry of Culture has advised that the Habitats Directive does not apply to Ombla HPP under present Croatian Law. The current study is being undertaken to ensure that the overall goals and principles of the Habitats Directive are acknowledged and achieved in this context.

2.6.2 Stages of Assessment under the Habitats Directive

An assessment under the Habitats Directive can be divided into four stages:

Stage 1: Screening – the process which initially identifies the likely effects upon a Natura 2000 site of the plan or project, either alone or in combination with other plans or projects, and considers on a site by site and feature by feature basis whether:

- it can be concluded there would not be a likely significant effect; or,
- it cannot be concluded that there would not be a likely significant effect.

Stage 2: Appropriate Assessment – the consideration of the effect on the integrity of the Natura 2000 site of the plan or project, either individually or in combination with other plans or projects, with respect to the site's conservation objectives and its structure and function. This is to determine on a site by site and feature by feature basis whether:

- it can be concluded there will be no adverse effect on site integrity; or,
- it cannot be concluded that there will be no adverse effect on site integrity.

Stage 3: Assessment of alternative solutions – the process which examines alternative ways of achieving the objectives of the plan or project that avoid adverse effects on the integrity of the Natura 2000 site. This stage may also identify alternatives to achieving the project objectives that have greater or lesser adverse effects on the integrity of the Natura 2000 site.

Stage 4: Assessment where no alternative solutions exist and where adverse impacts cannot be avoided – an assessment of whether the development is necessary for imperative reasons of overriding public interest (IROPI) and, if so, of the compensatory measures needed to maintain the overall coherence of the Natura 2000 network.

The process of completing these four stages of assessments to comply with the requirements of the Habitats Directive shall be referred to as Habitats Directive Assessment (HDA).

Chapters 3 to 7 of this report provides information that would allow for the Screening (Stage 1) and Appropriate Assessment (Stage 2) stages of an assessment under the Habitats Directive to be carried out. Chapter 8 of this report and also makes recommendations for possible compensatory measures (part of Stage 4 of a Habitats Directive Assessment), if necessary. The scope of work within this report does not include an assessment of alternative solutions or the provision of an IROPI case, however context is provided in view of the position held by HEP that the Ombla HPP scheme is of major national importance for Croatia and in particular the Drubrovnik area and wider region and that in the absence of feasible alternative solutions, a strong IROPI case can be developed and presented.

2.6.3 Alternative Solutions and IROPI

Competent authorities cannot consent to a project where they cannot determine that there will be no "adverse effect on the integrity of a European site" following such an assessment, except where three tests can be met as follows[12]: These are:

- There are no feasible alternative solutions to the project which are less damaging.
- There are "imperative reasons of overriding public interest" (IROPI) for the plan or project to proceed.
- Compensatory measures are secured to ensure that the overall coherence of the network of European sites is maintained.

These tests are required to be interpreted strictly and if it cannot be concluded that the project will not have an adverse effect on the integrity of a European Site, it can only be authorised once the above tests have been met. With regard to IROPI, the reasons for the scheme going ahead must be proven to be:

- Imperative, both necessary and urgent. Of a social or economic nature unless a priority habitat or species is affected or imperative reasons relating to human health, public safety or beneficial consequences of primary importance for the environment
- Overriding - of such scale and importance that they outweigh the harm to the integrity of the site;
- Of Public, not private Interest - i.e. the public must benefit (notable perhaps in relation to justifications on cost where economic reasons may not count)

2.7 EBRD Performance Requirements

2.7.1 Introduction

The EBRD seeks to ensure through its environmental and social appraisal and monitoring processes that the projects it finances are socially and environmentally sustainable; respect the rights of affected workers and communities; and are designed and operated in compliance with applicable regulatory requirements and good international practice. In order to translate this objective into successful practical outcomes, the Bank has

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[12] Habitats Directive: Guidance on the Application of Article 6(4), Alternative Solutions, Imperative Reasons of Overriding Public Interest (IROPI) and Compensatory Measures, Department for Environment, Food and Rural Affairs, August 2012

adopted a comprehensive set of specific Performance Requirements ('PRs') that clients are expected to meet, covering key areas of environmental and social issues.

The ten Environmental and Social Performance Requirements that apply to EBRD projects are as follows:

- PR 1: Environmental and Social Appraisal and Management
- PR 2: Labour and Working Conditions
- PR 3: Pollution Prevention and Abatement
- PR 4: Community Health & Safety and Security
- PR 5: Land Acquisition, Involuntary Resettlement and Economic Displacement
- PR 6: Biodiversity Conservation and Sustainable Resource Management
- PR 7: Indigenous Peoples
- PR 8: Cultural Heritage
- PR 9: Financial Intermediaries
- PR 10: Information Disclosure and Stakeholder Engagement

PRs 1 to 8 and 10 include the requirements for direct investment operations; PR 9 is for financial intermediary operations. Each PR defines, in its objectives, the desired outcomes, followed by specific requirements for clients to help them achieve these outcomes. Compliance with relevant national laws is an integral part of all PRs.

2.7.2 Performance Requirement 6

The PR of particular relevance to the Habitats Directive is PR 6: Biodiversity Conservation and Sustainable Resource Management. Within PR 6 the EBRD supports a precautionary approach to the conservation and sustainable use of biodiversity and the management of impacts upon it in line with the Rio Declaration and the Convention on Biological Diversity (CBD).

The CBD entered into force on 29 December 1993. It has three main objectives which are central to its Strategic Plan for biodiversity 2011 to 2020:

- The conservation of biological diversity
- The sustainable use of the components of biological diversity
- The fair and equitable sharing of the benefits arising out of the utilisation of genetic resources

The objectives of the EBRDs PR 6 are:

To protect and conserve biodiversity; to avoid, minimize and mitigate impacts on biodiversity and offset significant residual impacts, where appropriate, with the aim of achieving no net loss or a net gain of biodiversity; to promote the sustainable management and use of natural resources; to ensure that Indigenous peoples and local communities participate appropriately in decision-making; to provide for fair and equitable sharing of the benefits from project development and arising out of the utilization of genetic resources; to strengthen companies' license to operate, reputation and competitive advantage through best practice management of biodiversity as a business risk and opportunity; to foster the development of pro-biodiversity business that offers alternative livelihoods in place of unsustainable exploitation of the natural environment.

As identified in its Environmental and Social policy, the EBRD is guided by and supports the implementation of applicable international law and conventions and relevant EU Directives.1. The policy lists examples of relevant conventions and directives as follows:

- Convention on Biological Diversity and its protocols

- Convention on Wetlands of International Importance Especially as Waterfowl Habitat
- Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)
- Convention on the Conservation of Migratory Species of Wild Animals
- Convention on the Protection of the Black Sea Against Pollution
- Council Directive 92/43/EEC May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, as amended (the Habitats Directive)
- Council Directive 79/409/EEC April 1979 on the Conservation of Birds
- Council Directive 2004/35/EC April 2004 on Environmental Liability
- Council Directive 85/337/EEC 27 June 1985 as amended by Directive 97/11/EC of 3 March 1997 on Environmental Impact
- Council Directive 2001/42/EC June 2001 on Strategic Environmental Assessment

For this study, the most relevant of the above conventions and directives are the Convention on Biological Diversity and, of course, the Council Directive 92/43/EEC May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, as amended (i.e. the Habitats Directive).

PR 6 states that certain 'critical' habitats, and the species therein, require extra consideration. 'Irrespective of whether it is natural or modified, some habitat may be considered to be critical by virtue of (i) its high biodiversity value; (ii) its importance to the survival of endangered or critically endangered species; (iii) its importance to endemic or geographically restricted species and sub-species; (iv) its importance to migratory or congregatory species; (v) its role in supporting assemblages of species associated with key evolutionary processes; (vi) its role in supporting biodiversity of significant social, economical or cultural importance to local communities; or (vii) its importance to species that are vital to the ecosystem as a whole (keystone species).'

Set again these criteria the Ombla complex is considered to be 'critical habitat', as it meets at least criteria ii) and iii) above. Most of the bat species using Vilina Cave within the Ombla complex are listed as being vulnerable on the International Union for Conservation of Nature (IUCN) Red List; nevertheless, one bat species present, *Miniopterus schreibersi* (Schreiber's long-fingered bat, or Schreiber's bat), is listed as endangered within Croatia on the IUCN Red List. It is also recognised that the species using the cave systems are geographically restricted and endemic.

For critical habitats, PR 6 places the following stipulations before agreeing to fund development:

'Critical habitat must not be converted or degraded. Consequently, in areas of critical habitat, the client will not implement any project activities unless the following conditions are met:

- Compliance with any due process required under international obligations or domestic law that is a prerequisite to a country granting approval for project activities in or adjacent to a critical habitat has been complied with[13].
- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its ability to function in the way(s) outlined in paragraph 13 [this refers to the habitat virtues identified above]
- Taking a precautionary perspective, the project is not anticipated to lead to a reduction in the population of any endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
- Notwithstanding the above, all other impacts are mitigated in accordance with the mitigation hierarchy.'

In accordance with the mitigation hierarchy, PR 6 identifies that clients will need to identify measures to avoid, minimise or mitigate potentially adverse impacts and, where appropriate and as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.

[13] For example, countries may have to demonstrate that no plausible alternatives exist or that the project is in the national interest.

PR 6 identifies certain stipulations before agreeing to fund developments that are located in designated habitats. The Ombla complex is nationally designated within the National Ecological Network (NEN), and also covers the proposed the Site of Community Importance. The requirements for works within designated sites would therefore apply in this instance:

In addition to the applicable requirements [for critical habitats], the client will:

- consult protected area sponsors and managers, local communities and other key stakeholders on the proposed project in accordance with PR 10;
- demonstrate that any proposed development in such areas is legally permitted and that due process leading to such permission has been complied with by the host country, if applicable, and the client; and that the development follows the mitigation hierarchy (avoid, minimise, mitigate, offset) appropriately; and
- implement additional programmes, as appropriate, to promote and enhance the conservation aims of the protected area.

2.7.3 Performance Requirement 10

This biodiversity assessment is going through the information disclosure and stakeholder engagement process in accordance with the Aarhus Convention (discussed previously in section 2.5) and PR 10, and with the first bullet point above in relation to designated sites. PR 10 states the following: '*The EBRD considers stakeholder engagement as an essential part of good business practices and corporate citizenship, and a way of improving the quality of projects. PR10 outlines a systematic approach to stakeholder engagement that will help clients build and maintain over time a constructive relationship with their stakeholders, in particular the locally affected communities. The process of stakeholder engagement is an essential component of the appraisal, management and monitoring of environmental and social issues associated with the client's investments'*.

2.8 Other International Best Practices

In addition to EU directives and the EBRD Environmental and Social Policy, another applicable international best practice used to assess the environmental performance of proposed schemes is 'The Equator Principles'.

The Equator Principles (EPs) are a voluntary set of ten standards for determining, assessing and managing social and environmental risk in project financing. The EPs are considered the financial industry 'gold standard' for sustainable project finance. The EPs are adopted by most international finance institutions (known as Equator Principles Financial Institutions (EPFI)) when considering investments. EPFIs commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs. The EPs apply to all new project financings globally with total project capital costs of US$ 10 million or more, and across all industry sectors.

The EPs, are based on the International Finance Corporation (IFC) performance standards on social and environmental sustainability[14], and on the World Bank Group's Environmental, Health and Safety (EHS) general guidelines[15] (the EHS guidelines are specifically relevant to PS 3) and are intended to serve as a common baseline and framework for the implementation by each adopting EPFI of its own internal social and environmental policies, procedures and standards related to its project financing activities.

As with the EBRD PRs, the Performance Standard of particular relevance to this study is Performance Standard (PS) 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. As with PR 6, this PS adheres to the Convention on Biological Diversity. In many areas, the wording of the PS is very similar to that of PR 6, although there are a few sections where the PS goes beyond the requirements of PR 6, and these are noted below.

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[14] http://www1.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/publications/publications_handbook_pps

[15] http://www1.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC+Sustainability/Sustainability+Framework/Environmental,+Health,+and+Safety+Guidelines/

For ‘critical’ habitats, PS 6 identifies that funding will not be forthcoming without ‘a robust, appropriately designed, and long-term biodiversity monitoring and evaluation program which is integrated into the client’s management program.’ Furthermore, in relation to the mitigation strategy for critical habitats, PS 6 specifically states that the project’s mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains [defined in footnote][16] of those biodiversity values for which the critical habitat was designated’.

In accordance with best practice, the Ombla scheme will adhere to the requirements detailed in both PR 6 and PS 6; this will also include the additional requirements in PS 6 noted above, i.e. that the client will undertake long term monitoring, develop a biodiversity action plan, and ensure net gains for this ‘critical’ habitat.

[16] [15] Net gains are additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated. Net gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the requirements of paragraph 17 of this Performance Standard without a biodiversity offset, the client should achieve net gains through the implementation of programs that could be implemented in situ (on-the ground) to enhance habitat, and protect and conserve biodiversity.

3 Proposed Paleoombla-Ombla Site of Community Importance

3.1 Location and Scale

The proposed Ombla HPP site (the site) is situated in the southeast corner of the wider Proposed Paleoombla-Ombla Site of Community Importance (SCI) which is approximately 3750 hectares in total. The site comprises approximately 1% of the wider SCI area. Figure 2.1 shows the site location in the context of the SCI.

The SCI has been designated by SINP as part of the wider process of defining Croatia's Natura 2000 network of sites. This network of sites has been designated using existing data on the habitats and species identified in Annex's I and II of the Habitats Directive and on the basis of extensive field investigations since 2007 to collect data for more than 200 species and 70 habitats.

The boundary of the proposed SCI is based on the results of surveys and studies on the biospeleological value of the area, which were obtained during investigations undertaken by the Croatian Biospeleological Society (CBS) during 2008 and 2009. The boundaries of the potential SCI area have been set to include the most important biospeleological localities and underground ecosystems within the boundaries of recognisable features of the terrain (e.g. roads, etc.).

In addition to the Vilina-Ombla cave system, the SCI also provides protection for the Močiljska and Gromačka caves. Gromačka cave is cited as an isolated potential area of Natura 2000 network, whilst the Močiljska cave is part of the wider potential area of Paleoombla-Ombla SCI. The proposed Paleoombla-Ombla SCI also hosts a large extent of sub Mediterranean vegetation, assessed by SINP as covering more than 30% of the proposed SCI area. The specific features of the SCI are presented in Section 3.2.

Within the proposed SCI, the site is surrounded by steep rock formations in the Dinaric Alps Karst, which runs along the Croatian coast of the Adriatic Sea. The Ombla catchment lies outside of the proposed SCI in Herzegovina, and is discharged through a tectonically damaged Dolomite barrier into Ombla cave system which then discharges at the Ombla Spring into the Ombla River, which flows into the Adriatic Sea as the Rijecka Dubrovačka. The Ombla River rises as a karst spring fed by groundwater replenished by Trebišnjica, which is an influent stream flowing in Popovo and Trebinnje poljes, in the immediate hinterland of the Ombla.

The habitats immediately adjacent to the Vilina Cave entrance are open freshwater habitats, sub-Mediterranean and epi-Mediterranean dry meadows, rocky pastures and grasslands and cultivated habitat mosaics. The surrounding landscape is dominated by the same habitat types with patches of mixed woodland.

3.2 Designated Features

3.2.1 List of Features

The designated habitat and species features of the proposed Paleoombla-Ombla SCI are presented in Table 3.1 below (designated habitats and species identified by the SINP in Jan 2013). Detailed information about each interest feature is provided in Chapter 4, whilst Figure 3.1 shows the habitats features of the proposed Paleoombla-Ombla SCI in relation to components of the scheme.

Table 3.1: Proposed Paleoombla-Ombla SCI Features (Draft List January 2013)

Scientific Name	English Common Name(S)	Croatian Common Name	N2000 Code
Habitat Features			
N/A	Caves not open to the public *	Špilje i jame zatvorene za javnost	8310
N/A	Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*)	Istočno submediteranski suhi travnjaci (*Scorzoneratalia villosae)*	62A0
Species Features			
Miniopterus schreibersii	Schreibers' long-fingered bat Schreibers' bent-winged bat Common bent-winged bat	Dugokrili pršnjak	1310
Myotis blythii	Lesser mouse-eared bat	Oštrouhi šišmiš	1307
Myotis emarginatus	Geoffroy's bat	Ridi šišmiš	1321
Rhinolophus euryale	Mediterranean horseshoe bat	Južni potkovnjak	1305
Rhinolophus ferrumequinum	Greater horseshoe bat	Veliki potkovnjak	1304

Note: The previous draft species list included the olm salamander *Proteus anguinus.* However on the basis of the findings of surveys undertaken in 2012 by the CBS and a review of the basis for inclusion of the olm, the SINP has revised the list of SCI features, excluding the olm as a proposed feature of the SCI (official letter signed by director of SINP sent to HEP, dated January 2013).

3.2.2 Habitat Features

The habitat features listed as part of the proposed Paleoombla-Ombla SCI are defined in the Interpretation Manual of European Union Habitats - EUR27 (EC, 2007) as set out below.

3.2.2.1 Eastern sub-Mediterranean Dry Grasslands (*Scorzoneratalia villosae*)

Xeric grasslands of the sub-Mediterranean zones of Trieste, Istria and the Balkan Peninsula, where they coexist with steppic grasslands of the Festucetalia valesiacae (6210), developing in areas of lesser continentality than the latter and incorporating a greater Mediterranean element. This habitat includes the following communities; - Carici humilis-Centaureetum rupestris, Genisto holopetalae-Caricetum mucronatae, Chrysopogono-Centaureetum cristatae, Danthonio- Scorzoneretum villosae & Cleistogeno – Festucetum rupicolae.

Plants: *Carex humilis, Bromus erectus, Centeurea rupestris, Leucanthemum liburnicum, Plantago argentea, Jurinea mollis, Iris cengialti, Pulsatilla vulgaris ssp. grandis, Genista holopetala#, Hladnikia pastinacifolia, Euphrasia marchesettii, Pedicularis friderici-augusti, Sesleria juncifolii, Gentiana lutea, Gentiana clusii, Trinia glauca, Arctostaphylos uva-ursi, Euphorbia triflora, Festuca rupicola.*

3.2.2.2 Caves Not Open to the Public

Caves not open to the public, including their water bodies and streams, hosting specialised or high endemic species, or that are of paramount importance for the conservation of Annex II species (e.g. bats, amphibians).

Plants: mosses only (e.g. *Schistostega pennata*) and algal carpets at the entry of caves.

Animals: Very specialised and highly endemic cavernicolous fauna. It includes underground relic forms of the fauna which has been diversified outside. This fauna is mainly composed of invertebrates which exclusively live in caves and underground waters. The cavernicolous terrestrial invertebrates are mainly coleoptera, belonging to the *Bathysciinae* and *Trechinae* families in particular, which are carnivorous and have a very limited distribution. Cavernicolous aquatic invertebrates constitute a highly endemic fauna, dominated by crustaceans (Isopoda, Amphipoda, Syncarida, Copepoda) and include many living fossils. Aquatic molluscs, belonging to the Hydrobiidae family are also found. With regard to vertebrates, caves constitute hibernation sites for most European bat species, among which many are threatened (see Annex II, Habitats Directive). Several species can live together in the same cave. Caves also shelter some very rare amphibious species like Olm *Proteus anguinus* and several species of the Speleomantes genus[17].

[17] Interpretation Manual of European Union Habitats - EUR27

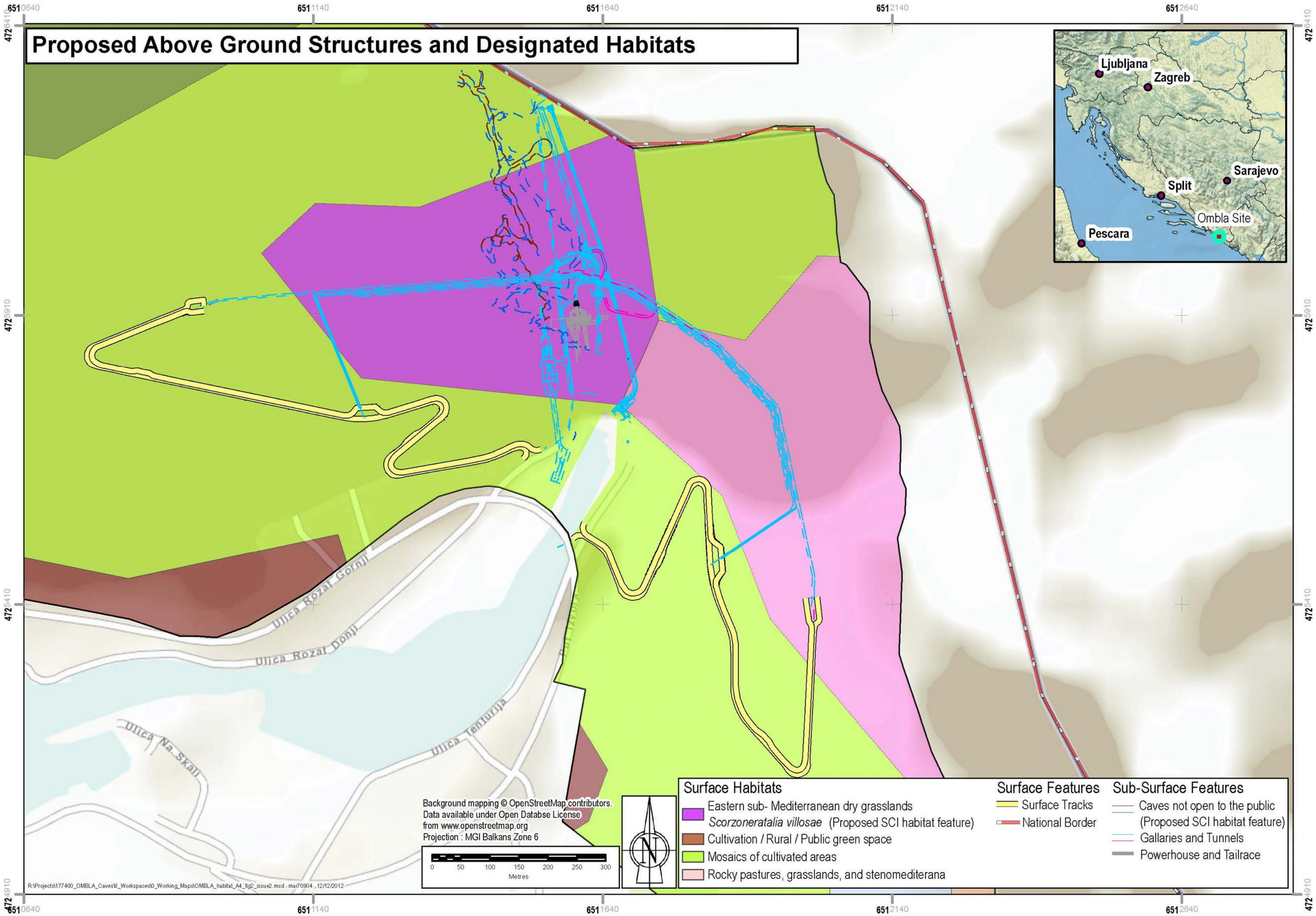


Figure 3.1: Designated Features of the Proposed Paleoombla-Ombla SCI in relation to Ombla HPP

3.2.3 Species Features

The EU (European Topic Centre on Biological Diversity) provides summary information regarding the distribution general habitat requirements and conservation status of the species listed as part of the proposed Paleoombla-Ombla SCI.

3.2.3.1 Schreibers' bat *Miniopterus schreibersii*

Schreibers' bat has a life expectancy of approximately 16 years. The species generally forages in open woodland habitats and urban areas, and primarily roosts in underground structures. The seasonal migration distance between summer and winter roosts is usually between 40km and 100km.

This species is recorded at 76 sites in the EU, with 25 of these being maternity colonies and 25 being winter colonies. The species has IUCN conservation status of 'endangered' in Europe and 'almost endangered' at the international level.

In Croatia, the population size of Schreibers' bat is estimated as 150,000 individuals, including 58,000 registered in hibernation colonies, and over 50,000 in the maternity. Despite a number of recent studies, the stability of the population is difficult to assess. Populations in the north of the country appear to be at risk as they depend on a small number of underground shelters that are influenced by anthropogenic activities.

3.2.3.2 The lesser-mouse eared bat *Myotis blythii*

The lesser-mouse eared bat has an average lifespan of between 14 and 16 years, and its population is widely spread across Europe as well as Asia and North Africa. The species usually roosts in caves, mines or attics of old (abandoned) buildings, and forages in scrub and grassland habitats and in farmlands. The seasonal migration distance between summer and winter roosts is usually only around 15km, but will occasionally travel longer distances.

In nearly all geographical regions of the EU (Alpine, Atlantic and Mediterranean) the status of the lesser-mouse eared bat is largely 'unknown'. This species is recorded at 59 sites in the EU, with 29 of these being maternity colonies and 3 being winter colonies. In the Pannonian region it is considered as 'inadequate' and in the Continental region it is considered as 'bad'. The overall assessment for this species is 'bad' and except for the Pannonian region the future prospects are also 'bad'. However this species is still quite common and therefore its IUCN conservation status is 'Least Concern'.

Based on more than 20 000 recorded in maternity colonies, the size of Croatia's population of the lesser-mouse eared bat is estimated at 50,000 to 60,000 individuals, and the species is considered stable with respect to the number of potential suitable residence.

3.2.3.3 Geoffroy's bat *Myotis emarginatus*

Geoffroy's bat has an average lifespan of two to three years and is widely distributed across southern, northwest and Central Europe. Furthermore it occurs in some regions in Northwest Africa and Southwest Asia. This species forages over scrub, grasslands and forests (often near water) and it roosts underground in caves or in abandoned buildings. The seasonal migration distance between summer and winter roosts is usually around 40km, but they will occasionally travel longer distances.

In the Atlantic and Pannonnian regions of the EU this species' status is assessed as 'favourable'. This species is recorded at 64 sites in the EU, with 22 of these being maternity colonies and 6 being winter colonies. In the Continental region the species status is assessed as 'inadequate' and in the Alpine and Mediterranean region it is assessed as 'unknown but not favourable', due to a lack of data from France, Greece and Spain. Many countries report a 'favourable' status for this species. After decades of population declines, the population is now considered to be stable and therefore its IUCN conservation status in Europe is 'Least Concern'.

Based on more than 20 000 recorded in maternity colonies, the size of Croatia's population of the Geoffroy's bat is estimated at 55,000 individuals. Stability of the population is difficult to determine, but it seems that areas in the north are vulnerable to human impact.

3.2.3.4 Mediterranean horseshoe bat *Rhinolophus euryale*

The Mediterranean horseshoe bat has an average lifespan of 13 years and is widely distributed across Europe, North and West Asia and North Africa. It forages in scrub and woodlands and avoids coniferous forests. It roosts in natural and artificial underground sites and abandoned houses. The seasonal migration distance between summer and winter roosts is believed to be around 50km, but this is poorly understood.

In many geographical regions of the EU the status of the species is largely ‘unknown’. This species is recorded at 83 sites in the EU, with 24 of these being maternity colonies and 13 being winter colonies. Overall the population status is assessed as ‘bad’ in four regions (Alpine, Atlantic, Continental and Mediterranean) and as ‘inadequate’ in the Pannonian region. The only country where this species is positively assessed is Hungary. Threats to this species are climate change, disturbance and loss of underground habitats (e.g. cave tourism) and habitat fragmentation. Its population is decreasing and its European IUCN conservation status is ‘Near Threatened’.

In Croatia, there are seven large maternity colonies of Mediterranean horseshoe bat, with an estimated population size of 7,000 individuals. One of the larger recorded maternity roosts is Vilina Cave. Only several hundred individuals have been recorded in hibernation colonies in the country.

3.2.3.5 Greater horseshoe bat *Rhinolophus ferrumequinum*

The greater horseshoe bat has a maximum life expectancy of 30 years and is widely distributed; from North Africa and southern Europe to southwest Asia and via Pakistan and Nepal further to Japan. It forages in pastures and several types of woodland. It roosts in caves and occasionally it uses abandoned buildings. The seasonal migration distance between summer and winter roosts is usually around 30km, but will occasionally travel longer distances.

The status of this species was assessed as ‘inadequate’ in the Atlantic, Continental and Pannonian regions of the EU. This species is recorded at 42 maternity colonies and 57 winter colonies in the EU. In the Mediterranean area the population status was assessed as ‘bad’ and in the Alpine region its status was assessed as ‘unknown but not favourable’. Many countries report a decreasing population and in Belgium and the Netherlands it has already become (regionally) extinct. Due to its wide distribution, the IUCN conservation status in Europe is ‘Least Concern’.

3.3 Conservation Objectives

Article 4(1) of the Habitats Directive requires Member States to propose a list ‘indicating which natural habitat types in Annex I and which species in Annex II that are native to its territory the sites host’. This information forms the basis for a Member State establishing ‘the site’s conservation objectives’. The reason for a site’s inclusion in the Natura 2000 network is evidently the protection of those habitats and species[18] (EC, 2000).

Article 6(1) specifies that the necessary conservation measures have to correspond ‘to the ecological requirements of the natural habitat types of Annex I and the species in Annex II present on the sites’. It is therefore in relation to these ecological requirements that Member States have to determine the conservation measures. Although the directive does not contain any definition of the ‘ecological requirements’, the purpose and context of Article 6(1) indicate that these involve all the ecological needs of abiotic and biotic factors necessary to ensure the favourable conservation status of the habitat types and species, including their relations with the environment (air, water, soil, vegetation, etc.). For example, for the bats included in Annex II of the directive, the ecological requirements differ between the period of hibernation (when they rest in underground environments, in hollow shafts or in dwellings) and the active period, from spring onwards (during which they leave their winter quarters and resume their activities of insect hunting) (European Commission, 2000).

The necessary conservation measures have to aim at maintaining or restoring the favourable conservation status of the natural habitat types and the species of Community interest. They are connected with the general objective of the directive which applies to the Natura 2000 network, as defined in Article 3. Article 3 specifies that it is the Natura 2000 network ‘composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II’ which has to ensure the objective pursued by Article 2(2). Article 2(2), in particular, specifies the objective of the measures to be taken under the terms of this directive: ‘Measures taken shall be designed to maintain or to restore, at a favourable conservation status, natural habitats and species of wild fauna and flora of Community interest’. These measures have, according to Article 2(3), to ‘take

[18] (European Commission (2000) Managing Natura 2000 sites : The provisions of Article 6 of the ‘Habitats’ Directive 92/43/EEC, Luxembourg).

account of economic, social and cultural requirements and regional and local characteristics' (European Commission, 2000).

The conservation objectives for the proposed Paleoombla-Ombla SCI interest features are shown below. The objectives are made up of the 'guidelines for protection measures for the ecological network' for each of the NEN sites that together make up the SCI:

- Conserve biological species important for habitat type, not to enter a foreign (alien) species and genetically modified organisms
- Conserve speleothems, living world caves, fossils, archaeological and other findings
- Do not change habitat conditions in caves, their overground and close by
- Remediate sources of pollution that threaten overhead and underground karst water
- Remediate landfills on river basins caves
- Preserve the favourable conditions (darkness, humidity, ventilation) and peace (no visits and other human impacts) in caves
- Preserve the favourable physical and chemical conditions, the amount of water and the water regime or improve them if they are unfavourable

In addition conservation objectives under the national network have been set for the Ombla spring pond:

- Conserve water and wetland habitats in a more natural state, and if necessary to help revitalisation
- Conserve biological species important for habitat type, not to enter a foreign (alien) species and genetically modified organisms

The Habitats Directive requires the effects of projects to be considered in relation to their 'conservation objectives'. The European Court of Justice (ECJ), in the Waddenzee case11 ruled that significant adverse effects on Natura 2000 sites are those which may undermine the conservation objectives of the sites. Where a project is likely to undermine a site's conservation objectives, it must be considered likely to have a significant effect on the site.

4 Baseline Studies

In order to inform the establishment of a sufficiently robust baseline for the Habitats Directive Assessment, HEP commissioned a consortium of organisations to carry out baseline ecology surveys, as follows:

- Croatian Ichthyological Society: fish and amphibians
- Croatian Biospeleological Society (CBS): cave fauna; cave exploration and speleodiving
- Oikon: bat fauna.

Each of the three organisations listed above have carried out three separate surveys of the Ombla site (lasting three to four days) during the following periods:

- March 2012 (winter)
- May 2012 (spring)
- June 2012 (early summer).

Survey techniques included the following: visual inspection including photo and video documentation (fish and amphibians, speleology, bats); baited and un-baited traps (fish and amphibians, speleology); trammel nets and electrofishing (fish and amphibians); sediment examination (speleology); and, ultrasonic detectors and mist nets (bats). Microclimate measurements were taken during speleology and bat surveys, and water level measurements were taken during fish and amphibian surveys.

The surveys took place in the following locations:

- Fish and amphibians: Ombla Spring (Spring Pond, Spring Cave)
- Speleology: all safely accessible parts of the Ombla cave system
- Bats: Vilina Cave as far back as is accessible.

The baseline surveys relevant to the proposed Paleoombla-Ombla SCI features that have been completed to date are summarised in Table 4.1. A synthesis of the findings of these surveys is presented in Section 4.1.

Table 4.1: Summary of Baseline Studies Relevant to Proposed SCI Features

Ref	Date	Survey Type	Surveyor	Scope	Notes/Limitations
1	2008	Bat fauna	University of Zagreb, Department of Zoology	Surveys of Vilina Cave in all seasons	
2	September 2011	Benthic habitats and species, fish species	University of Dubrovnik, Institute for Marine and Coastal	Survey of biological characteristics of the riverbed downstream of the Spring Pond weir in the Dubrovacka River.	
3	March, April and June 2012	Bat fauna	Oikon	Surveys of Vilina Cave including observational techniques and mist-netting.	No late summer, autumn or mid-winter surveys.
4	March, April and June 2012	Biospeleology	CBS	Survey and exploration of lower, middle and upper cave system, using observational and sampling techniques.	Not possible to dive survey through the main drainage conduit due to high water flows.
5	March, April and June 2012	Fish and amphibians	Croatian Ichthyological Society	Surveys of Spring Cave and Spring Pond, using observational and sampling techniques.	N/A
6	July 2012	Site visit	WSP, WSP / B&V and contracted specialists	Visual observations whilst visiting cave system, e.g. noted cave chambers where bats were present.	Not a formal survey
7	August 2012	Site visit	WSP, WSP / B&V and contracted specialists	Visual observations whilst visiting cave system, e.g. noted cave chambers where bats were present.	Not a formal survey
8	Draft 1: September 2012; and Draft 2: December 2012	Synthesis of 2012 studies (3 to 5) noted above and assessment of the impacts in relation to the Croatian National Ecological Network.	ElektroProjekt	As above	Not a survey. To be provided by HEP.
9	September 2012	NCS Habitat Mapping	SINP	Mapping of Terrestrial Habitat Areas	High level mapping of terrestrial habitat types.

4.1 Findings of Baseline Surveys

4.1.1 Eastern sub-Mediterranean Dry Grasslands (*Scorzoneratalia villosae*)

The SINP has produced mapping of the main habitat types in the SCI. Based on high level mapping, the SINP considers that more than 30% of the Ombla-Paleoombla SCI area is covered by habitats that can be categorised as Eastern sub-Mediterranean dry grassland, a designated habitat under the EU Habitats Directive.

The Ombla HPP site does not contain any Eastern sub-Mediterranean dry grasslands (*Scorzoneratalia villosae*) (Appendix B). The closest area of this grassland lies immediately north of the proposed construction site. The western access track to the 3rd grout curtain gallery is the closest part of the works to this habitat site (see Figure 3.1). This area therefore lies outside the footprint of the scheme and is not discussed further.

4.1.2 Caves Not Open to the Public

As defined in Section 3.2.2, the Caves feature of the proposed SCI encompasses both habitat (caves, their water bodies and streams) and the specialist or highly endemic species that they host. This section therefore considers the findings of the surveys and studies related to speleology, invertebrate fauna and fish. The bat species identified in Section 3.2.3 are individually cited as species of the proposed SCI and they are addressed in Section 4.1.3.

4.1.2.1 Speleology and Cave Invertebrates

The following reports provide the factual basis for the description of the proposed SCI baseline for speleology and cave invertebrates:

- HE Ombla Studija O Utjecaju He Ombla Na Ekološku Mrežu - Nacrt Glavna Ocjena Prihvatljivosti Zahvata Za Ekološku Mrežu (Study on the impact on the ecological Network of HE Ombla - Main Draft Impact Assessment Environmental Network), Elektroprojekt, August 2012 (received 19/10/2012)
- Vrednovanje I Zaštita Podzemne Faune Špiljskog Sustava Vilina Špilja – Izvor Omble (Evaluation and protection of underground cave system Fauna Fairy Cave - Source Ombla) - Hrvatsko biospeleološko društvo (Croatian Biospeleological Society) July 2012 (received 27/09/2012)

Caves

The explored cave system of the Vilina Cave –Ombla Spring system has approximately 3km of known natural channels, plus approximately 1.5km of man-made exploration tunnels. As noted in Section 1.2.2, the cave system is comprised of several cave sections over three defined levels:

- Higher (Vilina Cave),
- Middle (Ombla-Vilina Cave complex); and,
- Lower (Aquatic areas including the Great Lake, Spring Cave, the main cave channel and the external Spring Pond).

There is 280m of vertical difference between the main cave channel and Vilina Cave. The conduit connects with the lower system at the Great Hall and Spring Cave where water flowing through the conduit emerges into caves to form lakes. The conduit also connects directly to Spring Pond located outside the cave entrance at sea level.

A total of 150 species (excluding bats and fish) have been recorded in the Ombla cave system. These species comprise:

- 9 species of fungi,
- 139 species of invertebrate,
- 1 species of amphibian, and,
- 1 species of mammal.

Of those species recorded, 68 are entirely dependent on the cave environments found in the Dinaric karst region, 36 species are only found in the south Dinaric region, and 14 of these species have only been found in the Vilina Cave-Ombla Spring system. A full species list is provided in Appendix B, along with species lists identifying stenoendemic (of restricted distribution to the south Dinaric karts) species, endangered or protected species and species for which the Ombla system presently provides the only recorded location in Croatia or the world.

Culver and Pipan (2009) provide an overview of the ecological classification system and terminology used to categorise cave species based on their dependency and use of subterranean systems. This is set out in Table 4.2.

Table 4.2: Subterranean Fauna Ecological Classification Terminology

Category	Definition
Troglobiont	Obligate - restricted to caves for life cycle and a permanent resident of subterranean habitats. Can be applied to both terrestrial and aquatic fauna. (Synonym – Troglobite)
Stygobiont	As above but restricted to aquatic fauna only.
Troglophile	Facultative (not restricted to but), permanent resident of subterranean habitats (Synonym – Eutroglophile)
Subtroglophile	Obligate or facultative resident of subterranean habitats but associated with surface habitats for some part its life cycle. Synonym: Troglophile
Trogloxene	Species occurring sporadically in subterranean habitat

Source: After Culver and Pipan, 2010

Cave Fungi

The nine species of fungi recorded by the CBS within the cave system were found within the terrestrial cave system. Of these species, four are reported to be new species, unrecorded previously. Seven of the species recorded are thought to be specialised to cave environments (CBS, 2012). Five species were recorded in the upper caves associated with either bat droppings or other organic detritus. One species was recorded in the middle cave level, whilst three species were recorded on rotting wood in the Great Hall and one species was located in the tunnel close to the Spring Cave.

Mammals

One species of mammal the Dinaric vole (*Dinaromys bogdanovi*) has been recorded previously in the Vilina Cave - Ombla Spring system by the CBS (CBS, 2012).

Invertebrate Cave Fauna

The recent 2012 surveys recorded a total of 105 species of invertebrate within the cave system. Of the invertebrate species recorded in the Vilna Cave - Ombla Spring system, 28 species are listed on the national or global level on the IUCN red lists as either endangered, vulnerable, near threatened or of least concern. At the national level, seven species are listed as critically endangered, nine species are listed as endangered and two are listed as vulnerable. At the global level, one is listed as endangered, six are listed a vulnerable, two are listed as near threatened, whilst a further six are listed but are of least concern. These species are identified in Table 4.3.

Table 4.3: Rare and Endangered Cave Invertebrates Species Recorded in the Ombla Cave System

Species	IUCN Croatia Red List Status	IUCN Red List	Last recorded
Agardhiella stenostoma		LC	2000
Anisus leucostomus		LC	2000
Iglica absoloni		LC	2012
Iglica bagliviaeformis	EN	EN	2012
Belgrandia torifera	EN	VU	2012
Cecilioides spelaea	EN		2000
Emmericia expansilabris		VU	2012
Hauffenia edlaueri		NT	2000
Hauffenia plana		NT	2000
Lanzaia vjetrenicae vjetrenicae	CR	VU	2000
Lanzaia vjetrenicae kusceri	CR		2000
Plagigeyeria nitida angelovi	CR	DD	2005
Horatia knorri	CR		2005
Odontocyclas kokeilii		LC	2000
Pholeoteras euthryx	VU		2012
Platyla wilhelmi		LC	2000
Pyrgula annulata dalmatica		LC	2012
Saxurinator brandti	EN	VU	2000
Eukoenenia pretneri	CR		2011
Travunia anophthalma	EN		2012
Congeria kusceri	CR	VU	2000
Spelaeothrombium caecum	EN		2012
Niphargus trullipes	CR		2012
Typhlogammarus mrazeki	EN		2012
Cyphoniscellus herzegowinensis	VU		2012
Troglocaris anophthalmus		VU	2012
Troglocaris pretneri	EN		2012
Typhlogastrura topali	EN		2012

Source: CBS, 2012. (Note: species listed where data is deficient have not been included)

For 14 species of cave invertebrate the Ombla cave system supports the only known populations (See Appendix B). For other species the Ombla cave system is the second known habitat (e.g. *Iglica absoloni, Lanzaia vjetrenicae, Niphargus vjetrenicensis, Niphargus balcanicus, Belba gratiosa, Eukoenenia remyi*) or one of only a few known habitats (*e.g. Speleothrombium, Monolistra hercegoviniensis ornate, Sphaeromides virei montenegrina, Troglocaris (Troglocaridella) hercegovinensis)*. Other species are found in other locations within the wider SCI / southern dinaric karst system.

The most important existing pressures upon cave invertebrates are to water habitats, including: changing rainfall patterns, hydro-technical changes (e.g. river canalisation in BiH), over-abstraction and water pollution.

Cave Habitat Types and Zones

The CBS (2012) has identified the range of different cave habitat types in accordance with the Croatian National Habitat Types Classification and the Handbook of underground habitat in Croatia under the EU Habitats Directive (Gottstein, 2010). All cave habitat types fall under the classification of H.1. Karst caves and pits, and within this classification the CBS has identified a further 14 distinct cave ecosystem sub types identified by physical features and the associated characteristic cave fauna observed. In addition to the Karst caves and pits habitat types, the Ombla Spring Pond is classified as running water habitat (A.2.1. Springs).

Table 4.4 provides a summary of the distribution of the cave habitat types. A number of the habitat types are found as a mosaic within particular areas of the cave and are not easily delineated within those areas, therefore for the purpose of clarity in subsequent reporting the habitat types have been grouped into five discrete Cave Habitat Zones (CHZ) where these habitat mosaics occur. These CHZ are depicted in Figure 4.1, whilst the invertebrate species composition associated with each is provided in Appendix B.

The spatial extent of the different habitat zones varies significantly, however they can be delineated by a number of environmental factors that influence the presence, abundance and diversity of those species that are specially adapted to cave environments. These environmental factors include:

Stable microclimatic conditions: The CBS surveys undertook measurements of a number of microclimatic parameters in terrestrial and aquatic environments over a three month period (March to June, 2012). Terrestrial parameters included, relative humidity (%), air and sediment temperature ($^{\circ}$C), air flow (ms^{-1}) and carbon dioxide (ppm), whilst aquatic parameters included temperature, dissolved oxygen (%/mg/l), pH, redox potential (mV) and conductivity (μs cm^{-1}).

The results indicated that in the upper terrestrial caves, external temperature affected the range of cave temperatures in the zone between the cave entrance and the 2nd hall, with temperatures rising from 15.4°C in March to 17.5°C in June. Temperatures deeper into the cave (250m from the cave entrance at Arm/KRAK A) were more stable rising from 15.4°C in March to 15.7°C in June. Middle level cave temperatures were lower (14.8°C and 15.6°C on average) and fluctuated less. Lower level air temperatures were lower still (13.8°C at the Great Hall) and are likely to be regulated by the temperature of groundwater flows passing through them. Relative humidity was recorded as 100% throughout, although device error may have accounted for such consistently high readings in all areas.

The measurement of water parameters indicated that the variation in water temperatures between the different cave levels was closely correlated with that of air temperature. The lower aquatic level water temperatures ranged between 12.6 and 13°C whilst standing percolation water in the middle and upper levels varied between 14.4°C and 15.8°C. Oxygen saturation levels in the still water aquatic zone in the lower levels varied between 100 and 74.8%, whilst there was little variation in the other physico-chemical parameters of pH (7.5), redox potential (-47 mV) and conductivity(325-340 μs cm^{-1}). Microclimatic conditions relevant to each of the CHZ are set out in Table 4.4.

Darkness and the influence of light: Cave habitats can be delineated by the influence of light, or lack of it. Cave entrances provide unique conditions where the limited influence of light provides conditions for certain species of algae, moss, or ferns to flourish whilst other insects and arachnids take advantage of the more stable half-lit, sun sheltered relatively moist areas to shelter from the more extreme external environment or prey on those species that seek shelter. Importantly, truly subterranean terrestrial and aquatic cave fauna are often morphologically adapted to live in complete darkness, characterised by the reduction in pigment, eye size, the development of other sensory adaptations, elongation of appendages etc. These adaptations allow them to sustain populations within specific subterranean niches. All CHZ identified in Table 4.4, apart from CHZ1, are adapted to complete darkness.

Cave morphology and the provision of natural habitat niches: The morphology of karst caves provides the physical framework for a range of habitat niches; the presence of a range of cavernous openings, a variety of forms (stalactites, stalagmites), surfaces and features (cracks, fissures, boulders, sediment) that individual species utilise to feed, hunt, take refuge and or reproduce. A diverse range of morphological features and habitat niches is important, and the CHZ is set out in Table 4.4, as noted under the habitat attributes.

Sources of organic material: The lack of light in subterranean environments means that primary production of organic material is largely absent and cave ecosystems are reliant of organic material being deposited or carried into the caves. This material represents the basis of the food chain in such environments; therefore the distribution of this material largely determines where animals will be found. Important sources of such matter include: species (i.e. bats, insects etc.) whose daily life cycle whilst resident in caves involves hunting for food outside of caves and depositing waste products (guano, droppings, indigestible/waste parts of prey etc.); sources of water which transfer carbon, nutrients and organisms from the hinterland. The sources of organic material relevant to each of the CHZ in provided in Table 4.4.

Availability of water: The dependence of aquatic habitats on water availability is obvious, however, in addition to the medium it provides to host aquatic species within subterranean environments, it also provides a mechanism for the transport of organic material from the surface. Therefore the large water bodies and associated aquatic species are dependent on particulate organic material and dissolved organic material carried through groundwater flows, whilst perched ponds, pools and hygropetric (thin layers of water moving over vertical rock faces) habitats and associated species rely on dissolved organic matter from percolation waters for sustenance.

Connectivity with the wider karst system and surface inputs: Connectivity is a key attribute to the development and maintenance of cave ecosystems, both in the movement of organisms from different habitats within the karst system but also the transport of the nutrients, carbon and water through the various levels and formations within the rock. The composition of terrestrial and aquatic cave ecosystems will be largely dependent on the extent of the connection to the wider karst area where such organisms also exist. The scale and extent of the “reservoirs “of terrestrial and aquatic organisms that therefore populate the Ombla system may differ due to the nature of the dry and wet connections to the wider Dinaric karst. For caves with habitats dependent on connections from surface inputs by percolation and inputs from sinking streams, percolation is quantitatively less important for terrestrial cave habitats (i.e. it cannot sustain the volume of water required for aquatic habitats), but qualitatively more important (Culver and Pipan, 2009) because in the absence of trogliophilic species such as bats this water may also be the only source of organic inputs that are required to sustain life. The nature of connectivity relevant to the different CHZs is identified in Table 4.4.

Table 4.4: Summary Description of Cave Habitat Zones (CHZ), Location and Community Diversity, Endemism and Supporting Habitat Attributes

Zone	Habitat Code , Name & Characteristic Species Recorded*	Location in Cave System	Number Species	Endemic to South Dinaric	Unique to Ombla	New Species	Red List Species	Key Habitat Attributes
CHZ1 - Higher Cave Entrance Halls	H.1.1.1. Half caves and entrance (daylight) parts of caves : ***Hypena* sp.**, ***Amphipyra effusa, Dolichopoda araneiformis***	Day lit part of Vilina Cave	***3***	***0***	***0***		***0***	Fauna of low diversity and low endemism, characterised by species not specifically adapted to live in cave habitats.
	H.1.1.2. Dry fossil caves: ***Dinaromys bogdanovi***	Entrance part of Vilina Cave	***4***	***0***	***0***		***0***	
CHZ2 - Higher Cave Channel to High Hall	H.1.1.3. Caves and cave systems with sub troglophilic vertebrates: **Chiroptera**		**5**	**0**	**0**	**0**	**5**	Cave fauna of high diversity and high endemism characterised by bats and a range of invertebrate species either entirely dependent or partially dependent on the cave habitats to complete their lifecycle. Key supporting attributes include: ▪ The input of organic matter by bats as a food resource (guano and associated fungi and bacteria communities**)**. ▪ Stable microclimatic conditions (Ave Temp 15.4°C, ≤100% RH) ▪ Darkness, no disturbance ▪ Niche habitats provided by fractures, crevices boulders, speloethems ▪ Connectivity with wider Southern Dinaric Karst through terrestrial fossil cave system (fossil dissolution conduits and fractures) are not limited to the hydrogeological catchment.
	H.1.1.4. Caves and cave systems with sub troglobiont invertebrates, type 1: ***Typhlogastrura topali*, Isopoda: nov. gen. nov. sp., *Bathyscidius tristiculus fallaciosus*, *Histopona dubia*, *Sulcia* sp. nov i *Tychobythinus neumanni, Pholeoteras euthryx***	Vilina Cave entrance until High Hall	***12***	***5***	***2***		***4***	
	H.1.1.5. Caves with troglophilic invertebrates, type 1: ***Lithobius* sp. 1, *Trichoniscus matulici matulici*, *Amphipyra effusa*, *Roncus* sp. nov.1, *Chthonius subterraneus, Chthonius* sp. nov., *Nelima troglodytes***		***20***	***4***	***4***	***4***	***0***	
CHZ3 - Higher and Middle Level Terrestrial Caves	H.1.1.4. Caves and cave systems with sub troglobiont invertebrates, type 2: ***Belba gratiosa*, *Neotrechus suturalis otiosus*, *Antroherpon apfelbecki apfelbecki*, *Speonesiotes narentinus latitartis*, *Verhoeffiella media*, *Neelus* cf. *klisurensis*, *Archaphorura* sp. nov., *Plusiocampa remy*, *P.* sp. nov., *Cyphonethes herzegowinensis*, *Cyphoniscellus herzegowinensis*, *Travunia anophthalma*, *Eukoenenia* cf. *remyi*, *Stalagtia hercegovinensis***	Upper level: Coral, Main, East and West channel,	***18***	***6***	***3***	***3***	***2***	Cave fauna of high diversity and high endemism characterised by a range of invertebrate species either entirely dependent or partially dependent on the cave habitats to complete their lifecycle. The input of organic matter is a limiting factor in this environment. ▪ Limited organic inputs from seepage or rare/infrequent deposition of guano or feacal matter from non obligate cave species. ▪ A diverse range of niche habitats provided by karst morphological features such as fractures, crevices boulders, speloethems, ponded water and finer sediment deposits. ▪ Darkness, no disturbance. ▪ Stable microclimatic conditions (Ave Temp varying by location 14.8°C – 15.6 °C, ≤100% RH) ▪ Continued seepage and natural connections with adjacent karst habitats ▪ Connectivity with wider Southern Dinaric Karst through terrestrial fossil cave system (fossil dissolution conduits and fractures) are not limited to the hydrogeological catchment. The movement of terrestrial species within the southern Dinaric karst is multi directional and potentially unlimited provided open connections exist beyond the explored extent of the Ombla system. ▪ Hydgropetric zone dependent on seepage and morphological conditions that provide a thin film of laminar flow over cave surfaces which can contain microscopic organisms.
	H.1.1.5. Caves with troglophilic invertebrates, type 2: ***Nesticus eremita*, *Folsomia candida*, *Arrhopalites caecus***	Middle level; Dry parts of lowest level with all lateral channels	***12***	***0***	***0***	***0***	***0***	
	H.1.2.1.1. Hygropetric	Upper level: Main channel			0			
	H.1.3.2.2. Stone pools: ***Niphargus* sp. *Eukoenenia* cf. *remyi, Neelus* cf. *klisurensis*, *Archaphorura* sp. nov.**	Water pools in Upper level: Coral, Main, East and West channel	4	2	1	1	0	
	H.1.3.2.3. Clay pools: ***Niphargus* sp. *Eukoenenia* cf. *remyi*, *Neelus* cf. *klisurensis*, *Archaphorura* sp. nov.**	Middle level; Dry parts of lowest level with all lateral channels	4	2	1	1	0	
	H.3.1.1. Interstitial terrestrial habitats	All terrestrial cave parts			Unknown			
	H.4.1.1. Mines and underground passages: ***Plusiocampa remy***	Tunnels	***5***	***1***			***1***	

Zone	Habitat Code , Name & Characteristic Species Recorded*	Location in Cave System	Number Species	Endemic to South Dinaric	Unique to Ombla	New Species	Red List Species	Key Habitat Attributes
CHZ4 - Still Water Aquatic Zone	H.1.3.1. Underground streams – type 2 *(mixed H.1.3.1. and H.1.3.2.):* ***Troglocaris pretneri*, *T. hercegovinensis*, *T. anophthalmus*, *Niphargus balcanicus*, *N. vjetrenicensis*, *N. trullipes*, *N. steueri kolombatovici*, *N. salonitanus*, *Typhlogammarus mrazeki*, *Hadzia fragilis*, *Monolistra hercegoviniensis ornata*, *Sphaeromides virei* cf. *montenegrina*, *Prostoma cf. hercegovinense***	Spring cave, Siphon in West cavern and Deep lake in the Great Hall	*29*	*15*	*0*	*0*	*14*	Aquatic cave fauna of high diversity and high endemism characterised by a range of invertebrate species either entirely dependent or partially dependent on the still or slow flowing aquatic cave habitats to complete their lifecycle. The invertebrate community is a mix of "drift" species carried to the still water environments from the wider catchment BiH and species that have formed resident populations. Key supporting attributes include: ▪ Water quality and the existing natural flow regime ▪ Connectivity limited to the Ombla hydrogeological catchment in BiH, with movement of species being unidirectional reliant on drift from the hinterland. ▪ Natural morphology of the cave system and associated niche habitats; boulders, fractures, crevices, sediment.
	H.3.2.1. Interstitial water habitats: ***Proasellus anophthalmus rhausinus***	Spring cave and Deep lake in Great Hall	***2***	***0***	***0***	***0***	***0***	
CHZ5 - High Flow Aquatic Zone	H.1.3.1. Underground streams – type 1 (classical)	Main water channel			Unknown			The presence of any faunal community within the main water channel in the zone between 30- 130 m below sea level cannot be confirmed. The high flows observed from borehole observations and modelling make the present of free swimming species unlikely. However, the channel is likely to be an important connection point between the water bodies in the Great Hall and the Spring Cave, transferring species to the Spring Cave by drift.

* Other species recorded within these habitat types are presented in Appendix B.

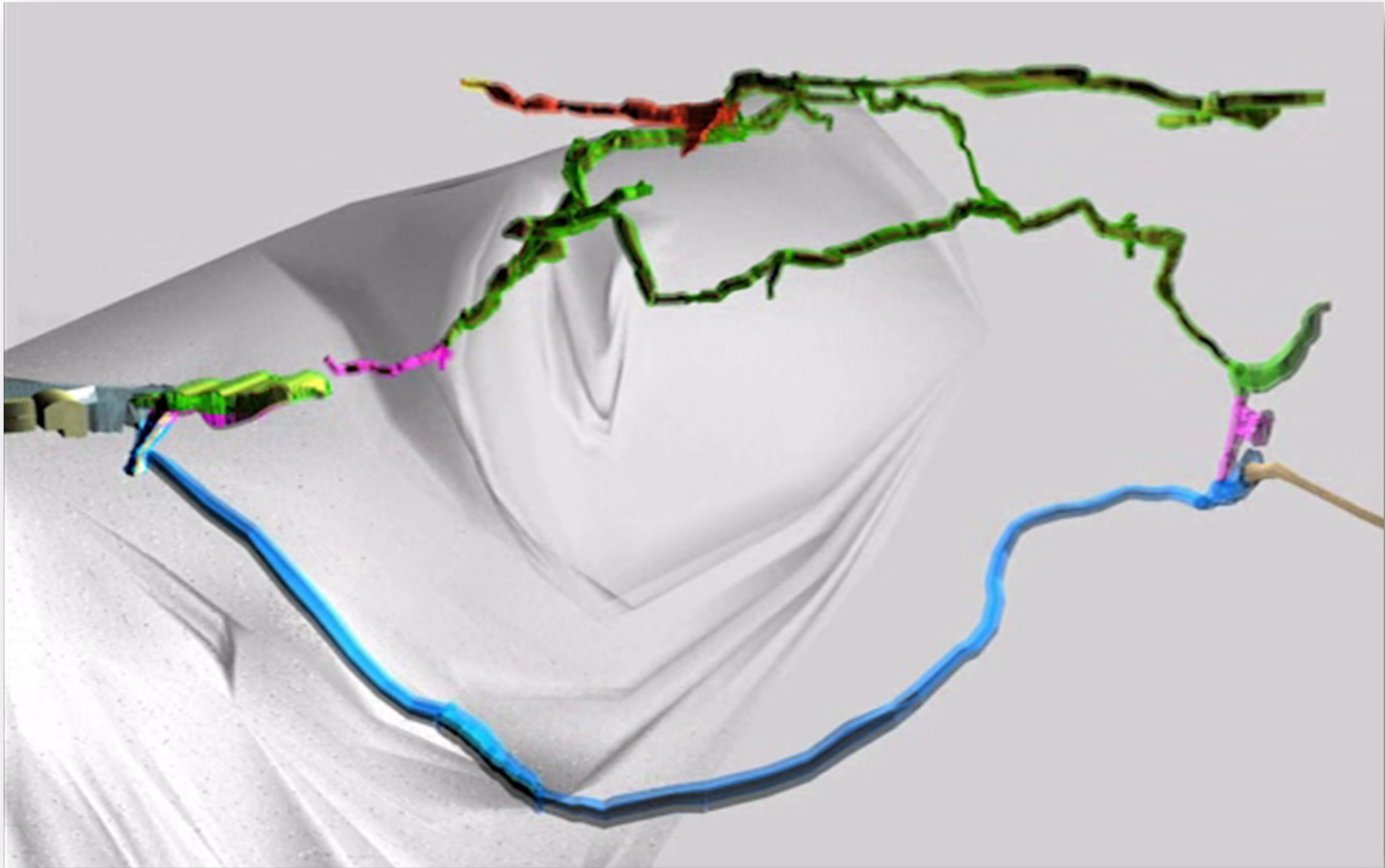


Figure 4.1: Cave Habitat Zones (CHZ) within the Ombla Cave System (Looking from the east within the limestone rock structure)

Key: Dark Green - CHZ1, Red - CHZ2, Light Green - CHZ3, Light Blue - CHZ4, Dark Blue - CHZ5

4.1.2.2 Fish

The Ombla cave system and spring provide limited support for fish species. The surveys carried out by the Croatian Ichthylogical Society in 2012 (Mrakovčić et al., 2012) upstream of the weir which separates the freshwater areas of the Ombla River and underwater lakes within the caves from salt water of the Dubrovacka River recorded two species of fish: Popovo minnow *Delminichthys ghetaldii* and eel *Anguila anguila*. Eel, although a protected species, are not reliant on any part of the Ombla system as key habitat. The Popovo minnow has been recorded within the Spring Cave and the Great Lake, however the poor condition of these fish indicates that these individuals are likely to have been washed through from the Popovo Polje in BiH. Due to the nature of how water flows through the Ombla cave system it is considered very likely that these fish are not able to return to the main population (Mrakovčić et al., 2012). The Ombla system does not provide them with breeding habitat and so they will be lost to the Popovo polje population and unable to create an isolated/self sustaining population within the Ombla system. Because there is no sustained fish population within the Ombla system, the population of the Popovo minnow are unlikely to be affected by any works and are therefore not considered to be affected by changes resulting from the Ombla HPP.

4.1.3 Bats

4.1.3.1 Population Dynamics and Ecology

All five bat species listed as reasons for designation of the proposed SCI have been recorded using Vilina Cave in Summer. Maternity colonies of all five species have been recorded in surveys undertaken between 1999 to 2012, including pregnant females of Screibers' bat *Min. schreibersii*, females with juveniles of Lesser mouse-eared bat *Myotis blythii*, greater horseshoe *Rhinolophus ferrumequinum* and and both pregnant and females with juveniles of Geoffrey's bat *M. emarginatus*, and Mediterranean horseshoe *Rh. euryale*.

In the winter period three of these species have been recorded: greater horseshoe, Screibers' bat and Mediterranean horseshoe (the latter species recorded in late March; the period immediately after the end of hibernation). All five species use the cave in Spring and Schreibers' bat, lesser mouse-eared bat, and greater horseshoe bats have been recorded in Autumn. The cave is recorded as a mating site of Schreibers' and lesser mouse-eared bat.

The habitat requirements and conservation status of each species of bat are described in Section 3.2.3. In summary, all species roost in underground sites including caves and abandoned buildings, but have slightly varying foraging resource preferences including open woodland and forests and/or grassland habitats and scrub. The Geoffreys' bat forages over or near water, and the Mediterranean horseshoe avoids coniferous forests.

The presence and abundance of all five species of bat during each life-cycle stage of the year is presented in Table 4.5, and summarised below.

Schreibers' bat *Miniopterus schreibersii*

Surveys of the Vilina Cave in 2012 identified more than 42 individuals of this species, 15 in March, >25 in May and two in June. Based on surveys between 1997 and 2007, the University of Zagreb identified an average of up to 1 individual of this species using the cave in winter and more than 50 using it in spring. The population using the cave is estimated to be 2% of the Croatian population of the species.

Lesser mouse-eared bat *Myotis blythii*

Surveys of the Vilina Cave in 2012 identified more than 270 individuals of this species, 90 in May and >180 in June. Based on surveys between 1997 and 2007, the University of Zagreb identified an average of up to 100 individuals of this species using the cave in spring, 220 using it in summer, and 60 using it in autumn. The population using the cave is estimated to be 2% of the Croatian population of the species.

Geoffrey's bat *Myotis emarginatus*

Surveys of the Vilina Cave in 2012 identified more than 805 individuals of this species, >685 in May and >120 in June. Based on surveys between 1997 and 2007, the University of Zagreb identified an average of 70 individuals of this species using the cave in spring and 450 using it in summer. The population using the cave is estimated to be 2% to 5% of the Croatian population of the species.

Mediterranean horseshoe bat *Rhinolophus euryale*

Surveys of the Vilina Cave in 2012 identified more than 185 individuals of this species, >15 in March, >100 in May and >70 in June. Based on surveys between 1997 and 2007, the University of Zagreb identified an average of 80 individuals of this species using the cave in spring and 200 using it in summer. The population using the cave is estimated to be 2% to 5% of the Croatian population of the species.

Greater horseshoe bat *Rhinolophus ferrumequinum*

Surveys of the Vilina Cave in 2012 only identified approximately two individuals of this species, >2 in May. Greater numbers of this species have been recorded previously in later months of the year. Based on surveys between 1997 and 2007, the University of Zagreb identified an average of 20 individuals of this species using the cave in summer, 150 using it in autumn and up to five using it in winter. The population using the cave is estimated to be 2% of the Croatian population of the species.

Table 4.5: Populations of Proposed Paleoombla-Ombla SCI Bat Interest Features in Vilina Cave System Based on Surveys Carried out between 1997 and 2012

Bat Species		Spring (March - May)	Summer (Maternity) (May - August)	Autumn (August - November)	Winter (Hibernation) (November - March)	Max. Abundance of Adult Individuals	Proportion of Croatian Population
1	Schreibers' Bat	> 50 [1] > 25 [2]	+[1] ~ 50 M [3] 2 [2]	+ [4]	0-1 [1] > 15 [2]	>50	≤2
2	Lesser mouse-eared bat	100 [1] > 90 [2]	220 M [1] ~130 [3] > 180 [2]	60 [1]	-[2]	200-250	≤2
3	Geoffrey's bat	70 [1] > 685 [2]	450 M [1] ~300 M[3] > 120 M [2]		- [2]	600 -700	2 to 5%
4	Mediterranean horseshoe bat	80 [1] > 100 [2]	200 M [1, 3] > 70 M [2]		> 15 [2]	200 -250	2 to 5%
5	Greater horseshoe bat	+[1] > 2 [2]	20 M [1] ~10 [3]	150 [1]	0-5 H [1]	150-200	≤2

Legend: 1 - Research conducted by University of Zagreb, 2008 (based on surveys from 1997 to 2007), 2 - Oikon Ltd 2012 (based on surveys in March, May and June 2012); 3 Ministry of Culture and SINP (Hamidović 2009); 4 Pavlinić et al. 2010. M-maternity colonies, H-hibernation colonies, +Species present.

4.1.3.2 Distribution of Bats and Associated Habitat Conditions Within the Vilina Cave System

Roost selection by bats depends on a number of different factors including: microclimate, light intensity, safety from predators [and levels of disturbance], proximity to foraging areas and takeoff height (Gaur 1980; Hill and Smith 1984; Kunz 1982; McCracken 1989; Morrison 1980; Tuttle and Stevenson 1981).

Microclimate: Temperatures measured in June 2009 and May and June 2012 in different locations in Vilina Cave varied between 15.9°C and 19.3°C and relative humidity was 73.8% – 95.0% (Hamidović 2009, Oikon 2012). This corresponds to literature data for maternity and summer roosts of interest species (Niethammer and Krapp 2001, 2004). In winter, only a small number of individuals of three bat species have been recorded. Mrakovčić et al. 2008 noted that Vilina Cave is not an important hibernation site, since the temperature is too high for hibernation, unless bats use deeper parts of the cave.

The higher passages of the Vilina Cave are not subject to flooding, but the microclimate is influenced by seepage of rainwater likely to result in increased humidity.

Light intensity: The Vilina Cave system entrance is generally subject to low light levels with half-lit and sun sheltered pockets. Complete darkness is found further into the cave system. Being situated in a protected area, the surrounding area is subject to minimal light-spill.

Light pollution might influence species through habitat disturbance, changing of behaviour, and in some cases on survival if intervening with crucial steps in the life cycles of species. In particular for bats, at least three main areas can be identified as having a possible influence on populations:

- (In)direct effects on maternity colonies, hibernation sites and roosts
- Effects on commuting e.g. barrier function of lit roads and fragmentation of the night landscape.
- Interaction with feeding activity, including prey distribution and intra-bat species competition

Light has been proven to have a negative effect of the activity of several bat species (EUROBATS, 2008).

Safety from predators/levels of disturbance: Roosting bats are vulnerable to predation; the Vilina Cave system provides good protection from predation, particularly as it is subject to very dark conditions. The entrance to the cave system used by bats is on a cliff face 138m above ground level, deterring mammal predators. Bat maternity and hibernation sites are particularly vulnerable to disturbance; current conditions are subject to very low levels of disturbance.

Proximity to foraging areas: Bats regularly travel up to 10km from their roost sites to forage (Hundt, 2012), often using linear habitat corridors or landscape features to navigate. Sources of freshwater and areas of open water often provide valuable feeding habitat, particularly where they support insect prey. The surrounding landscape is largely rural and comprises a wide variety of habitat types suitable for use as foraging resources.

Patterns of distribution: The upper levels of the Vilina Cave system can be split into three Bat Usage Zones (BUZs) according to variations in environmental conditions, distribution, roost types, seasonal use, the abundance and the range of bat species they support. These zones are listed below, illustrated in Figure 4.2 and referenced in Table 4.6:

- BUZ 1 (First Hall and Second Hall) - spring and summer use and mixed maternity colonies
- BUZ 2 (Second Hall to High Hall) - main area; bats inhabit deeper cave environments with greater use in spring and summer by all species, and larger maternity colonies
- BUZ3 (Low Hall – Milky Lake-Entrance from the High Hall to Coral Channel) - spring and summer use by a lower abundance and number of species

Table 4.6 provides a summary of the distribution of bats within the Vilina Cave system, and the environmental conditions associated with each BUZ. The distribution of bat fauna is based on surveys undertaken in the spring and summer period only.

Through the year the bats have been recorded as using the following locations:

- Winter (March) – up to 150m from the cave entrance.
- Spring - the majority of the cave through to 400m from the cave entrance.
- Summer - the majority of the cave up to the entrance of the coral channel with the majority of the maternity roosts found between the First Hall and the High Hall location (and up to 200m from the cave entrance).

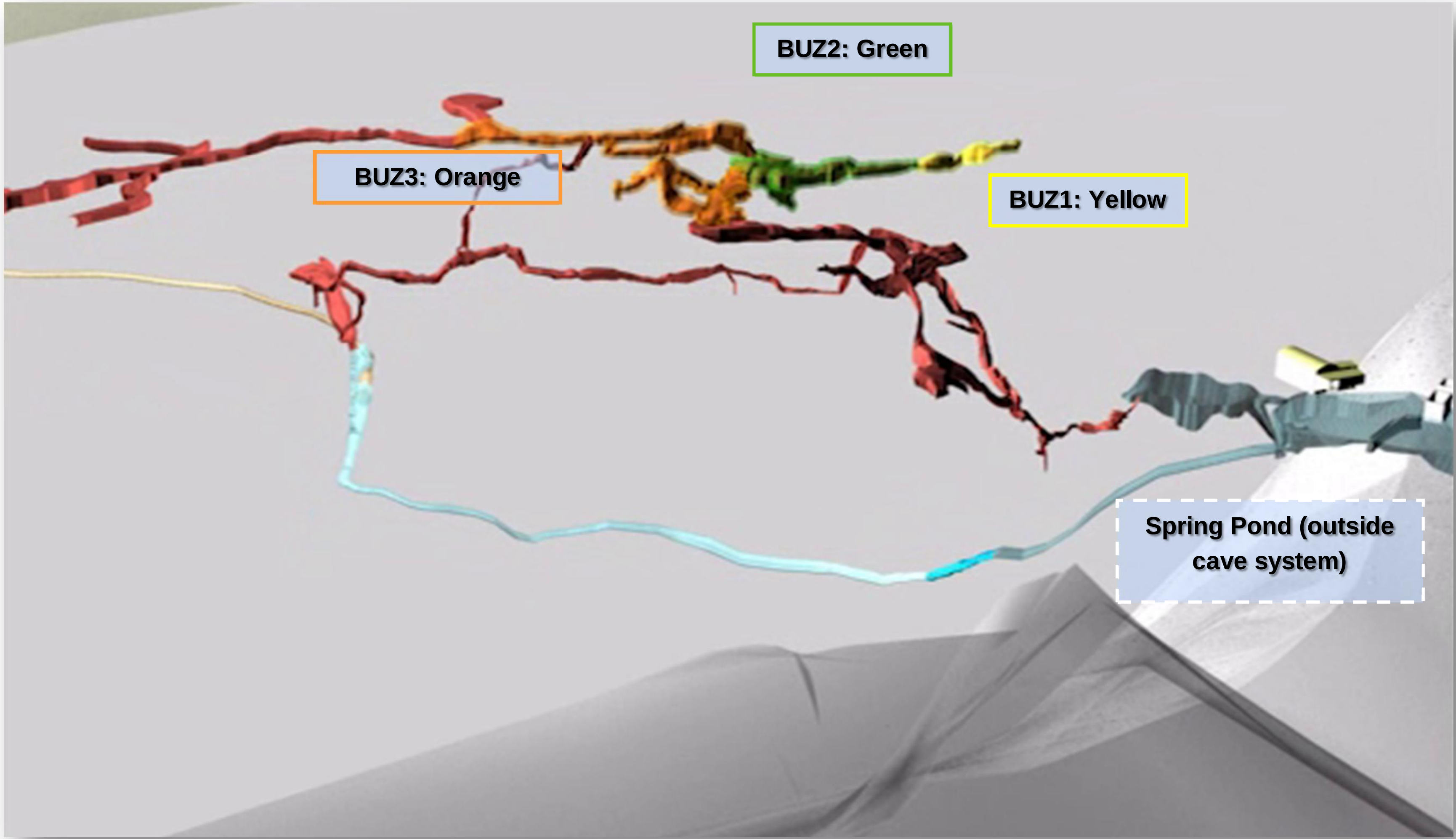


Figure 4.2: 3D Model Visualisation of Bat Usage Zones (BUZs) in the Vilina Cave System in Which Roosting Bats Have Been Recorded and Differentiation between the Zones of the Cave System (Vilina Cave and Middle Caves shown in Red; Aqatic Caves shown in Blue).

Table 4.6: Summary Distribution of SCI Bat Interest Features in the Vilina Cave System and Key Environmental Attributes

Bat Usage Zone Species and Usage	Key Environmental Attributes
BUZ1 (Approximate Passage Length 60m) **Spring** - Small numbers of Greater horseshoe bat*;* Mediterranean horseshoe bat*;* Schreibers' bat; and lesser mouse-eared bat *(*In March 2012, Mediterranean horseshoe bat and Schreibers' bat were found within the first 150m of the cave). **Summer** - Small numbers of Greater horseshoe bat (also within the cave)*;* Mediterranean horseshoe bat; Geoffrey's bat; and lesser mouse-eared bat (individually and in a small colony), and mixed maternity colonies of: a) lesser mouse-eared bat*;* Schreibers' bat*;* and Geoffrey's bat*,* and b) *Rhinolophus sp.*, lesser mouse-eared bat and Geoffrey's bat. Schreibers' bat also reported individually within first 200m.	Extent of suitable roosting habitat Subject to some fluctuations in temperature/air movement and humidity depending on external climatic/weather conditions. Proximity to standing water (Spring Pond – Zone 4) Easy access to foraging resources of surrounding countryside (requires less energy to exit roost). Proximity to cave mouth enables bats to light-sample. External temperate affects the range of cave temperatures; temperatures measured at two points in this zone of the cave system in 2012 fluctuated from 15.4°C in March to 17.5°C in June. Relative humidity 73.8 – 95.0% (Hamidović 2009, Oikon 2012).
BUZ2 (Approximate Passage Length 150m) **Spring** - Small numbers of Mediterranean horseshoe bat and Schreibers bat. A mixed colony of a) *Rhinolophus* sp., Schreibers' bat, lesser mouse-eared bat and Geoffrey's bat and b) *Rhinolophus* sp. and Geoffrey's bat. Mixed colonies of pregnant females of Mediterranean horseshoe bat and Geoffrey's bat and individuals of Schreibers bat were found in small numbers in late spring (up to 180m from the entrance).**Summer** - Maternity colonies of: a) Mediterranean horseshoe bat Greater horseshoe bat, Geoffrey's bat and lesser mouse-eared bat in the first 180m of the cave; b) Mediterranean horseshoe bat and c) Geoffrey's bat (with individuals of lesser mouse-eared batand pregnant females of Schreibers bat near and in the colony); d) mixed maternity colony of *Rhinolophus* sp., Geoffrey's bat, lesser mouse-eared bat and Schreibers' bat. Separate colonies of lesser mouse-eared bat, *Rhinolophus* sp. and Schreibers bat were also recorded.	Extent of suitable roosting habitat Stable temperatures (of indicative range 15.4°C in March to 15.7°C in June. Relative humidity varied from 73.8 – 95.0% (Hamidović 2009, Oikon 2012). Proximity to standing water (Spring Pond – Zone 4) Easy access to foraging resources of surrounding countryside (requires less energy to exit roost).
BUZ3 (Approximate Passage Length 350m) **Spring** - Individuals of Mediterranean horseshoe bat and two colonies of Geoffrey's bat were reported deep into the cave system. **Summer** - Colonies of Mediterranean horseshoe bat and Geoffrey's bat reported.	Cooler, darker, more stable conditions Directly connected to lower, wetter channels.

All three zones of the upper cave system are used by bats in spring; BUZ2 supported the highest species diversity and greater numbers in 2012. The cave system is an important maternity roost, suitable for maternity colonies of all five SCI bat interest features. All BUZs supported maternity colonies of bats during the summer months of 2012, with BUZ2 appearing to support the greatest number of colonies.

4.1.3.3 Above-Ground Habitat Conditions and Foraging/Roosting Resources Nearby

The habitats immediately adjacent to the cave entrance are open freshwater habitats, sub-Mediterranean and epi-Mediterranean dry meadows, rocky pastures and grasslands and cultivated habitat mosaics. The surrounding landscape is dominated by the same habitat types with patches of mixed woodland. This provides all of the SCI bat interest features with extensive areas of suitable foraging resources, and is likely to support a wide range and high numbers of invertebrate species. As such, the assemblage of bats roosting in the Vilina Cave system is unlikely to be dependent on the terrestrial habitats immediately surrounding the cave entrance for foraging, and the limiting ecological resource for population expansion is likely to be roost sites.

In research undertaken by the Croatian Natural History Museum, the University of Zagreb, and Hamidović (2009), a total of 21 potential roost sites (caves) in the wider Dubrovnik area have been explored and interest features of the SCI have been found. In the wider Dubrovnik area there are a total of 9 sites that are known to provide roosting habitat for the bat interest features of the SCI; notable sites include Rafova špilja, Glogova jama and Tunnels 1 and 3 near the village of Mihanići. Sites and species recorded in the wider Dubrovnik area are listed in Table 4.7.

Table 4.7: Roost Sites and the Species They Support in the Landscape Surrounding the Vilina Cave System

Site	Species	Roost Type
Jama za Gromačkom Vla-kom*	Greater horseshoe bat	Winter and spring roost [4]
Močiljska špilja	Greater horseshoe bat	Hibernation roost [4]
Glogova jama	Lesser mouse-eared bat	Autumn roost [4] >40 in hibernation and spring roost [1]
Kuna	Lesser mouse-eared bat	Species present[1]
Aragonka	Greater horseshoe bat	Summer roost[1]
Tunnel 1 near the village of Mihanići	Greater horseshoe bat	~ 300 Maternity colony [3]
	Mediterranean horseshoe bat	
	Schreibers' bat	~ 50 Maternity colony [3]
	Geoffrey's bat	~ 50 Maternity colony [3]
	Lesser mouse-eared bat	Summer roost [3]
Tunnel 3 near the village of Mihanići	Greater horseshoe bat	~ 450 Maternity colony [3]
	Mediterranean horseshoe bat	
	Schreibers' bat	~ 450 Maternity colony [3]
	Geoffrey's bat	~ 1400 Maternity colony [3]
	Lesser mouse-eared bat	Summer roost [3]
Dubravka (abandoned house)	Geoffrey's bat	Summer roost [4]
	Greater horseshoe bat	Summer roost [4]
Rafova špilja	Geoffrey's bat	< 150 Maternity colony [1]
	Greater horseshoe bat	<150 Maternity colony [1] & 60 Maternity colony [3]
	Mediterranean horseshoe bat [a]	Summer roost [1]

* other cave sites located in Ombla-Paleoombla SCI

Legend: 1 - Research conducted by University of Zagreb, 2008 (based on surveys from 1997 to 2007), 2 - Oikon Ltd 2012 (based on surveys in March, May and June 2012); 3 Ministry of Culture and SINP (Hamidović 2009); 4 Pavlinić et al. 2010. M-maternity colonies, H-hibernation colonies, +Species present.

4.1.3.4 Summary

In the context of the Dubrovnik area, the Vilina Cave system is an important maternity roost, used by maternity colonies of all five interest species and is listed as an Internationally Important Underground Site for Bats. Temperatures and humidity measured in 2009 and 2012 throughout the upper sections of the Vilina Cave system corresponds to published literature describing suitable maternity and summer roost conditions of the interest species (Niethammer and Krapp 2001, 2004). Other cave sites located in Ombla-Paleoombla SCI are of lesser value for bats, they are the Gromačka Cave, where greater horseshoe bats have been recorded in winter and spring and the Močiljska cave which was historically known to host a maternity colony of Mediterranean horseshoe bats before the cave entrance was gated and shut. Vilina Cave is estimated to support up to 2% of the Croatian population of greater horseshoe, Shreiber's and lesser mouse eared bat, and between 2 and 5% of the Croatian population of Mediterranean horseshoe and Geoffroy's bat. The cave provides support for the greatest number of these species in wider area.

Only a small number of individuals of three interest species have been recorded in the cave system in the winter period. Mrakovčić et al. (2008) noted that the Vilina Cave is not an important hibernation site, since the temperature is too high for hibernation; it is not possible to conclusively state that bats do not use deeper parts of the cave system. It is considered unlikely that the cave is a significant roost site for hibernation colonies, however, the cave could be used by a number bats species through the winter months, most likely to occur if the prevailing weather is warm and a food source is available.

The habitats in the surrounding landscape provide optimal foraging resources for all interest species of bats roosting within the Vilina Cave system.

4.2 Discussion of Evidence Base for SCI Interest Features

The Habitats Directive Assessment allows the assessor to reach three possible conclusions:

1. It is possible to conclude the project will not have a significant effect/adverse effect on site integrity

2. It is possible to conclude that the project will have a significant effects/adverse effect on site integrity

3. Due to uncertainty it is not possible to conclude the project will not have a significant effect/adverse effect on site integrity

The status and condition of the interest features of the SCI required to inform an assessment of impacts against the conservation objectives, is described as far as possible in Section 4.1. Where known gaps in this information exist, these are identified and discussed below. If insufficient information is available to conclude that the project will or will not have a significant effect and a subsequent adverse effect on site integrity, it will not be possible for the assessor to conclude that the project will not have a likely significant effect / adverse effect in site integrity.

4.2.1 Caves Not Open to the Public

4.2.1.1 Speleology and Cave Fauna

Extensive survey and assessment of the Ombla SCI cave system and the habitats and species it supports has been carried out over a number of years, including three separate surveys in 2012. Research into cave invertebrate fauna in the Ombla cave system started at the beginning of the 20th Century. The most important research has been carried out in the period between 1998 and 2011, with intensive work also undertaken in 2012 specifically for this assessment. Surveys undertaken between 1998 and 2011 by CBS recorded a total of 41 species. The survey effort in 2012 recorded 105 of the total species recorded (not including bats or fish) for the site. A total of 45 species of previously recorded fauna were not recorded in 2012. The main feeder canal was not surveyed in 2012 due to high water levels and flows, and surveys of the caves deeper than 42m have not been undertaken. The high flow velocities in the deeper channel are likely to preclude the use of this habitat by most if not all fauna.

Although no study can fully identify and map all components of an ecosystem, and surveys represent a snapshot in time only, good understanding of the geology and hydrology of the wider area, recording of micro-climatic conditions throughout the known Vilina Cave system, and extensive ecology data collected throughout the cave system are considered likely to provide sufficient information for an assessment of impacts against the conservation objectives of the feature. However, very deep and fast-flowing waters of the lower tunnels prohibited full investigation in 2012, and surveys of the system deeper than previously explored sections of the Vilina cave and Vilina-Ombla system have not been undertaken due to security reasons. It should be noted that:

Scientific understanding of the ecology of subterranean fauna is limited by a number of factors:

- Access to subterranean environments is limited by the physical constraints such environments place on surveys, sampling and census techniques and research efforts – i.e. in many cases research is limited to caves where direct human access is readily available, whilst survey effort is inherently more labour and cost intensive than in easily accessible environments;
- The widely dispersed nature and low abundance of fauna within cave environments, limits the ability of scientists and researchers to accurately define population size and distribution;
- The “cryptic” nature of species physiology and morphology also leads to inherent uncertainties over whether two morphologically different individuals are the same species or conversely whether morphologically similar species have distinct differences when DNA testing is undertaken;
- The life cycle of many species of invertebrate cave fauna is poorly understood.

Culver and Sket (2000) state that *“Understanding patterns of subterranean biodiversity requires an understanding of regional patterns. In general, the number of species found in any one cave or subsurface site is small relative to the number of species in the region.”* In relation to Ombla, this understanding and the factors referred to above lead to inherent uncertainties over the importance of the site for individual species. The following issues are of particular note:

- In context, species (particularly aquatic cave taxa e.g. *Niphargus vjetrenicensis*) where Ombla is cited as the only known record in Croatia are unlikely to be found outside of the local vicinity of Ombla due to the narrow political (National) boundary that divides Croatia from BiH. BiH hosts the vast majority of the catchment and Ombla acts as the terminal point for this catchment area. Consequently the population of such species is largely dependent on the aquatic subterranean environment within the wider catchment. Ombla acts as the final collecting point of these species, hence the diverse natura of the aquatic cave fauna recorded.
- The cryptic nature of subterranean endemic invertebrates and discovery of new morphologically different specimens leads to inherent uncertainties over the accuracy of historic records of species. For instance the IUCN lists Horatio knorri and Orientalina troglobia as pseudonyms (requiring review) of Pseudamnicola troglobia, a species of aquatic snail. Both *Horatio knorri and Orientalina troglobia* are listed as species recorded only in the Ombla system. However *Pseudamnicola troglobia* is considered to be stable and widely found in the Popovo Polje in BiH and of Least Concern by the IUCN.
- Therefore, on the basis of present scientific understanding, it cannot be conclusively stated that Ombla is the only site that supports a particularly species, but that it is the only known recorded location. It is highly likely that such species (or genetically closely related species) will be present to a greater or lesser extent in the fossil caves that connect the wider karst limestone massif or the hydrogeological catchment that supplies Ombla with drift species of aquatic fauna.

In this context, it is the diversity that the structure and function of the Ombla system cave habitat that qualifies under the Caves not open to the public feature, not the presence or record of any one given species, and it is the structure and function of the habitat that is the focus of the Conservation Objectives of the proposed SCI i.e. it is the supporting habitat conditions which are subject to management and assessment under a precautionary principle, not per se the individual species. By taking this approach the protection of the endemic species that use these habitats is ensured, by conserving the conditions that support these species.

4.2.2 Bats

Surveys of the upper cave system during the ‘active season’ (between March and September) have been undertaken up to 200m from the cave entrance in 2012. Surveys have not been undertaken in the middle winter period and although incidental observations of winter use of the cave by bats has been made in previous years, the use of the deeper parts of the cave in winter is not clear. Mrakovčić et al. (2008) researched Vilina Cave in

January 2002 and reported individual specimens of four species. It is mentioned that the number might be greater (some individuals might be hidden in crevices) and that bats might be in deeper parts of the cave. Based on the information obtained on micro-climatic conditions, fluctuations in temperature and humidity, the known distribution and use of the cave by bats, it has been concluded that Vilina Cave is unlikely to be important for bat hibernation. However, the possibility that significant bat colonies use the Ombla cave system during winter cannot be disregarded, especially during warmer winters.

According to the data available, data-loggers for microclimate measurements were not set in the cave. Microclimate was measured by pocket weather meters in 2009 and 2012 (Hamidović 2009 and Oikon report 2012). This however does not provide sufficient data on the average microclimate conditions in the cave, which is necessary for future monitoring.

There is no data on swarming during the breeding season at the Vilina Cave site, bat species foraging areas and flyways in the Ombla area as this research has not been undertaken. However, as the cave is used by bat colonies in autumn, it can be concluded that swarming may occur. It is also assumed that the surrounding landscape provides a variety of suitable foraging resources for all important species roosting in the cave system. Colonies of bats have been recorded in other underground habitats in the wider Dubrovnik area.

Research into the connectivity between Vilina Cave bat populations and populations from other caves in the area has not been undertaken and alternative roosts can only be speculated. Connection of bats from Vilina and Rafova cave is likely and Rafova cave might represent alternative roost. However due to its morphology and location in touristic attractive area, it is subjected to disturbance and a decrease of bat numbers in the cave has already been recorded. (Mrakovčić et al. 2008).

5 Assessment of Likely Significant Effects

5.1 Background and Method

The Habitats Directive (Article 6) requires an assessment to determine whether a plan or project is 'likely to have a significant effect thereon, either individually or in combination with other plans or projects'. To inform this assessment, it is necessary to explore what sorts of effects are covered ('significant effect') and what sorts of causes are likely to create such effects ('likely to have … either individually or in combination').

The conservation objectives of a site and a clear understanding of the baseline information are important in identifying the sensitivity and vulnerability of the designated features of the Natura 2000 site to change. Where a project is likely to undermine the site's conservation objectives, it must be considered likely to have a significant effect on the site. The assessment of that risk must be made in the light, inter alia, of the characteristics and specific environmental conditions of the site concerned. An effect that would undermine the conservation objectives would be a significant effect and the likelihood of it occurring is a case-by-case judgement, taking account of the precautionary principle and the local circumstances of the site.

The Habitats Directive identifies a range of factors that may contribute to a likely significant effect. These factors include: the size of a project; the production of waste; pollution and nuisances; the risk of accidents; existing land use; the relative abundance, quality and regenerative capacity of natural resources in the area; the absorption capacity of the natural environment, with particular attention to natural areas and sites classified or protected under the Directive; the extent of the potential impact; the magnitude and complexity of the impact; the probability of the impact; the duration, frequency and reversibility of the impact (EC, 2000).

In order to check for the likelihood of significant effects requires consideration of the potential causes and the potential effects. We have considered the causes of potential effects by identifying changes brought about by the construction and operation of the scheme (the effects) and assessing whether those changes cause a "hazard" to the special interest features of the site.

5.2 Hazards of the Ombla HPP

5.2.1 Construction Phase Hazards

The Ombla HPP construction phase hazards that have been identified are:

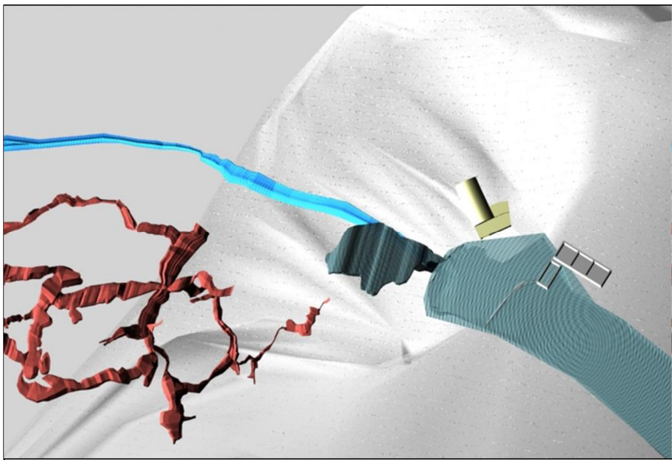
Physical disturbance: The construction of the project will cause physical disturbance due to the disruptive nature of the works to access and excavate limestone to create the voids (more open volume of subterranean space) for the various elements of hydropower infrastructure. Further works to construct the hydropower structures have the potential to cause disturbance. The sections of the explored cave system exposed to this direct physical disturbance will be limited, as the majority of the hydropower infrastructure is located away from the cave system. The locations within the cave system that will be affected by direct physical disturbance are:

- Spring Cave – where construction works are required to enlarge the Spring Cave to receive water from the tail race tunnels from the turbines, the biological minimum flow, and vertical overflow structure.
- Main channel – where construction works are required 1) to drill a series of boreholes into the main channel and inject a grout plug 130m below sea level and 2) to drill four boreholes from the intake structure into the main channel to divert water through the intake structure.
- Vilina Cave – where construction works are required drill through the cave to create drainage boreholes that will drain accumulations of percolation waters to the middle cave system downstream of the grout curtain in accordance with the requirements of the Croatian Ministry of Environment opinion (2009).

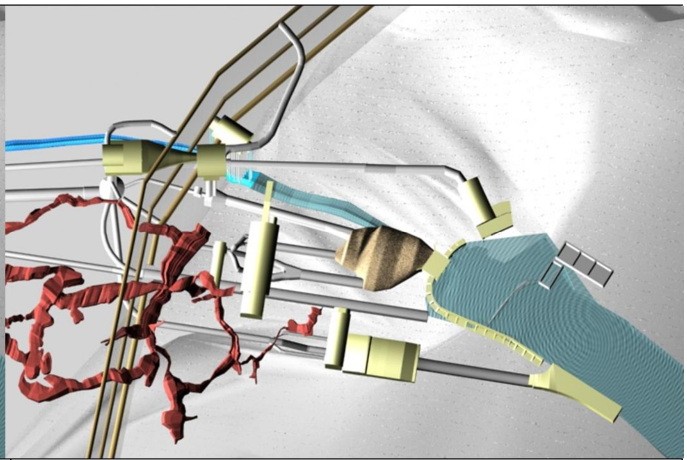
- The middle cave system – where construction works are required to install a concrete plug to bisect the cave system and allow water to accumulate behind the grout curtain, and at the level of 55m asl where the vertical shaft connects to the middle cave system.

The excavation of grouting galleries (by blasting, drilling and removal of rock) and drilling of boreholes will also create extensive physical disturbance throughout the area where the grout curtain is to be located. However none of the grout galleries will directly intersect the mapped cave system.

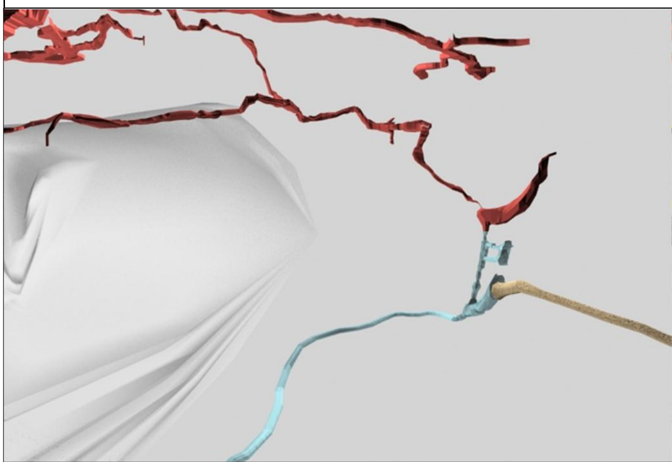
Construction excavation works may increase the risk of rock falls within the caves and or opening of new fissure and water flow routes. This may lead to physical disturbance beyond the immediate localised effects of the planned construction works. However, these effects are likely to be limited in the explored part of the cave system. This hazard will affect the Cave feature (see Section 5.3.1) and Bat features (see Section 5.3.2).



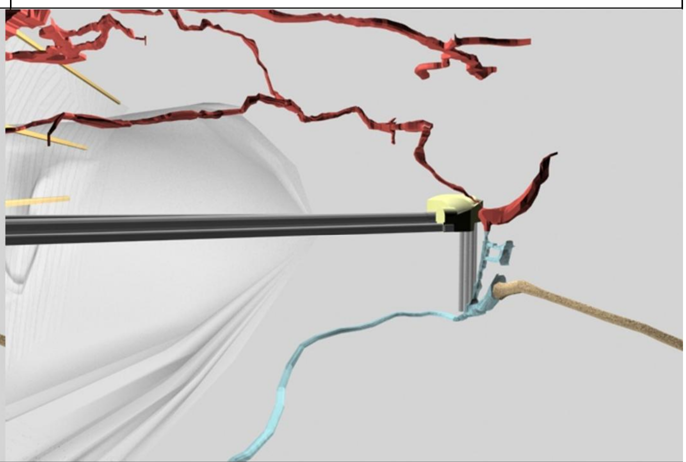
Spring Cave pre construction



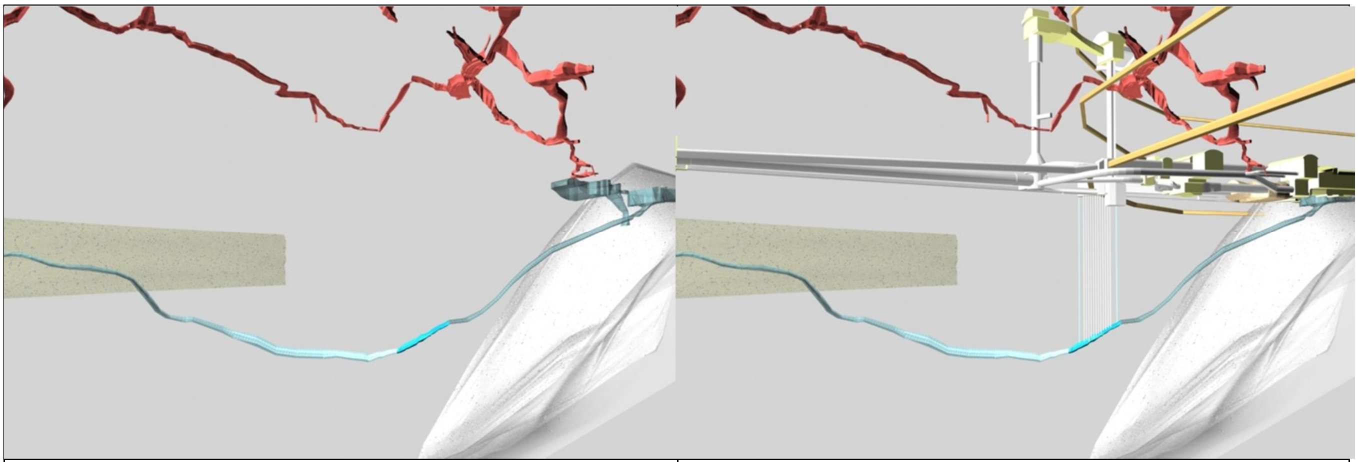
Spring Cave post construction



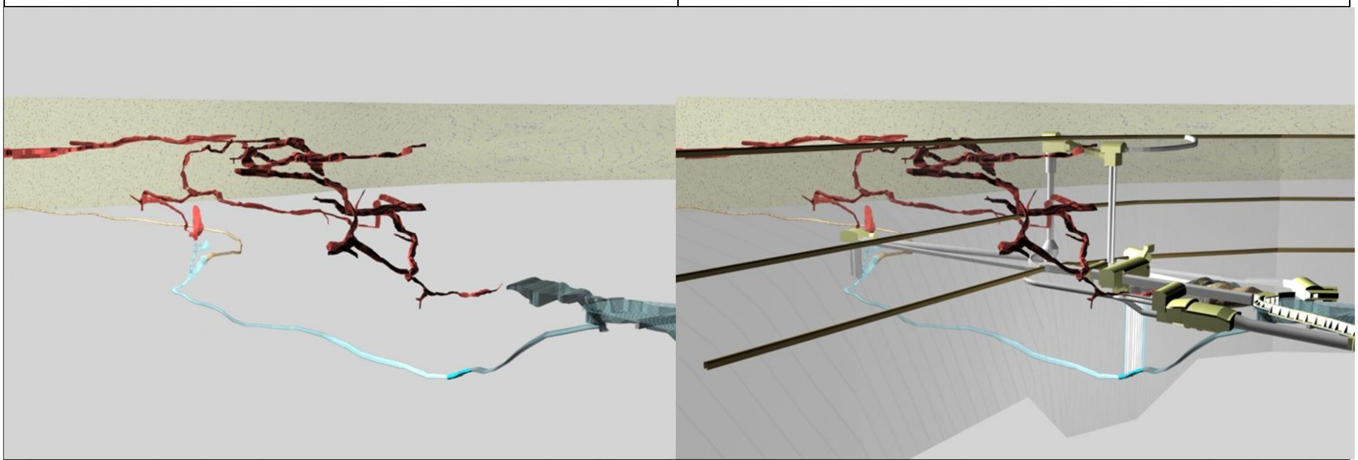
Main Channel pre boreholes These four figures are presented in reverse orientation (left-to-right reverse, that is) compared to most other figures, including the next four.



Main Channel post boreholes and intake



Main Channel Pre Plug | Main Channel Post Plug



Middle Caves pre grout Curtain | Intersection of Middle Caves post grout Curtain

Figure 5.1: Ombla HPP Construction Elements

Sensory (visual, auditory and vibration) disturbance: Construction works to excavate voids within the limestone and construct the hydropower infrastructure and grout curtain, as detailed above will lead to a wider area being affected by visual, noise or vibration disturbance. Drilling through the Vilina Cave from Grout Gallery III will lead to potential visual, noise and vibration disturbance within a localised area (it should be noted that this drilling is required to provide a mitigation measures requested by the Ministry of Environment (2009). The excavation of third (top) grout galleries may lead to potential disturbance of species present within the middle and upper Vilina Cave. Vibration from operation such as drilling, blasting or the operation of hydraulic rock breakers will attenuate through the rock mass within 50m. Beyond 50m, the attenuation of vibration by the rock mass is unlikely to cause significant disturbance (e.g. vibration of hydraulic rock breakers is attenuated from 4.5mm/s @ 5m to 0.1mm/s @ 50m in normal ground conditions). Any excavation within 50m of the Vilina Cave will not include blasting and will be undertaken using drilling and rock-breaking techniques between November and April in line with the measures set out by the Ministry of Culture (2009).

If lighting is used for access, or in construction areas, this may also cause sensory disturbance for species like bats.

Direct loss of habitat to infrastructure development: The construction of the grout curtain will lead to the loss of cave surfaces in the areas of the explored cave system that are filled with grout or concrete. The Spring Cave will be altered through general enlargement of the void to make a more uniform space to be able to receive discharge waters from the turbine, ecological minimum flow and overflow tailraces. As a result there will be a direct and permanent loss of the existing cave surface areas, cave form and the variety and distribution of deposited rock and sediment within the Spring Cave.

There will be a direct loss of terrestrial cave habitat area within the middle cave system due to the installation of a concrete plug in three limbs of the existing middle cave system. The area of direct habitat loss will be limited to 15m (three cave limbs bisected with 5m concrete plugs) of cave passage reducing the extent of habitat by 0.5% of the total length of terrestrial cave passage. The concrete plug will bisect the middle cave system leading to a reduction in connectivity between terrestrial cave passages in the upper and middle levels. This hazard will affect the Cave feature (see Section 5.3.1).

Water pollution and sediment generation: The generation of dust and operation of machinery close to or within aquatic environments has the potential to lead to fine particles, lubricants, fuel and other materials mixing with water leading to an increase in the risk of pollution. Such pollution could lead to changes in turbidity, sedimentation and dissolved oxygen levels. This risk will be limited to points in the cave system that will be intersected by the works; the main channel intersected by abstraction boreholes and the grout plug and the Spring Cave. The risk of water pollution will be limited in duration by the temporary nature of the construction works and the diversion of the main water flow from the main channel during installation of the grout plug in the main water channel which will limit the dispersion of grouting material beyond the plug extent by creating still water conditions. The potential for water pollution beyond the Spring Cave enlargement zone will also be limited by the diversion of the main flow of water in the main channel (to the Spring Cave) to a discharge point downstream of the present Ombla Weir. This hazard will affect the Cave feature (see Section 5.3.1).

Change in water flows through the cave system: The diversion of the flows from the main channel in year's three to five of the construction works will temporarily change the way 95% of the water flows through the present cave system. The water will be diverted through the intake structure to the headrace tunnel and then through the bottom outlet headrace, tailrace and outlet structure downstream of the Komolac Weir. This hazard will affect the Cave feature (see Section 5.3.1).

Change in water levels within and outside the cave system: The change in water flows through the cave system during construction will allow the Spring Cave to be drained before subsequent enlargement works take place. Diverting the flows downstream of Komolac Weir will bypass the Spring Pond which will be drained to allow for the construction of the outlet structure from the enlarged Spring Cave into the Spring Pond. This hazard will affect the Cave feature (see Section 5.3.1) in relation to the Spring Cave and Bats features in relation to the Spring Pond (see Section 5.3.2).

Change in microclimate conditions within the cave system: The installation of drainage pipes within the Vilina Cave is required, in accordance with the Ministry of Culture Decision 2008, to allow for the drainage of percolation water from the Vilina Cave during operation of the hydropower scheme. The construction of boreholes to create drainage pipes within the Vilina Cave has the potential to increase the extent of air circulation with the Vilina Cave system, leading to potential changes to the microclimate (relative humidity and temperature) in the vicinity of the new openings and beyond. This hazard will affect Bat features in relation to the Vilina Cave (see Section 5.3.2) and the Cave feature in the vicinity of the drainage discharge points in the middle cave system (See Section 5.3.1).

Habitat degradation from rising dust inside the cave: Construction works will generate dust through the areas where excavation, drilling and other construction activities will occur. Such effects have the potential to affect the Spring Cave, Middle Cave bisected by the Grout Curtain, and the Vilina Cave where the drilling of grout curtain boreholes and drainage pipes intersects it. Such effects are likely to be localised and temporary given the limited points at which the caves system is intersected by the construction works. Dust is likely to settle out of the air quickly given the still nature of the air flow within the system. This hazard is likely to affect the Cave feature (see Section 5.3.1) and Bats features in relation to works in the Vilina Cave (see Section 5.3.2).

Change in prey/food availability: The construction works have the potential to change prey food availability within the cave system due to the indirect effects of construction hazards identified in the paragraphs above. Diversion of the water flows will alter the path of food/prey (organic carbon/drift invertebrates) sources which are delivered to the cave system from the catchment, whilst temporary disturbances and or habitat degradation may affect deposits of food (organic matter) or localised species distribution. Drainage of the Spring Pond will also alter the extent of aquatic habitat that provides a water/food resource of bat species that use the caves system. This hazard is likely to affect the Cave feature (see Section 5.3.1) and Bats features in relation to works in the Vilina Cave (see Section 5.3.2).

Change in cave morphology: As noted above the excavation and enlargement of the Spring Cave will permanently alter its morphology, removing the natural karstic formations found within. The enlargement works are localised to Spring Cave, the most accessible point of the cave system. The bisection of the middle cave system will lead to the potential localised loss of karstic cave features where works are carried out to build the concrete plugs and any supporting structural works (reinforced foundations, shotcreting etc.). Such works will be limited in their extent but have a permanent effect.

In addition to the direct works to the cave system, the excavation of the grout galleries and creation of voids within which to install the hydropower infrastructure has the potential to increase the risk of rock falls within the explored cave system, due to the potential to create new fractures or fissures in the limestone structure. The increase in risk is likely to be limited to the sections of the cave system in close proximity to the construction works. This hazard is likely to affect the Cave feature (see Section 5.3.1) and Bats features in relation to works in the Vilina Cave (see Section 5.3.2).

Introduction of alien species: The construction of the grout curtain and hydropower infrastructure will require the significant movement of plant and machinery. The movement of vehicles and construction personnel to excavate the grout galleries and remove large volumes of material have the potential to introduce species of flora and fauna not usually found within the cave system, or transport species from another cave system that is undesirable, where such species are inadvertently carried to the site on vehicles or on clothing/footwear. Such species have the potential to act as invasive species disrupting the balance of ecosystems found within cave systems (USGS, 2012). Direct exposure to the explored caves system will be limited to the intersection points of construction identified earlier. However, in addition invasive species may also be introduced to the wider karst system via the grout galleries and enter the explored caves system through smaller conduits or fractures leading to delayed dispersion. This hazard is likely to affect the Cave feature (see Section 5.3.1).

5.2.2 Operation Phase Hazards

The potential operation phase hazards that we have considered are:

Change in water flows through the cave system: The operation of the hydropower plant will lead to the permanent re-routing of the majority (95%) of incoming water flows from the wider Ombla catchment through the hydropower infrastructure. To maintain the desired head of water within the accumulation area behind the grout curtain the turbine and generator scheme will be operated as “run-of-river” with the input of water to the system equal to the output once the optimal level of water has been achieved behind the grout curtain. This means that there will be no change in the discharge volumes to the Spring Pond. However the Spring Cave will directly receive this flow, whereas under natural conditions it acts as a back water flow reservoir. Velocities under normal flow conditions will be increased and the water body within the Spring Cave will form one continuous water body with the Spring pond and will cease to become a fully subterranean habitat. ,.

The existing main channel (spring siphon) will change from a fast flowing underground watercourse to two separate still/slow moving subterranean channels with limited water exchange. This will result in a fundamental change in flow and therefore the physico-chemical properties of the water in these slow water areas may also change. The extent of slower moving aquatic habitat within the Ombla system will increase. There will be localised increases in speed and turbulence of water flow around the turbine intake and discharge into the Spring Cave. The change in water levels relative to the main input of flow from the hinterland (i.e. an increase to 130m.asl from 0.15m.asl with inflows remaining at -54m.als) is likely to affect the input of dissolved and fine particulate organic carbon to the water column that drowns out the Great Lake and Great Hall. The abstraction of up to 360 l/s of water at 55m.asl from the vertical shaft close to the grout curtain is likely to provide some circulation of water within the middle cave system. However, it is unlikely to replicate existing conditions throughout the water column throughout the flooded middle cave. This hazard is likely to affect the Cave feature (see Section 5.3.1).

Direct mortality or damage: The flow or water through the turbines will carry individual fauna through the cross section of the water column that drives the turbine blades. Direct contact with turbine blades has the potential to cause damage or mortality to individual species which pass through the blades. However the size of those species and their physiology determines the level of risk of damage or mortality, for instance, vertebrate species are more likely to be struck by blades and experience the effects of differential sheer stress and tissue damage than small invertebrate species. For example, fish passing through hydroelectric turbines can be injured or killed as a result of rapid and extreme pressure changes, cavitation, strike, grinding, turbulence, and shear stress (Cada et al, 2007). An indication of the scale of such effect on vertebrate species moving through hydroelectric turbines is provided by Scottish Natural Heritage (undated) which estimates that 10-40% of salmon smolts may be killed or injured after passing through turbines. There is little evidence to suggest that invertebrates suffer the same level of damage or mortality due to passage through hydroelectric turbines.

Sensory (incl. Noise and vibration) disturbance: The project design does not propose permanent new lighting of access tracks or within the plant compound, however if these were to be included in future detailed design this may lead to an increase in visual disturbance to foraging bats. The hazard from new lighting during operation has been discounted at this stage on the basis that the current design does not include the lighting indicated above.

The operation of the turbines is unlikely to lead to a significant increase in noise or vibration beyond the immediate vicinity of the turbine house, head race and tail race due to their relative isolation from the natural cave system. The noise and vibration generated from turbines will not attenuate through the body of rock, whilst vibrations through water are likely to be undetectable in the fast moving column of water that passes through the turbine headrace and tail race.

Change in water levels within the cave system: The operation of the hydropower plant requires the raising of water levels to 130 metres within the middle cave passages under normal operation. This will lead to the flooding of previously dry sections of fossil cave and sections of cave that are only usually submerged for a short period of time in every year. Table 5.2 sets out the changes in extent of the flooded and dry caves sections under proposed operation of Ombla HPP.

The design of the scheme is intended to prevent the flooding of Vilina Cave, which will not be plugged or bisected by the grout curtain. Where the line of the grout curtain intersects the Vilina Cave it will be lowered from the standard 138.7m level to the level of the cave floor to ensure that the cave is not blocked and that there is little visible evidence of the existence of the grout curtain from inside the cave. The design to prevent flooding in the Vilina Cave is based on the assumption that due to the low porosity of the limestone rock the increase in the phreatic level to 130m will not be experienced in the Vilina Cave, a proportion of which lies below this level behind the line of the grout curtain. This assumption is made on the basis that within the explored cave system there is no confirmed conduit connection below 130m asl between the Vilina Cave and the section of the middle cave system that will be flooded as a result of the scheme.

The CBS (2012) and a review of the three dimensional model of the cave system produced from historic cave mapping indicates that there may be unmapped connections (fractures and /or conduits blocked with sediment or rock) that have the potential to provide a route for wider water level rises to affect water levels in the Vilina Cave. If such connections are present, there is the potential for water levels to rise up to 130 masl. Dependent on the nature of potential connections there is a risk that such a rise in water levels would partially or fully submerge the section of the Vilina Cave between the Front Hall and the High Hall.

Table 5.2: Change in Extent of Permanently Flooded Sections of the Ombla - Vilina Cave System during Proposed Operation of Ombla HPP

Scenario	Existing Length	Length under Operation (Max Water Level – 130masl) and % Change	Length under Operation (Min Water Level – 75 masl) and % Change
Fossil Cave Passages	3060	1065 (-65%)#	2368 (-23%)
Fossil Cave Passage Subject to Annual Flooding	306	0* (-100%)	0* (-100%)

Notes: # includes upper and middle caves upto 130masl. *200m will be permanently flooded upstream of the grout curtain, 106m will be permanently dry downstream of the grout curtain.

Change in microclimate conditions within the cave system: The raising of water levels within the middle cave system will lead to potential changes in the microclimate (relative humidity and temperature). The existing range of temperature and relative humidity is influenced by air flow and proximity to water, with the lowest temperatures observed in the fossil cave passages closest to the submerged cave passage where the temperature of the water regulates the air temperature. By raising the water levels within the middle cave system it is likely that the air column within the immediate vicinity of the new water surface will be cooled by up to 2°C., based on recorded temperatures within the cave system between March and June of 2012. Relative humidity is unlikely to change as a result of the rise in water levels, as it is already at 100% in the locations in the cave that would be affected.

5.3 Potential Effects on Conservation Objectives

The potential for the hazards to cause a significant effect has then been considered based on whether those hazards have the potential to cause a change that stops the site being able to meet its conservation objectives; these hazards (causes), associated effects and existing mitigation incorporated into the 2010 scheme design are described in this section and summarised in Table 5.5.

Each of the hazards described in section 5.2 has been considered against the conservation objectives of the proposed SCI.

5.3.1 Caves not Open to the Public

Conservation Objective: Conserve biological species important for habitat type, not to enter a foreign (alien) species and genetically modified organisms.

Construction Hazard – Introduction of Alien Species

The introduction of alien species has the potential to change community structure within the parts of the cave system that will be most frequently visited by construction workers and machinery. The main intersection points will be within the drained Spring Cave, and the middle section of the cave system that will be plugged and the grout galleries. Reeves (1999), notes that particularly invasive species include ants, centipedes, earthworms, isopods, millipedes, mites, and spiders. Newly introduced non-cave species have the potential to out-compete endemic cave fauna or introduce parasites or disease which can adversely affect endemic cave fauna populations.

Information relating to the potential risk of the introduction of invasive species has not been considered as part of the 2010 scheme design and therefore no mitigation measures were included. The new information will now be incorporated into the design. Mitigation for this impact is considered in Section 6.

Construction Hazard - Physical and sensory disturbance

Physical and sensory disturbance from construction works has the potential to lead to short term, temporary and localised effects on endemic terrestrial cave fauna. The short term and limited nature of the works at the intersection points with the terrestrial cave system and the widely dispersed nature of cave fauna within the system will limit the exposure of cave fauna to such hazards. Physical and sensory disturbance is therefore unlikely to have a significant impact on the populations of terrestrial cave fauna or their habitat.

Works to drain and subsequently enlarge the Spring Cave will lead to the direct loss of aquatic invertebrate species leading to direct adverse effects on the populations of up to 13 endemic species in the short term (see Table 5.4). The permanence of such an impact is dependent on the ability of cave fauna to recolonise the Spring Cave habitat which is considered in relation to cave morphology later in this section. Information relating to the potential impact of the scheme on aquatic invertebrates was not available to inform the 2010 scheme design and therefore no mitigation measures were included. Mitigation for this impact is considered in Section 6.

Operation Hazard - Direct mortality or damage – As noted in Section 4 aquatic vertebrate species recorded in the Ombla system are the Popovo minnow and. The proposed SCI site is not considered to provide support to viable populations of these aquatic vertebrate species. Therefore the risk to the wider populations of these species is not considered to be significant.

Conservation Objectives: Do not change habitat conditions in caves, their overground and close by; and, Conserve speleothems, living world caves, fossils, archaeological and other findings:

***Construction Hazard - Change in Cave Morphology and direct habitat loss* to infrastructure development** - The existing habitat provided by the Spring Cave will be completely changed by enlargement to accommodate higher flows and volumes. Drainage and excavation of the cave will lead to the direct loss of areas of sediment, irregular and sloping walls and floors and rocks/boulders will change the morphology of Spring Cave and lead to a loss of available habitat niches. The enlarged Spring Cave will continue to provide aquatic habitat once the scheme is operational which has the potential to be re-colonised by drift species and remnant resident species however this habitat will not provide the range of habitat niches found within the existing Spring Cave. As a result there will be a permanent, adverse effect on the 13 species of endemic cave fauna identified in Table 5.4.

There will be a direct loss of cave habitat within the footprint of the grout curtain, due to the plugging of three limbs of the Middle Cave system and injection of grout into terrestrial and aquatic interstitial spaces around the cave system. Loss of aquatic interstitial spaces will be offset by the increase in water levels under operation. When considered in isolation the direct loss of terrestrial could be considered to be trivial in relation to the extent of the explored cave system, however the indirect effect of this change will be the potential loss in access to the wider extent of the cave system that is bisected by the grout curtain for cave fauna within the middle cave system.

Information relating to the potential impact of the scheme on endemic cave invertebrates was not available to inform the 2010 scheme design and therefore no mitigation measures were included. The new information will now be incorporated into the design. Mitigation for these impacts is considered in Section 6.

Conservation Objective: Preserve the favourable conditions (darkness humidity, ventilation) and peace (no visits and other human impacts) in caves:

Operation Hazard - Water level rises and drainage changes: There will be change in the distribution of habitat types within the cave system due to extensive flooding of the open passages of the middle cave behind the grout curtain. This will reduce the area used by specially adapted invertebrate species so far only found in this location or in a limited number of other sites.

As identified in Section 5.2.2 the lower sections of the Ombla cave system are subject to periods of flooding on an annual basis. Observations by the CBS noted that during the period of the 17th to 18th April 2012 the water levels for the Spring Cave rose to 7.6m, water in the west cavern reached a maximum of 9.3 m and levels in the Deep Lake rose to 14.6 m at a period when the Ombla spring discharge was measured as $91m^3/s$. The CBS also noted that terrestrial fauna within these areas adapted to these short-term flooding events indicating a level of resilience to seasonal flooding of the lower terrestrial cave habitat. Anecdotal information indicates that flooding of up to 50 masl in the vicinity of the Great Hall during annual high flow events, whilst historically flow rates through the Ombla system where 30% greater than present day extreme flows prior to the canalisation and regulation of the Trebisnjica River due to hydropower development in BiH.

Despite the system being adapted to temporary seasonal flooding, the permanent inundation of the terrestrial habitats within the middle cave system up to 130 masl has the potential to adversely affect CHZ3 habitat types which support a number of stenoendemic terrestrial cave invertebrate species and other species of high conservation importance. The flooding will lead to the loss in extent of 800m of CHZ3 habitat types comprising the following habitat types (refer to Table 4.4):

- H.1.1.4. Caves and cave systems with sub troglobiont invertebrates, type 2,
- H.1.1.5. Caves with troglophilic invertebrates, type 2,
- H.1.3.2.2. Stone pools,
- H.1.3.2.3. Clay pools,
- H.3.1.1.Interstitial terrestrial habitats

Table 5.3 identifies those species recorded within sections of the middle cave passage that will be subject to adverse effects due to flooding. In summary they include three species of fungi and 11 invertebrate species. Of these species the Ombla cave system represents the:

- Only known locality in the world for two species of invertebrate (*Archaphorura* sp. new. and *Plusiocampa* sp. new.)
- Only known location in Croatia for four species of invertebrate (*Belba gratiosa, Histopona krivosijana, Eukoenenia cf. Remy and, Neelus cf. Klisurensis*) and three species of fungi (*Gleotinia sp. new., Ombrophila sp. new.* and, *Syncephalis* sp. new.)
- Part of the confirmed (CBS) south Dinaric range for six endemic invertebrate species and two endemic species of fungi.

Uncontrolled flooding of the Vilina Cave through unidentified fissures and connections to the flooded middle cave may lead to either a large section of the floor of the cave filling with water changing the temperature, humidity and airflow conditions, or the complete flooding of the cave up to the point of the ground curtain. This has the potential to adversely affect all recorded habitat types within CHZ2 and CHZ3 found at or below 130 masl, estimated to be in the order of a further 1200m of terrestrial cave habitat in the Vilina Cave (comprising 190m of CHZ2 habitat and 1010m CHZ3 Habitat).

The installation of the drainage pipes connecting the Vilina cave with the middle cave system to the south of the grout curtain has the potential to lead to localised changes in microclimate due to:

- Potential changes in airflow, temperature and relative humidity in the Vilina Cave and the middle cave system due to the new open connections between the cave passages; and,
- Intermittent discharge of drainage water to previously dry sections of the fossilised middle cave system downstream of the grout curtain.

Information relating to the potential impact of the scheme on endemic cave invertebrates was not available to inform the 2010 scheme design and therefore no mitigation measures were included. The new information will now be incorporated into the design. Mitigation for these impacts is considered in Section 6.

Conservation Objective: Preserve the favourable physical and chemical conditions, the amount of water and the water regime or improve them if they are unfavourable:

Construction Hazard - Change in water levels and flows within the cave system and change in food availability: The diversion of 95% of the Ombla flow from the main channel to downstream of the Komolac weir during Year 3 via the new intake structure and bottom outlet will temporarily interrupt the flow of dissolved organic carbon and downstream drift aquatic invertebrate species to the Spring Cave. The diversion is unlikely to interrupt the flow of drift species to the Great Lake as the flow diversion will bypass this via boreholes sunk into the main channel downstream of the Great Lake. The diversion will be short term and temporary in nature and is designed to allow for the safe enlargement of the Spring Cave during this period. Under natural conditions a proportion of drift invertebrate species will be discharged over the Komolac weir via the Spring Pond and lost the system. The drainage of the Spring Cave during this period will be temporary, however the loss of the water column within the Spring Cave has the potential to lead to the loss of a number of endemic aquatic cave invertebrate fauna only recorded within this part of the cave system (for example, *Prostoma cf. Hercegovinense, Troglocaris hercegovinensis and T. anophthalmus)*

Information relating to the potential impact of the scheme on endemic aquatic cave invertebrates was not available to inform the 2010 scheme design and therefore no mitigation measures were included. The new information will now be incorporated into the design. Mitigation for the wider impact on the Spring Cave is considered in Section 6.

Construction Hazard - Water pollution and sediment generation: There will be limited exposure of aquatic cave fauna to water pollution and sediment generation due to a construction sequence that allows for the building of the temporary wall at the site of the construction of the intake structure to screen and isolate the Great Lake from the construction effects and the subsequent diversion of the flow to downstream of the Komolac Weir. Existing controls to minimise water pollution and sedimentation are also set out in the ESAP (October, 2011). The risks of water pollution due to construction works are therefore not considered to be significant.

Operation Hazard - Change in water flows and level through the (aquatic) cave system:

The blockage of the main flowing water connection to raise water levels behind the grout curtain will change water flow paths. The diversion of the water flow will permanently alter the route and flow of incoming aquatic drift species and organic carbon. There will be a change in the functional area of aquatic cave habitats through the general raising and extension of the flooded zone within the Ombla system. This may benefit some species which are adapted to living in narrow fissures and cracks within the rock and in unexplored wider openings beyond the known cave system. The raising of the general water level back to the dolomite barrier is unlikely to improve the connections between the wider underground karst area in BiH and the Popovo Polje. There is not predicted to be any increase in surface flooding due the project in the BiH Popovo Polje area.

The change in flows will have the greatest effect on the long term viability of the Spring Cave to provide suitable flow and morphological habitat features to support the full range of aquatic drift and resident invertebrate fauna. The change in flow speeds and discharge volumes and simplified habitat structure will make it unlikely that still water aquatic species will be able utilise the newly enlarged water body once the scheme is operational. This fundamental change in the flow and habitat characteristics is likely to lead to long term and permanent adverse impacts on that habitat that supports 22 species of stenoendemic aquatic cave invertebrate species and other species of high conservation importance. Of the species potentially impacted by the permanent changes to the Spring Cave, the Ombla cave system represents:

- The only recorded location in the world for three species (*Horatia knorri, Lanzaia vjetrenicae kusceri, Plagigeyeria nitida angelovi* although none were recorded in 2012);
- The only recorded location in Croatia for eight species (*Prostoma cf. Hercegovinense, Lanzaia vjetrenicae vjetrenicae, Orientalina troglobia, Monolistra hercegoviniensis ornate, Niphargus vjetrenicensis, Niphargus balcanicus, Niphargus hercegovinensis, and Troglocaris hercegovinensis)*;
- Part of the confirmed south Dinaric range for 13 endemic aquatic invertebrate species (CBS, 2012).

The permanent change in flows and raising of the water levels upstream of the grout curtain will have uncertain effects on the aquatic fauna found primarily in the Great Lake. The rise in water levels will raise the water column surface to the 130masl level whilst lowering the relative input point of the main flow of fine/dissolved organic matter. This has been identified as having a permanent and potentially adverse effect on habitat that supports 14 species of stenoendemic aquatic cave invertebrate species and other species of high conservation importance. Of the species impacted by these changes to the Great Lake, the Ombla system represents the:

- The only recorded location in Croatia for four species (*Orientalina troglobia, Monolistra hercegoviniensis ornate, Sphaeromides virei cf. Montenegrina and Niphargus vjetrenicensis*)
- Part of the confirmed south Dinaric range for eight endemic aquatic invertebrate species (CBS, 2012)

Information relating to the potential impact of the scheme on endemic aquatic cave invertebrates was not available to inform the 2010 scheme design and therefore no mitigation measures were included. Mitigation for the wider impact on the Spring Cave is considered in Section 6.

Table 5.3: Terrestrial Cave Fauna and Fungi Subject to Ombla HPP Construction and Operation Impacts

	Species	Location / Habitat Type	Importance / Vulnerability			Construction Impacts	Operation Impacts	Present 2012
			Steno endemic	IUCN (HR) Red List Status	Unique to Ombla (HR/World)			
Fungi	Hyphomycetes sp.	U	✓		✓ (HR)			✓
	Gleotinia sp. new.	L (GH)			✓ (HR)		✓	✓
	Myxotrichum deflexum	U (VC)			✓ (HR)			✓
	Ombrophila sp. new.	L (GH)	✓		✓ (HR)		✓	✓
	Syncephalis sp. new.	U (VC), M	✓		✓ (HR)		✓	✓
Gastropod	Agardhiella stenostoma	NR	✓	LC		✓		
	Cecilioides spelaea	NR		EN		✓		
	Platy wilhelmi	NR		LC		✓		
	Pholeoteras euthryx	CHZ1 U(VC)		VU (HR)				✓
	Odontocyclas kokeilii	NR		LC		✓		
Acar	Spelaeothrombium caecum	CHZ2 U(VC)		EN				✓
	Belba gratiosa	CHZ3 M			✓ (HR)		✓	✓
	Biscirus sylvaticus convexus	NR	✓				✓	
	Uroobovella cf. reticulata	CHZ2 U(VC)			✓ (HR)			✓
Araneae	Sulcia sp. new.	CHZ2 U(VC)	✓		✓ (W)			✓
	Histopona krivosijana	NR	✓		✓ (HR)		✓	
	Histopona dubia	CHZ2 U(VC)	✓					✓
Pseudo scorpio	Pseudoscorpion gen. new. sp. new.	CHZ2 U(VC)	✓		✓ (W)			✓
	Roncus sp. nov.1	CHZ2 U(VC)	✓		✓ (W)			✓
	Roncus sp. nov.2	CHZ2 U(VC)	✓		✓ (W)			
	Chthonius sp. new.	CHZ2 U(VC)	✓		✓ (W)			✓
Palpigrada	Eukoenenia pretneri	CHZ2 U(VC)	✓	CR (HR)	✓ (W)			
	Eukoenenia cf. Remy	CHZ3 M	✓		✓ (HR)		✓	✓
	Travunia anophthalma	CHZ3 U(VC), M, L (GH,T)	✓	EN			✓	✓
Isopoda	Isopoda gen. new. sp. new.	CHZ2 U(VC)	✓		✓ (W)			✓
	Cyphoniscellus herzegowinensis	CHZ3 U(VC), M		VU (HR)			✓	✓
Collembola	Typhlogastrura topali	CHZ1 & CHZ2 U(VC)	✓	EN				✓
	Archaphorura sp. new.	CHZ3 M, L	✓		✓ (W)		✓	✓
	Pygmarrhopalites sp. new.	CHZ2 U(VC)	✓		✓ (W)			
	Neelus cf. klisurensis	CHZ3 M, L			✓ (HR)		✓	✓
Diplura	Plusiocampa sp. new.	CHZ3 M	✓		✓ (W)		✓	✓
	Plusiocampa remy	CHZ3 M, L (GH)					✓	✓
Cole opter	Bathyscidius tristiculus fallaciosus	CHZ2 & CHZ3 U(VC), M						✓

	Species	Location / Habitat Type	Importance / Vulnerability			Construction Impacts	Operation Impacts	Present 2012
			Steno endemic	IUCN (HR) Red List Status	Unique to Ombla (HR/World)			
	Anthroherpon apfelbecki	CHZ3 L	✓				✓	✓

Key: (Code; CHZ# - Identified in Table 4.3; NR - Not Recorded; U - Upper Caves, M – Middle Caves; L - Lower Caves; (VC) – Vilina Cave, (GH) - Great Hall, (T) - Tunnel; LC - Least Concern, EN – Endangered, VU - Vulnerable; CR - Critical)

Table 5.4: Aquatic Cave Fauna (CHZ4) Subject to Ombla HPP Construction and Operation Impacts

	Species	Location	Importance / Vulnerability			Construction Impacts	Operation Impacts	Present 2012
			Steno endemic	IUCN (HR) Red List Status	Unique to Ombla (HR/World)			
Neme rtea	*Prostoma cf. hercegovinense*	SC	✓		✓(HR)	✓		✓
Gastropod	*Anisus leucostomus*	(SC)		LC		✓		
	Belgrandia torifera	GL	✓	EN			✓	✓
	Emmericia expansilabris	GL		VU			✓	✓
	Hauffenia edlaueri	(SC)		DD		✓		
	Hauffenia plana	(SC)		NT		✓		
	Horatia knorri	(SC)	✓	CR	✓ (W)	✓		
	Iglica absoloni	SC, GL	✓	LC		✓	✓	✓
	Iglica bagliviaeformis	SC, GL		EN		✓	✓	✓
	Lanzaia vjetrenicae vjetrenicae	(SC)	✓	VU (CR)	✓(HR)	✓		
	Lanzaia vjetrenicae kusceri	(SC)	✓	(CR)	✓	✓		
	Orientalina troglobia	SC, GL	✓		✓(HR)	✓	✓	✓
	Plagigeyeria robusta robusta	GL		DD			✓	✓
	Plagigeyeria nitida angelovi	(SC)	✓	DD (CR)	✓ (W)	✓		
	Saxurinator brandti	(SC)		VU		✓		
Isopoda	*Monolistra hercegoviniensis ornata*	SC, GL, S	✓		✓(HR)	✓	✓	✓
	Sphaeromides virei cf. Montenegrina	GL	✓		✓(HR)		✓	✓
Amphipoda	*Niphargus steueri kolombatovici*	SC, GL, S	✓			✓	✓	✓
	Niphargus vjetrenicensis	SC, GL	✓		✓(HR)	✓	✓	✓
	Niphargus balcanicus	SC	✓		✓(HR)	✓		✓
	Niphargus hercegovinensis	(SC)	✓		✓(HR)	✓		
	Niphargus trullipes	SC		(CR)		✓	✓	✓
	Niphargus salonitanus	GL, S	✓				✓	✓
	Typhlogammarus mrazeki	SC, GL, S		EN		✓	✓	✓
D e	*Troglocaris anophthalmus*	SC		VU		✓		✓

	Species	Location	Importance / Vulnerability			Construction Impacts	Operation Impacts	Present 2012
			Steno endemic	IUCN (HR) Red List Status	Unique to Ombla (HR/World)			
	Troglocaris pretneri	SC, GL, S		EN		✓	✓	✓
	Troglocaris hercegovinensis	SC	✓		✓(HR)	✓		✓

Key: Location:- SC – Spring Cave; GL – Great Lake; S – Siphon/Western Cavern ( ) – No Record 2012 Location column

5.3.2 Bats

Conservation Objective: Conserve biological species important for habitat type

There are no hazards which are likely to lead to the direct mortality of bats due to the construction and operation of the hydropower plant, however a number of hazards have the potential to affect the underpinning conservation objectives that follow and therefore potentially impact on the populations found within the Vilina Cave.

Conservation Objective: Do not change habitat conditions in caves, their overground and close by.

Construction Hazard - Change in water levels outside the cave system and change in freshwater/prey availability: The drainage of the Spring Pond during construction will lead to short term (Construction Years 3-4), temporary and localised loss of a freshwater source of drinking water and insects for foraging bats. The loss of the freshwater feeding resource will have a negative impact on bat populations through the year. The period of greatest vulnerability for the bat populations utilising the Vilina Cave will be during the summer period when the site is used as a maternity roost and females rely on food sources to be in close proximity to the roost site.

Information relating to the potential impact of the scheme on bats in relation to impacts on the Spring Pond was not available to inform the 2010 scheme design and therefore no mitigation measures were included. Mitigation for this impact is considered in Section 6.

Operation Hazard - Increase in water levels: The risk of uncontrolled water level increases within the Vilina Cave due to flow of water from the middle cave passages through unidentified conduits and fissures (see Table 1.4) has the potential to lead to a number of possible impacts on the bat population. Either through partial submersion of the cave floor due to the effective drainage of raising waters by the installed drainage pipes; or, full submersion of a longer section of cave passage if the volume of water were to exceed the installed capacity of the drainage pipes:

- If accidental increase in water levels were to lead to partial or full submersion of a large section of the floor of the cave between the Front Hall and High Hall (estimated to be in the region of >50m). The introduction of a 50m long expanse of water would be likely to change the temperature, humidity and airflow conditions in this part of the cave leading to a change in the present conditions that are favourable for bats. It is understood from observations (P Žvorc, Pers. Comm) at other maternity roosts sites in the Croatia that maternity roosts within cave systems are more often found over dry areas within cave systems, therefore there is the potential for the increased extent of flooding to reduce the area available for maternity roosts sites within the Vilina Cave system.
- If the accidental increase water levels were to lead to full submersion of the cave between the Front Hall and High Hall (estimated to be in the region of 190m in length), water will block the passage of bats further into the interior of the cave reducing the amount of available habitat for maternity and other roosts. This is likely to have a serious negative impact upon the populations of each of the bat species found within the cave.

Information relating to the potential risks posed from accidental flooding of the Vilina Cave and its impact on bats was not available to inform the 2010 scheme design and therefore no mitigation measures were included.

The new information will now be incorporated into the design. Mitigation for this impact is considered in Section 6.

Conservation Objective: Preserve the favourable conditions (darkness humidity, ventilation) and peace (no visits and other human impacts) in caves.

Construction Hazards - Physical and sensory disturbance and habitat degradation from rising dust from construction works has the potential to lead to short term, temporary and localised effects on bat fauna in the Vilina Cave, during periods when Grout Gallery III is excavated within 50m of the Vilina Cave and the drilling and grouting works to install the grout curtain from Grout Gallery III are undertaken. The impacts of such effects are considered to be greatest during periods when the Vilina Cave is used as a site for maternity colonies when the cave is used by the largest number of bats during the a critical and vulnerable stage in their life cycle. The location most likely to be subject to disturbance during construction works is BUZ2 (Table 4.6), specifically the passage connecting the Second Hall with the High Hall, which in spring hosts *Rhinolophus euryale* and *Miniopterus schreibersii*, recorded individually and in maternity colonies. In summer this section has been recorded as supporting maternity colonies of *Rhinolophus euryale*, *Rhinolophus ferrumequinum*, *Myotis emarginatus, Myotis blythii* and *Miniopterus schreibersii*.

The decision of the Ministry of Culture in 2009 has set out mitigation measures which have been incorporated into the scheme design to avoid impacts on Spring and Summer usage by stipulating that works within the Vilina Cave will take place exclusively from November to April. In addition, the 2010 scheme design has been undertaken in a way to avoid the need for access of machinery and construction personal to the Vilina Cave to undertake the works to install the grout curtain and the drainage pipes to the mid level caves (required by the Ministry of Culture). All works that intersect Vilina Cave are carried out from Grout Gallery III.

Construction within this winter period still leaves the residual risk of potential disturbance to low numbers of bats using the caves in winter. Although there are no confirmed records within this section of the cave, due to a historic low winter survey effort, there remains the possibility that the cave is used by hibernating or active species during winter. Although this is likely to have an impact on very limited numbers of bats the consequence could potentially be significant for vulnerable populations of bat such as *R. blasii*. The decision of the Ministry of Culture requires the developer to monitor the state of bat fauna during construction, and include eventual additional protection measures. Additional protection measures to address this risk are discussed in Section 6.

Construction Hazard - **Change in microclimate conditions within the cave system:** The construction of drainage pipes within the Vilina Cave has the potential to alter air flow and relative humidity within the area where the drainage pipes are installed. Bats are known to be sensitive to such microclimatic changes, particularly in the choice of roosts and a reduction in relative humidity and change in temperature as a result of increased air flow has the potential to reduce the available roost extent within the affected area.

Information relating to the potential risks associated with drainage pipes required by the Ministry of Culture Decision was not available to inform the 2010 design, therefore mitigation have not be included. The new information will now be incorporated into the design. Additional protection measures to avoid this risk are discussed in Section 6.

Conservation Objective: Conserve speleothems, living world caves, fossils, archaeological and other findings.

Construction Hazard – Changes in cave morphology may result in the increase in the risk of rock falls within the Vilina Cave as a result of the works to excavate Grout Gallery III and drill through the cave to raise the grout curtain. The probability of such an event is considered to be low; however the consequence would be dependent on the nature of the damage to the cave system. The loss of stalactites in a localised area would be unlikely to be significant; however, complete collapse of the cave would have the potential to significantly alter the nature (suitable roosting locations) of the cave habitat available to bats and their access to the interior extent of the cave system.

Prior to 1983 the bat population was noted to be largely restricted to an interior section of the cave between 15m and 64m (Pers. Comms P. Milanovic and R. Ozimec). Removal of a large stalactite (by blasting) in 1983 allowed deeper sections of the cave beyond 64m to be colonised by bats.

Based on consideration of risks of cave collapse and the effects of previous activities within the cave system the occurrence of falls that will cause significant effects is considered unlikely.

5.4 Summary and Conclusions

Consideration of the potential exposure to a range of hazards associated with the Ombla HPP has identified the potential for likely significant effects that may undermine the conservation objectives of the proposed SCI if further counteracting measures are not implemented. These likely significant effects of the scheme, prior to mitigation other than that specific by the Ministry of Culture 2009 or integrated into the 2010 project design are summarised in Table 5.5.

Table 5.5: Likely Significant Effects of Ombla HPP upon the Proposed SCI Interest Features

SCI Interest Feature / CHZ & code(s)	Conservation Objectives, Hazards, and Consideration of SCI Feature Vulnerability, Likely Impact and Mitigation Integral to Project Design	LSE*
Habitats Features: Caves not open to the public		
Higher (Vilina) Cave Ecosystem		
CHZ1 (H.1.1.1:& H.1.1.2)	**No hazards identified**. .	**No**
CHZ2 (H.1.1.3: H.1.1.4 st1: H.1.1.5 st1)	**Conserve biological species** **Construction Hazards:** ■ Increased risk of the introduction of alien species through movement of plant and machinery in constructing grout curtain and hydropower infrastructure has potential to change community structure within parts of the cave system most frequently visited by construction workers and machinery. ■ Physical and sensory disturbance of the Vilina Cave through installation of drainage boreholes will lead to short term, temporary and limited disturbance on cave fauna. **Do not change cave habitat conditions** **Construction Hazards:** ■ Change in cave morphology and direct habitat loss through construction of grout curtain causing reduced access to wider cave system for endemic invertebrates. **Preserve favourable conditions** **Operation Hazards:** ■ Accidental uncontrolled flooding of the Vilina Cave through unidentified fissures and connections causing changes in temperature, humidity and airflow as well as changes in all recorded habitat types within CHZ2 and CHZ3.	**Yes**
CHZ3 H.1.2.1.1: H.1.1.4 st2: H.1.1.5 st2: H.1.3.2.2/3: H.3.1.1:	**Conserve biological species** **Construction Hazards:** ■ Increased risk of the introduction of alien species (see CHZ2) **Preserve favourable conditions** **Operation Hazards:** ■ Accidental uncontrolled flooding of the Vilina Cave through unidentified fissures and connections (see Zone 2)	**Yes**

SCI Interest Feature / CHZ & code(s)	Conservation Objectives, Hazards, and Consideration of SCI Feature Vulnerability, Likely Impact and Mitigation Integral to Project Design	LSE*
Middle Cave Ecosystem		
CHZ3 H.1.1.4 st2; H.1.1.5 st2; H.1.3.2.2/3; H.3.1.1: H.4.1.1:	**Conserve biological species** **Construction Hazards:** ■ Increased risk of the introduction of alien species (see CHZ2) ■ Physical and sensory disturbance of the Middle Cave through installation of the grout curtain will lead to short term, temporary and limited disturbance. (as per CHZ2 upper cave section) **Do not change cave habitat conditions** **Construction Hazards:** ■ Change in cave morphology and direct habitat loss through construction of grout curtain causing reduced access to wider cave system for endemic invertebrates. **Preserve favourable conditions** **Operation Hazards:** ■ Extensive flooding of 800m of the middle cave system terrestrial habitat, with the loss of associated invertebrate species	**Yes**

SCI Interest Feature / CHZ & code(s)	Conservation Objectives, Hazards, and Consideration of SCI Feature Vulnerability, Likely Impact and Mitigation Integral to Project Design	LSE*
Lower Cave Ecosystem		
CHZ4 H.1.3.1.1/2: flowing groundwater & standing water	**Conserve biological species** **Construction Hazards:** ■ Increased risk of the introduction of alien species (see CHZ2) ■ Physical and sensory disturbance of the Spring Cave **Operation Hazards:** ■ Direct mortality or damage – not significant **Do not change cave habitat conditions** **Construction Hazards:** ■ Change in cave morphology and direct habitat loss to Spring Cave habitat **Preserve the favourable physical and chemical conditions and water regime** **Construction Hazard** ■ Exposure to water pollution and sediment generation will be limited and mitigated by screening and isolating points of the system where construction works abut existing part of the aquatic cave system – not significant. ■ Drainage of the Spring Cave and diversion of 95% of the Ombla flow from the main channel to downstream of the Komolac weir during Year 3 via the new intake structure and bottom outlet will have an adverse impact aquatic invertebrate species in the Spring Cave. **Operation Hazards:** ■ Change in water flows and levels throughout the aquatic system will increase the extent of aquatic habitat, alter the distribution of still water and flowing water habitats, change the relative distribution of dissolved organic carbon and downstream drift aquatic invertebrate species (Great Lake) and affect flows and long term morphology of the Spring Cave.	Yes
H.3.2.1 Interstitial water habitats	**Do not change cave habitat conditions** **Construction Hazards:** ■ Direct habitat loss to of interstitial water habitats will be offset by the permanent increase in water levels.	No
Bats	**Do not change habitat conditions in caves, their overground and close by** **Construction Hazard**: ■ Drainage of the Spring Pond will lead to the temporary loss of a potentially important freshwater foraging resource for the bats of Vilina Cave. **Operation Hazard:** ■ Increase in water levels due to increased ponding of percolation waters and impeded drainage due to wider water level rises. Mitigated through the installation of drainage pipes in accordance with the Ministry of Culture decision.	Yes No

SCI Interest Feature / CHZ & code(s)	Conservation Objectives, Hazards, and Consideration of SCI Feature Vulnerability, Likely Impact and Mitigation Integral to Project Design	LSE*
	■ Possible increase in water levels due the risk of accidental/uncontrolled water level increases (exceeding installed drainage capacity) within the Vilina Cave due to flow of water from the middle cave passages through unknown connection points between the middle and upper cave system.	Yes
	Preserve the favourable conditions **Construction Hazard:** ■ Physical and sensory disturbance and habitat degradation from rising dust from construction works has the potential to lead to short term, temporary and localised effects. Restrictions prevent any works within 50m of the Vilina Cave to between November 31 to April 1st avoiding the high use and vulnerable maternity periods. A residual risk to low numbers/if any of wintering or hibernating bats remains. ■ Change in microclimate conditions within the cave system due to the construction of drainage pipes leading potential localised changes in microclimate.	Yes
	Conserve speleothems, living world caves **Construction Hazard:** ■ Changes in cave morphology may result in the increase in risk of rock falls within the Vilina Cave as a result of the works to excavate Grout Gallery III and drill through the cave to raise the grout curtain. Based on consideration of risks of cave collapse and the effects of previous activities within the cave system the occurrence of significant falls is considered improbable.	No

Note: LSE = Likely Significant Effect; for effects prior to mitigation and not addressed by the Ministry of Culture Decision (2009) of the 2010 Ombla HPP design. Mitigation for these effects is discussed in Section 6.

6 Appropriate Assessment and Counteracting Mitigation Measures

This section considers those elements of the proposed projects which could give rise to significant effects which cannot be addressed by the measures set out under the existing permitting situation. A number of these effects have been highlighted within the 2012 survey reports (refs) and the ElektroProjekt synthesis report (ref). These reports have highlighted a number of potential counteracting measures to address such effects, and these are considered within this section in more detail, alongside additional measures to counteract any residual effects.

European Commission (EC, 2000) guidance defines mitigation as "*measures aimed at minimising or even cancelling the negative impact of a plan or project, during or after its completion*". Mitigation measures form an integral part of a project and aim to minimise or cancel negative impacts on a Natura 2000 site itself. In order of preference, the possible approaches to mitigation are:

- Avoid impacts at source
- Reduce impacts at source
- Abate (reduce) impacts on site
- Abate impacts at receptor.

Table 6.1 identifies the mitigation hierarchy adopted within this section in relation to approach to identification and definition of counteracting measures.

Table 6.1: Definition of Counteracting Measures and their Hierarchy

Measures	Description
Avoidance	Avoidance measures are where effects are avoided either through a change in the design where hazards are eliminated or the pathway by which an effect can affect a feature, or through timing of specific construction works or operations that remove the pathway of a (temporary/transient) effect for features that use the area affected as part of their life cycle.
Reduction	Where avoidance measures are not possible, reduction measures are where effects are reduced in magnitude; to eliminate the significance of that effect, or reduce to a level that either reduces the risk of an effect to an acceptable level or to an extent that it will be likely to provide a measurably reduced effect.
Offsetting	Where avoidance and or reduction effects are not possible, offsetting measures will be used with the aim of providing the equivalent structure and function to that potentially lost by effects that cannot be avoided or reduced to acceptable levels. Offsetting, primarily addresses loss of habitat extent or function (with reference to the site's conservation objectives) and may only be considered as part of counteracting measures under Article 6(3) of the Habitats Directive where the offsetting measure can be undertaken with the boundaries of that site.

6.1 Construction and Operation Impacts on the Spring Cave and Water Regime Changes

In the absence of mitigation, the construction impacts due to the enlargement and change in morphology of the Spring Cave, and operational impacts of the change in water flows through the Spring cave, as described in Section 5.3.1, are assessed as leading to permanent, direct and long term adverse effects on the Cave habitat feature and the support that it provides to the CHZ4 fauna.

6.1.1 Impact Avoidance Measures

The location of the Spring Cave (in conjunction with the Spring Pond) as the main discharge point of the current cave system and the planned location for the discharge from the turbine tailrace, ecological minimum flow and overflow structure means that it would not be technically feasible to alter the present discharge point design without altering the hydraulic performance of the scheme and its ability to extract power. A change in discharge point will also possibly lead to flooding of the engine house or creating wider disturbance to the lower cave system.

There is no means of avoiding the diversion of the main channel flow that has the potential to change the provision of fine organic particulate matter to aquatic cave fauna presently found in the Great Lake. The conceptual design of the scheme requires that the main flow of water is abstracted at -50masl with water levels within the middle caves system reaching an optimum 130 masl to achieve required power output.

6.1.2 Impact Reduction Measures

A measure to reduce the impact of the change in distribution of the flow of fine organic matter within the raised column of water in the fossil caves above the Great Hall will be to install a flexible small (3") diameter pipe which runs from the inlet structure and up to the 130masl level in the middle cave system to be flooded. The pipe will be perforated at 10 m intervals to provide inputs of fine organic matter and provide a form of mixing within the permanently flooded sections of the middle cave system. This will ensure the continued flow of organic matter to species found in the upper sections of the water column.

There is no means of reducing the impact on the site or habitat within the Spring Cave, however it is possible to reduce the impact of construction works on the cave fauna found within the variety of habitats found there. The only means for doing this will be to:

1) Provide a refuge for the aquatic cave fauna that will be affected during construction.
2) Provide a range of habitat niches within the floor of the newly enlarged Spring Cave to provide shelter from the increase in discharge flow velocities from the turbine tailrace and swirling spillway tailrace.

Aquatic Cave Fauna Refuge

Prior to any works commencing within the Spring Cave, a new aquatic cave habitat will be excavated and formed to provide an equivalent range of depth, form and sediment to those areas impacted by enlargement. The physical features of the new cave will comprise:

- A non-uniform cave floor that will provide a range of niches (i.e. finer material up to boulder size rocks). Rocks and smaller stone will be laid as substrate and set out in a way that will allow future water flows to deposit natural sand and mud carried from the hinterland.
- A form that will allow for a range of water depths with the deepest sections of the cave having a depth of no less that 5m but with a range of depths above that (the depth of Spring Cave varies greatly with depths ranging from 5m to over 20m).
- An island or spit providing a terrestrial/aquatic interface would also replicate the function of the existing island in the Spring Cave.

The newly created artificial cave habitat will be in the order of 40m^2 in plan form and it will be linked to the Spring Cave habitat for 12 months allowing it to fill with water and allow for colonisation of the new cave aquatic area provided. The 12 month period would ensure that the new artificial cave is exposed to any seasonally induced flow and drift patterns. It is important that the time period covers some form of natural variability in connectivity between Ombla and other parts of the upper catchment that potentially serve as the source for the taxa. The new habitat will then be isolated from the Spring Cave system before works commence to drain the Spring Cave and enlarge it. The provision of the refuge habitat for the duration of the construction will reduce the direct loss of cave fauna species from the Spring Cave component of Ombla cave system.

The effectiveness of this measure will be monitored by biospeleogical specialists prior to the isolation of the refuge cave habitat to ensure a representative range of species of the endemic cave fauna found in the Spring Cave has colonised the new area and that the physico-chemical conditions provided are suitable. Passive translocation of species via from the Spring Cave will be the preferred means of populating the refuge habitat; however, if monitoring of the new area identifies limited success then a programme of active translocation (either pumping of Spring Cave water through the new artificial cave and / or live trapping/netting and immediate transfer) will be implemented.

Habitat Niches within the Spring Cave

Following enlargement of the Spring Cave, and prior to the commencement of operation, a range of boulders and or gabion rock mattresses will be installed around the margins of the cave to provide new habitat niches and marginal slow/dead water areas under average discharge conditions. This measure will reduce the operational impact of change in flows and reduce the extent of functional habitat lost within the Spring Cave.

6.1.3 Impact Offsetting Measures

In order to address the permanent loss of the natural conditions within the Spring Cave, the refuge cave habitat will be reconnected with the main flow of water to provide the equivalent long term conditions within the refuge cave to those found within the Spring Cave. This will ensure that the passage of drift species and flow of dissolved organic carbon, other nutrients and finer sediments will be reconnected to the remnant Spring Cave fauna isolated and protected from the construction works (Section 6.1.2). In order to do this the following measures will be taken prior to operation of the scheme.

- The refuge cave will be connected, via the enlarged Spring Cave, with a proportion of the flow from the ecological minimum flow, discharged via the main headrace – ecological min flow tunnel - swirling spillway tailrace tunnel, Figure 1.5).
- The water flow conditions within the new cave will be of minimal flow velocities under normal conditions in the majority of the new wet cave area through means of a siphoning arrangement (e.g. a siphon pipe and/or baffle and weir arrangement) that connects the flow from the ecological minimum base flow in the spring cave to the new cave. This would also ensure that there is flow of nutrients/carbon would flow through the cave as well as the drift species.
- The new cave will discharge via an overflow pipe to the Spring Cave to ensure the water body does not stagnate.

The new cave will be of artificial origin and will provide $40m^2$ and 5m of equivalent passage length of permanent aquatic habitat relative to the $2100m^2$ area and 70m of equivalent passage length of Spring Cave aquatic habitat that will be subject to the enlargement and simplification.

6.1.4 Residual Effects and Uncertainty

The effectiveness of the artificial cave habitat as a refuge during construction will be dependent on the extent to which the new habitat can be colonised before it is sealed off from the works to drain and enlarge the Spring Cave. It is likely that there will still be some loss off water taxa, which in any case is a natural part of the regime where cave fauna are entrained in the main channel flow and flushed out into the Spring Pond. However, the risk of the loss of vulnerable species will be significantly reduced. The effectiveness of this measure can be monitored prior to the commencement of works, whilst active relocation of water taxa may also be possible between the spring cave and the adjacent offset habitat area.

Water regime changes upstream of the grout curtain are a source of inherent uncertainty due to the scale of the change in the 800m of permanently flooded middle cave passage. Mitigation to feed a small proportion of the main hinterland inflow via a flexible pipe from the main intake to the higher sections of the flooded cave passage seeks to address this uncertainty. The principle of this mitigation is proven to work in reservoirs where physico-chemical stratification of the water column causes water quality problems. However it is untested in subterranean environments and its effectiveness cannot be fully ascertained in advance of monitoring. There would be a higher degree of uncertainty over the effects on aquatic fauna due to the change in the water regime without this mitigation in place. However, with mitigation in place, although some uncertainty remains, the effects can be monitored through water quality and invertebrate taxa sampling. The mitigation also provides some flexibility to provide the optimum water flow to the newly formed aquatic habitat as the diameter of pipe and perforation intervals and aperture size can be adapted in the event that monitoring indicates a reduction or change in taxa.

The creation of the artificial aquatic cave habitat will permanently offset (by around 2%) some of the loss of the Spring Cave habitat. However, when considered in conjunction with measures to provide additional habitat niches within the enlarged Spring cave and the increase in the aquatic still water zone (CHZ4) by 800m of aquatic cave passage in the wider cave system behind the Grout Curtain, it is likely that the cave system will continue to provide suitable habitat for all of the water taxa identified. It should be noted that some uncertainty remains due to the limited research and understanding of the lifecycle of many the endemic aquatic species.

6.2 Habitat Loss Due to Grout Curtain and increased water levels in the Middle Cave System

In the absence of mitigation, the construction impacts due to the bisection of three middle caves passages by the grout curtain (with a loss of 15m of passage length, and the operational impacts due to water level (flooding) and drainage changes affecting 800m of cave passage, as described in Section 5.3.1, are assessed as leading to permanent, direct and long term adverse effects on the Cave habitat feature and the support that it provides to the CHZ3 fauna.

6.2.1 Impact Avoidance Measures

There are no means of avoiding the loss of the middle cave habitats that will be lost during construction and flooded during the operation of the scheme. The conceptual design of the scheme requires a sufficient head of water within flooded karst conduits between the levels of 130 masl and 75 masl to operate effectively.

6.2.2 Impact Reduction Measures

In order to reduce the immediate impact on cave fauna found within the middle cave system, the water level behind the grout curtain will be raised slowly over the course of a month to allow non sessile cave fauna to move. Observations by the CBS noted that in the lower – middle cave system (for example, within the Great Hall) cave fauna appeared to be resilient to seasonal flooding. However the gradual increase in levels will not reduce the permanent loss in extent of suitable cave habitat for cave fauna found in the CHZ3.

6.2.3 Impact Offsetting Measures

In order to offset the loss of the structure and function due to flooding of cave habitat that supports terrestrial endemic species of cave fauna, the scheme will provide alternative habitat in close proximity to the habitat lost and within the boundary of the proposed SCI.

This will be achieved through the conversion of the grouting galleries to provide a new extent of subterranean habitat that provides the attributes/environmental factors necessary to replace the structure and function of the habitat lost to flooding. The dimensions of Grout Gallery II are 3.2m wide and 3.9 high whilst the dimensions of Grout Gallery III varies between 3.2m wide and 3.9m high and 4m wide and 5m high. Both of the galleries are horseshoe shaped.

The habitat will be designed and managed to ensure that it will embody the following environmental attributes:

- Limited organic inputs - CHZ3 Habitat type are relatively limited by carbon inputs, being the areas of the cave system less favoured by bats, whose guano deposits form the main source of organic inputs in the CHZs 1 and 2 Habitat areas in the upper cave system.
- Niche habitats provided by karst morphological features such as fractures, crevices, boulders, ponded water and finer sediment deposits. This will be replicated within the body of Grout Galley II and Grout Gallery III, by physical forming of the internal surfaces once the grout injection has been successfully completed. The walls of the grout galleries will be unlined where rock stability and safety requirements allow, therefore some integral fractures within the gallery walls will already exist. Additional niches will be formed through the deposit of rocks and boulders of varying sizes and arrangements (as specified by biospeleological specialists during detailed design) to provide equivalent habitat types to those lost to flooding. Areas of standing water will be provided through adaptation of the tunnel drainage channels

which will be graded out and dammed to allow shallow accumulations of percolation water to form. A number of the shallow standing water areas will be lined with stones whilst others will be left unlined to allow for a variety of percolation water habitats to form.

- Darkness, no disturbance – The new grout gallery habitats will be isolated from human access under normal conditions. Grout Gallery II is unlikely to be subject to the need for maintenance visits following successful commissioning of the scheme and therefore can be closed to operational staff. Grout Gallery III provides access to the access tunnel to the vertical shaft and swirling spillway headrace tunnel (Figure 1.5.) and so some infrequent access for maintenance checks and repairs may be required. This can be achieved via access from one entrance of Grout Gallery III allowing access via the remaining entrance to be closed to allow for minimal disturbance along the remaining 50% of the Grout Gallery III length. The grout galleries will not be lit.
- Stable microclimatic conditions (Ave Temp varying by location 14.8°C – 15.6°C, ≤100% RH). The close proximity to the existing cave system will allow for the grout galleries to naturally develop the same microclimatic conditions as the caves being flooded, provided the entrances to the galleries are sufficiently narrowed or closed off from the surface airflows and, in the case Grout Gallery III the Access tunnels from the vertical shaft and swirling spillway. This will be achieved through appropriate gating of the gallery entrances and installation of interim gate/baffle structures, under supervision from biospeleological and bat specialists (see Section 6.7).
- Continued seepage and natural connections with adjacent karst habitats will be achieved by ensuring that the majority of the tunnel walls and ceilings remain unlined. It is likely that percolation water (from rainfall) will continue to discharge into the grout galleries following their completion.
- Connections with existing and future terrestrial cave habitats will provide for the natural colonisation of the new grout gallery habitats by the cave fauna found within the middle and upper cave system. This will be achieved in the main by keeping the walls of the caves un-lined to allow for colonisation of the habitat through minor conduit and fractures. Consideration will also be given to the creation of a narrow connection where Grout Gallery II is found in close proximity to the middle cave system (see Figure 6.1). However, if connections are made they will need to implemented in such a way as to lead to no measureable change in the microclimate of the middle cave system (i.e. by lining the entry and exit points with brushes or filaments to limit change in air flow).

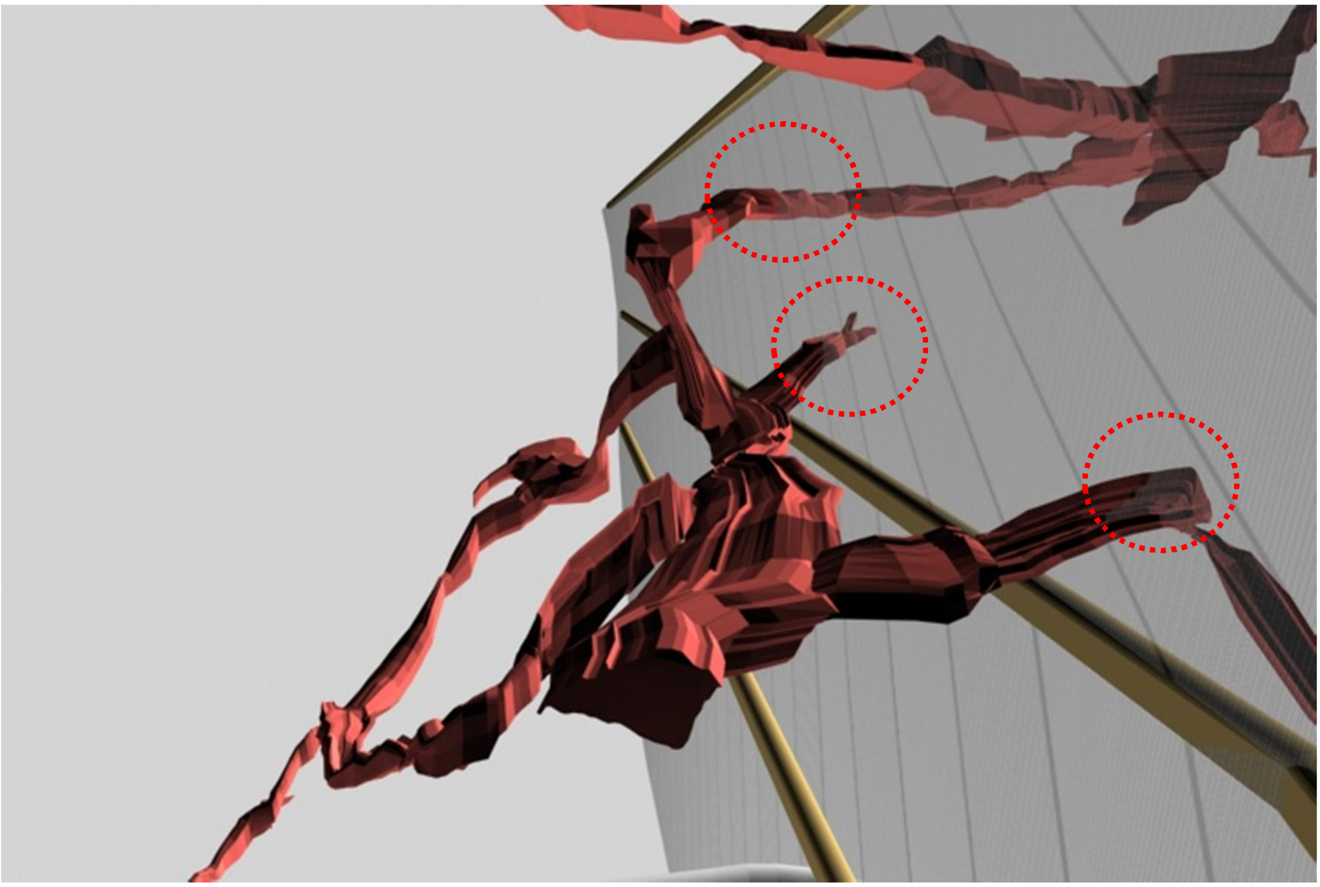


Figure 6.1: Connection Points between the New Grout Gallery Habitats and Existing Middle Level Cave System

To be most effective the creation of the new habitat will precede the functional loss of the middle cave system by flooding. Provision of the new habitat 12-18 months prior to testing of the third stage of the grout gallery (raising water levels between 50m.asl and 130m.asl) will provide cave fauna the opportunity to colonise the new habitat extent.

The effectiveness of the offset habitat over the long term will depend on the implementation of sensitive habitat design and management measures that will provide equivalent form, function and extent of the habitat subject to flooding behind the grout curtain. There are important parallels that can be considered within the existing system that indicate the creation of the new habitat can continue to provide the structure and function required to maintain the favourable conservation status of endemic terrestrial cave fauna within the Vilina-Ombla system.

- The Vilina Cave system has been exposed to blasting in the past, it is considered likely that this opened up a greater area of use by bats. CHZ2, where the blasting occurred in the past recorded the presence of a comparable species diversity and endemism to CHZ3.
- Surveys of the exploratory tunnel, linking the Great Hall to the exterior survey, recorded the presence of 5 species (compared with 18 and 12 species found in H.1.1.4 and H.1.1.5 habitats in CHZ3), including 1 endemic to south Dinaric regions without the presence of any habitat creation within the interior. It should also be noted that the tunnel is prone to periodic seasonal flooding which limits its potential to support greater numbers of species.

A review of available literature on analogous situations elsewhere also supports the principle.

Isaia *et al* (2011) undertook a comparative study on the biodiversity and conservation value of abandoned mines and a natural cave in the north western Italian Alps. The results of the study indicated that:

"*artificial subterranean habitats sometimes show the same peculiarities as natural subterranean ecosystems, hosting important populations of subterranean short-range species, and they should be considered as equivalent*".

The study also noted that:

"the *ecological optimum for the most sensitive and ecologically important taxa is determined by low thermic variability (high environmental stability), relatively cold temperatures and intermediate conditions of eutrophy* (from external organic inputs)...... *In contrast, valuable steno-endemic species are missing in conditions of thermic instability, higher temperatures and higher eutrophy* (from the introduction of too much organic matter)."

This recognises the potentially significant value that artificially created subterranean systems provide, however the EC guidance clearly defines that the designated habitat of *"Caves not open to the public"* is a "natural habitat type" (EC, 2007). When applied by member states in reporting on the favourable conservation status of this habitat type within the EU, it is clear that the extent of such habitat types cannot include artificially created caves (JNCC, 2007). Therefore, under the Habitats Directive, the offsetting of impacts can only be applied to species found within the cave system and not be used to offset the loss of the extent of the middle cave habitat itself, even if the overall goals of the Habitat Directive regarding protection of biodiversity are achieved.

As noted in Section 6.4, the movement of materials to make the new habitat niches (boulders, smaller stones etc.) will increase the risk of introducing non cave dwelling species into the new habitat area and the wider cave system. Therefore bio security measures including a materials management plan will need to be implemented to reduce this risk to an acceptable level (further detail is provided in Section 6.4).

Over the long term the provision of this new habitat will provide approximately 1300m of gallery habitat in Grout Gallery **II** and up to 650m of undisturbed gallery and 650m or periodically (once a year) disturbed gallery habitat in Grout Galley **III** (taking into account the requirement for maintenance access). The potential for additional enhancement measures for bats in Grout Gallery **III** is considered in Section 6.7 but could provide for around 200m of potential roosting habitat. This provides a potential net increase in extent of potential habitat that will provide equivalent support to the ecological communities and species impacted by the flooding of CHZ3 cave fauna as set out Table 6.2.

Table 6.2: Losses and Gains of Middle Level Terrestrial Cave Habitat with Offsetting Mitigation in Place.

Scenario	Cave/Gallery Passage Length (m)
a) Existing Terrestrial Upper and Middle Level CHZ3 Cave Habitat Length	2660
b) Existing Terrestrial Middle Level CHZ3 Cave Habitat Length	1400
c) Loss of CHZ3 Middle Level Habitat to Grout Curtain Footprint	-15
d) Loss of CHZ3 Middle Level Habitat to Permanent Flooding	- 800
e) Terrestrial Middle Level CHZ3 Cave Habitat Length under HPP operation (water level 130masl)	585 (b – c - d)
f) Terrestrial Upper Level CHZ3 Cave Habitat Length under HPP operation (water level 130masl)	1260 (a – b)
g) Mitigation (offset) refuge habitat length provide by Grout Galley **II**	≤+1300
h) CHZ3 Habitat Extent plus additional refuge habitat (Grout Gallery **II**)	≤3145 (e + f + g)
i) Mitigation (offset) Habitat length provide by Grout Galley **III**	≤450*
j) Available equivalent CHZ3 Habitat Extent / Change from Existing	≤3595 / ≤+935) (h+j / h+j – a)

(Note *650m – 200m bat roosting habitat); This does not take into account the risks of upper level cave habitat changes due to uncontrolled flooding (See Section 6.3)

6.2.4 Residual Effects and Uncertainty

The loss of cave habitat is an unavoidable effect that cannot be reduced due to the conceptual design of the proposed Ombla HPP. However, the creation of offset terrestrial subterranean habitat of equivalent structure and function will lead to a net gain in equivalent passage length of suitable habitat area with the potential to support all of the cave fauna recorded within the Ombla caves system.

This offset measure is untested in this particular circumstance, having no known precedent due to the unique nature of the proposed scheme and the nature conservation value of the site. However, it should be noted that artificial subterranean habitats throughout the EU (i.e. mines and tunnels) are known to provide comparable levels of support to cave fauna, provided the microclimatic and physical conditions provided replicate natural conditions. In time (over the long term) such artificial habitats may even develop speleoethems (Isaia, 1999; Pers. Comm Dr. P. Wood and Prof J. Gunn). Therefore in the long term there is no reason why such an offset habitat should not provide equivalent permanent habitat. It should be noted that the time taken to colonise the habitat and the degree to which the new gallery habitat in the short term will provide a simplified equivalent needs to be taken in to account when considering whether such habitats provide equivalent structure and function to those habitats submerged through flooding (see Section 7).

Monitoring by biospeleological specialists will be required to determine whether the speed of colonisation is deemed to be sufficient to enable a representative sample of the target species to be detected in the new gallery habitat. Where the rate of colonisation is deemed to be too slow, consideration will be given to a programme of trapping and translocation of species and or substrates from the middle cave to the newly created gallery habitats.

6.3 Risk of Accidental of Flooding of the Vilina Cave

In the absence of mitigation, the risk of accidental flooding of the Vilina Cave due to operation of Ombla HPP, as described in Sections 5.3.1 and 5.3.2 has the potential to have direct, permanent and long term effects on sections of the Vilina cave that support CHZ2 and CHZ3 habitats of the Caves feature and all bat species features.

6.3.1 Impact Avoidance Measures

In order to manage the risk of uncontrolled flooding due to the passage of water through unidentified connections the following procedure will be followed:

- The water levels behind the third stage of the grout curtain will be raised slowly (a minimum 30 day period is anticipated), with associated increases in level and pressure monitored extensively throughout the system (as per mitigation noted in 6.2.2).
- In the event that there are signs of seepage within the Vilina Cave due to the increase in water levels through fissure, cracks or conduits the operation of raising the water level within the rock mass will cease and the water level reduced under gravity through the bottom outlet. The control over water levels behind the grout curtain is responsive to water level management control within minutes, ensuring that a lag between the identification of a connection from the middle level into the higher Vilina Cave will not lead to unavoidable short impacts due to flooding.
- Further to the lowering of the water level and identification of possible connection points, directional drilling and the injection of concrete grout will be undertaken to form a grout seal in the rock mass (filling voids, fractures and fissures that are the leakage source) between the connection point and the Vilina Cave. Injection will be performed from the Grout Gallery III (see Figure 6.2).

In the event that connections cannot be sealed, the water levels will be reduced to a level which ensures that the Vilina Cave will not be flooded.

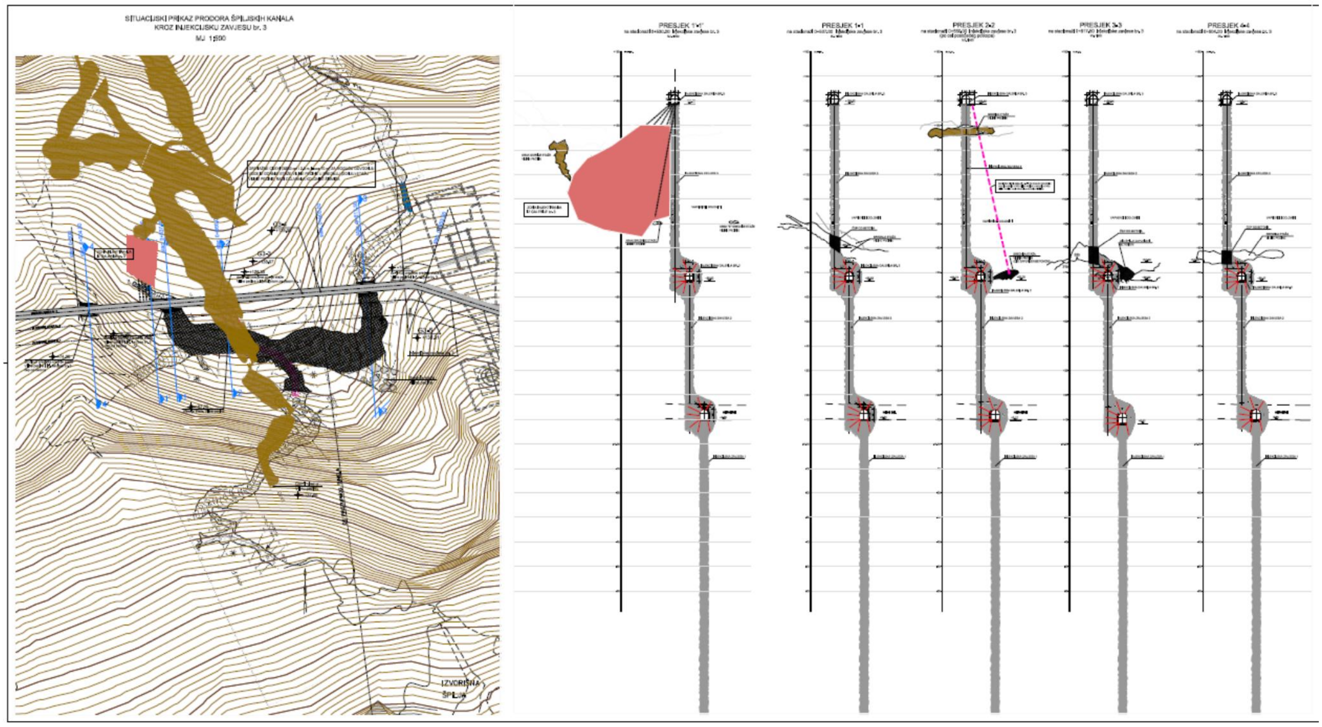


Figure 6.2: Proposed Method of Sealing Potential Conduit and Fracture Connections between the Middle Level Caves System and Vilina Cave. (Source: ElektroProjekt)

The successful implementation of the mitigation measures proposed will avoid impacts associated with accidental flooding of the Vilina Cave. Further impact reduction or offsetting measures are therefore not required.

6.4 Increased Risk of the Introduction of Alien Species

In the absence of mitigation, the increased risk of the introduction of the alien species due to the construction of the scheme is assessed as having the potential to lead to indirect, permanent and long term effects on potentially all features of the site.

6.4.1 Impact Avoidance Measures

The risk of occurrence of an action or event that leads to the introduction of an alien species can never be fully avoided, however measures to reduce that risk to an acceptable level can be implement in accordance with good practice guidelines. These are set out in Section 6.4.2.

6.4.2 Impact Reduction Measures

In order to reduce the risk of the introduction of alien species, including non endemic invertebrate, fungus and bacteria, a detailed biosecurity management plan will be produced by the contractor in close co-operation with the biospeleology and bat specialists species to prevent the introduction and spread of unwanted and potentially hazardous organisms. The biosecurity management plan will set out procedures to manage:

- The risk of organisms being brought to site by materials (imported and/ or stockpiled externally) used in construction of the project
- The risk of organisms being brought to site on plant, delivery vehicles and by construction personnel
- The risk of organisms being brought to site by visitors

Specific measures will include:

- Provision of appropriate protective clothing and welfare facilities (showers and wash facilities, disinfectants etc.) for personnel to decontaminate before and after periods of work within subterranean areas;
- Provision of vehicle check points prior to site entry and washdown areas
- Provision of suitable clothing (overalls and boots etc.) to visitors or infrequent personnel visits
- Provision of toolbox talks and information to all staff and visitors prior to entry to subterranean areas
- Increased risk of introducing alien species - Clean vehicles and hygiene at entrance points

6.5 Change in Water Level in the Spring Pond and Change in Freshwater/Prey Availability

In the absence of mitigation, the change in water levels outside of the cave system and change in freshwater/prey availability due to the drainage of the spring pond, as described in Section 5.3.2, will have potential construction impacts that are assessed as indirect, temporary and of short to medium term duration.

6.5.1 Impact Avoidance Measures

In order to avoid the loss of the feeding and freshwater resource of the Spring Pond during the Spring and Summer (maternity) periods when the bat populations are most vulnerable drainage of the Spring Pond to its lowest levels will take place during the period of 31st November to 1st April, provided favourable spring discharge and weather conditions allow.

6.5.2 Impact Reduction Measures

Where weather or spring discharge conditions do not allow for the drainage of the Spring Pond with the period 31st November to 1st April a constant area of fresh water cover of 25m^2 will be maintained to ensure a sufficient freshwater resource and feeding habitat is provided. In the event that this measure is required, monitoring of the bat use of the Spring Pond will be undertaken by qualified bat specialists. This will be compared against pre construction bat foraging surveys (see Section 9 for further details).

6.5.3 Residual Effects and Uncertainty

Due to the absence of any data on the use of the Spring Pond by bats, there is uncertainty over the reliance/importance of the Spring Pond to bat populations. Therefore if works are considered to be required outside of the November to April period, they should only be undertaken if pre-construction monitoring (specific to drainage of the Spring Pond) is undertaken and it is shown that the reliance of the bat colonies on the Spring Pond is insignificant relative to other sources of freshwater and forage habitat within 2km of the Vilina Cave entrance.

6.6 Disturbance of Bats and Risk of Microclimate Change in the Vilina Cave

In the absence of mitigation, construction disturbance impacts due to drilling of Grout Galley III and drilling, injection of the third stage of the grout curtain and installation of drainage pipes within the Vilina cave as described in Section 5.3.2, are assessed as leading to potential direct, temporary and short term effects on the bat fauna supported by BUZ2 during the Winter period. The operation impact of a change in microclimate due to the installation of drainage pipes in the Vilina Cave has been assessed as direct, permanent and having a long term effect on habitat that support bats species in BUZ2.

6.6.1 Impact Avoidance Measures

In order to avoid the potential residual risk of disturbance to hibernating species, pre works checks will be undertaken for winter roosting bats which will be made within 50 metres of the works to the Vilina Cave. If roosting bats are found in significant numbers (i.e. >10 individuals), the works will need to be delayed until it is confirmed by competent bat specialists that works can commence without significant disturbance to the roosting bats identified. Where winter roosting bats are found, they will be encouraged by none invasive methods to move to sections of the cave that will not be disturbed by the works within 50m of the Vilina Cave passage. Where significant numbers of bats in torpor/hibernation are found they will need to be left undisturbed until they move of their own accord.

The potential adverse impact on the change in microclimate within the Vilina cave due to the installation of drainage pipes to the middle cave system will be mitigated by the fitting of automatic valves to the pipes to ensure they only operate when drainage is required. This will avoid potential changes to the microclimate from a change to air flow both in the Vilina Cave and the middle cave system.

6.7 Summary

A summary of the adverse effects for which mitigation measures have been identified and where relevant residual risks identified are presented in Table 6.3.

Table 6.3: Summary of Adverse Effects, Mitigation and Residual Risks, Uncertainty and Effects

Adverse Effect	Counteracting Measures	Risks, Residual effect, and Outline Monitoring and Contingency Plan Requirements
Potential reduction in flow of dissolved and fine particulate organic carbon in the water column between 130 masl and 0 masl in the flooded fossil cave system	■ Installation of a small diameter flexible perforated pipe connecting the main channel inflow at the intake structure and the flooded cave system will provide inputs of dissolved or fine particulate matter and mix the water column.	There would be a high degree of uncertainty over the effects on aquatic fauna due to the change in the water regime without this mitigation in place. However, with mitigation in place, although some uncertainty remains, the effects can be monitored through water quality and invertebrate taxa sampling. The mitigation also provides some flexibility to provide the optimum water flow to the newly formed aquatic habitat as the diameter of pipe and perforation intervals and aperture size can be adapted in the event that monitoring indicates a reduction or change in taxa.
Enlargement of the Spring Cave leading to loss of water taxa present within the Spring Cave and wider system	■ Creation of a new artificial cave adjacent to the Spring Cave and creation of a temporary connection prior to enlargement of the Spring Cave. The new cave will provide a refuge for stygobionts within the Spring Cave during construction and reduce the number of taxa lost through draining of the cave and subsequent excavation work. ■ During operation the new artificial cave will offset the loss and simplification of the aquatic habitat that provides support to aquatic invertebrates within the Spring Cave. During operation diversion of a proportion ecological minimum flow through the new artificial cave connected to the Spring Cave which will simulate the conditions.	Some loss off water taxa may still occur, however, the risk of the loss of vulnerable species will be significantly reduced. The effectiveness of this measure can be monitored prior to the commencement of works, whilst active relocation of water taxa may also be possible between the spring cave and the adjacent offset habitat area. The new cave will be artificial origin.
Diversion of main flows through the Spring Cave and simplification of Spring Cave habitat.	■ Provision of habitat niches within newly excavated Spring Cave and peripheral dead/slow flow water areas. ■ Permanent ecological minimum flow connection to new artificial cave via slow flow siphon.	The creation of the artificial aquatic cave habitat will permanently offset some of the loss of the Spring Cave habitat. When considered in conjunction with the increase in area and volume of the aquatic still water zone (CHZ4) it is likely that the cave system will continue to provide suitable habitat for all of the water taxa identified, although some uncertainty remains due to the limited research and understanding of the lifecycle of many endemic species.

Adverse Effect	Counteracting Measures	Risks, Residual effect, and Outline Monitoring and Contingency Plan Requirements
Flooding of middle cave passages during commissioning and operation of the grout curtain	■ Minimise effects by a gradual increase in water levels over a 30 day period to allow non aquatic species to move to higher cave habitats. ■ Offset habitat losses due to the footprint of the grout curtain and hydropower infrastructure and the flooding of middle level caves through the creation of suitable conditions for endemic terrestrial cave fauna.	There will be uncertainty over the speed of colonisation within the newly formed gallery habitat. Monitoring will be undertaken on a monthly basis by biospeleogial specialists. Where colonisation appears to be too slow a translocation programme will be considered. (see Section
Uncontrolled flooding of the Vilina cave	■ Avoid the impact by gradual raising of water levels and monitoring of potential connection points to the Vilina Cave. Where connections are found the water levels will be reduced and the connections grouted by directional drilling from the grout curtain galleries (to avoid entering Vilina Cave) ■ Where this mitigation is not deemed effective in protecting the Vilina Cave from flooding water levels will be reduced during operation to a level that avoids flooding of the Vilina Cave.	**No significant adverse effect**
Risk of disturbance of hibernating bats during works within 50m of the Vilina Cave	■ Undertake preconstruction surveys and pre works checks and cease work if >10 individual roosting bats are found with 50m proximity until a bat specialist has evaluated the risk and confirmed that works can continue.	**No significant adverse effect**
Change in the water level of the Spring Pond during construction leading to loss of bat freshwater prey and water source.	■ Undertake works necessary to drain the Spring Pond during the period 31st November to 1st April, where possible. ■ Where works to the drain the Spring Pond are required outside of the November to April period, provide a constant water surface area of 25m^2.	There is uncertainty over the reliance/importance of the bat population on the Spring Pond. Therefore where works are required outside of the November to April period monitoring of bat usage of the 25m^2 water area should be undertaken to ensure it is effective.
Increased risk of the introduction of alien species	■ Bio-security management plan and measures to ensure risk is reduced to an acceptable level in line with good practice guidelines.	**No significant adverse effect**
Change in microclimatic conditions	■ Minimise any residual effect caused by the installation of drainage pipes at the lowest part of the sloping hallway by fitting pipes with one way valves to avoid risk of changing air flow within the Vilina Cave.	**No significant adverse effect**

6.8 Enhancement Measures

The potential for the provision of habitat and species enhancement measures has been considered in addition to mitigation to avoid, reduce and offset effects on the proposed SCI site. As noted in Section 6.2.3 there is significant potential to provide a long term enhancement to the available habitat for bat species within the boundaries of the proposed SCI through the creation of suitable conditions within the first 200m of each entrance Grout Gallery III where light can be completely excluded (i.e. through the provision of suitable gates of internal barriers).

It should be noted that it will not be possible to identify the specific roosting requirements for individual bat species. This is because social interaction between individuals of the same species and between species is likely to play a key part in roost selection (Pers.Comm. S. Markham) as well as the physical environmental and biological factors that influence the choice of roosting site.

The following considerations have been made to provide for an increase in the extent and access to suitable spring, summer and winter roosting habitat in Grout Gallery III for the species of bat found within the Vilina cave.

- **Access**: Measures will be put in place to ensure that bats are able to enter the gallery from their foraging areas without disturbance, with a clear flight line and no other barriers such as lighting, power lines or unsuitable gates. Access to unauthorised persons will also be controlled by suitable exclusion areas (see below).
- **Shape of Void**: The gallery will be constructed as a regular horseshoe shape with some enlarged sections (to accommodate the directional drilling above the Vilina Cave. Construction of two to three larger irregular spaces within the gallery with smaller voids within their surface will provide an effective means of providing preferable microclimate conditions for maternity colonies and bat hibernation. In Croatia, large maternity colonies are recorded in larger spaces - on the ceilings of tunnels (e.g. Tunnel 1 and 3 near the village Mihanići) or in larger halls that might be close to the entrance of the caves (depending on microclimate conditions within the cave and species microclimate requirements).
- **Internal Surface:** The artificial tunnel when constructed should have a rough surface suitable so that bats can find a suitable place to hang/roost. A proportion of the surface texture should be as similar to the texture of preferred roost locations in the Vilina cave as possible. In addition, a range or different surfaces should be tested (i.e. detachable rough canvas coverings). Colonies are likely to form on the ceiling of the gallery or enlarged sections and it will be necessary to provide cracks and crevices for individuals or small groups of bats (to take refuge). For this, piling rocks, clay bricks (with holes), cut crevices (of varying widths into the rock face – done with a grinder or drill) and bat houses may be used. These cracks should be available for bats to use on various heights and be made as deep as possible.
- **Air Flow**: At least one end of the gallery should have a restricted air flow as set out in EUROBATS Guidance (Publication Series 2) The management of airflow through the cave/tunnel will be considered carefully; with the potential use of internal partial barriers would create variation in the micro-climate in the uniformly shaped section of the gallery. Detailed design of internal barrier will be undertaken by qualified bat specialists initial introduction of internal barriers will be temporary to determine the best configuration. In addition, varied slopes in caves help to create a varied climate. The enhanced grout gallery should aim to have a varied rock floor surface, so that it mimics the fossil cave (but is still safe to walk into].
- **Access to Water**: It will be important to provide access to permanent water surfaces within the gallery (a pond). Therefore damming and grading out of the grout gallery drainage channels can provide small shallow pools to form.
- **Protection from Disturbance**. The length of tunnel; from the point where bats enter the cave/tunnel to areas designated for bat use, will be managed so disturbance is minimised. This will be documented in a more detailed management plan following completion of the construction works. It should be noted that the bats could roost anywhere in the cave/tunnel from the entrance to the areas designated for bat use. The addition of grills/ or other barrier to prevent access and disturbance by people should be included from the outset.

- **Monitoring**: A program of monitoring as set out by the management plan will form an integral part of the gallery bat habitat design. Monitoring will be systematic and include temperature, humidity and bat use (species/abundance/location/time of year).A budget should be set aside so that alterations to the cave/tunnel can be made in response to monitoring results (e.g. to the air flow in the cave/tunnel).

There remains some of uncertainty over the degree to which the existing bat population of the proposed SCI will use newly created and formed bat galleries. There are few examples of caves designed especially for bats and projects are still in an experimental phase. However, it should be noted that:

- Many bat roosts have been created unintentionally (they create the right environment e.g. temperature and humidity underground in an area that already has many bats).
- One of the largest bat roosts in Europe is man-made Nietoperek in Poland;
- In the UK most mines (now abandoned) are used by bats because the surrounding habitat and the roosting habitat that the mines provide are suitable.
- In the local context (see Table 4.7) the tunnels near the village of Mihanići provide significant support to colonies of all the bats features of the Vilina Cave.

The newly created bat galleries at Ombla will be in a location that already has a population of bats and the gallery will have a temperature and humidity similar to the natural fossil caves. It should be noted that immediate success should not be anticipated as it is likely to take a period of time for bats to become familiar with and utilise the new galleries.

7 Assessment of Effect on Site Integrity

7.1 Consideration of Site Integrity

The integrity of a site can be defined as "the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitats, complex of habitats and/or populations of species for which it was classified" (Tyldesley, 2011). An adverse effect on integrity is likely to be one that prevents the site from maintaining at least the same contribution to favourable conservation status (as defined in the EU Habitats Directive) for the relevant feature as it did at the time of its designation.

The assessment, therefore, determines if any of the hazards have the potential to adversely affect the achievement of the conservation objectives of any European Interest Feature, either directly or indirectly through an effect on the ecological structure and/or function of the site, either alone or in combination with other plans and projects. Where relevant, the assessment takes into account the mitigation measures included as an integral part of the 2010 scheme design referred to in Section 5, and the proposed measures to avoid, reduce and offset effects defined in Section 6.

To provide context to consideration of potential effects on site integrity Table 7.1 provides summary of the likely permanent change in functional habitat extents within and adjacent to the existing Vilina Cave – Ombla Spring System and within the proposed SCI boundary following completion of the scheme.

Table 7.1: Summary of Cave Fauna Habitat Extents (Passage Length, m)

Cave Habitat Zone (CHZ)	Existing	Habitat Loss	Habitat Gain (in Natural System)	Existing Cave System with HPP	Offset / Enhancement	Total under HPP	Net Change
CHZ1 (H.1.1.1:& H.1.1.2)	10	0	0	10	0	10	0
CHZ2 (H.1.1.3: H.1.1.4 st1: H.1.1.5 st1) (Optimum Bat Roosting habitat)	390	0	0	390	≤400* (e)	≤790*	≤+ 400*
CHZ3 H.1.2.1.1: H.1.1.4 st2: H.1.1.5 st2: H.1.3.2.2/3: H.3.1.1: (Potential Bat Roosting habitat)	2660	-15 (a) -800 (c)	0	1845	≤1750* (f)	≤3595*	≤+935*
CHZ4 H.1.3.1.1/2: flowing groundwater & standing water	170	-70 (b)	+ 800 (c) + 650 (d)	≤1550	5*(g)	≤1555	+1335
CHZ5 H.1.3.1.1: flowing groundwater	750	-50 (a) -650 (d)	0	50	0	50	-700

Key:

*Figures quoted refer to habitat suitable for endemic cave fauna, it does not refer to habitat that necessarily qualifies as the Caves not Open to the Public (which are natural in origin):

(a) Permanent footprint losses due to construction of the grout curtain;

(b) Habitat simplification and connection with open air at Spring Cave;

(c) Permanent flooding;

(d) Conversion of fast flowing channel to slow flowing/still water aquatic habitat;

(e) New bat galleries created in Grout Gallery III;

(f) New cave invertebrate habitat created in Grout Galleries II and III;

(g) New artificial cave adjacent to Spring Cave

7.2 Assessment of Effects on Site Integrity

Information on the HPP's predicted impact on the integrity of the site is provided in Table 7.2

Table 7.2: Predicted Impact on the Integrity of the Site

SCI Interest Feature / Habitat zone (CHZ) & code(s)	Consideration of the Scheme Impacts and Mitigation on the Integrity of the Proposed SCI
Habitats Features: Caves not open to the public	
CHZ2 H.1.1.3: H.1.1.4 st1: H.1.1.5 st1	■ **Extent:** During construction the extent of the CHZ2 Habitat will not be significantly disturbed. During operation of the hydropower plant, the risk of uncontrolled flooding due to percolation will be mitigated by the installation of drainage pipes and measures to control flooding from rising water described in Section 6. Enhancement measures to create suitable bat roosting areas within Grout Gallery III are likely to provide an increased equivalent extent to this habitat type, due to the invertebrate community's associated with bat guano, following the completion of the scheme and into the long term. However, the man made nature of this habitat will not provide an extension to the Cave feature due to its artificial origin. ■ **Structure:** There may be localised permanent loss in some of the features of the caves morphology due to the physical disturbance of the works, however this is unlikely to adversely affect the populations of endemic cave fauna that are likely to be widely dispersed and dependent in large part within this section of the Vilina Cave on the input of organic matter from roosting bats, the thermal stability and refuge from disturbance that the cave environment provides. ■ **Function:** Despite some short term temporary impacts it is considered that the scheme will not adversely affect the function of this habitat type. Provision of an additional bat roosting habitat within parts of Grout Gallery III has the potential to contribute to the favourable conservations status of the bat species of the proposed SCI.

SCI Interest Feature / Habitat zone (CHZ) & code(s)	Consideration of the Scheme Impacts and Mitigation on the Integrity of the Proposed SCI
CHZ3 H.1.2.1.1: H.1.1.4 st2: H.1.1.5 st2: H.1.3.2.2/3: H.3.1.1:	■ **Extent:** The extent of the existing natural terrestrial cave habitat types within CHZ3 will be significantly reduced by the permanent rise in water levels within the cave system due to the operation of the HPP. Mitigation for the impact on the endemic cave ≤1300m of offset habitat length within the Grout Gallery II will be provided 12-18 months before an increase in water levels between 55masl and 130masl where the majority of the 800m of middle cave habitat are expected to be lost. This will provide for over twice the extent of the habitat lost. An additional ≤450m of offset habitat length within the Grout Gallery III following testing and completion of the grout curtain. However, the man made nature of this habitat will not provide an extension to the Cave feature due to its artificial origin. The offset habitat will provide refuge for endemic cave fauna to ensure that the existing populations can be sustained within terrestrial cave habitats that remain. ■ **Structure:** There will be a change in the structure of all the cave habitats found within the habitat bisected by the grout curtain and the permanently flooded section of the cave habitat. The new offset habitat will take a period of time to provide the full range of attributes that are present in the middle cave habitat that will be permanently flooded. However, it will be possible to ensure that the abiotic attributes of stable microclimatic conditions (Ave Temp varying by location 14.8^{o}C – 15.6 ^{o}C, ≤100% RH) and darkness and no disturbance are provided. Appropriate gating of the gallery entrances and use of internal barriers to regulate air flow. A suitable period for trial and adjustment of internal structures supported by monitoring of microclimatic conditions to ensure the right conditions are provided in the 12-18month period before water levels are raised behind the grout curtain. The provision of a variety of substrates (stone, rocks boulders and finer sediment) and habitat niches (shallow scrapes dammed drainage channels etc.) will provide for the equivalent variation in form encountered within the existing have system. The habitat (at least in the short term) will be a simplified version of the existing habitat; however, the provision of artificial habitat in the ration of over 2:1 will provide suitable refuge habitat. Input of organic carbon is limited in these systems, therefore the initial absence of organic inputs it is not likely to be a significant factor in determining the effectiveness of the offset habitat (it is also possible that bats will use this habitat as well as providing limited and dispersed organic inputs). ■ **Function:** The function of the existing middle cave habitats will be altered permanently. The effectiveness of the offset habitat will be uncertain, most notably in the short term, in the period between when the middle caves section are flooded and the new offset habitat is able to be colonised by the equivalent representative ecological community found in the areas that will be permanently submerged. In the medium to long term there is greater confidence that the offset habitat will be colonised by endemic cave fauna provided that the right conditions are present. This will require the development of a long term management plan for the new habitat and sufficient funding to enable monitoring and alterations to internal habitat niches/air flow barriers/gates if required.

SCI Interest Feature / Habitat zone (CHZ) & code(s)	Consideration of the Scheme Impacts and Mitigation on the Integrity of the Proposed SCI
CHZ4 H.1.3.1.1/2: flowing groundwater & standing water	■ **Extent:** The extent of this habitat type will be increased significantly by the blockage of the main channel and the rise in water levels following the installation of the grout curtain which will add ≤700m and ≤600m of aquatic cave passage length respectively. The provision of the artificial cave linked to the Spring Cave will provide an additional refuge area of 40m^2 adjacent to this habitat type prior to the main construction works in the Spring Cave taking place. ■ **Structure (Spring Cave):** The structure of the existing still and (low) flowing ground water habitat will be altered significantly. The structure of the Spring Cave will be changed completely through enlargement and simplification of its form, whilst the point/area at which it receives that majority of the spring discharge will also be altered. The main discharge point will enter the cave at -2masl from the north via the turbine tail races and the ecological minimum flow and overflow (swirling spillway discharge point). Under natural conditions the main channel siphons flow from -130m asl and discharges into the Spring Cave from underneath. The creation of an Outlet Structure (see Figure 1.5) set at -2masl directly connects the Spring Cave to the Spring Pond effectively creating one body of water, further altering the cave's function through a provision of a new outflow point. The provision of a new artificial cave connected to the Spring Pond by a siphon or weir arrangement and overflow pipe will seek to replicate the present structure of the Spring Cave by providing an equivalent range of depth (to 5M deep), sediment type and terrestrial/aquatic interfaces (an island) under normal flow conditions. ■ **Structure (Great Lake):** The change in upper water level upstream/north of the Grout Curtain will significantly alter the depth profile of the aquatic system effectively doubling the depth of water in the cave passages. Using the Great Lake as a reference point at 0masl and the main channel input to the system at -50masl at this point, the water surface will rise 130m above this input point potentially affecting the mixing of the water column and the distribution of dissolved or fine particulate organic matter. Impacts on aquatic invertebrates due to hydropower often relate to the installation of dams or reservoirs and the mode of operation. The installation of a flexible perforated pipe providing a small feed discharge of water from the main inflow channel through the water column between 0 to 130masl will ensure the water column remains mixed, maintaining a stable temperature and is provided with a constant through-flow of the limited organic and dissolved nutrients provided by upstream flows. ■ **Function (Spring Cave):** The Spring Cave effectively acts as a backwater water habitat perched around 25m above the discharge point of the Main Channel into the Spring Pond. It therefore provides a final known point of refuge for subterranean aquatic fauna before they are washed out of the system into the Spring Pond and beyond the Komolac Weir into the sea. With the change in flows and the installation of the Outlet Structure (shown in Figure 1.5) the Spring Cave will cease to provide this function to the system. However, the blockage (at -130masl) of the main channel which flows underneath the spring cave converting it to a still water habitat (estimate channel length of 200-300m) and the provision of the artificial cave set off the Spring Cave and linked to the closed off main channel will continue to provide an equivalent function downstream/south of the grout curtain. ■ **Function (Great Lake):** The Great Lake functions as a still/slow moving water reservoir which sits perched above the main channel flow from the hinterland. As with the Spring Cave it provides a back water habitat refuge for drift species and those species of aquatic fauna permanently resident within the system. Although there is uncertainty over the effects of how the aquatic cave species will adapt to the change in cave water levels - the significant increase in available habitat extent is likely to be of benefit to resident and drift species in the long term provided water quality remains suitable.

SCI Interest Feature / Habitat zone (CHZ) & code(s)	Consideration of the Scheme Impacts and Mitigation on the Integrity of the Proposed SCI
CHZ5 H.1.3.1.1: flowing groundwater	■ **Extent:** The extent of the fast flowing ground water habitat will be reduced significantly with the diversion of around 700m of fast flowing channel through the HPP. ■ **Structure:** The morphological structure of the main channel will change as sediments within the water column are deposited over time. It will become a new subterranean still water channel as described above. ■ **Function:** There is no evidence from the surveys undertaken to date that this main channel provides support to any aquatic cave fauna, however it does provide the existing source of water to the still/slow moving water area of the Great Lake and the Spring Cave. The diversion of the main channel flows through the HPP infrastructure in relation to these still water habitats is provided above.
Species Features (Bats): *Miniopterus schreibersii; Myotis blythii; Myotis emarginatus; Rhinolophus euryale; and, Rhinolophus ferrumequinum*	
Vilina Cave and Spring Pond	■ **Extent:** There will be no long term change in extent to the bat habitats provided by the Vilina Cave due to the construction and operation of the HPP with all mitigation measures implemented. The drainage of the Spring pond during the construction period has the potential to temporarily reduce an available feeding resource close to the cave if undertaken during the spring or summer months. During construction the extent of the CHZ2 Habitat will not be significantly disturbed. During operation of the hydropower plant the risk of uncontrolled flooding due to percolation will be mitigated by the installation of drainage pipes and measures to control flooding from rising water described in Section 6. Enhancement measures to create suitable bat roosting areas within Grout Gallery III are likely to provide an increased extent in habitat suitable for designated bat species following completion of the scheme and into the long term. ■ **Structure:** There may be localised permanent loss in some of the features of the caves morphology due to the physical disturbance of the works; however this is unlikely to adversely affect the populations of bats. Anecdotal evidence indicates that previous blasting altered the morphology of the Vilina Cave and also increased access for bats to deeper parts of the caves. There is no evidence that it has had an impact on the long term viability of the populations found within. ■ **Function:** There will be no measurable impact on the function of the Vilina Cave with the required mitigation in place. However there is a degree of uncertainty over the potential impact related to the temporary loss of the Spring pond as a feeding resource if undertaken during the Spring and Summer months. The provision of a 25m^2 area of water within the Spring Pond during this period is likely to mitigate the effect, however early warning monitoring of bat feeding activity in this area before construction around the Spring Pond begins will be undertaken and compared with pre construction monitoring of the Spring Pond. Additional mitigation will then be agreed with bat specialists before works commence and as required. The provision of additional bat roosts with Grout Gallery III following the completion of the HPP has the potential to further contribute to favourable conservation status of the site.

Based on the consideration of the changes the proposed HPP will have on the Vilina Cave-Ombla Spring component of the proposed SCI it is possible to reach the following conclusions:

- The coherence of the Vilina Cave habitat structure and function that supports bat species and associated CHZ2 habitat karst cave invertebrate communities will not be adversely affected.
  - There will be short term, localised effects due to construction however this in itself is unlikely to lead to an adverse effect on the use of the Vilina Caves by bats with the mitigation described in Section 6 in place.
  - Potential operation impacts associated with uncontrolled flooding of the upper cave levels will be avoided through strict monitoring of water levels within the Vilina cave during commissioning and operation with mititgation measures to either block the flow of water through fractures and conduits by directional drilling and grouting outside of the Vilina Cave or where this proves not to be feasible through the control of water levels via the bottom outlet. the provision of mitigation
  - The provision of 400m of bat roost habitat in Grout Gallery III following completion of the HPP has the potential further contribute to the favourable conservation status of the proposed SCI in relation designated bat species in the long term.
- The scheme will lead in the long term to a significant increase in aquatic cave habitat due to the raising of normal water levels from 0m.asl to 130m.asl. Together with the conversion of the fast flowing main channel to a slow/still water habitat this represents a net gain of approximately 1500m of passage length of aquatic cave habitat that will be potentially colonised by a range of endemic cave fauna. As such there are potentially significant beneficial effects for aquatic cave fauna, historically affected in the past by a reduction in aquatic habitat due to river canalisation in the Ombla catchment area. However, due to the scale of the change brought about by the proposed scheme, considerable uncertainty remains regarding the short and long term effects of the changes to the water regime.
- The scheme will lead to a potential long term increase in subterranean habitat that provides the structure and function to support terrestrial invertebrate species recorded in the existing explored upper and mid level cave system. When considered in conjunction with the potential increases in available habitat provided by creation of suitable habitat niches within Grout Galleries II and III, the scheme will lead to a potential increase in suitable habitat of up to 200m of CHZ2 cave invertebrate habitat and up to 950m of CHZ3 cave invertebrate habitat. However, there is residual uncertainty about the rate of colonisation of the new habitat which cannot be resolved until monitoring is undertaken prior to the rise in water levels. The scale of change of CHZ3 cave invertebrate habitat flooded within the middle cave system (800 m long) is also a source of residual uncertainty which cannot be addressed at this stage.
- EC guidance clearly defines that the designated habitat of *"Caves not open to the public"* is a "natural habitat type" (EC, 2007). When applied by member states in reporting on the favourable conservation status of this habitat type within the EU, it is clear that the extent of such habitat types cannot include artificially created caves (JNCC, 2007). Therefore the offsetting of impacts can only be applied to species found within the cave system and not be used to offset the loss of the **extent** of middle cave or the Spring Cave habitat itself.
- It is proposed that it can be concluded that there is no adverse effect on integrity for bat species, subject to the successful implementation of all mitigation measures set out in Sections 5 and 6.
- Due to uncertainty regarding the of the scale of the change in water regime and short term impacts upstream and downstream (Spring Cave) of the grout curtain, and the loss of extent of natural cave habitat (800 m long) it is not possible to conclude that there will be no adverse effect on the Caves not open to public habitat feature. However, it should be noted that the provision of adjacent man-made offset habitat within Grout Galleries II and III, significant increase of length of aquatic cave habitat and the preparation of artificial cave adjacent to the Spring Cave with an extensive monitoring program have the significant potential to reduce the impact that the construction and operation that Ombla HPP will have on endemic cave fauna and potentially allow for the populations of terrestrial and aquatic endemic cave fauna to be sustained with the boundary of the proposed SCI. Also it is important to underline that all existing habitat above 130 m, which are not explored due to limited access, will stay intact.

8 Compensatory Measures

8.1 Introduction

The Habitats Directive requires that before a project that will have an adverse impact on a Natura 2000 site can be permitted, it is necessary to secure compensatory measures to offset the negative impacts. Compensatory measures are implemented independently of the project and are intended to compensate for the negative effects of a project on a habitat and on the species that habitat supports (EC, 2000). The aim of compensatory measures is to maintain the overall coherence of the Natura 2000 network.

Under such circumstances, in order for a project to comply with the direct requirements of the EU Habitats Directive, it needs to demonstrate that it is able to fulfill the requirements of Article 6 (4). It therefore has to demonstrate that:

- There are no less damaging alternatives to achieve the project objectives.
- The project is required for imperative reasons of overriding public interest; and
- Compensatory measures area/have been secured to maintain the integrity of the Natura 2000 network.

It is not the purpose of this document to decide whether the compensatory measures are needed or to set out information relating to project alternatives or imperative reasons of overriding public interest, however information relating to the public, regional and national benefits of the scheme are summarised in Section 1, whilst Section 8.2 outlines potential compensatory measures that could be undertaken to ensure that the coherence of the proposed Nature 2000 network is maintained.

8.2 Potential Compensatory Measures

The objective of compensatory measures is to ensure that the integrity of the network is maintained. The success of these compensatory measures is entirely dependent on their ability to provide an equivalent support (structure and function of habitat) for the interest features of the proposed Paleoombla-Ombla SCI that are considered to be adversely affected. It is recognized there is uncertainty as to the ultimate success of mitigation measures in preserving and creating habitat, and in protecting important fauna. A robust monitoring program is therefore necessary to allow refinements to the management program to be made if necessary to achieve the overall conservation objectives of the protected area.

Translocation of species between existing cave systems is not considered to be appropriate, due to the:

- Potential risks in affecting the receiving habitat's ecological community; and,
- A poor success rate (high mortality of species in translocation) where the distance between the cave systems, handling and transportation time will affect the species being translocated.

Under the Habitats Directive, the only means of providing additional compensatory measures would therefore be to:

- Extend the level of protection to similar sites not presently proposed for inclusion within the Natura 2000 network in Croatia; and or,
- Close or restore caves or sections of caves which are, or have been, routinely exploited for tourism within the Natura 2000 network;
- Restore caves that support endemic cave fauna that are exploited for use other than tourism and extend the level protection provided.

It is usual for the scale and extent of compensatory measures to exceed the extent and scale of potential losses or habitat change. Therefore compensatory measures that maintain the coherence of the Natura 2000 network focus on maintaining the coherence of terrestrial and aquatic cave habitats that support diverse communities of endemic cave fauna analogous to those found at Ombla. A number of potential sites that provide equivalent extents either alone, or in combination are identified in Table 8.1.

In addition to the measures set out in the above table, another possible means of offsetting the potential effect on the populations of adversely affected cave fauna would be to undertake a programme of karst habitat restoration in the Popovo Polje in BiH. This is on the grounds that it would provide the best ecological solution to the situation by improving the habitats of the same or linked populations of species within the wider Ombla catchment system. However, its location outside of the EU and the Natura 2000 network, and outside Croatia, places a significant impediment to the delivery of such measures.

However, if such restoration / enhancement work in BiH would lead to beneficial effects in the proposed Paleoombla-Ombla SCI in Croatia, because there are or would be ecological and hydrological links between where the works were undertaken and the proposed SCI, then they could potentially be regarded as legitimate mitigation measures. They could be considered to be mitigation, rather than compensation, because they would lead to benefits for the interest features in the proposed SCI itself. They would be legitimate because there is no constraint on mitigation measures being undertaken in the territory of a non-member state, so long as their implementation is guaranteed and the effects are beneficial to the proposed SCI in a member state.

There are significant time-related implications given that there is a requirement to securing such measures as either mitigation or compensation in advance of the project effects being realised. In addition, this would set a new precedent in the provision of mitigation or compensatory measures for Natura 2000 impacts as there is no known precedent of providing such measures outside of the EU.

Table 8.1: Locations and Description of Proposed Compensatory Measures by Extension of the Natura 2000 Network in Croatia

Site	Habitat/Species	Existing / Currently Proposed Protection	Existing Use	Potential Compensatory Measures		a) Extent (m, passage length) b) Extent additionally protected/restored
Močiljska cave	Caves providing habitat for Terrestrial endemic species including: *Sulcia sp. new.*, *Travunia anophthalma*, *Cyphoniscellus herzegowinensis*, *Typhlogastrura warm*, *Verhoeffiella media*, *Antroherpon apfelbecki*, *Spelaeothrombium caecum*, *Tychobythinus Neumann Histopona dubia*, *Plusiocampa (Stygiocampa) Remy*, *Bathyscidius tristiculus fallaciosus*, *Saxurinator brandt* and *Pholeoteras euthrix*	Geomorphologic nature since 1963 and NEN site HR2000090; referred to Paleoombla - Ombla HR2001010 designation, however not part of the propsed SCI;	Partially used for tourism	Close or reduce extent of eventual tourist activities and extend level of Natura 2000 protection under code 8310	D & O	a) 938 m b) 938m
Špilja za Gromačkim vlakom cave		Geomorphologic nature since 1986; part of the proposed Paleoombla – Ombla SCI HR2001465; NEN site HR2000169	Partially used for tourism	Close or reduce any planned extent of tourist activities #	D & O	a) 2407 m b) TBC
Šipun Cave	Siphun Cave contains both terrestrial and aquatic habitat	Not presently part of a proposed SCI. Geomorphologic nature since 1963 and NEN Site HR2001135.	Used for tourism.	Close or reduce extent of tourist activities and extend level of protection under Natura 2000 under code 8310	D	a) 120m b) 120m
Čikola Spring	Caves providing habitat for : Aquatic endemic species including *Troglocaris pretneri*	Not presently part of a proposed SCI. Part of NEN Čikola Canyon (HR2000919); within the boundary of the Krka National Park (HR2000918)	Water source; Urban zone	Restoration and extend level of protection under Natura 2000 under code 8310	NA	a) 20m b) 20m
Krka Spring (Krčić Waterfall)	Springs providing habitat for : Aquatic endemic species including *Proasellus*	Proposed SCI (HR2000917), EU Habitat code 8310.	Krčić Hydroelectric Power Plant	Monitoring and restoration programme as	NA	a) 20 m b) 20m

Site	Habitat/Species	Existing / Currently Proposed Protection	Existing Use	Potential Compensatory Measures		a) Extent (m, passage length) b) Extent additionally protected/restored
Miljacka source	*anophthalmu; Speleocaris pretneri*, Monolistra hercegovinensis**	All Miljacka sources are included within the boundary of proposed SCI as part of the wider region of Krka National Park (HR2000918), EU Habitat code 8310.	Miljacka Hydroelectric Power Plant	appropriate	NA	a) 640m b) 640m
Spring near Žegar (exact location unknown		Not presently part of a proposed SCI. The area around the cave Golubnjača HR2001375, Milic caves HR2000089 Part of Zrmanja river site (HR2000641)	Unknown	Exploration of exact location and extend level of protection under Natura 2000 if appropriate	NA	a) unknown b) unknown

Sources: After CBS, 2012; Duplic et al, 2012; Ozimec et al., 2009; Bedek et al, 2006; Ozimec, 2012 (Notes * Krka River Spring; # due to the present inclusion of the Gromacka cave within the proposed SCI boundary this could be considered to be mitigation).

9 Management and Monitoring Programme

This section provides a summary of the proposed measures and monitoring requirements that will be implemented as a part of the Biodiversity Management Plan. The measures referred to are those identified in:

- Sections 5 and 6 which are required to avoid, reduce or offset potentially significant effects on the designated features of the proposed SCI; and,
- Section 8, if HEP and the Competent authority agree to provide additional compensatory measures.

Recommendations for monitoring are also included based on the relevant elements of the proposed monitoring program recommended the ElektroProjekt report (2012), monitoring requirements set out by the Ministry of Culture in 2009 and additional monitoring recommendations identified in relation to the issues raised in section 6 and 7.

Recommendations for monitoring are made in order to provide:

- Validation of the impacts and mitigation measures (as is standard good practice) that will benefit future understanding of the site involved and improve the evidence base for future impact assessment and development of mitigation measures and aide decision making for subsequent schemes of a similar nature.
- Early warning monitoring to allow identified risks to be addressed should an accident or event that is considered unlikely occur, and where action can be taken to prevent harm to site integrity occurring.

Table 9.1: Summary Biodiversity Management and Monitoring Plan (Key to Column 1 - A - All Features; B – Bat Features; C – Cave Feature)

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
		Pre Construction		
A1	**Issue**: Increased risk of the introduction of alien species **Action**: HEP in conjunction with appointed contractor will be required to produce a bio-security action plan to ensure all construction activities and associated access to the subterranean environment is proportionately assessed for risk. The bio-security action plan will be reviewed by a competent biospeleogical specialist and submitted to the SINP for comment. **Aim**: To reduce the risk of the introduction of alien species to an acceptable level.	EU Habitats Directive	Prior to the start of construction	All risks to biosecurity assessed and mitigated by actions agreed in liaison with the SINP.
B1	**Issue**: Potential construction impacts on bat freshwater/food resources and uncertainty over the importance of Spring Pond and usage of other areas for foraging. **Action**: Preconstruction monitoring of bat foraging use of the Spring Pond. Undertake monitoring of bat foraging areas (use of the Spring Pond and other sources of open water) and flyways in Ombla HPP construction area using least invasive methodology (bat detectors) at least one time in spring, summer, autumn and winter. **Aim**: To validate proposed mitigation of avoidance of drainage during spring and summer use or provide $25m^2$ of water surface area if drained between 1 April and 31 November. For use as the basis of early warning monitoring should there be measurable change in bat foraging use of the Spring Pond.	Ministry of Culture Opinion, 2009 EBRD PR6 Eurobats Resolution 6.3	Prior to any to works within the vicinity of the Spring Pond: At least 1 survey a month Mar to Oct to include: Survey with 3 transects/ spot counts on the hillside and at sea level around the existing Water Treatment works and Ombla River. Static bat broadband bat detectors placed at key locations. Continuous recording 5 days a month in 10 locations.	Provision of preconstruction baseline of use of the Spring Pond and wider area against which the impacts of drainage of the Spring Pond and associated works can be compared. Baseline to identify bat flyways and key foraging areas in relation to Spring Pond. No measurable reduction in important bat food or water resource during sensitive periods. Revisions to proposed mitigation, if required, submitted to Ministry of Environmental and Nature Protection and SINP.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
B2	**Issue**: Potential changes of bat fauna within the Vilina cave. **Action**: Monitor the state of bat fauna (species/ abundance/location) within Vilina cave using least invasive methodology, 1 in spring; 2 in summer; 1 in autumn and 2 in winter (January or February) to obtain data on bat usage of the cave in winter period. **Aim**: To validate proposed mitigation of avoidance of significant effects on bats by timing works that have the potential to disturb bats in Vilina Cave between 31 November and 1 April. For use as the basis of early warning monitoring should bats be found in significant numbers during the winter period.	Ministry of Culture Opinion, 2009 EBRD PR6 Eurobats Resolution 6.3 EU Habitats Directive	Start in preconstruction period/ Complete in Year 1. Winter (1 count Nov, Dec, Jan, Feb & Mar), 1 count Spring, 2 counts Summer and 1 count Autumn) Temperature and humidity loggers 7 locations equally spaced through Vilina Cave recorded every hour.	Preconstruction/Year 1 Monitoring report submitted to Ministry Environmental and Nature Protection and State Institute for Nature Protection. Provide robust baseline against which potentially measureable impacts on bat fauna of Vilina Cave can be detected and avoided.
C1	**Issue**: Construction and operation impacts on aquatic cave fauna due to the enlargement of the Spring Cave. **Action**: Produce conceptual and detailed design in liaison with biospeleogical specialists to provide equivalent habitat conditions in an artificial cave adjacent to the Spring Cave and habitat niches within the margins of the Spring Cave. The design should allow for the artificial cave to a) to be refuge with a connection to the Spring cave which can then be closed during the works to enlarge the Spring Cave; and b) provide equivalent habitat (form, water flow and function) during operation of Ombla HPP. **Aim**: To provide equivalent habitat to provide for the continued maintenance of a community/ representative endemic aquatic cave fauna within and adjacent to the enlarged Spring Cave.	EBRD PR6 EU Habitats Directive	Design to be completed with approval of competent biospeleological specialists and approved by the SINP, prior to works to construct the artificial cave.	Design reviewed by independent biospeleological specialists and approved by SINP.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
C2	**Issue**: Uncertainty over changes in water regime and supply of freshwater and dissolved or fine particulate organic matter to areas of new aquatic habitat behind the grout curtain. **Action**: Design freshwater feed from main intake house to habitat within the new elevated water column (elevation 130 m.asl to 0m.asl) via such measures as a small diameter flexible pipe perforated along its length at 10m intervals. **Aim**: To provide supply of freshwater, nutrients and drift species to newly flooded sections of terrestrial cave habitats and avoid or reduce measurable adverse operation impacts on the existing aquatic fauna.	EBRD PR6 EU Habitats Directive	Design to be completed with approval of competent biospeleological specialists and approved by the SINP, prior to works to construct the water intake structure.	Design approved by biospeleological specialists and SINP.
C3	**Issue**: Uncertainty over changes to environmental factors within aquatic and terrestrial cave habitats. **Action**: Install a network of continuous monitoring devices to record temperature, humidity and water level throughout the terrestrial and aquatic (still water) habitat zones (CHZs). Undertake quarterly monitoring of cave fauna through visual inspection including photo and video documentation; baited and un-baited traps and sediment examination. **Aim**: To provide pre construction and pre operation baseline with which to validate impact prediction, the effectiveness of mitigation and, if needed the identification of further protection measures during construction and operation of Ombla HPP.	EBRD PR6 EU Habitats Directive	Monitoring network to be installed prior to Year 1 Construction activities.	Production of monthly data reports to inform construction and operation monitoring of effects on cave invertebrates and production of quarterly reports on cave fauna.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
D1	**Issue:** Likely requirement for compensatory measures and confirmation of No Alternatives and Imperative Reasons of Overriding Public Interest (IROPI). **Action**: Produce and agree Statement of Case for No Alternatives and IROPI and secure compensatory measures, taking advice from the SINP to confirm the number and extent of measures set out in Table 8.1, Section 8 if required. **Aim:** To ensure compliance with the requirements of the Habitats Directive Article 6 (4)	EBRD PR6 EU Habitats Directive	Prior to construction within the subterranean environment.	Confirmation from the Ministry of Environmental and Nature Protection and SINP that all necessary compensatory measures are secured and the requirements of Article 6 (4) of the Habitats Directive have been satisfied.
		During Construction		
A2	**Issue:** Increased risk of the introduction of alien species **Action:** Contractor to implement those risk reduction measures identified in the bio-security action plan. HEP to audit the implementation of actions on the bio-security action plan and submit audit outcomes to the SINP. **Aims:** To reduce the risk of the introduction of alien species to an acceptable level.	EU Habitats Directive	Prior to the start of construction	Monthly reporting to SINP with achievement of a target of 100% compliance with requirements of bio security action plan.
B3	**Issue**: Check biodiversity of bats in Vilina Cave during project construction and suitability of cave to support bats **Action**: Undertake regular and systematic monitoring of Vilina Cave for bats and climate. **Aim**: To validate proposed mitigation of avoidance of significant effects on bats. Early warning monitoring in line with the obligations set out by the Ministry of Culture, 2009.	Ministry of Culture Opinion, 2009 EBRD PR6 Eurobats Resolution 6.3 EU Habitats Directive	Complete yearly monitoring reports in years 2-5 Winter (1 count Nov, Dec, Jan, Feb & Mar), 1 count Spring, 2 counts Summer and 1 count Autumn) Temperature and humidity loggers 5 locations equally spaced through Vilna cave recorded every hour.	Monitoring report and present or additional avoidance measures confirmed in report submitted to Ministry Environment and Nature protection and State Institute for Nature Protection. No significant change in climate or measureable impact on bat fauna of Vilina Cave during construction.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
B4	**Issue**: Potential adverse impacts on bats due to drainage of the Spring Pond and provision of fresh water cover 25m^2; potential changes of bat flyways during the construction period. **Action**: Monitoring of the bat use during the period that drainage of the Spring Pond occurs by qualified bat specialists. Data to be compared to preconstruction surveys. **Aim**: To validate the mitigation of 25m2 is sufficient and provide early warning monitoring should the early monitoring prior to construction works on the weir indicate a measurable impact on feeding bats.	Ministry of Culture Opinion, 2009 EBRD PR6 EU Habitats Directive	Monitoring of drained Spring pond should be undertaken for a week before any construction works commence on the temporary weir and spring cave outlet. Monitoring to continue through the period of works to the Spring Pond and in the vicinity of any additional feeding resources/flyways identified during preconstruction monitoring.	Include with monitoring report and present or additional avoidance measures confirmed in report submitted to Ministry of Environmental and Nature Protection and State Institute for Nature Protection. No measurable reduction in significant feeding/water resource for bats during the construction period.
B5	**Issue**: Residual risk of bats present in Vilina cave within 50m of grout curtain works during winter. **Action**: Undertake specific preconstruction checks. If bats are found in significant numbers (i.e. >10 individuals), delay works until it is confirmed by bat specialists that works can commence without significant disturbance to the hibernating bats identified. **Aim**: To avoid residual effects on roosting bats during the winter period.	Ministry of Culture Opinion, 2009 EBRD PR6 EU Habitats Directive	Pre works checks for bats in the cave in period from 1st December to 31st March should be made within 50 metres of the works to the Vilina Cave. Bat surveyor to check a week and a day before activity starts and then to make regular checks during the works.	Produce as a supplement to the yearly monitoring report and present or additional avoidance measures to Ministry of Environmental and Nature Protection and State Institute for Nature Protection. No significant disturbance to winter bat roosts in the Vilina Cave.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
B6	**Issue**: Potential uncontrolled water level increase (exceeding installed drainage capacity) within the Vilina Cave. **Action**: Constant monitoring of water levels during works to raise the water levels behind the third grout curtain level to ensure that the cave will not be flooded. Water levels should be monitored at a number of locations through the length of the Vilina Cave and as a minimum at the location of a) the installed drainage pipes, b) the lowest part of the High Hall, and c) the lowest section of the Glavni Kanal between Krak A and Krak D. **Aims**: To avoid changes in water levels that lead to loss of suitable bat roost extent in the Vilina Cave.	Ministry of Culture Opinion, 2009 EBRD PR6 EU Habitats Directive	Continuous monitoring through the water level raising period in conjunction with continuous monitoring of changes or reactions to water level raising by bat species using the cave. Ideally water level raising timing should be agreed with bat specialists. (September may prove to be the optimal time, as this marks the end of the vulnerable maternity period whilst the presence of higher numbers of bats provides a better indication of their reaction to water level changes).	No measurable change in water levels within the Vilina Cave, and no measurable reduction in use of the Vilina cave by bat species as a result of water level changes.
C4	**Issue**: Uncertainty over changes to environmental factors within aquatic and terrestrial cave habitats. **Action**: Continuous monitoring devices to record temperature, humidity and water level throughout the terrestrial and aquatic (still water) habitat zones (CHZs). Undertake quarterly monitoring of cave fauna through visual inspection including photo and video documentation; baited and un-baited traps and sediment examination. **Aim**: To provide construction monitoring to validate impact prediction, the effectiveness of mitigation and, if needed the identification of further protection measures during construction and operation of Ombla HPP.	EBRD PR6 EU Habitats Directive	Year 1 to Year 5 Construction activities.	Production of monthly data reports to inform construction and operation monitoring of effects on cave invertebrates and production of quarterly reports on cave fauna through the construction period.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
C5	**Issue**: Loss in 800m extent of functioning habitat that hosts endemic terrestrial cave fauna in middle level cave system. **Action**: Provide offset habitat in excess of that loss within the existing cave system with equivalent structure and function by installation of equivalent habitat niches found in the middle cave system within Grout Gallery **II**. The range and distribution of habitats will be installed to the satisfaction of appointed biospeleological experts and representatives of the SINP. **Aim**: No net loss in critical habitat found within the middle cave system through provision of equivalent structure, function and extent	EBRD PR6 IFC PS6 EU Habitats Directive	At least 12 months prior to the increase in any water levels behind the grout curtain between the elevations of 50m.asl to 130m.asl.	Provision of a range of equivalent middle level cave habitats that provide habitat for cave fauna representative of those species recorded in the middle cave system.
C6	**Issue**: Uncertainty over the effectiveness of the offset functional habitat created in Grout Gallery **II**. **Action**: Undertake monthly monitoring of the rate of colonisation of the new Grout Gallery **II** habitat through visual inspection including photo and video documentation; live traps and sediment examination. If after 8 months the rate of colonisation is deemed to be insufficient, undertake a programme of translocation of cave fauna from middle cave through live trapping and translocation of individual species, movement of sediment and water samples to marked seed locations **Aim**: To ensure effective use as a refuge and subsequent viable permanent habitat of the newly created terrestrial cave fauna habitat within Grout Gallery **II** that provides an equivalent extent, structure and function to the extent of cave habitat flooded as a result of the scheme.	EBRD PR6 IFC PS6 EU Habitats Directive	4 months prior to the increase in any water levels behind the grout curtain between the elevations of 50m.asl to 130m.asl.	Record of a representative range of endemic terrestrial cave fauna in monthly reporting for three consecutive months prior to water level change between 50m.asl and 130m.asl.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
C7	**Issue**: Construction and operation impacts on aquatic cave fauna due to the enlargement of the Spring Cave. **Action**: Construct the artificial cave adjacent to the Spring Cave to provide refuge habitat for cave fauna within the Spring Cave during construction. The design of the cave will include include cracks, crevices, rockpiles and sediment that will replicate the range of niches found in the Spring Cave. The cave will be constructed in isolation from the Spring Cave observing the water pollution and prevention measures identified in the ESAP. Following construction the artificial cave will be connected to the Spring Cave for a period of not less than 3 months during a period of suitable flows to allow for colonisation by aquatic cave invertebrates. Following this period the artificial cave will be isolated (no physical connection) from the extent of Spring Cave to ensure aquatic cave fauna are not exposed to disturbance, waste or sediment generated by the enlargement works. Monitoring of aquatic fauna colonisation rate will be undertaken on a biweekly basis by competent biospeleologists, where colonisation rates are deemed to be too low, pumping of water to increase interchange of water from the Spring Cave to the new artificial cave will be undertaken. Additional live trapping and translocation will also be considered. Following completion of the enlargement works, the artificial cave will be connected via a siphon or weir flow to the incoming flow from the ecological minimum flow route. An overflow pipe will allow the artificial cave to discharge back into the Spring Cave to avoid stagnation. Habitat creation, isolation and reconnection will be undertaken under supervision of a competent biospeleogist. **Aim**: To protect a representative proportion of aquatic cave fauna species from construction impacts and provide an equivalent structure and function to the habitat lost as a result of the Spring Cave enlargement.	EBRD PR6 IFC PS6 EU Habitats Directive	Completion of the artificial cave habitat not less than three months before work commence to enlarge the Spring Cave.	Successful translocation of representative aquatic cave fauna from the Spring Cave to the new artificial cave.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
		Post Construction/ Operation		
A3	**Issue**: Increased risk of the introduction of alien species **Action**: HEP to develop biosecurity action plan for operation phase of Ombla HPP in agreement with SINP and undertake 6-montly audits as part of EMS. **Aim**: To reduce the risk of the introduction of alien species to an acceptable level.	EU Habitats Directive	Prior to the start of construction	6-monthly reporting submitted to SINP with achievement of a target of 100% compliance with requirements of bio security action plan.
B7	**Issue**: Potential changes of bat fauna in Vilina Cave during operation. **Action**: Monitor the state of bat fauna (species/ abundance/location) within Vilina cave using least invasive methodology, 1 in spring; 2 in summer; 1 in autumn and, depending on results of earlier research, once or twice in winter (in January or February). Undertake constant monitoring of the microclimate of the Vilina Cave. Ensure unauthorized access is excluded. **Aim**: To monitor bat populations and microclimate /physical conditions of the Vilina Cave and ensure any unforeseen changes as a result of Ombla HPP are identified and avoided at the earliest opportunity.	Ministry of Culture Opinion, 2009 EBRD PR6 EU Habitats Directive	For at least 10 years after Ombla HPP construction. (Under the Habitats Directive it is likely that the scheme will be required to ensure it has no measurable impacts on bat species of Vilina Cave in perpetuity)	Monitoring report and present or additional avoidance measures confirmed in report submitted to Ministry of Environmental and Nature Protection and State Institute for Nature Protection. No measurable reduction in abundance or number of species of bats using the Vilina cave through all parts of the year which can be attributed to the operation of HPP Ombla.
B8	**Issue**: Potential uncontrolled water level increase (exceeding installed drainage capacity) within the Vilina Cave. **Action**: Constant monitoring of water levels to ensure that the Vilina Cave will not be flooded. **Aim**: To avoid accidental flooding and any measurable impact on the bat fauna of the Vilina Cave.	Ministry of Culture Opinion, 2009 EBRD PR6 EU Habitats Directive	During all phases of operation for the lifetime of HPP Ombla.	Include records of water levels within monitoring report and present or additional avoidance measures confirmed in report submitted to Ministry of Environmental and Nature Protection and State Institute for Nature Protection. Avoid uncontrolled or accidental increase in water levels within the Vilina Cave.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
B9	**Issue**: Conversion of the Grout Gallery III to provide additional subterranean habitat suitable for roosting bats. **Action**: Creation of a series of enlarged spaces within the first 200m of Grout Gallery III. The spaces should be unlined and incorporate smaller pockets within their surface area to provide variations in microclimate that will suit different species of bats. In addition suitable measures (i.e. internal barriers to airflow) to control microclimate and provide thermic stability in the range of 14°C to 16°C. Design to be undertaken in liaison with/by bat specialist in order to obtain optimal conditions for bat fauna. Ensure unauthorized access is excluded. **Aim**: To ensure HPP Ombla contributes to the favourable conservation status of the bat species found in the Vilina Cave.	EBRD PR6 IFC PS6 EU Habitats Directive	Within two months of the final testing of the upper level of the grout curtain.	Design and construction approved by bat specialists and SINP.
C8	**Issue**: Conversion of section of Grout Gallery III to provide additional subterranean habitat suitable for endemic cave invertebrates. **Action**: Provide additional offset habitat for that lost within the existing cave system with equivalent structure and function by installation of equivalent habitat niches found in the middle cave system within Grout Gallery III. The range and distribution of habitats will be installed to the satisfaction of appointed biospeleological experts and representatives of the SINP. Ensure unauthorized access is excluded. **Aim**: To ensure HPP Ombla contributes to the favourable conservation status of the bat species found in the Vilina Cave.	EBRD PR6 IFC PS6 EU Habitats Directive	Within two months of the final testing of the upper level of the grout curtain.	Design and construction approved by biospeleogy specialists and SINP.

No.	Issue/Action	Source of Requirement (EBRD PR #, EU, BAT, etc.)	Date to be completed	Measure of success
C9	**Issue**: Uncertainty over changes to environmental factors within aquatic and terrestrial cave habitats. **Action**: Continuous monitoring devices to record temperature, humidity and water level throughout the terrestrial and aquatic (still water) habitat zones (CHZs). Undertake quarterly monitoring of cave fauna through visual inspection including photo and video documentation; baited and un-baited traps and sediment examination. **Aim**: To provide construction monitoring to validate impact prediction, the effectiveness of mitigation and, if needed the identification of further protection measures during construction and operation of Ombla HPP.	EBRD PR6 IFC PS6 EU Habitats Directive	For at least 10 years after Ombla HPP construction. (Under the Habitats Directive it is likely that the scheme will be required to demonstrate it has minimised impacts on Cave fauna as far as feasibly possible in perpetuity)	Production of quarterly reports to inform operation monitoring of effects on cave invertebrates.

10 Information Disclosure and Stakeholder Consultation Plan

10.1 Purpose of the Plan

The purpose of this Plan is to set out information disclosure and consultation activities for the Appropriate Assessment and Biodiversity Management Plan for Proposed Ombla Natura 2000 Site that would allow for obtaining public opinion in accordance with Croatian legislation and international best practice.

The plan for public disclosure and consultation has been designed around both EU and national legislation and best practice such as the Aarhus convention. Both the EU Habitats Directive and the EU EIA Directive have been consulted, as well as the Croatian national legislation for specific requirements on disclosure periods.

The EU Habitats Directive does not provide any specific requirements on disclosure or consultation periods. It states *'and if appropriate, after having obtained the opinion of the general public.'* The Nature Impact Assessment specifies 15 days consultation (by the Competent Authority) for IROPI (and not the other stages of the assessment). This states "*Article 18 - (1) During the procedure for establishing overriding public interest and compensation terms, the Ministry shall collect written comments and suggestions from the public for a period of 15 days from the day of publishing the Report on carrying out the Assessment of other feasible options".* The work undertaken as presented in this report does not cover an IROPI assessment.

The EU EIA Directive does not stipulate any specific time requirements for public consultation and information disclosure *'The public shall be informed, whether by public notices or by other appropriate means such as electronic media where available, of the following matters early in the environmental decision-making procedures.'* The Aarhus Convention refers to a 'reasonable timescale' although no specifics are defined in the guidance; this is usually interpreted and set by Member States. The Croatian regulations stipulate a 30 day disclosure period for the SEIA and EIA (specified in Article 18 of the Decree on Provision of Information and Participation of the General Public and Stakeholders on Environmental Issues from 2008). However, as this project is not an ESIA or EIA then adherence to this clause is not obligatory. Similarly, there is no stipulation of disclosure periods of the Habitats Directive transposed into Croatian law. Consideration has been given to ensure that a reasonable timescale for disclosure and consultation will be provided to allow effective public participation as detailed in this section of the report.

The plan is structured around three topics, the first of which presents documents / information already available to the public. The second pertains to the planned public disclosure and consultations process and the third presents the plans for disclosure of the final plan including responses to received comments.

10.2 Documents / Information Available to the Public

The following Environmental and Social Impact Assessment (ESIA) package documents are available on HEP's website (http://www.hep.hr/hep/en/group/Development/Ombla.aspx), since May 24th 2011:

- Environmental Impact Assessment (EIA), including a note explaining that maps can be reviewed in hard copy or obtained on a CD from HEPs offices (in Croatian) – prepared and first disclosed in 1999.
- EIA Executive Summary (in English and Croatian) – prepared and first disclosed in 1999.
- Impact of the HPP Ombla on Bat Fauna in the Vilina Cave and Protection Measures (in Croatian) – prepared in December 2008.
- Non Technical Summary (NTS), Ombla Hydro Power Plant, Dubrovnik, Croatia (in English and Croatian) – disclosed in May 2011.
- Stakeholder Engagement Plan (SEP), Ombla Hydro Power Plant, Dubrovnik, Croatia (in English and Croatian) – disclosed in May 2011.

- Environmental and Social Action Plan (ESAP), Ombla Hydro Power Plant, Dubrovnik, Croatia, (in English and Croatian) – draft disclosed in May 2011, updated document disclosed in October 2011.
- List of locations where the ESIA package can be viewed and/or obtained on a CD.
- Contact details for any comments and suggestions (for the ESIA and Project in general) are also provided.

These documents were made available within the process of stakeholder engagement conducted as part of the Environmental and Social Due Diligence for Ombla Hydro Power Plant project, conducted between May and October 2011.

The Croatian version of the website also contains an overview of assessments being carried out in connection with the Ombla HPP Project in 2012/2013, as well as a summary of the planned water supply improvement project for Dubrovnik City.

In addition to stakeholder engagement activities from October 2011, HEP organised a presentation in Dubrovnik on the proposed technical solutions for constructing HPP Ombla, with participation of experts from Croatia and the region (13th December 2012). The aim of the meeting was to discuss technical and safety aspects of the Project while hoping to reduce concerns raised by the public with regard to these topics. Experts from the following institutions presented their views and conclusions:

- Faculty of Mining, Geology and Petroleum Engineering, Zagreb, Croatia
- University of Civil Engineering, Sarajevo, BiH
- IBE d.d. Engineering and Consulting Company, Ljubljana, Slovenia
- Institute of Earthquake Engineering and Engineering Seismology, IZIIS, University "Ss. Cyril and Methodius", Skopje, Macedonia
- Faculty of Civil Engineering, Architecture and Geodesy, Split, Croatia

10.3 Public Disclosure and Consultations

10.3.1 Disclosure of Documents

The following documents will be uploaded on HEP's website (http://www.hep.hr) at the beginning of March 2013, which will mark the formal start of the 30-day disclosure period:

- Habitats Directive Assessment and Biodiversity Management Plan for Proposed Paleoombla-Ombla Natura 2000 Site (in English and Croatian).
- Non Technical Summary (NTS) of Habitats Directive Assessment and Biodiversity Management Plan for Proposed Paleoombla-Ombla Natura 2000 Site (in English and Croatian).
- 3D model representations (with English and Croatian subtitles).
- Study on the Impact on the Ecological Network of HE Ombla - Main Draft Impact Assessment Environmental Network), ElektroProjekt (in Croatian).

Hard copies of the above documents will be available at the following locations:

- EBRD's Business Information Centre, One Exchange Square, London EC2a 2JN, United Kingdom.
- EBRD Croatia Resident Office, Miramarska 23, 3rd Floor 10000 Zagreb, Croatia.
- HEP Proizvodnja d.o.o. Pogon HE Dubrovnik Dr Ante Starčevića 7, 20000 Dubrovnik, Croatia, Tel: +385(0)20 468 613, E-mail: ombla@hep.hr
- Department for Citizen Relations, City of Dubrovnik Pred Dvorom 1, 20000 Dubrovnik, Croatia, Tel: +385(0)20 35 18 31

Stakeholders (See Appendix F) will be informed by email about the disclosure period, the availability of above listed documents and submission of comments.

Announcements about the disclosure of documents and deadlines for comments will be sent to the following media:

- HINA
- Slobodna Dalmacija
- Dubrovacki vjesnik
- Web – HEP
- Web – city of Dubrovnik
- Web – Dubrovacki list
- Dubrovnik Radio

Comments on the above documents will be received by HEP during the 30-day disclosure period in any of the following ways:

- Electronic form on HEP's website: http://www.hep.hr/hep/kontakti.aspx
- Email: ombla@hep.hr
- Post or hand delivered to:
  - HEP d.d., address: Ulica grada Vukovara 37, 10000 Zagreb
  - HEP Proizvodnja d.o.o., Pogon HE Dubrovnik office, address: Dr Ante Starčevića 7, 20000 Dubrovnik
- Phone using:
  - HEP d.d., tel: 01 63 22 111
  - HEP Proizvodnja d.o.o., Pogon HE Dubrovnik office, tel: 020 468 613

Responses (in English and Croatian) will be published on HEP's website three weeks after the disclosure period formally ends.

The following documents will also be made available on the website, in addition to the document listed above:

- An overview of stakeholder engagement activities carried out by HEP in 2011 previously during the ESIA disclosure process (in English and Croatian)
- A summary of comments previously received by HEP during the previous ESIA disclosure package in 2011 and HEP's responses (in English and Croatian).

10.3.2 Consultation Meetings

The following meetings will be held during the disclosure period:

1. Dubrovnik - Local Authorities (County and City)
2. Dubrovnik - General public
3. Dubrovnik - Local NGOs and expert organisations
4. Zagreb - NGOs

There will be an additional meeting with BiH and Republika Srpska Authorities.

Stakeholders (See Appendix F) will be directly invited to the relevant consultation meetings once they are scheduled, by phone or email. Announcements about the meeting for the general public will be made through the media and posters, which will be placed in several public places in Dubrovnik.

Outcomes from the meetings will include:

- Attendance sheets (meetings with NGOs and other expert organisations).
- Meeting minutes, focussing on questions / comments from participants.

- Consultation process report (summarising information from the previous two items)

10.4 Disclosure of the Final Plan

As well as the documents that will be disclosed as listed previously, a consultation process report, along with comments received during the disclosure period and responses will also be published on the website. Stakeholders (See Appendix F) will be informed about the publication of this final consultation process report on HEP’s website and the general public will be informed through media announcements.

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Abbreviations

Abbreviation	Full Terminology
B&V	Black and Veatch Limited
BiH	Bosnia and Herzegovina
BMP	Biodiversity Management Plan
BUZ	Bat Usage Zone
CBD	Rio Declaration and the Convention on Biological Diversity
CBS	Croatian Biospeleological Society
CHZ	Cave Habitat Zone
DD	Data Deficient
EBRD	European Bank for Reconstruction and Development
ECJ	European Court of Justice
EEC	European Economic Community
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EN	Endangered
EPFI	Equator Principles Financial Institutions
EPs	Equator Principles
ESAP	Environmental and Social Action Plan
ESDD	Environmental and Social Due Diligence
EU	European Union
EUR27	Interpretation Manual of European Union Habitats
GH	Great Hall
GWh	Gigawatt hours
HDA	Habitats Directive Assessment
HEP	Hrvatska Elektroprivreda d.d
HPP	Hydropower Project
HR	Hrvatska (Croatia)
IFC	International Finance Corporation
IROPI	Imperative Reasons of Overriding Public Interest
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
km	kilometres
LC	Least Concern
l/s	Litres per second
LSE	Likely Signficant Effect
m	Metres
m^2	Metres squared
m^3/s	Cubic metres per second
m.asl	Metres above sea level
mm	Millimetres
mm/s	Millimeters per second
N2000	Natura 2000
NEN	National Ecological Network
NGO	Non Governmental Organisation
NIA	Nature Impact Assessment
NPL	Nature Protection Law
NR	Not Recorded
NT	Near Threatened
NTS	Non Technical Summary
O#	Borehole numbers (HEP records)

Abbreviation	Full Terminology
PR	Performance Requirement
RH	Relative Humidity
S	Siphon
SC	Spring Cave
SCI	Site of Community Importance
SINP	State Institute for Nature Protection
U	Upper Caves
UNECE	United Nations Economic Commission for Europe
US	United States
VC	Vilina Cave
VU	Vulnerability
WSPE	WSP Environmental UK Limited

Appendices

A	Information relating to the Olm at Ombla *Proteus anguinus* at Ombla
B	Vilina Cave – Ombla Sysytem Species and Habitat Lists
C	Habitat Map (Karta staništa)
D	Data Register
E	3D cave model Visualisations
F	Stakeholders

Appendix A: Information relating to Olm *Proteus anguinus* at Ombla

Introduction

The olm occurs in the karst areas along the eastern coast of the Adriatic Sea. Its natural range spreads from Northern Italy to Herzegovina. It can be found in underground water systems in karst formations. It prefers calm, well oxygenated and cold water. Olm is an entirely aquatic species that can survive without food for up to 10 years and can live to an age of 58 or more.

The natural habitat for the olm is the fresh water reserves found in dark underground caves of the Dinaric Alps along the Adriatic Sea, from north-eastern Italy to Bosnia and Herzegovina and possibly Serbia and Montenegro. It prefers underground water systems in limestone and dolomite Karst formations, with calm, well-oxygenated water and a constant low water temperature of between 6ºC (winter) and 9-12ºC (summer). The olm may be found in cave entrances (especially during episodes of high rainfall and flooding) and abandoned mine workings. Many of the caves within the olm's range are connected to rivers that run above ground for the first 50 to 100km and then disappear into the ground. Populations may be found close to the ground surface or as much as 300m underground depending on the thickness of the Karstic formation where they dwell – (accessed from- http://www.edgeofexistence.org/amphibians/species_info.php?id=563).

The conservation status in both the Continental and the Mediterranean biogeographical regions is 'unfavourable inadequate'; the population size and the area of habitat are decreasing. The species reacts very sensitively to the changes of its environment. The olm is listed as Vulnerable in the IUCN Red List of Threatened Species because its area of occupancy is less than 2,000 km sq., its distribution is severely fragmented, and there is continuing decline in the extent and quality of its habitat, and in the number of mature individuals. (Add IUCN reference).

The olm *Proteus anguinus*, is a cave-adapted salamander with numerous adaptations to its entirely aquatic underground life. This species inhabits a world without light, and as a consequence has poorly developed eyes and no skin pigmentation. The olm has developed an acute sensory system for hunting in the dark; they have one of the best senses of smell of any amphibian, and are capable of sensing very low concentrations of organic compounds in the water through both smell and taste. The ear is specialised to receive sound waves in the water, as well as vibrations from the ground. Experiments indicate that the optimal hearing sensitivity of this species between 10 Hz-15,000 Hz.

The olm are social, and usually aggregate either under stones or in rock fissures, although males become aggressive and antisocial during the breeding season. Males guard eggs throughout development. The rate of development depends on water temperature which can range from 8 to 15ºC.

The Olm in the Ombla Cave System and Wider Catchment

There are only two records of olm in the Ombla system, the last record dated from 1986 (Krašovec & Miller, 1986); one 4cm animal was found (a juvenile). Recent surveys of the aquatic Ombla system undertaken on behalf of HEP by the Croatian Ichthyological Society and Croatian Biospeleology Society in 2012 have been unable to detect the presence of olm. These surveys, lasting three to four days on each occasion, were undertaken during March, May and June of 2012 and comprised observational diver surveys and the setting of baited traps to collect aquatic vertebrate and invertebrates. Although deep water and high flows prevented access to some deeper, faster-flowing sections of aquatic habitats, these surveys were able to access aquatic habitats where conditions were better suited to the requirements of the species, with high oxygen content, lower water flows and availability of prey.

In order to the put the results of these recent surveys in to context additional commentary from Professor Petar Milanovic, a karst specialist with a wide ranging knowledge of the Ombla catchment area, is provided alongside consideration of published literature on the distribution of olm within Croatia and adjacent countries. Sket (1997) identified four distinct localities where groupings of olm are found, either wholly or partially within Croatian territory. These groupings are defined as:

- The IST grouping in the southern part of the Istra Peninsula (10 records)
- The LIK grouping in Croatian Lika, between the Kapela and Valebit mountains (9 records) - LIK
- The DAH grouping in localities in Middle Dalmacija and neighbouring Herzegovina, northwest of the Neretva River (22 records in Croatia, 9 records Herzegovina)
- The HED grouping, a group of localities in south eastern Herzegovina and southern most Dalmcija (occupying the area between Trebinje, Dubrovnik and the Neretva estuary) (29 records in Herzegovina, 2 records in Croatia)

Sket (1997) locates the 1986 sighting of olm with this last grouping, where for context the 29 records within Herzegovina are found exclusively within the karst areas of the Popovo polje and Trebinje polje areas. Elaborating on this Professor Milanovic makes the following points:

- On the base of investigations at past 50 years olm has been found and documented at many localities of the Ombla Spring catchment area. The majority of these localities are situated in the Popovo polje and Trebinje urban area (more than 40 locations at an elevation of approximately 270 m asl).
- At all of these localities olm has been found in shallow underground channels and lakes connected with temporary springs and estavelles, no deeper than 25 - 30 m, although it is noted that the majority of diving surveys are limited beyond such depths.
- The capability of olm to swim against strong water current in karst channel is limited.
- During rainy periods a number of olm have been found at surface close to the outlet of karst channels (not alive).
- There are a number of deep siphonal springs which provide hydrographical links between this part of the Adriatic Sea Coast and the interior Dinaric karst. The maximum discharge of those springs ranges between 50 m^3/s to 300 m^3/s. Deepest parts of channels are 50m – 130 m lower than spring outlets. The Ombla siphon is deepest one in this region, so far (-150 m).
- It is considered that such siphons with extremely fast flows and extremely high pressure (10 – 15 bars) are not natural habitat for olm. In the case of Ombla Spring some Proteus can be transported from the area of Popovo polje by fast underground turbulent flows, after heavy rains, however it is unlikely that many are able to survive.
- The term Paleoombla was created by the Czech speleologist K. Absolon (1916) for the Vjetrenica Cave in the middle section of Popovo polje. It has been hypothesized by Absolon that during an early stage of genesis of the Popovo polje there existed the direct hydrogeological underground connection between the Vjetrenica Cave and Ombla Spring. In spite of many tracer tests and other investigations there is no evidence of a direct connection that currently exists between the Vjetrenica Cave and Ombla Spring. It is noted that biospeleological research highlights a significant number of cave water taxa that occur in both the Vjetrenica Cave and Ombla Spring. This may indicate a historic connection between the two caves.

Figure 4.3 shows the underground flow connections between Karst polje in Eastern Herzegovina and Dubrovnik littoral, and the location of records of olm.

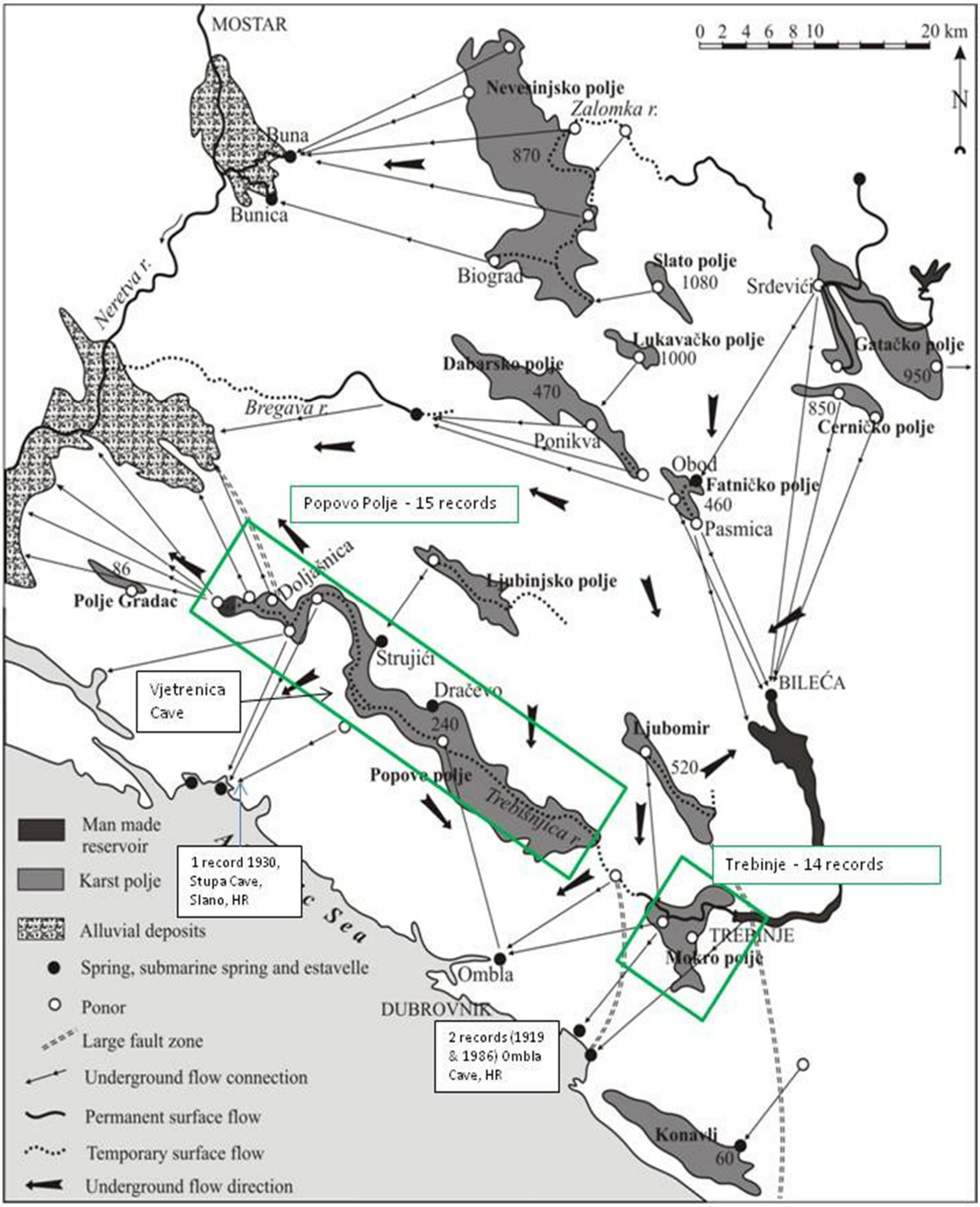


Figure 4.3: Underground flow Connections between Karst polje in Eastern Herzegovina and Dubrovnik littoral (after Milanovic, 2010) and Location of Records of Olm (after Sket, 1997)

The severe physical constraints on a viable ecological corridor connection between the Ombla cave system and the Popovo and Trebinje poljes, the individual record of a 4cm juvenile olm in 1986, the absence of any further records (including the recent surveys undertaken in 2012) suggest that a viable population of olm is not present in the Ombla cave system. In light of this, it is also considered questionable as to whether the HED grouping of site can be considered to significantly contribute to the population of olm in Croatia.

Known information on olm habitat preferences, and the hydrological data collected from the Ombla cave system suggest that the favourable habitat conditions required to support the this species at Ombla are limited by high water flows and fluctuations in flow rates.

Implications for the listing of the olm as part of the proposed SCI

As stated in the directive, where the presence of the Annex II species is deemed to be 'non-significant' for purposes of the format (of inclusion in the Natura 2000 network), these should not be considered as included in 'the site's conservation objectives'. Article 6(1) specifies that the necessary conservation measures have to correspond 'to the ecological requirements of the natural habitat types of Annex I and the species in Annex II present on the sites'; it is indicated that the 'ecological requirements' are all the ecological needs of abiotic and biotic factors necessary to ensure the favourable conservation status of the habitat types and species, including their relations with the environment (air, water, soil, vegetation, etc.)

The favourable conservation status is defined by Article 1(i), and occurs when:

- 'the population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future;
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis'.

Based on the information provided here, it is considered likely that the existing Ombla cave system does not contribute to supporting the olm at a favourable conservation status. If present, it is reasonable to conclude that the olm is not an important species for the cave habitat types present.

Conclusion

Aside from the records of the olm at Ombla in 1986 and 1919, no further data for this taxa exists. The olm was not detected during the 2012 surveys of the Great Lake and Spring Cave, whilst the main channel was not surveyed in 2012 due to high water levels and flows. No other records of any amphibian species have been detected in the Ombla cave habitats to date. At this point in time there is no evidence to suggest if or how olm use the cave system or confirm whether the cave system is able to host a viable population. The Ombla system is connected by known and unknown underground fractures and flow channels that convey water from caves in BiH where olm are known to be present in significant numbers. Work in the 1970's on hydroelectric power has led to a reduction in flooding and the amount of water that flows through to Ombla from this area, however, based on the current evidence it is not possible to conclude that olm are permanently present or that a viable population exists within the Ombla system. Based on the 2012 survey information from Ombla, the SINP has initiated the process of removing the olm as a feature of the proposed SCI as set out in an email communication from the SINP to HEP January 2013, the olm has therefore not be included within this document as a cited feature of the proposed SCI.

Appendix B: Vilina Cave – Ombla Sysytem Species and Habitat Lists

B-1: Full Species List

No	Kingdom	Sub-kingdom	Sub-kingdom	Latin Name	Author	Endemic	Ecological Classification	Data Source
1	FUNGI	ASCOMYCOTA		Gymnoascus uncinatus	Eidam, 1880		sTf	R
2	FUNGI	ASCOMYCOTA		Hypomycetes sp			Tb	R
3	FUNGI	ASCOMYCOTA		Isaria			TB?	R
4	FUNGI	ASCOMYCOTA		Gleontinia sp. nov			Tx	R
5	FUNGI	ASCOMYCOTA		Hymenoscyphus imberbis (Bull)	Dennis, 1964		TX	R
6	FUNGI	ASCOMYCOTA		Myxotrichum cancellatum	W Philips, 1884		sTf	R
7	FUNGI	ASCOMYCOTA		Myxotrichum deflexum	Berk, 1838		sTf	R
8	FUNGI	ASCOMYCOTA		Ombrophila sp. nov			Tf	R
9	FUNGI	ZYGOMYCOTA		Syncephalis sp. nov			TB?	R
10	ANIMALIA	TURBELLARIA		? Dendrocoelum so.			SB	R
11	ANIMALIA	NEMERTEA		Prostoma cf. hervegovinense	Tarman, 1961	E	Sb	R
12	ANIMALIA	NEMATODA		Gen sp.		?	Sb	R
13	ANIMALIA	OLIGOCHAETA		Gen sp.		?	SB	R
14	ANIMALIA	POLYCHAETA		Marifugia cavatica	Absolon & Hrabe, 1930	e	Sb	L
15	ANIMALIA	BIVALVIA		Congesia Kusceri	Bole, 1962	e	Sb	L
16	ANIMALIA	BIVALVIA		Pisidium amnicum	O. F. Müller, 1771		Sx	L
17	ANIMALIA	GASTROPODA	Hydrobiidae	Iglica absoloni	A. J Wagner, 1914	E	Sb	L/R
18	ANIMALIA	GASTROPODA	Hydrobiidae	Iglica bagliviaeformis	Schutt, 1970	E	Sb	L/R
19	ANIMALIA	GASTROPODA	Hydrobiidae	Belgrandia torifera	Schutt, 1961	E	Sb	L/R
20	ANIMALIA	GASTROPODA	Hydrobiidae	Plagigeyeria robusta robusta	Schutt, 1959	E	Sb	L/R
21	ANIMALIA	GASTROPODA	Hydrobiidae	Plagigeyeria robusta asculpta	Schutt, 1972	E	Sb	L
22	ANIMALIA	GASTROPODA	Hydrobiidae	Plagigeyeria robusta angelovi	Schutt, 1972	E	Sb	L
23	ANIMALIA	GASTROPODA	Hydrobiidae	Lanzaia vjetrenicae vjetrenicae	Kuščer, 1933	E	Sb	L
24	ANIMALIA	GASTROPODA	Hydrobiidae	Lanzaia vjetrenicae kusceri	Karaman, 1954	E	Sb	L
25	ANIMALIA	GASTROPODA	Hydrobiidae	Horatia knorri	Schutt, 1961	E	Sb	L
26	ANIMALIA	GASTROPODA	Hydrobiidae	Saxurinator brandti	Schutt, 1968	E	Sb	L
27	ANIMALIA	GASTROPODA	Hydrobiidae	Orientalina troglobia	Bole, 1961	E	Sb	L/R
28	ANIMALIA	GASTROPODA	Hydrobiidae	Hauffenia plana	Bole, 1961	E	Sb	L
29	ANIMALIA	GASTROPODA	Hydrobiidae	Hauffenia edlaueri	Schutt, 1968	E	Sb	L
30	ANIMALIA	GASTROPODA	Pyrgulidae	Pyrgula annulata dalmaticia	Schutt, 1968		sSf	L/R
31	ANIMALIA	GASTROPODA	Emmericiidae	Emmericia explansilabris	Bourguignat, 1880	E	Sf	L/R
32	ANIMALIA	GASTROPODA	Aciculidae	Platyla willhelmi	A. J. Wagner, 1910	E	Tx	L
33	ANIMALIA	GASTROPODA	Carychiidae	Zospeum amoenum	Frauenfeld, 1856	E	Tb	L
34	ANIMALIA	GASTROPODA	Cyclophoriidae	Pholeoteras euthrix	Sturany, 1904	E	Tb	L/R
35	ANIMALIA	GASTROPODA	Vertiginidae	Truncatellina claustralis	Gredler, 1856		Tx	L
36	ANIMALIA	GASTROPODA	Vertiginidae	Vertigo pygmaea	Draparnaud, 1801		Tx	L
37	ANIMALIA	GASTROPODA	orculidae	Odontocyclas kokeilii	Rossmassler, 1837		Tx	L
38	ANIMALIA	GASTROPODA	arginidae	Agardhiella stenostoma	Flach, 1890	E	Tf	L
39	ANIMALIA	GASTROPODA	ferussaciidae	Cecilioides spelaeae	A J Wagner, 1914	E	Tf	L
40	ANIMALIA	GASTROPODA	bithyniidae	Bithynia tentaculata	Linnaeus, 1758		Sx	L
41	ANIMALIA	GASTROPODA	Planorbidae	Anisus leucostoma	Millet, 1813		Sx	L
42	ANIMALIA	GASTROPODA	Azecidae	Hypnophila pupaeformis	Cantraine, 1835	e	sTf	L/R
43	ANIMALIA	ARACHNIDA	Palpigradi	Eukoenenia cf. remyi	Conde, 1974		Tb, R, R	Tb, R, R
44	ANIMALIA	ARACHNIDA	Palpigradi	Eukoenenia cf. pretneri	Conde, 1977	E	Tb	L/Z
45	ANIMALIA	ARACHNIDA	Araneae	Stalagtia hercegovinesis	Nosek, 1905	e	Tb	L/Z/R
46	ANIMALIA	ARACHNIDA	Araneae	Histopona dubia	Absolon & Kratochvil, 1933	e	Tb	L/Z/R
47	ANIMALIA	ARACHNIDA	Araneae	Histopona krivosijana	Kratochvil, 1935	e	Tb	L
48	ANIMALIA	ARACHNIDA	Araneae	Nesticus eremita	Simon, 1879		Tf	L/Z/R
49	ANIMALIA	ARACHNIDA	Araneae	Nesticus cellulanus cellulanus	Clerck, 1758		Tf	L
50	ANIMALIA	ARACHNIDA	Araneae	Sulcia sp. nov?		E?	Tb	Z/R
51	ANIMALIA	ARACHNIDA	Araneae	Holocnemus pluchei	Scopoli, 1763		sTf	sTf
52	ANIMALIA	ARACHNIDA	Araneae	Meta sp			sTf	L/Z/R
53	ANIMALIA	ARACHNIDA	Scorpiones	Euscorpius sp.			Tx	Z/R
54	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Gen. nov. sp. nov.			Tb	E/Z/R
55	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Chthonius subterraneus	Beier, 1931	e	Tf	L/Z/R
56	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Chthonius (Globbochthonius) caligatus	Beier, 1938	E	Tb	L/Z

No	Kingdom	Sub-kingdom	Sub-kingdom	Latin Name	Author	Endemic	Ecological Classification	Data Source
57	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Chthonius (Globbochthonius) sp. nov.		E	Tf	Z/R
58	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Roncus sp. nov. 1		E	Rf	L/Z/R
59	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Roncus sp. nov. 2		E	Tb	Z/R
60	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Neobisium sp.		?	Tf	R
61	ANIMALIA	ARACHNIDA	Pseudiscorpiones	Lamprochemes chyzeri	Tomosvary, 1882		sTf	L/Z/R
62	ANIMALIA	ARACHNIDA	Opiliones	Travunia anophthalma	Absolon & Kratochvil, 1927	E	Tb	R
63	ANIMALIA	ARACHNIDA	Opiliones	Nelima troglodytes	Roewer, 1910	e	TF	Z/R
64	ANIMALIA	ARACHNIDA	Opiliones	Trogulus torosus	Simon, 1885	E	Stf	R
65	ANIMALIA	ARACHNIDA	Acari	Spelaeothrombium caecum	Willmann, 1940	E	Tb	Z/R
66	ANIMALIA	ARACHNIDA	Acari	Belba gratiosa	Willmann, 1940	E	Tb	R
67	ANIMALIA	ARACHNIDA	Acari	Ixodes sp.			Tx	Z/R
68	ANIMALIA	ARACHNIDA	Acari	Parasitus sp.			Tf	Z/R
69	ANIMALIA	ARACHNIDA	Acari	? Pergamasus sp.		?	sTf	Z/R
70	ANIMALIA	ARACHNIDA	Acari	Eugamasus sp.			Tf	Z/R
71	ANIMALIA	ARACHNIDA	Acari	Rhagidia sp.		?	Tb	R
72	ANIMALIA	ARACHNIDA	Acari	Galumna sp.			Tf	Z/R
73	ANIMALIA	ARACHNIDA	Acari	Gen/sp. 1			Tx	R
74	ANIMALIA	ARACHNIDA	Acari	Gen/Sp.2			Tx	R
75	ANIMALIA	ARACHNIDA	Acari	Uroobovella cf. reticulata	Willmann, 1941	E	sTf	R
76	ANIMALIA	ARACHNIDA	Acari	Biscirus sylvaticus convexus	Willmann, 1941	e	sTf	L/R
77	ANIMALIA	MALACOSTRACA	Amphipoda	Niphargus eteuri kolombatovici	Karaman, 1950	e	Sb	R
78	ANIMALIA	MALACOSTRACA	Amphipoda	Niphargus trullipes	Sket, 1958	e	Sb	R
79	ANIMALIA	MALACOSTRACA	Amphipoda	Niphargus vjetrenicensis	Karaman, 1932	E	Sb	R
80	ANIMALIA	MALACOSTRACA	Amphipoda	Niphargus balcanicus	Absolon, 1927	E	Sb	R
81	ANIMALIA	MALACOSTRACA	Amphipoda	Niphargus hercegovinensis	Karaman, S, 1950	E	Sb	L
82	ANIMALIA	MALACOSTRACA	Amphipoda	Niphargus salonitanus	Karaman, S, 1950	e	Sb	R
83	ANIMALIA	MALACOSTRACA	Amphipoda	Typhlogammarus mrazeki	Schafema, 1906	e	Sb	R
84	ANIMALIA	MALACOSTRACA	Amphipoda	Hadzia fragillis	Karaman, S, 1932	e	Sb	R
85	ANIMALIA	MALACOSTRACA	Isopoda	Proasellusanophthalmus rhausinus	Remy, 1941	E	Sb	L
86	ANIMALIA	MALACOSTRACA	Isopoda	Microcharon hercegovinensis	S Karaman, 1959	E	Sb	L
87	ANIMALIA	MALACOSTRACA	Isopoda	Monolistra (Pseudomonolistra) hercegoviniensis ornata	S Karaman, 1953	E	Sb	Z/R
88	ANIMALIA	MALACOSTRACA	Isopoda	Sphaeromides virei cf. montenegrina	Sket, 1957	E	Sb	R
89	ANIMALIA	MALACOSTRACA	Isopoda	Trichoniscus matulici	Verhoeff, 1901	e	Tf	L/Z/R
90	ANIMALIA	MALACOSTRACA	Isopoda	Cyphonethes herzegowinensis	Verhoeff, 1900	E	Tb	Z/R
91	ANIMALIA	MALACOSTRACA	Isopoda	Cyphoniscellus herzegowinensis	Verhoeff, 1900	E	Tb	Z/R
92	ANIMALIA	MALACOSTRACA	Isopoda	Armadillidium sp.			Tx	Z/R
93	ANIMALIA	MALACOSTRACA	Isopoda	Gen. nov. sp. nov.		E	Tb	Z/R
94	ANIMALIA	MALACOSTRACA	Decapoda	Troglocaris (Troglocaridella) hercegovinensis	Babić, 1922	E	Sb	R
95	ANIMALIA	MALACOSTRACA	Decapoda	Troglocaris (Spealaeocaris) pretneri	Matjašić, 1956	E	Sb	L/R
96	ANIMALIA	MALACOSTRACA	Decapoda	Troglocaris (Troglocaris) anophthalmus	Kollar, 1848	e	Sb	R
97	ANIMALIA	MYRIAPODA	Chilopoda	Lithobius sp 1			Tf	Z, R
98	ANIMALIA	MYRIAPODA	Chilopoda	Eupolybothrus sp			Rx	R
99	ANIMALIA	MYRIAPODA	Chilopoda	Cryptops cf. illyricus	Kollar, 1848	E	Tf	R
100	ANIMALIA	MYRIAPODA	Diplododa	Glomeris pulchra	Verhoeff, 1847		sRf	Z/R
101	ANIMALIA	MYRIAPODA	Diplododa	Apfelbeckia sp.			Tf	Z/R
102	ANIMALIA	MYRIAPODA	Symphyla	Sympylella? sp.			sTf	R
103	ANIMALIA	ENTOGNATHA	Collembola	Typhlogastrura topali	Loksa & Bogojević, 1967	E	Tb	L/Z/R
104	ANIMALIA	ENTOGNATHA	Collembola	Xenylla maritima	Tullberg, 1869		Tx	L
105	ANIMALIA	ENTOGNATHA	Collembola	Archaphorura sp. nov.		E	Tb	R
106	ANIMALIA	ENTOGNATHA	Collembola	Onychiuroides pseudogranulosus	Gisin, 1951		Tx	L
107	ANIMALIA	ENTOGNATHA	Collembola	Protaphorura subcancellata	Gisin, 1963		Tx	L
108	ANIMALIA	ENTOGNATHA	Collembola	Mesaphorura sp.			Tf	R
109	ANIMALIA	ENTOGNATHA	Collembola	Folsomia candida	Willem, 1902		Tf	R
110	ANIMALIA	ENTOGNATHA	Collembola	Isotomiella minor	Schaeffer, 1896		Tx	R
111	ANIMALIA	ENTOGNATHA	Collembola	Proisotoma minuta	Tullberg, 1871			Tx, R
112	ANIMALIA	ENTOGNATHA	Collembola	Verhoeffiella media	Loksa & Bogojević, 1967	E	Tb	L/Z/R
113	ANIMALIA	ENTOGNATHA	Collembola	Heteromurus nitidus	Templeton, 1835		Tf	Z/R

No	Kingdom	Sub-kingdom	Sub-kingdom	Latin Name	Author	Endemic	Ecological Classification	Data Source
114	ANIMALIA	ENTOGNATHA	Collembola	Heteromurus tetrophthalmus	Borner, 1903		Tx	L
115	ANIMALIA	ENTOGNATHA	Collembola	Lepidocyrtus lignorum	Fabricius, 1793		Tx	L
116	ANIMALIA	ENTOGNATHA	Collembola	Lepidocyrtus curvicollis	Bourlet, 1839		Tx	R
117	ANIMALIA	ENTOGNATHA	Collembola	Lepidocyrtus lanuginosus	Gmelin, 1788		Tx	L
118	ANIMALIA	ENTOGNATHA	Collembola	Entomobrya sp.			Tx	R
119	ANIMALIA	ENTOGNATHA	Collembola	Coecobrya tenebricosa	Folsom, 1902		Tx	R
120	ANIMALIA	ENTOGNATHA	Collembola	Neelus cf. klisurensis	Kovač & Papač	e?	Tb	R
121	ANIMALIA	ENTOGNATHA	Collembola	Megalothorax sp.			TF	R
122	ANIMALIA	ENTOGNATHA	Collembola	Arrhopalites caecus	Tullberg, 1871		Tf	R
123	ANIMALIA	ENTOGNATHA	Collembola	Pygmarrhopalites sp. nov.		E	Tf	R
124	ANIMALIA	ENTOGNATHA	Collembola	Lipothrx lubbocki	Tullberg, 1872		Tx	L
125	ANIMALIA	ENTOGNATHA	Collembola	Ptenothrix atra	Linnaeus, 1758		Tf	R
126	ANIMALIA	ENTOGNATHA	Diplura	Plusiocampa remy	Conde, 1937	E	Tb	Z/R
127	ANIMALIA	ENTOGNATHA	Diplura	Plusiocampa sp. nov.			Tx	Z/R
128	ANIMALIA	INSECTA	Coleoptra	Blaps sp.			Tx	Z/R
129	ANIMALIA	INSECTA	Coleoptra	Neotrechus suturalis otiosus	Obenberger, 1917	e	Tb	Z/R
130	ANIMALIA	INSECTA	Coleoptra	Laemostenus cavicola ssp.		e	Tf	R
131	ANIMALIA	INSECTA	Coleoptra	Bathyscidius tristiculus fallaciosus	J. (G) Müller, 1910	E	Tb	R
132	ANIMALIA	INSECTA	Coleoptra	Speonesiotes narentinus latitarsis	Apfelbeck, 1919	E	Tb	R
133	ANIMALIA	INSECTA	Coleoptra	Antroherpon apfelbecki apfelbecki	J. (G) Müller, 1910	E	Tb	R
134	ANIMALIA	INSECTA	Coleoptra	Tychobythinus neumanni	J. (G) Müller, 1909	E	Tb	R
135	ANIMALIA	INSECTA	Coleoptra	Gen/sp			Tx	R
136	ANIMALIA	INSECTA	Coleoptra	Ocypus sp.			Tx	R
137	ANIMALIA	INSECTA	Coleoptra	Gen/sp			Tx	R
138	ANIMALIA	INSECTA	Diptera	Gen/sp			Tf	R
139	ANIMALIA	INSECTA	Diptera	Gen/sp		?		R
140	ANIMALIA	INSECTA	Trichoptera	Hydropsyche sp.			Tx	R
141	ANIMALIA	INSECTA	Lepidoptera	Amphipyra effusa	Boisduval, 1829		Tf	Z/R
142	ANIMALIA	INSECTA	Lepidoptera	Hypena sp.			sTf	R
143	ANIMALIA	INSECTA	Lepidoptera	Noctuidae, Gen/sp			Tx	R
144	ANIMALIA	INSECTA	Lepidoptera	Geometridae, Gen/sp			Tx	R
145	ANIMALIA	INSECTA	Lepidoptera	Tineidae?, Gen/sp			Tx	R
146	ANIMALIA	INSECTA	Hymenoptera	Gen/sp			Tx	R
147	ANIMALIA	INSECTA	Orthoptera	Dolichopoda araneiformis	Burmeister, 1838	e	Tf	Z/R
148	ANIMALIA	INSECTA	Psocoptera	Gen/sp			Tx	Z/R
149	ANIMALIA	VERTEBRATA	Amphibia	Proteus anguinus	Laurenti, 1768		Sb	L
150	ANIMALIA	VERTEBRATA		Dinaromys bogdanovi	Martino, 1922	e	sTf	Z

LEGEND

Taxonomic definition

cf. - Probably, but not certainly identified taxon

Gen. new - new, still unknown and undescribed genus of Science
sp. new. - new, still unknown and undscribed species for science
Gen/sp - taxon has not determined the level of taxonomic genus
sp. - taxa determined only to the genus

Edemism

E - endemic to south-dinaric biogeographic region
e - endemic Dinaric biogeographic region
? - endemism cannot be defined

Ecological Classification

Tb - troglobiont

Sb - stigobiont

Tf - troglophile

Sf - stiglophile

STF - Conditional troglophile

SSF - Conditional stigophile

Ed - edafon

Pek - ectoparasite

Pen - endoparasites

Date Source

L - Literature (references)

Z - a collection of CBSS (bundled previous research CBSS-a)
R - CBSS recent research in the period 19:03 to 18:06 2012th

B-2: Habitat Types

List of established habitats by NCS within parts of the cave system with characteristic fauna and other established (channel names and polygon points under Krašovec, 1988 and Misetic *et al.*, 2012) – Taken from CBS 2012. (See Appendix C for Corresponding Map)

NCS Habitat	Location within the Cave System	Characteristic (Bold) / other Fauna Found
A.2.1. Sources	Source Ombla	-No-researched
H.1.1.1. Half-cave and the input and (lit) portion of the cave	Illuminated caves Viline	***Hypena* sp., *Amphipyra effusa, Dolichopoda araneiformis***
H.1.1.2. Dry fossil cave	Input part Viline caves	***Dinaromys bogdanovi*** / *Hypena* sp., *Amphipyra effusa, Dolichopoda araneiformis*
H.1.1.3. Caves and cave systems with subtroglof. vertebrates	Fairy cave high up the hall	**Chiroptera**
H.1.1.4. Caves and cave systems troglobiontic invertebrates - *Subtype 1*	Fairy cave high up the hall	***Typhlogastrura warm,* Isopoda: new. gen. new. sp., *Bathyscidius tristiculus fallaciosus, Histopona dubia, Sulcia* sp. new and *Tychobythinus Neumann Pholeoteras euthryx*** / *Spelaeothrombium caecum; Stalagtia hercegovinensis; Verhoeffiella media, Eukoenenia pretneri,* Chthoniidae gene. new. sp. new.
H.1.1.4. Caves and cave systems troglobiontic invertebrates - *Subtype 2*	Upper floor: Coral, Main, East and West trench, medium level and dry parts of the lower floors, with all the wiring and side channels	***Belba gratiosa, Neotrechus suturalis otiosus, Antroherpon Apfelbeck Apfelbeck, Speonesiotes narentinus latitartis, Verhoeffiella media, Neelus* cf. *Klisurensis, Archaphorura* sp. new., *Plusiocampa Remy, P.* sp. new., *Cyphonethes herzegowinensis, Cyphoniscellus herzegowinensis, Travunia anophthalma, Eukoenenia* cf. *Remy Stalagtia hercegovinensis*** / *Rhagidia* sp.; *Bathyscidius tristiculus fallaciosus; Plusiocampa* sp. new.; Chtoniidae gene. new. sp. new.
H.1.1.5. Troglopffllous cave invertebrates - *Subtype 1*	Fairy cave high up the hall	***Lithobius* sp.1, *Trichoniscus Benelli Benelli, Amphipyra effusa, Roncus* sp. nov.1, *Chthonius subterraneus, Chthonius* sp. new., *Nelim troglodytes*** / *Eugamasus* sp.; *Galumna* sp.; *Uroobovella* cf. *Reticulata; Cryptops* cf. *Illyricus; Pygmarrhopalites* sp. new.; *Hypnophila pupaeformis; Hypena* sp., *Amphipyra effusa, Trogulus torosus, Dolichopoda araneiformis, Roncus* sp. Nov 2, *Lamprochernes chyzeri, Symphylella?sp.*
H.1.1.5. Troglopffllous cave invertebrates - *Subtype 2*	Upper floor: Coral, Main, East and West trench, medium level and dry parts of the lower floors, with all the wiring and side	***Nesticus hermits, Folsomia Candida, Arrhopalites caecus*** / *Eugamasus* sp., *Parasitus* sp; *Pergamasus* sp. ; *Laemostenus cavicola; Ptenothrix atra; Hypnophila pupaeformis; Trichoniscus Benelli Benelli, Nelim troglodytes, Dolichopoda araneiformis*

NCS Habitat	Location within the Cave System	Characteristic (Bold) / other Fauna Found
	channels	
H.1.2.1.1. Higropetrik	Upper floor: main trench (t 27)	-Not specified-
H.1.3.1. Underground streams - *Subtype 1 (classic underground streams)*	The main supply cave Channel	-No-researched
H.1.3.1. Underground streams - *Subtype 2 (mixed habitat H.1.3.1.Underground streams and H.1.3.2. Stagnant groundwater)*	The source Cave Trapped in the west cavern, deep lake in the Great Hall	***Troglocaris pretneri, T. hercegovinensis, T. anophthalmus, Niphargus balcanicus, N. vjetrenicensis, N. trullipes, N. kolombatovici Steuer, N. Saloni, Typhlogammarus Mrazek, Hadzia fragilis, Monolistra hercegoviniensis ornata, Sphaeromides Vire*** **cf.** ***Montenegrin, the Prostoma cf. hercegovinense*** / *Belgrandia torifera; Emmericia expansilabris; Hauffenia plan; Hauffenia edlaueri; Horatio Knorr; Pin Absolon; Pin bagliviaeformis; Lanzaia vjetrenicae; Lanzaia kusceri; Orientalina troglobia; Plagigeyeria robusta robusta, robusta Plagigeyeria asculpta; Plagigeyeria nitida Angel; Saxurinator Brandt,?Dendrocoelum* sp. Oligochaeta gene. sp.
H.1.3.2.2. Kamenice/H.1.3.2.3. Puddles	Oysters and ponds in the upper floor: Coral, Main, East and West trench, middle level and dry parts of the lower floors, with all the wiring and side channels	Puddles in the lower deck: ***Niphargus*** **sp.** Found on the surface: ***Eukoenenia*** **cf.** ***remy Neelus*** **cf.** ***Klisurensis, Archaphorura*** **sp. new**.
H.3.1.1. Interstitial terrestrial habitats	Throughout terrestrial caves	-Not-researched
H.3.2.1. Interstitial water habitat *	Source cave, Great Lake	***Proasellus anophthalmus rhausinus*** / *Microcharon hercegovinensis*
H.4.1.1. And underground mines. passes	Tunnels	***Plusiocampa remy*** / *Neotrechus suturalis otiosus, Cyphonethes herzegowinensis, Travunia anophthalma, Verhoeffiella media*

* Fauna characteristic of interstitial water habitat has not been established

B-3: List of Endangered Species Recorded in Ombla System

The list of species protected by international regulations, listed in the Red Book of Croatian Cave Fauna (Ozimec et al., 2009) and the International List of threatened species: The IUCN Red List of Threattened Species (IUCN, 2012).

Taxa	Regs	Appendix	IUCN HR	IUCN Red List	Most Recent Record	Presence/ Location 2012
Polychaeta						
1.Marifugia cavatica			DD		2000	No
Gastropod						
2.Agardhiella stenostoma				LC	2000	No
3.Anisus leucostomus				LC	2000	No
4.Belgrandia torifera			EN	VU	2012	Yes - Deep Lake
5.Cecilioides spelaea			EN		2000	No
6.Emmericia expansilabris				VU	2012	Yes - Deep Lake
7. Hauffenia edlaueri				DD	2000	No
8. Hauffenia plana				NT	2000	No
9.Horatio Knorr			CR		2005	No
10. Iglica Absolon				LC	2012	Yes - source cave, deep lake
11. Iglica bagliviaeformis			EN	EN	2012	Yes - source cave, deep lake
12. Lanzaia vjetrenicae vjetrenicae			CR	VU	2000	No
13.Lanzaia vjetrenicae kusceri			CR		2000	No
14.Odontocyclas kokeilii				LC	2000	No
15.Pholeoteras euthryx			VU		2012	Yes - entrance hall Viline caves and medium level
16. Plagigeyeria robusta robusta				DD	2012	Yes - Deep Lake
17. Plagigeyeria nitida angelovi			CR	DD	2005	No
18.Platy Wilhelmi				LC	2000	No
19.Pyrgula annulata dalmatica				LC	2012	Yes - Deep Lake

Taxa	Regs	Appendix	IUCN HR	IUCN Red List	Most Recent Record	Presence/ Location 2012
20.Saxurinator Brandt			EN	VU	2000	No
BIVALVIA						
21.Congeria kusceri	Habitats Directive	III, IV	CR	VU	2000	No
Acari						
22.Spelaeothrombium caecum			EN		2012	Yes - the cave entrance hall Viline
PALPIGRADA						
23.Eukoenenia pretneri			CR		2011	No
Opiliones						
24.Travunia anophthalma			EN		2012	Yes-Great Hall, tunnel, middle and upper level
Isopoda						
25.Cyphoniscellus herzegowinensis			VU		2012	Yes - middle and upper level
26.Microcharon hercegovinensis			CR		1951	No
27.Proasellus anophthalmus rhausinus			EN		1941	No
Amphipods						
28.Niphargus trullipes			CR		2012	Yes - The source of caves and deep lakes
29.Typhlogammarus Mrazek			EN		2012	Yes - source cave, chiffon in western caverns and deep lakes
Decapoda						
30.Troglocaris anophthalmus				VU	2012	Yes - source cave
31. Troglocaris pretneri			EN		2012	Yes - source cave, chiffon in western caverns and deep lakes
Collembola						
32. Typhlogastrura Topali			EN		2012	Yes - upper floor
Diplura						

Taxa	Regs	Appendix	IUCN HR	IUCN Red List	Most Recent Record	Presence/ Location 2012
33.Remy Plusiocampa			DD		2012	Yes - medium level, Great Hall
AMPHIBIA						
34.Proteus anguinus	Habitats Directive	III, IV	VU	VU	1986	No
	Bern	II				

B-4: List of Taxa for which the Ombla Cave System Is currently the only known location in Croatia and the only known site in the world

Taxa	The only known Sites in the World	Environmental Category	Latest Findings
FUNGI			
1.Hyphomycetes sp		TB	2012 - upper floor
2. Gleotinia sp. new.		TX	2012 - Great Hall
3.Myxotrichum deflexum		STF	2012 - Fairy Cave
4.Ombrophila sp. new.	+	STF	2012 - Great Hall
5.Syncephalis sp. new.	+	TB?	2012 - upper and middle floors
NEMERTEA			
6.Prostoma cf. Hercegovinense		SB	2012 - source cave
Gastropod			
7. Lanzaia vjetrenicae vjetrenicae		SB	2000
8. Lanzaia vjetrenicae kusceri	+	SB	2000
9. Plagigeyeria nitida angelovi	+	SB	2005
10. Orientalina troglobia		SB	2012 - Deep Lake, the source cave
11. Horatio knorri	+	SB	2005
PALPIGRADA			
12. Eukoenenia pretneri	+	TB	2012 - medium level
13.Eukoenenia cf. Remy		TB	2011
Pseudoscorpiones			
14th gen. new. sp. new.	+	TB	2012 - upper floor
15.Chthonius sp. new.	+	TF	2012 - upper floor
16. Roncus sp. new.1	+	TF	2012 - upper floor
17.Roncus sp. new.2	+	TB	/2008.
Acar			
18.Belba gratiosa		TB	2012 - medium level
19.Uroobovella cf. Reticulata		STF	2011
Araneae			
20.Histopona krivosijana		TB	1980
Amphipods			
21.Niphargus vjetrenicensis		SB	2012 - source cave, a large hall

Taxa	The only known Sites in the World	Environmental Category	Latest Findings
22.Niphargus balcanicus		SB	2012 - source cave
23.Niphargus hercegovinensis		SB	1998
Isopoda			
24. Gen. new. sp. new.	+	TB	2012 - Fairy Cave
25.Microcharon hercegovinensis		SB	1951
26.Monolistra hercegoviniensis ornata		SB	2012 - Great Hall, the source cave, a cavern with a siphon
27.Sphaeromides Vire cf. Montenegrina		SB	2012 - Great Hall
Decapoda			
28.Troglocaris (Troglocaridella) hercegovinensis		SB	2012 - source cave
Collembola			
29.Archaphorura sp. new.	+	TB	2012 - middle and lower floors
30.Neelus cf. Klisurensis		TB	2012 - middle and lower floors
31. Pygmarrhopalites sp. new.	+	TF	2011
Diplura			
32. Plusiocampa sp. new.	+	TB	2012-medium level

B- 5: New Species Found within the Ombla Cave System

List of new species for science established in the cave system Ombla

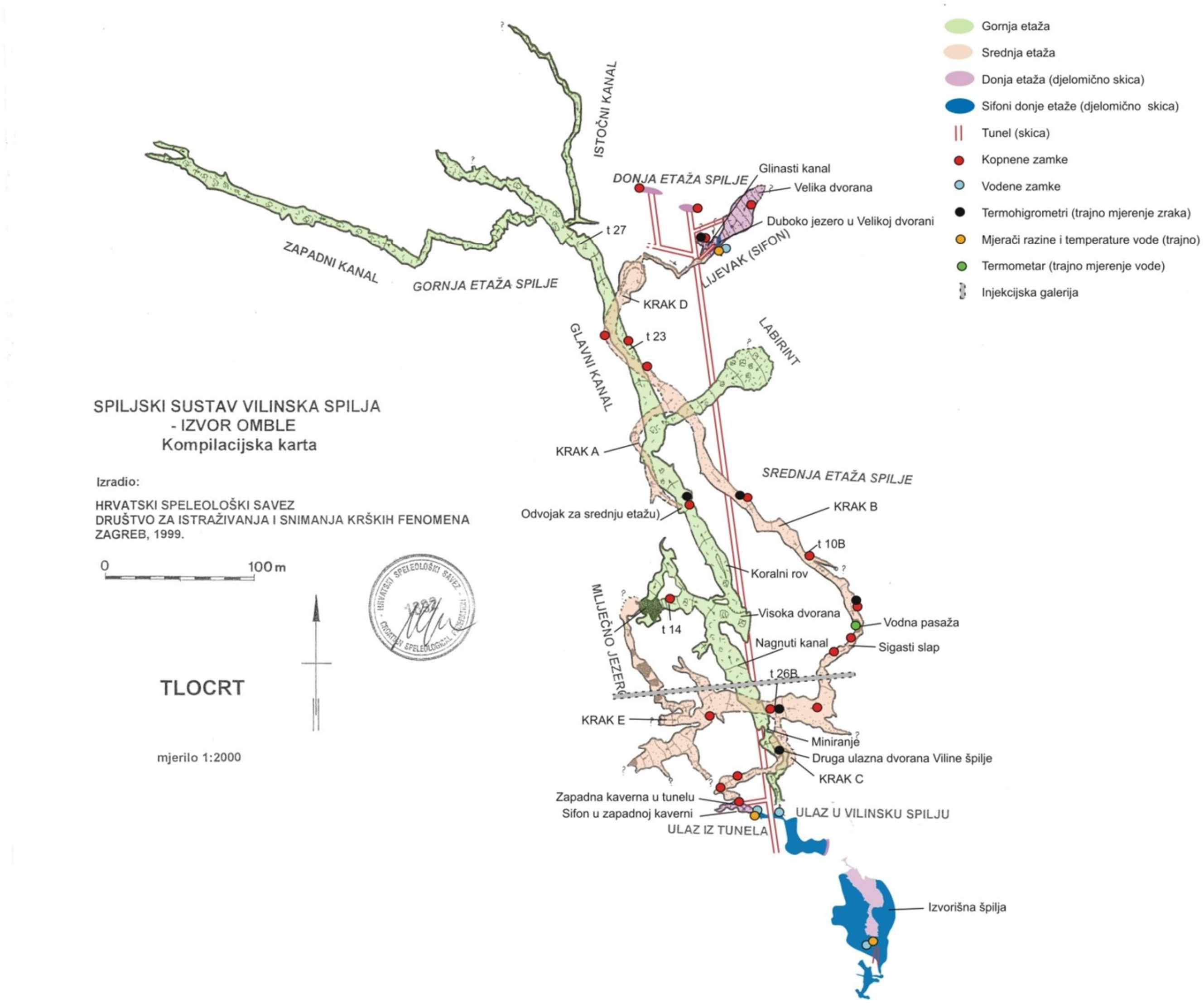
Taxa	Environmental Category	Latest Findings
FUNGI		
1.Gleotinia sp. new.	TX	2012-lower level
2. TheOmbrophila sp. new.	STF	2012-lower level
3.Syncephalis sp. new.	TB?	2012 - medium level
Araneae		
4.Sulcia sp. new.	TB	2012 - upper floor
Pseudoscorpiones		
5th gen. new. sp. new.	TB	2012 - upper floor
6.Roncus sp. nov.1	TF	2012 - upper floor
7. Roncus sp. nov.2	TB	2008 - upper floor
8. Chthonius sp. new.	TF	2012 - upper floor
Isopoda		
9th gen. new. sp. new.	TB	2012 - upper floor
Collembola		
10. Archaphorura sp. new.	TB	2012 - lower and medium level
11. Pygmarrhopalites sp. new.	TF	2011 - upper floor
Diplura		
12. Plusiocampa sp. new	TB	2012 - medium level

B- 6: List of Steno-endemic Species

Taxa	Environmental Category	Latest Findings
FUNGI		
1.Hyphomycetes sp	TB	2012 - The upper floors
2. TheOmbrophila sp. new.	STF	2012 - Lower level
3. Syncephalis sp. new.	TB?	2012 - Upper and middle storey
Gastropod		
4. Iglica absoloni	SB	2012- Source cave
5.Belgrandia torifera	SB	2012 - Deep Lake
6.Lanzaia vjetrenicae vjetrenicae	SB	2000 -
7. Lanzaia vjetrenicae kusceri	SB	2000 -
8. Plagigeyeria nitida angelovi	SB	2005
9.Orientalina troglobia	SB	2012 - Deep Lake, the source cave
10. Horatio Knorri	SB	2005th
PALPIGRADA		
11. Eukoenenia pretneri	TB	2011
12. Eukoenenia cf. Remy	TB	2012
Pseudoscorpiones		
13th gen. new. sp. new.	TB	2012 - The upper floors
14.Chthonius sp. new.	TF	2012 - The upper floors
15.Roncus sp. nov.1	TF	2012 - Fairy Cave
16. Roncus sp. nov.2	TB	2008
Opiliones		
17.Travunia anophthalma	TB	2012- Upper, middle and lower floors
Acar		
18.Biscirus sylvaticus convexus	STF	1941
Araneae		
19.Histopona dubia	TB	2012 - The upper floors
20.Histopona krivosijana	TB	1980
21.Sulcia sp. new.	TB	2012 - The upper floors
Amphipods		
22.Niphargus steueri kolombatovici	SB	2012 - Deep Lake, the source cave, Western Cavern
23. Niphargus salonitanus	SB	2012 - Deep Lake, West Cavern

Taxa	Environmental Category	Latest Findings
24.Niphargus vjetrenicensis	SB	2012 - Deep Lake, the source cave
25.Niphargus balcanicus	SB	2012 - The source Cave
26.Niphargus hercegovinensis	SB	1998
Isopoda		
27th gen. new. sp. new.	TB	2012 - Fairy Cave
28.Microcharon hercegovinensis	SB	1941
29.Monolistra hercegoviniensis ornata	SB	2012 - Deep Lake, the source cave, Western Cavern
30.Sphaeromides Vire cf. Montenegrina	SB	2012 - Deep Lake
Decapoda		
31.Troglocaris (Troglocaridella) hercegovinensis	SB	2012 - Source cave, Western Cavern
Collembola		
32.Typhlogastrura Topali	TB	2012- The upper floors
33. Archaphorura sp. new.	TB	2012 - Middle and lower floors
34. Pygmarrhopalites sp. new.	TF	2011- The upper floors
Diplura		
35. Plusiocampa sp. new.	TB	2012 - Middle floors
COLEOPTERA		
36.Anthroherpon apfelbecki	TB	2012- Lower level

Appendix C: Habitat Map (Karta staništa)



Appendix D: Data Register

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
1	Cro	Bioloski pregled izvorista omble	Biological characteristics of submarine environment on the location of temporary embankment needed for construction of HPP Ombla	Report of survey carried out on River Ombla downstream of Ombla Spring and the weir in 2011.
2	Cro	slikovnica ombla	Picture Book Ombla	Underwater photos from 2011 River Ombla survey (Croatian)
3	Eng	N/A	Picture Book Ombla	Underwater photos from 2011 River Ombla survey (English)
4	Eng	N/A	River Ombla photos (6 total)	Surface photos from 2011 River Ombla survey. Show turbidity.
5	Cro	Izvještaj 1 terenski izlazak Ombla.docx	Report 1 field observation Ombla [fish survey]	Report from first fish and amphibian survey (March 2012)
6	Cro	Studija utjecaja izgradnje HE Ombla na faunu šišmiša.pdf	ENVIRONMENT IMPACT ASSESSMENT OF HPP OMBLA CONSTRUCTION ON THE BAT FAUNA – First report	Report from first bat survey of Vilina cave (March 2012)
7	Cro	PRELIMINARNI IZVJESTAJ_1_04_2011	PRELIMINARY REPORT 1 04 2011 [Spelelogy]	Report from first speleology survey (March 2012)
8	Cro	RIBE-Izvještaj 2 terenski izlazak Ombla	FISH – Report 2 field observation Ombla	Report from second fish and amphibian survey (May 2012)
9	Cro	Fauna-PRELIMINARNI IZVJESTAJ_2_05_2012 _integral.docx	Fauna-PRELIMINARY REPORT 2_05_2012_integral	Report from second speleology survey (March 2012)
10	Cro	Studija utjecaja izgradnje HE Ombla na faunu šišmiša_2	ENVIRONMENT IMPACT ASSESSMENT OF HPP OMBLA CONSTRUCTION ON THE BAT FAUNA – Second report	Report from second bat survey of Vilina cave (May 2012)
11	Cro	N/A	Bat_fauna_in_Vilina_Cave.pdf	Bat survey report from 2008
12	Cro	HE_Ombla_analiza_rev. 1	Analysis and assessment of proposed nature protection measures for the Ombla HPP construction project; 2011	Report by EKONERG into proposed mitigation methods, with particular reference to bats
13	Eng	HE_Ombla_analiza_eng (SR)	Analysis and assessment of proposed nature protection measures for the Ombla HPP construction project; 2011	Report by EKONERG into proposed mitigation methods, with particular reference to bats

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
14	Cro	HE Ombla - Mišljenje o stručnoj podlozi šišmiši - MIK_06-08-2009	HE Ombla - Opinion on professional background bats - MIK_06-08-2009	Sets out Ministry expert opinion on the effects of the project and the protection measures to be fully implemented for bats.
14a	Eng	N/A	Ministry_opinion_bats	English translation of Ref 14
15	Cro	Vilina pecina_djel.uzduz.presjek	Vilina cave _ partial longitudinal cross-section	Vilina cave map
16	Cro	HE Ombla_situacija postrojenjapdf	HPP Ombla _ map of the HPP site – general layout of the Vilina cave system and HPP construction site	HPP layout map
17	Eng	N/A	Cave system - eng	Maps of cave system
18	Cro	Popis dokumentacije za Omblu 2012	List of documents for Ombla 2012	List of documents available about the Project from HEP, 2012
19	Eng	OMBLA_R_2011-01-25_Popis dokumentacije_eng	List of available documents: English version from 2011 list	List of documents available about the Project from HEP, 2011
20	Eng	N/A	List of documents for Ombla 2012 - addition.doc	Additional HEP documents available since 2011
21	Cro	HE_Ombla_KS	HPP Ombla map of habitats	Terrestrial habitat map
22	Eng	N/A	HE ombla-ENG	Presentation about the project by the ElektroProjeckt Design Engineer (Zvonimir Sever) (see also ref 54).
23	Eng	N/A	Ombla Field Visit Report	Report by Petra Žvorc of observation visit, June 2012
24	Eng	N/A	Sustainable Use of Groundwater with Underground Dams.pdf	Review paper by Japanese insitiutions. Published Japan Agricultural Research Quarterly (JARQ) 45 (1), 51 - 61 (2011)
25	Cro	Spiljski Sustav Vilinska Spilja - Izvor Omble. Kompilacijska karta	Fairy Cave cave system - Source Ombla. Compilation map	B&W map of cave system,labels Croatian
26	Eng	N/A	Ombla Hydropower Project, Tractabel Enginnering	Report on the technical aspects and possible risks of the project and their probable commercial consequences
27	Cro	Vilina spilja - Kopneni	Vilina Fossil caves	Detailed Mapping of Vilina fossil Caves System: surveys 1987 & 1994

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
28	Cro	Vilina spilja - Vodeni dio	Vilina Cave System Active Caves	Detailed Mapping of Vilina active Caves System: surveys 1987 & 1993
29	Cro	HE Ombla Sinteza geoloških istraživačkih radova_svibanj 2008	HE Ombla Synthesis of geological research radova_May 2008	
30	Eng	Rezultati ispitivanja +ípilja eko-sonderom P-122.5	Results of the Cavity Survey by means of Echo-Sounding in the cavity Ombla P-122.5 (11 October 2005)	Detailed results of cave survey by echo sounding
31	Eng	Rezultati ispitivanja +ípilja eko-sonderom PHD-2	Results of the Cavity Survey by means of Echo-Sounding in the cavity PHD-2 (13 October 2005)	Detailed results of cave survey by echo sounding
32	Cro	prezi_ombla_07	Presentation Ombla 2007	Presentation about the Ombla Project. Appears to be set up / formatted more for public consultation than technical audience. Includes many maps and photographs.
33	Cro	Speleoloski snimak OMBLA stabilnost licnih padina prethodna studija - 1986	Speleological survey OMBLA stability of slopes - 1986	Findings of speleology surveys from 1986. Scans of paper copies
34	Cro	Speleoloski snimak OMBLA stabilnost licnih padina prethodna studija - 1987	Speleological survey OMBLA stability of slopes - 1987	Findings of speleology surveys from 1987. Scans of paper copies
35	Cro	Speleoloski snimak OMBLA stabilnost licnih padina prethodna studija - 1989	Speleological survey OMBLA stability of slopes - 1989	Findings of speleology surveys from 1989. Scans of paper copies
36	Cro	Strukturni model Ombla 20.05.2011	The structural model Ombla 5/20/2011	Plans showing geology / cave system with outline of proposed project marked on
37	Cro	HE Ombla -Opis zahvata	HE Ombla - Description of the project	Written report describing the project
38	Cro	HE OMBLA_PREGLEDNA SITUACIJA	HE OMBLA - Review of the Situation	Overview plan of the project design
39	Cro	SISMISI_DJELOMI-ÎNI TLOCRT A3	Layout plan with caves A3	Plan of project with cave system shown
40	Cro	SISMISI_DJELOMI-ÎNI TLOCRT A4	Layout plan with caves A4	Plan of project with cave system shown
41	Cro	SISMISI_UZDUZNI PRESJEK SA SPILJAMA	Longitudinal section with caves	Longitudinal section of project with cave system shown

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
42	Cro	Studija mogu-çeg utjecaja na okolinu HE Ombla s obzirom na seizmi-ìke sile	Translation pending (if required)	Environmental Assessment related to siemic activity. 1989. Scan.
43	Cro	Analiza pona+íanja podzemne akumulacije HE Ombla u zoni razvodnice prema izboru Palata	Analysis of the behavior of underground reservoirs íanja HE Ombla zone in the watershed election Palace	Analysis of the behavior of underground reservoirs; exact details will need translation. 1993. Scan
44	Eng	N/A	Conceptual Design-Hydraulic Structures	Technical description for hydraulic structures, including during construction. 2007
45	Eng	N/A	Figure 3.13 translated legend	Plan of hydrogeology characteristics of watershed
46	Cro	HE OMBLA - Projekt za energetsko kori+ítenje podzemnih voda u Kr+íu	HE OMBLA - Project for energy use + ítenje groundwater in BC + in	Description of project, its develepomnt and operation. Exact details will need translation. 2008
47	Cro	HE OMBLA Geolo+íki elaborat - Rekapitulacija i monitoring	HE OMBLA Geological Iki study - Summary and Monitoring	Summary of geology research. Exact details will need translation. 2008
48	Cro	HE Ombla-strukturni model	HE Ombla-structural model	Plan of investigations for the engine tunnel. Shows artificial tunnels (and boreholes?)
49	Cro	Numeri-ìki model pona+íanja podzemne akumulacije	Numerical model of behavior-Iki + íanja underground reservoirs	Numerical model of groundwater. 1997
50	Eng	N/A	OMBLA_Feasibility Study Summary	Summary of Feasibility Study. 2010
51	Eng	N/A	Ombla_Project_Feasibility_2010	Feasibility Study. 2010
52	Cro	Pregledna karta podruìja monitoringa	Overview map of the area of monitoring	Location map of groundwater monitoring sites and existing abstraction sites. Forms part of Ref 56.
53	Cro	Prethodna studija o utjecaju izgradnje HE Ombla na stabilnost padina njenog okoli+ía	Previous studies on the impact of building HPP Ombla on the slope stability of its environment	Slope stability assessment. Exact details will need translation. 1989. Scan
54	Eng	PREZENTACIJA Ombla engl R1.Dubrovnik 07.04.2011.ppt	PRESENTATION Ombla Eng R1.Dubrovnik 07.04.201	Presentation about the project. Ppt version of ref 22.
55	Eng	Prilog 5 - Stabilnost Podzemne Brane_english	Appendix 5 - Ground Stability Brane_english	Stability Check – Conservative Approach plus Finite Elements Method

Doc ref	Lang .	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
56	Cro	Program monitoringa vodnih objekata i istra+¥nih bu+íotina u uplivnom podru-ìju podzemne akumulacije	Monitoring program of water facilities and exploration wells in the underground uplivnom accumulation Ombla	Details of groundwater monitoring programe. See ref 52 for Map.
57	Cro	Water_regulation_croatian_02-BiH-HV_28-05-2008	Water_regulation_croatian_02-BiH-HV_28-05-2008	Agreement between Croatia and BiH: Croatian
58	Eng	N/A	Water regulation conditions_english	Agreement between Croatia and BiH: English
59	Cro	Hydrology-1994-part1	Hydrology-1994-part1	Hydrological Analysis. See ref 62
60	Cro	Hydrology-1994-part2	Hydrology-1994-part2	Hydrological Analysis. See ref 62
61	Cro	Hydrology-2009	Hydrology-2009	Hydrological Foundations for the HPP Ombla: data and graphs only, no text. See Ref 63
62	Eng	N/A	Hydrographic analysis final translation 1994.doc	Hydrological Analysis. Translation of Refs 59 and 60
63	Eng	N/A	Hydrology 2009 translation.doc	Hydrological Foundations for the HPP Ombla: data and graphs only, no text. Translation of Ref 61
64	Cro	N/A	Barrier Location - Faults along cross-section mine2	Structural geological mapping and Barrier location: Refs 63 to 71
65	Cro	N/A	Barrier Location - Frontal Dinarika Cover Profile2	Structural geological mapping and Barrier location: Refs 63 to 73
66	Cro	N/A	Barrier Location - Frontal Dinarika Cover2	Structural geological mapping and Barrier location: Refs 63 to 72
67	Eng	N/A	Barrier Location - Legend Translation	Structural geological mapping and Barrier location: Refs 63 to 74
68	Cro	N/A	Structural geological Mapping - Cross Section	Structural geological mapping and Barrier location: Refs 63 to 75
69	Cro	N/A	Structural geological Mapping - Faults Map	Structural geological mapping and Barrier location: Refs 63 to 76
70	Cro	N/A	Structural geological Mapping - Powerhouse Investigation Tunnel	Structural geological mapping and Barrier location: Refs 63 to 77
71	Eng	N/A	Structural geological Mapping - Legend Translation	Structural geological mapping and Barrier location: Refs 63 to 78

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
72	Cro	HE OMBLA Izvjestaj I	HE OMBLA Report Part I	Hydrogeological model: Part II
73	Cro	HE Ombla Izvjestaj II	HE OMBLA Report Part II	Hydrogeological model: Part II
74	Cro	HE Ombla-NumMod.ppt	HE Ombla-NumMod	Hydrogeological / Numerical Model: Presentation
75	Eng	N/A	HPP Ombla report part I_english.doc	Hydrogeological model: Part II
76	Eng	N/A	HPP Ombla report part II_english.doc	Hydrogeological model: Part II
77	Eng	N/A	Ombla-Num-model-natural_vs_project.doc	Hydrogeological model: comparison between existing and with scheme conditions
78	Cro	Ocjena maksimalne kote uspora	Assessment of maximum impoundment elevation of underground reservoir	Assesses potential maximum water impoundment in the karst underground of the Ombla spring hinterland on the basis of existing data. 1995
79	Eng	N/A	Assessment of maximum impoundment elevation of underground reservoir	Translation of Ref 78
80	Eng	N/A	HE OMBLA - Borehole O-19.doc	Report on Groundwater Flow Routing through Borehole O-19
81	Eng	N/A	HE OMBLA - Borehole O-21.doc	Report on Groundwater Flow Routing through Borehole O-21
82	Cro	Hidrogeologija - slike	Hydrogeology - pictures	Scans of maps. Zip file.
83	Cro	N/A	Geological Drawings	Scans of drawings. Zip file.
84	Cro	Geoloski zavod Ljubaljana	Geological Institute Ljubaljana	Drawings of cave systems: hydrospeleology and fossil caves. Zip file. Overlap with Refs 27 and 28.
85	Cro	Seizmička aktivnost	Seismic activity 1994_2009	Records of seismic activtiy 1994 to 2009. Zip file.
86	Cro	N/A	Design Drawings	Pdfs of design drawings. Zip file.
87	Cro	Geodetsko opažanje	Geodetic observations	Reports of geodetic observations from 1990, 1991, 1995, 1996. Scans. Zip file.

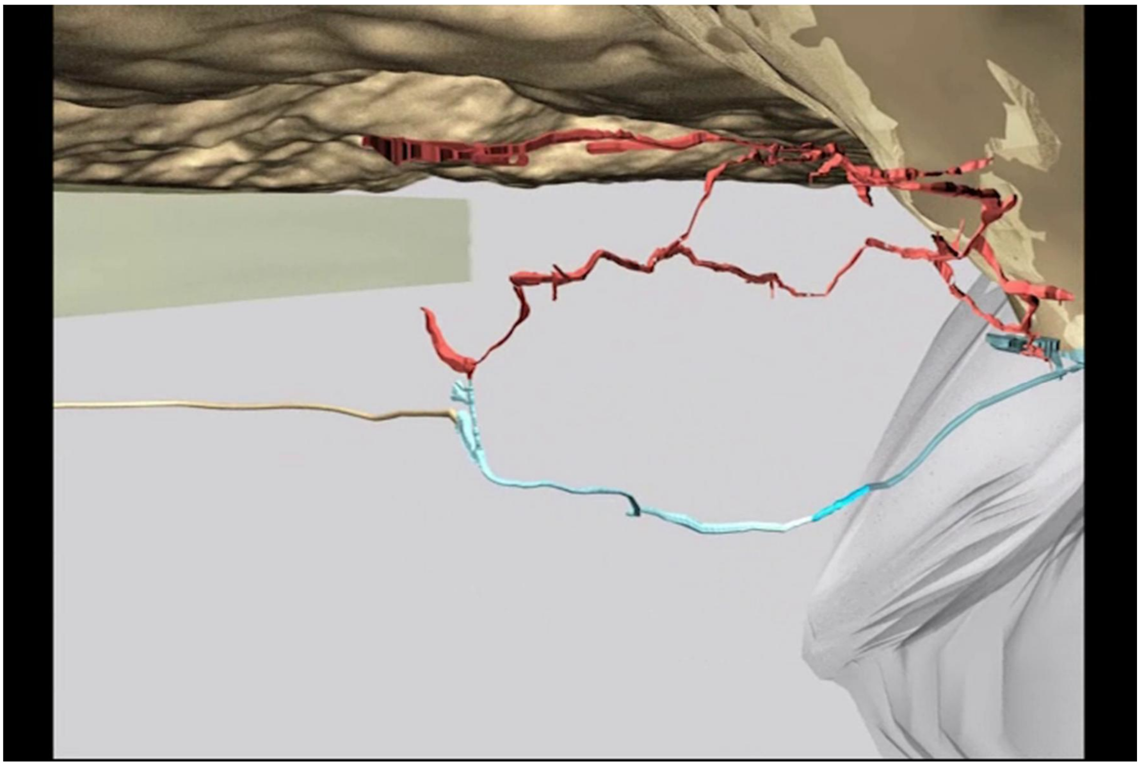
Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
88	Cro	HE Ombla - Analiza utjecaja akumulacije na stabilnost padina-IGH_10-1996	HE Ombla - Analysis of the impact of accumulation on the stability of the slope-IGH_10-1996	Slope stability analysis. 1996. Scan of paper copy.
89	Cro	HE OMBLA tekst sinteza radova	HE OMBLA text synthesis papers	Geotechnical Report: Summary of the results of geological, hydrogeological, structural tectonic, geophysical and engineering research papers.
90	Cro	Izvješće o ispitivanju vode rijeke Omble prije izgradnje HE Ombla	Report on the examination of water of the river before the construction of HPP Ombla Ombla	Water Quality Report
91	Cro	HE OMBLA rotary1.ppt	HE OMBLA rotary 1	Presentation about the project by HEP (Tomislav Paviša). Appears to be aimed at a more technical audience than Ref 32. Contains figures, maps and photos.
92	Cro	Oikon 3 izvješće	Oikon 3 report	Report of third bat survey of Vilina cave (June 2012)
93	Cro	Ombla treće izvješće	Ombla third report	Report of third fish survey (June 2012)
94	Cro	PRELIMINARNI IZVJESTAJ_3_06_2012 _integral Biospeleološko društvo	Preliminary report 3_06_2012_integral Biospeleological Society	Report of third biospelelogy survey (June 2012)
95	Eng	N/A	The Ombla HPP Multipurpose Hydro Project	Paper by Zvinimir Zever (Elektro-Project) for the 2003 HYDRO conference
96	Eng	N/A	HPP Ombla in Croatia - Proposed use of energy from groundwater in karst system	Paper by Thomislav Pavisa (HEP) for the 2003 HYDRO conference
97	Eng	N/A	Numerical models of karst flows	Paper by V Jovic (University of Split) for the 2003 HYDRO conference
98	Eng	N/A	Numerical model of flows in underground storage reservoir of the Ombla HE plant	Paper by V Jovic (University of Split) for the 2003 HYDRO conference
99	Cro	OIKON_Završni elaborat - Studija utjecaja izgradnje HE Ombla na faunu šišmiša_FINAL	Final technical report of the study into the impact of constructing HE Ombla on bat fauna	Draft of technical report by Oikon on potential impacts of Ombla HPP on bats

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
100	Cro	PRILOG_FINAL_Završni elaborat_small	Figure for final technical report into impacts on bat fauna	Draft map showing locations of bats and mitigation measures within Vilina cave
101	Cro	STUDIJA O UTJECAJU NA OKOLIŠ PLANIRANE HIDROELEKTRANE OMBLA	A study on the environmental impact of the planned Ombla HPP plant	Draft of technical report by Croatian Ichthyological Society on potential impacts of Ombla HPP on fish and herpetofauna
102	Cro	Opis područja ekološke mreže	Ombla_and_Natura_Description of the ecological network	List of features and conservation objectives for the NEN network sites at Ombla
103	Eng	HE Ombla-naslovna	OMBLA HPP TENDER DOCUMENTS FOR SELECTION OF CONTRACTOR 5 – DRAWINGS	Tender drawings of 2010 design in AutoCAD
104	Cro	Pojašnjenje Državnog zavoda za zaštitu prirode	Opinion from Croatian State institute for Natura protection and additional data	Response to questions regarding Proposed SCI, Generic Information on Terrestrial Habitats and Boundary of SCI in GIS
105	Cro	elaborat_biospeleologija_ombla_hbsd_ffin4.docx	Evaluation and protection of underground fauna cave system Vilinia Cave Ombla (Sep 2012)	Croatian biospeleology 2012 survey report and assessment
106	Eng	NA	Groundwater behaviour in Karst - Bonacci	
107	Eng	NA	Analysis of maximum discharge in karst springs - Bonacci	
108	Eng	NA	Challenges in transboundary karst water resource management	
109	Cro	Izvjesce o kompilacijskom topografskom snimku Vilinska spilja-Ombla_OCR	The report of a compilation recording topographical Fairy Cave-Ombla	
110	Eng		Transboundary Aquifers in Karst - Source of Water Management and Political Problems Case Study, SE Dinarides	
111	Cro	vilina spilja arheologija elaborat HEP 2012	Fairy cave archeology study HEP 2012	
112	Eng		Biogeography of the olm	
113	NA	NA	Piezometer data from HEP for various boreholes	
114	Eng/ Cro	NA	Ombla Water level modelling explanation	

Doc ref	Lang.	Title of drawing or document (Croatian)	Title of drawing or document (English)	Description
115	Eng/ Cro	NA	Data relating to the prevention of flooding of the Vilina Cave	Method and design drawings for Risk managment approach to flooding Viliina Cave
116	Cro	he_ombla_prilog_2_s_hederom.docx	Ombla Nature Impact Assessment	ElektroProjekt NIA 1st Draft Report
117	Eng	NA	Note for WSP on Olm Distribution and Ombla	Observations on data relating to Proteus and hydrogeology
118	Eng/ Cro	šišmiši i tunel	Bats and caves	Outline offset habitat proposal for Spring Cave, enhancements for bats and IROPI basis
119	Eng	NA	Ombla Hydropower Project, Tractabel Enginnering	Technical due diligence report for EBRD and HEP
120	Cro	he_ombla_prilog_2_s_hederom.docx	Ombla Nature Impact Assessment	ElektroProjekt NIA Final Draft Report

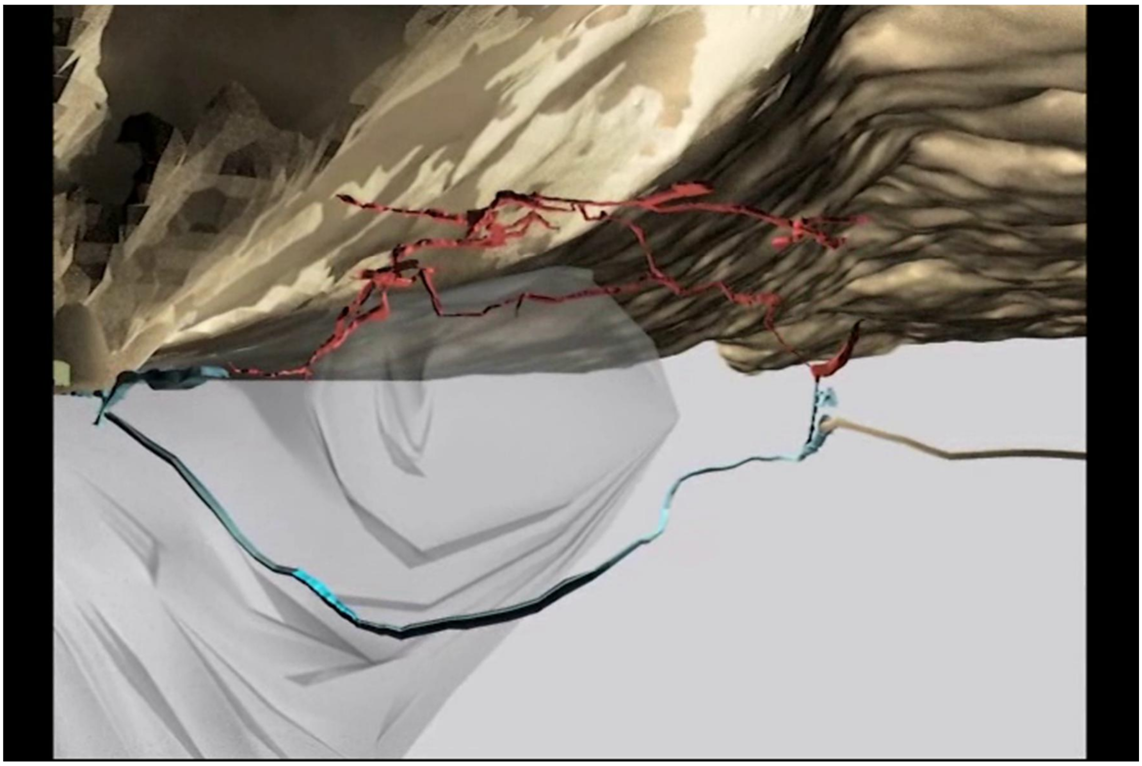
Appendix E: 3D Model Information

Current Cave System Series (4 screenshots):

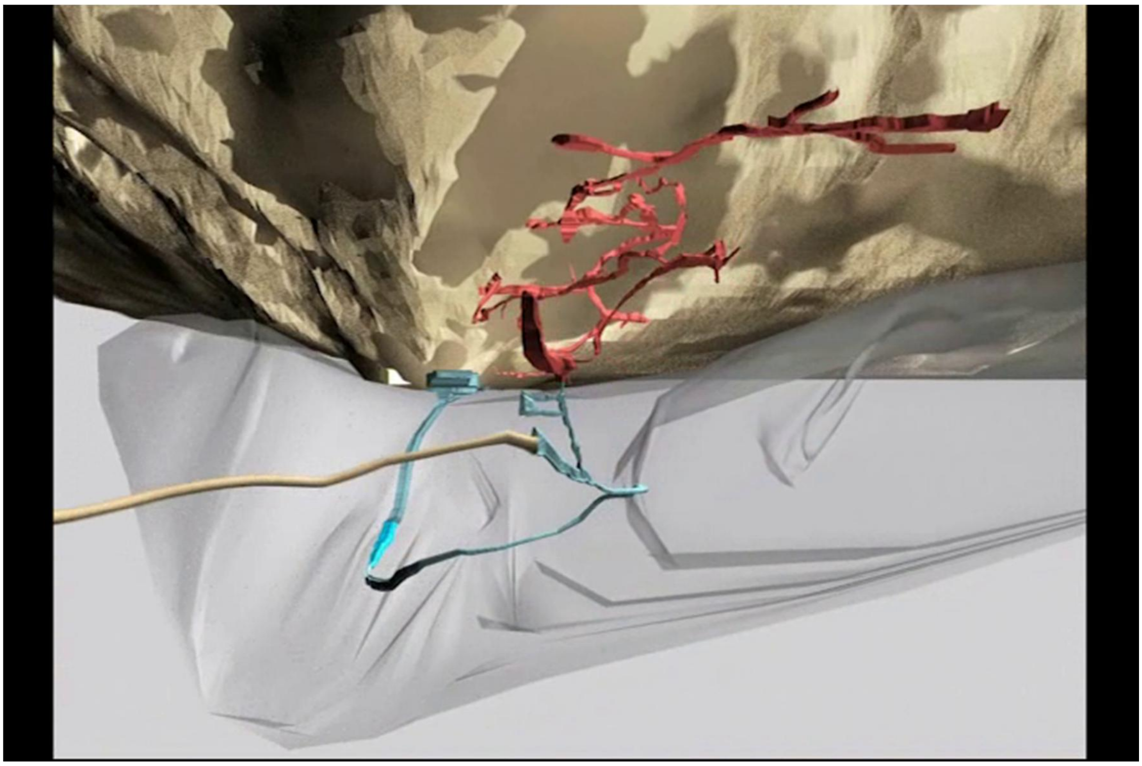


Internal Looking East

External Looking North

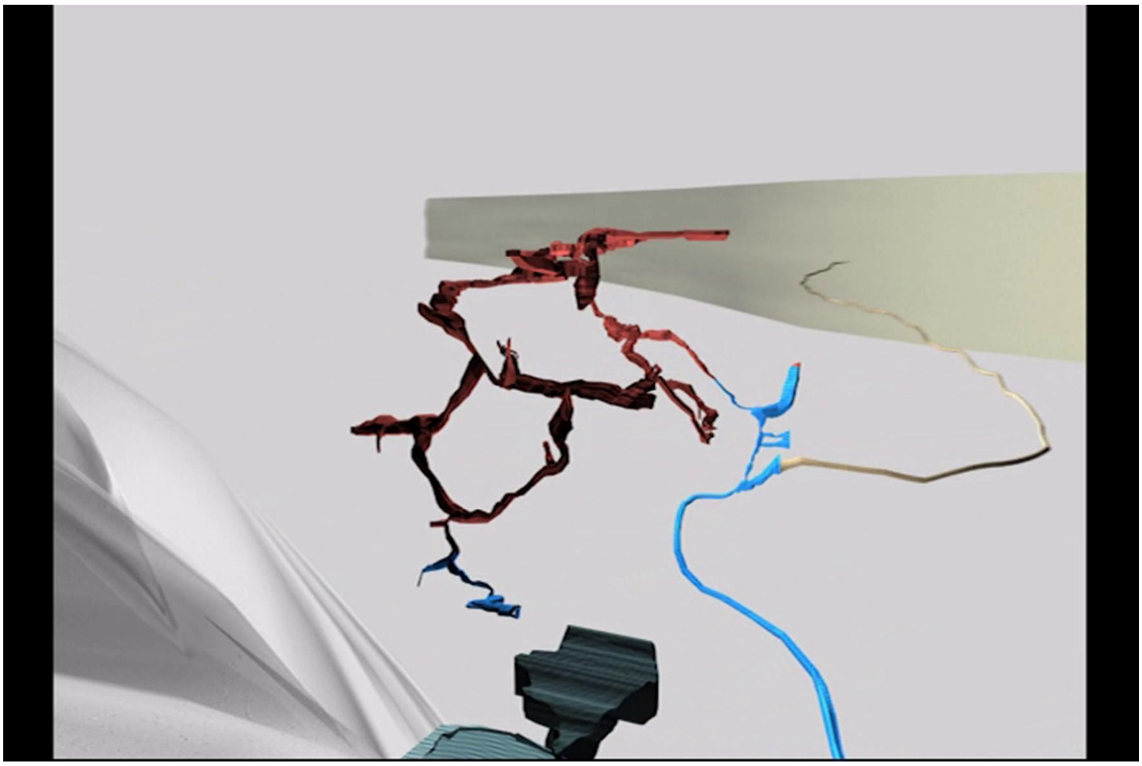


Internal Looking West

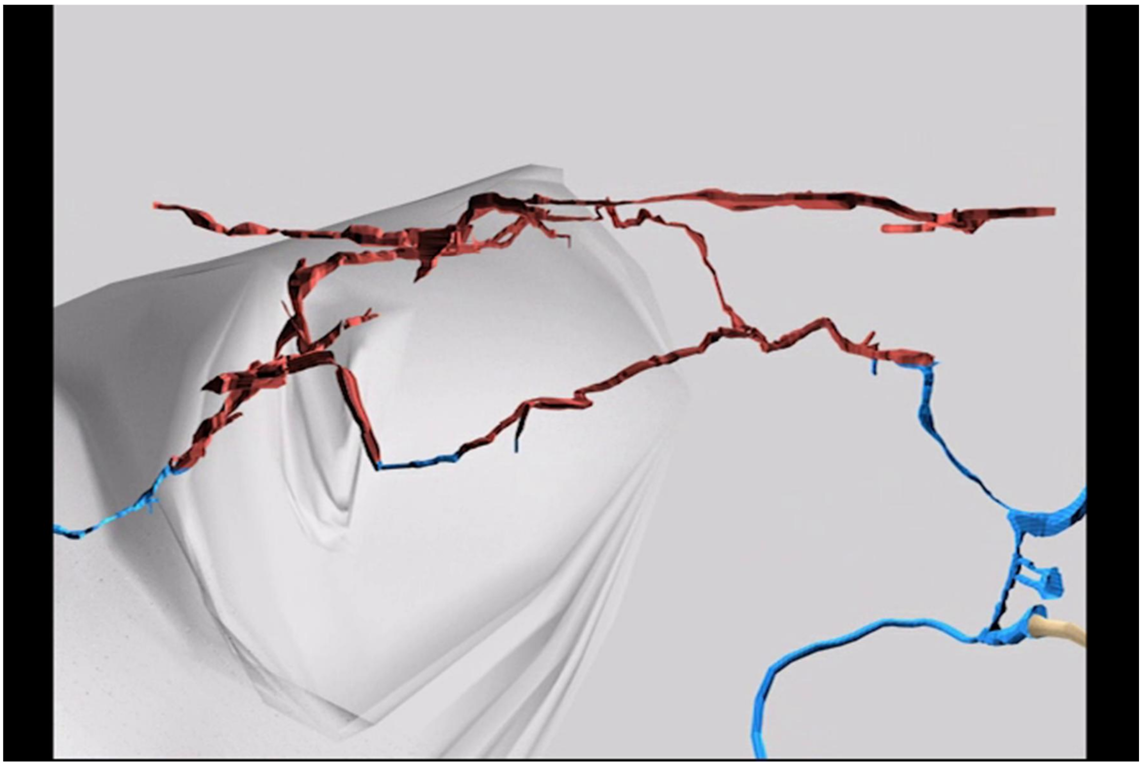


Internal Looking South

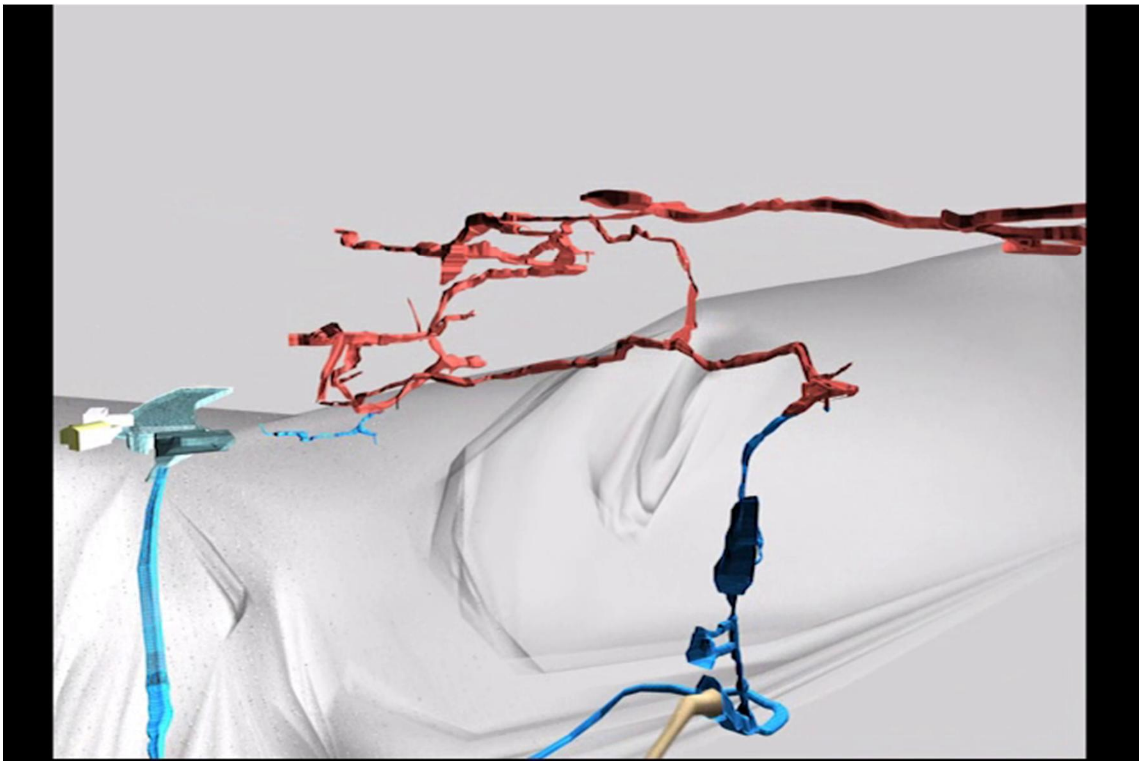
Current Cave System Rising Water Levels (Under normal conditions) Series (4 screenshots):



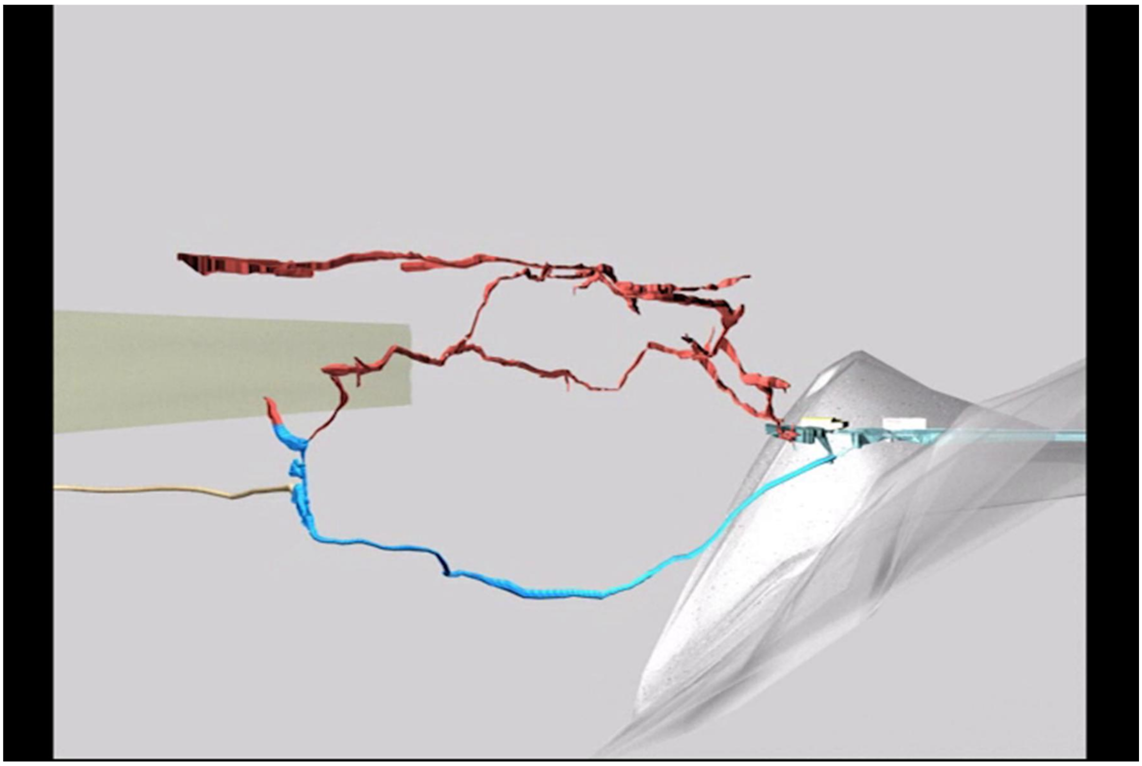
Internal Looking North (Water level rising to 50m.asl).



Internal Looking West (Water level rising to 50m.asl).

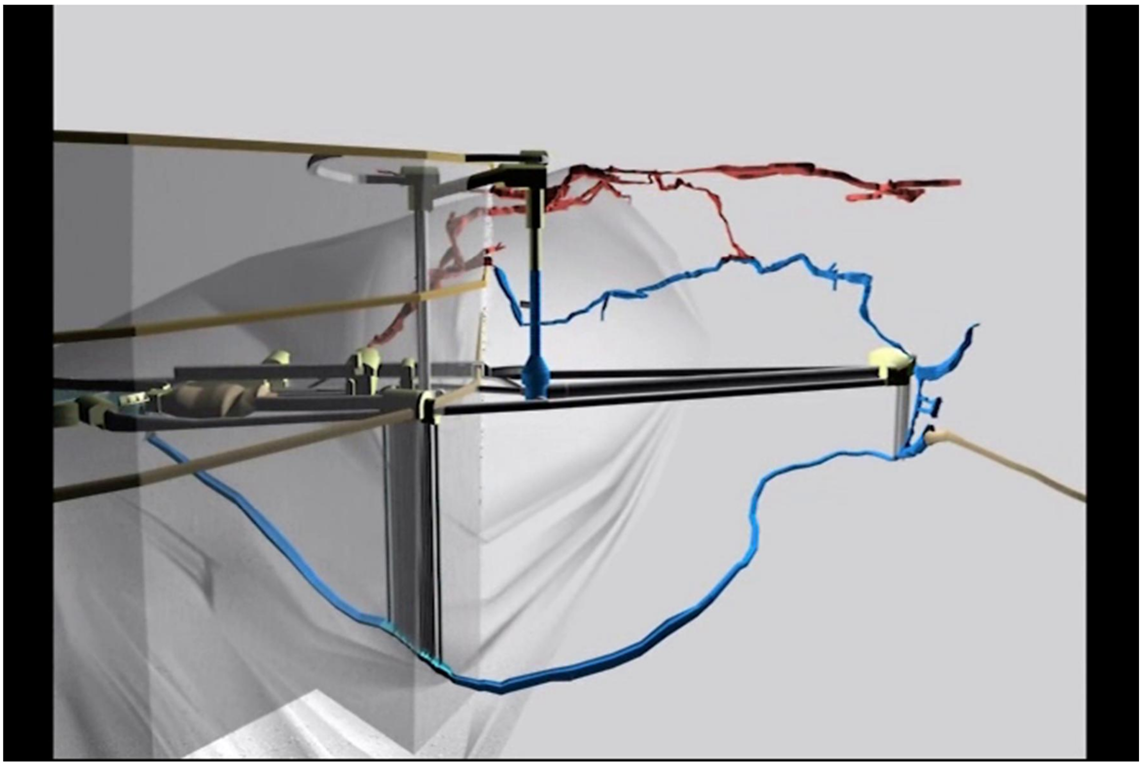


Internal Looking South (Water level rising to 50m.asl).

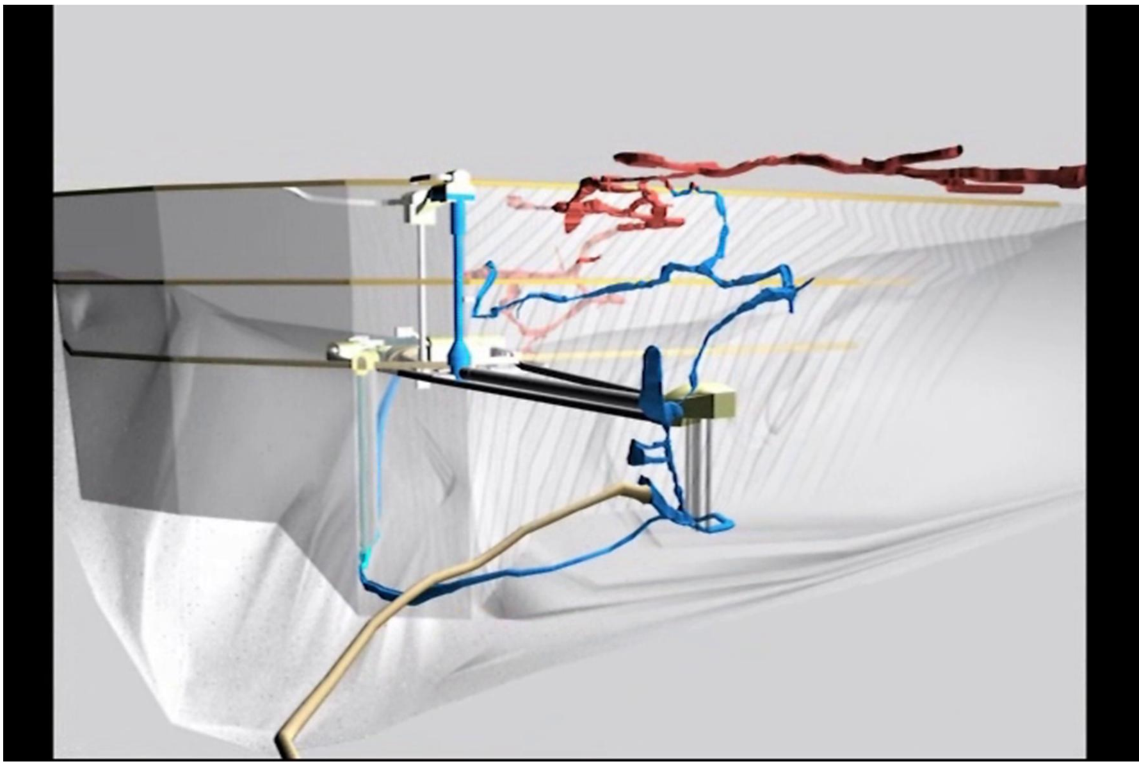


Internal Looking East (Water level falling from 50m.asl).

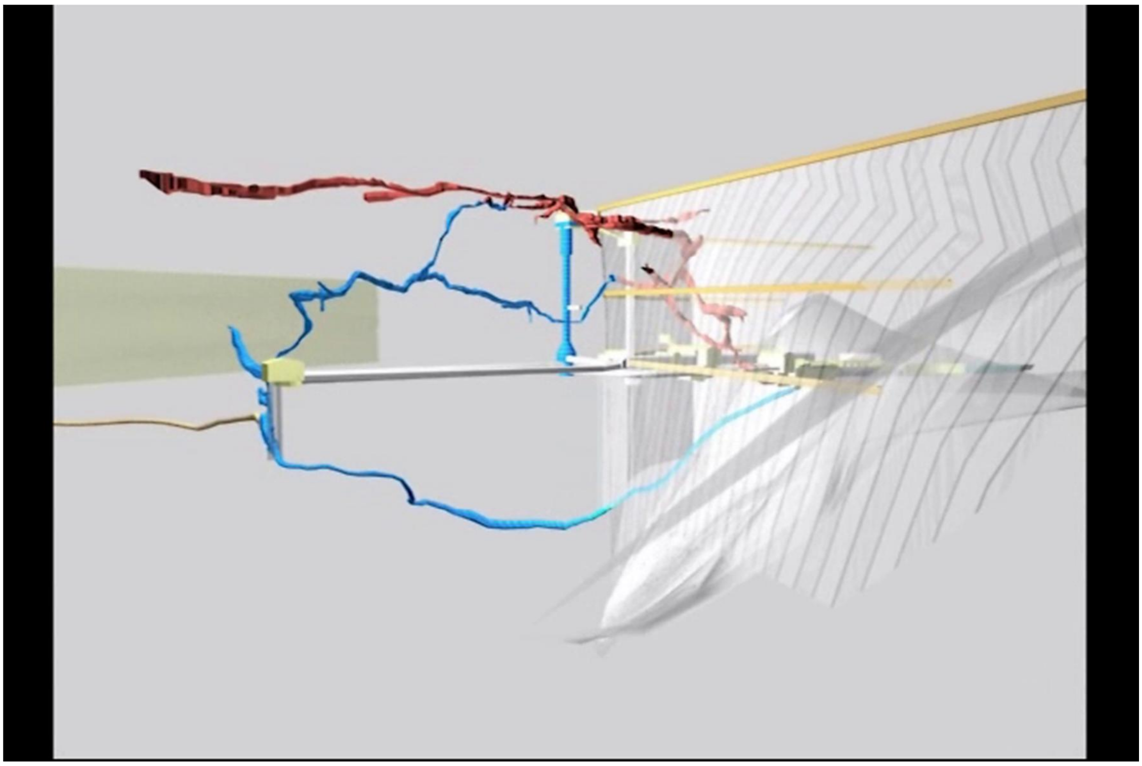
Cave System with Ombla HPP and 75m.asl aand 130m.ssl Operation Water Levels Series (4 screenshots):



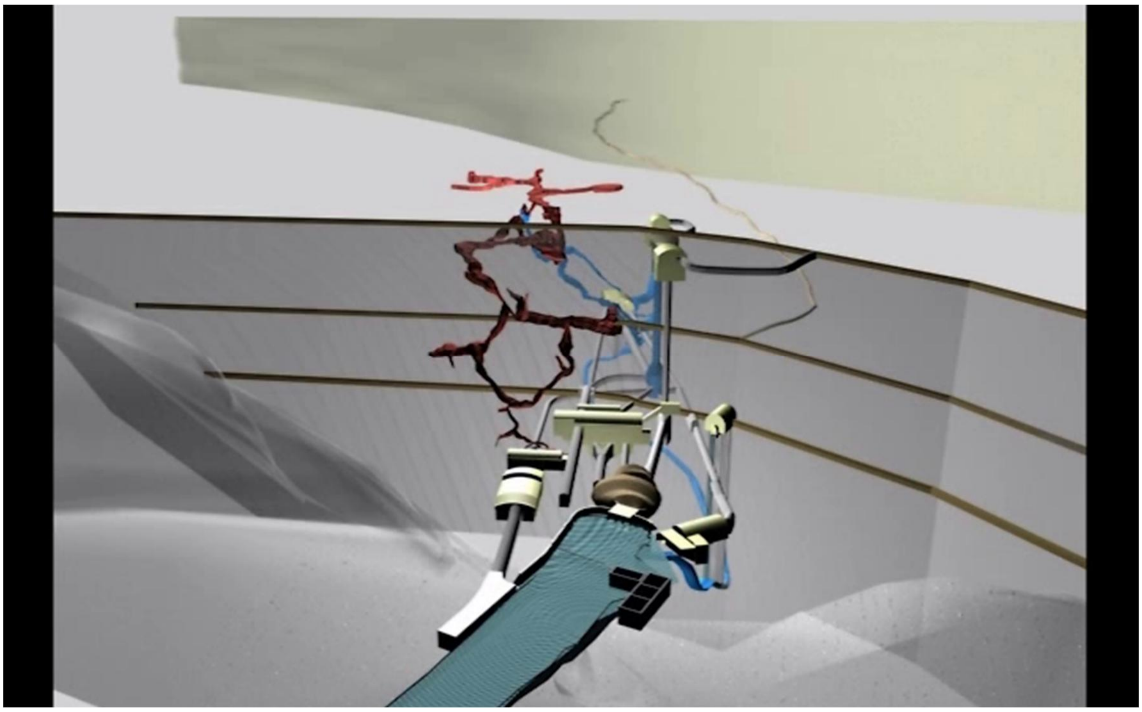
Internal Looking West (Water level at 75m.asl minium operation level).



Internal Looking South (Water level at 130m.asl operation level).



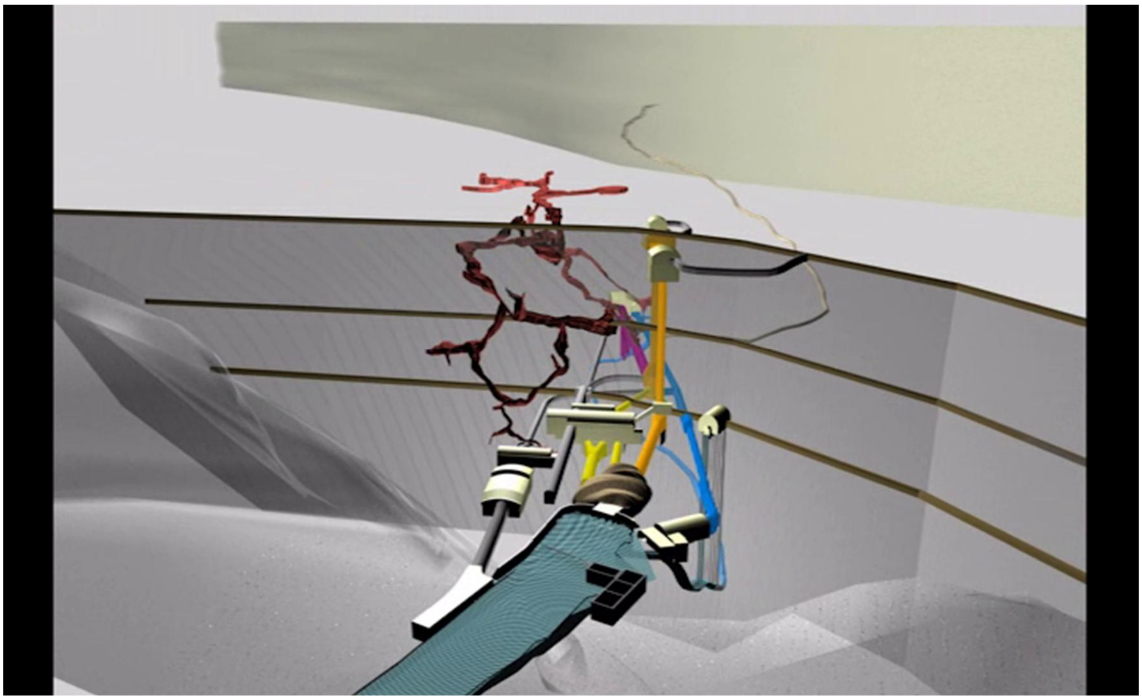
Internal Looking East (Water level at 130m.asl operation level).



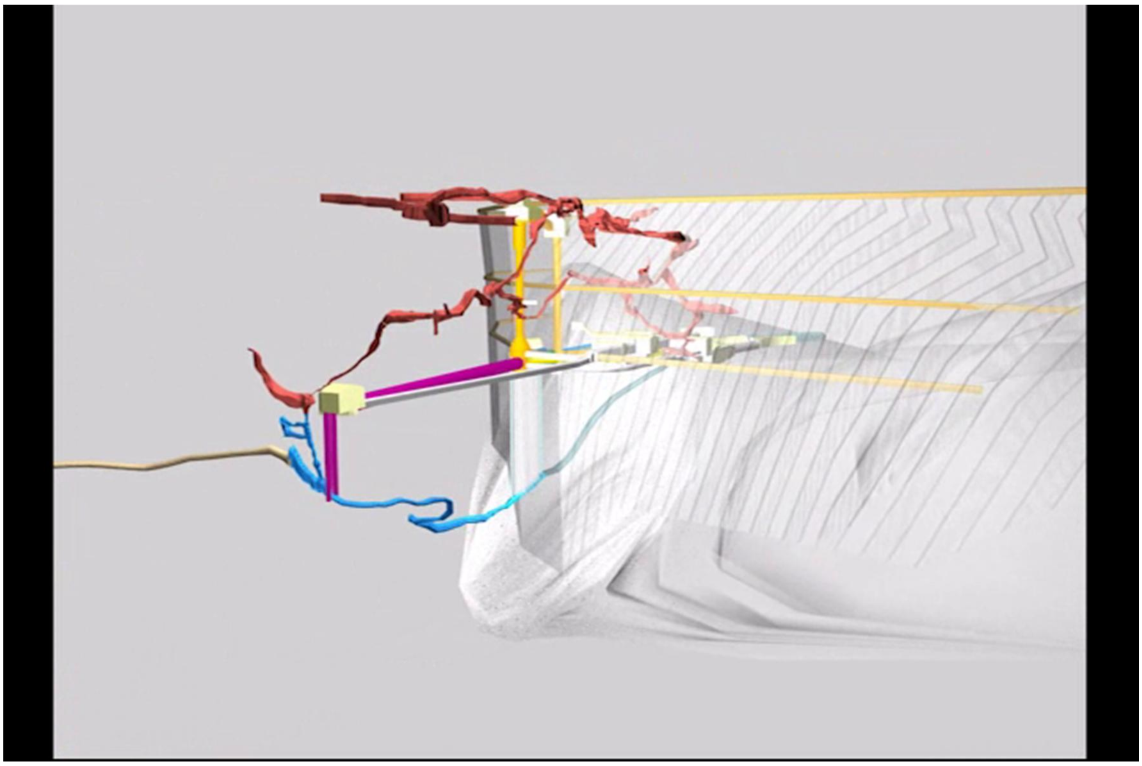
Internal Looking North (Water level at 130m.asl operation level).

Cave System with Ombla HPP and Flow Routes Through HPP Infrastructure Series (2 screenshots):

Key: Grey Flow = Bottom Outlet and Construction Flow; Yellow Flow - Turbines; Orange Flow = Vertical Shaft and Overspill; Blue Flow - Route to Water Abstraction; Purple = Main Headrace.

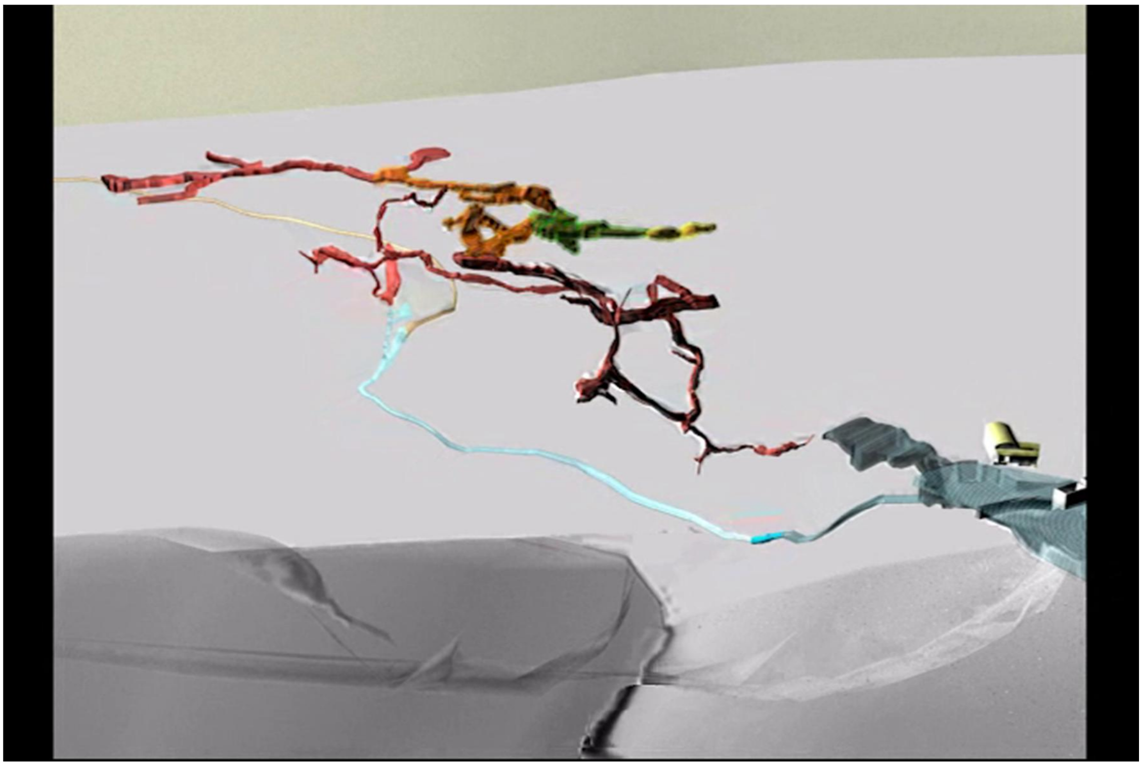


Internal Looking North

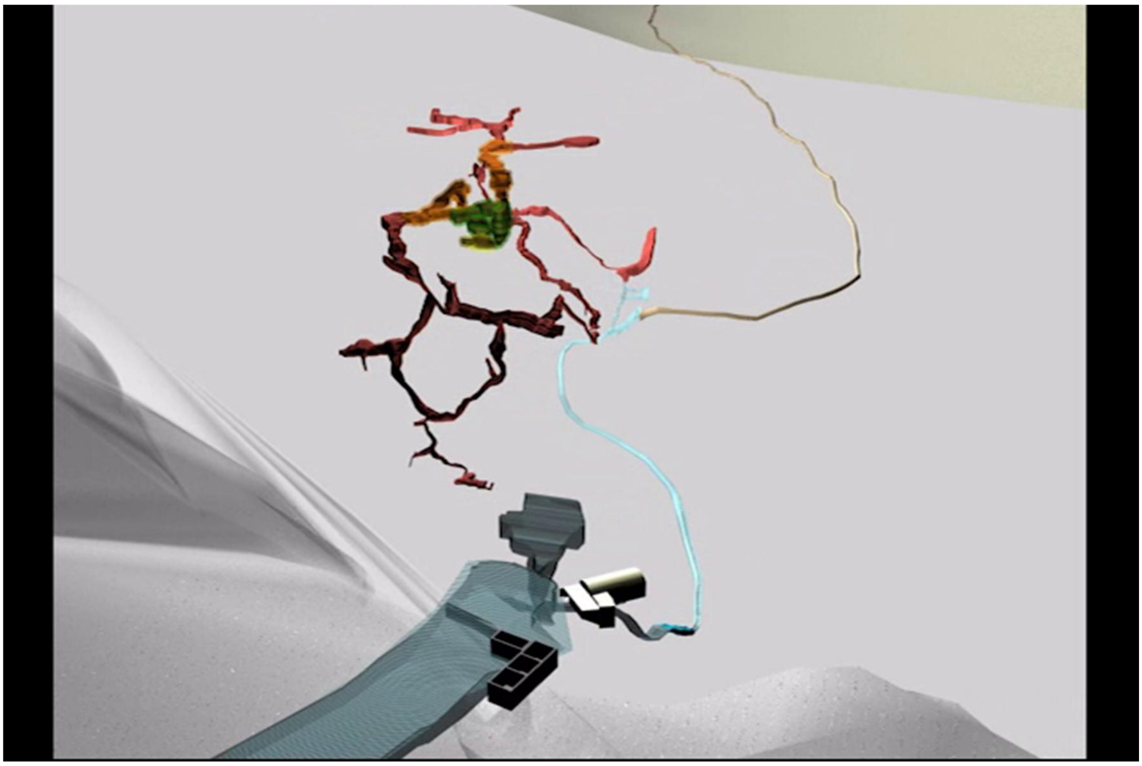


Internal Looking South East

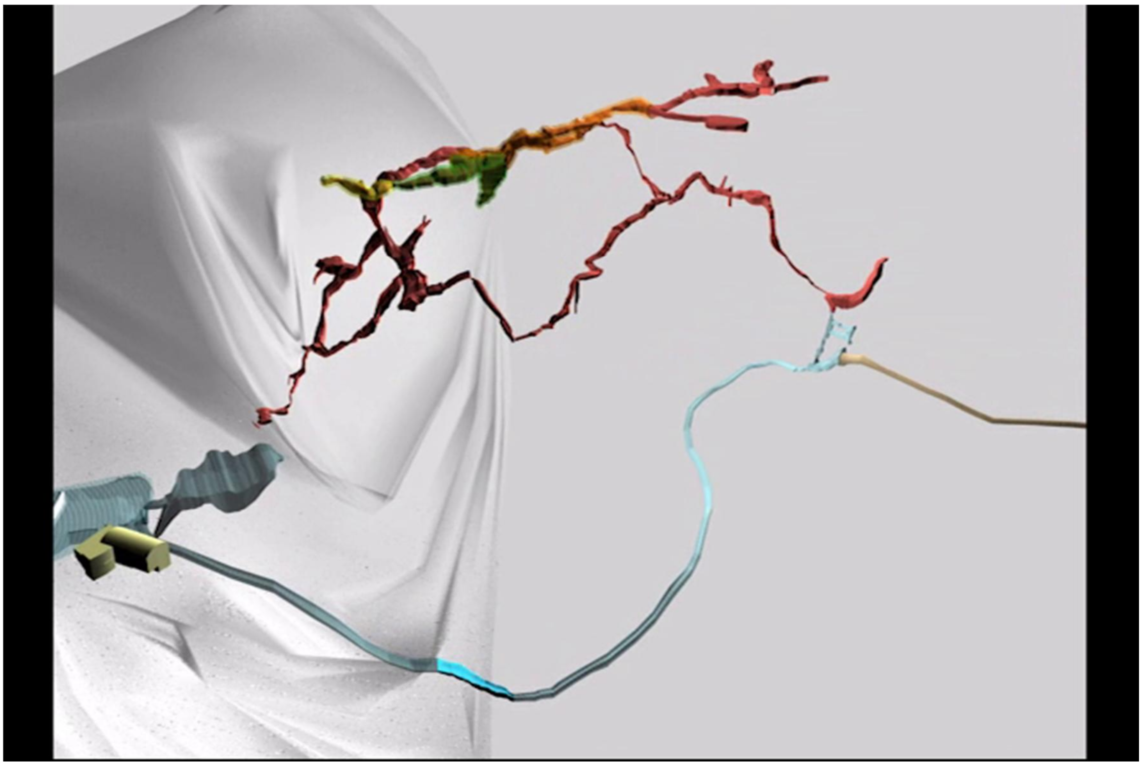
Cave System with Bat Usage Zones Highlighted (See Figure 4.2) Series (4 screenshots):



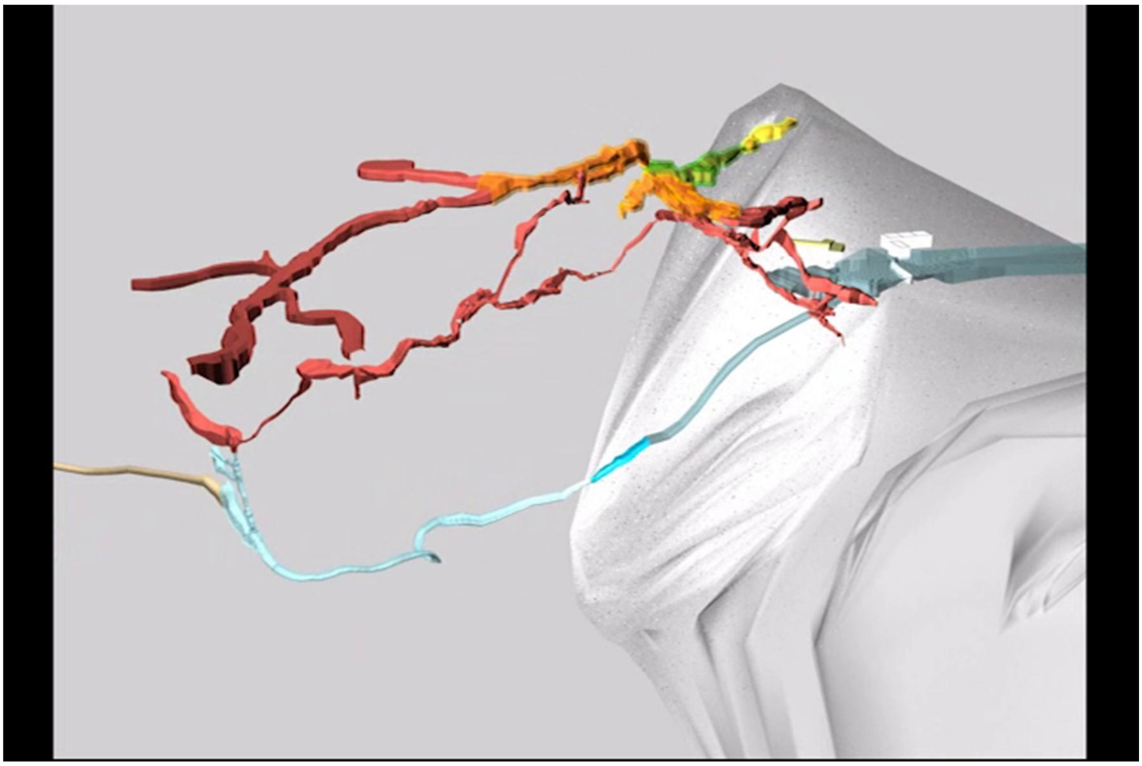
Internal Looking North East



Internal Looking North

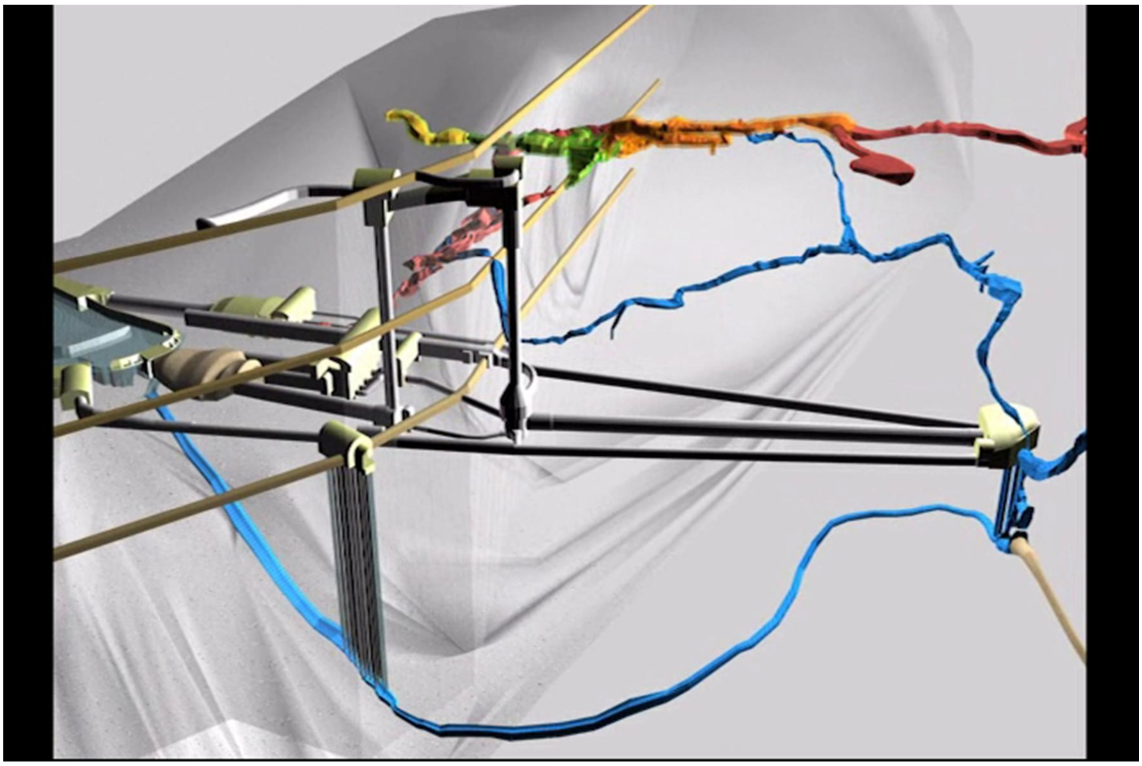


Internal Looking West

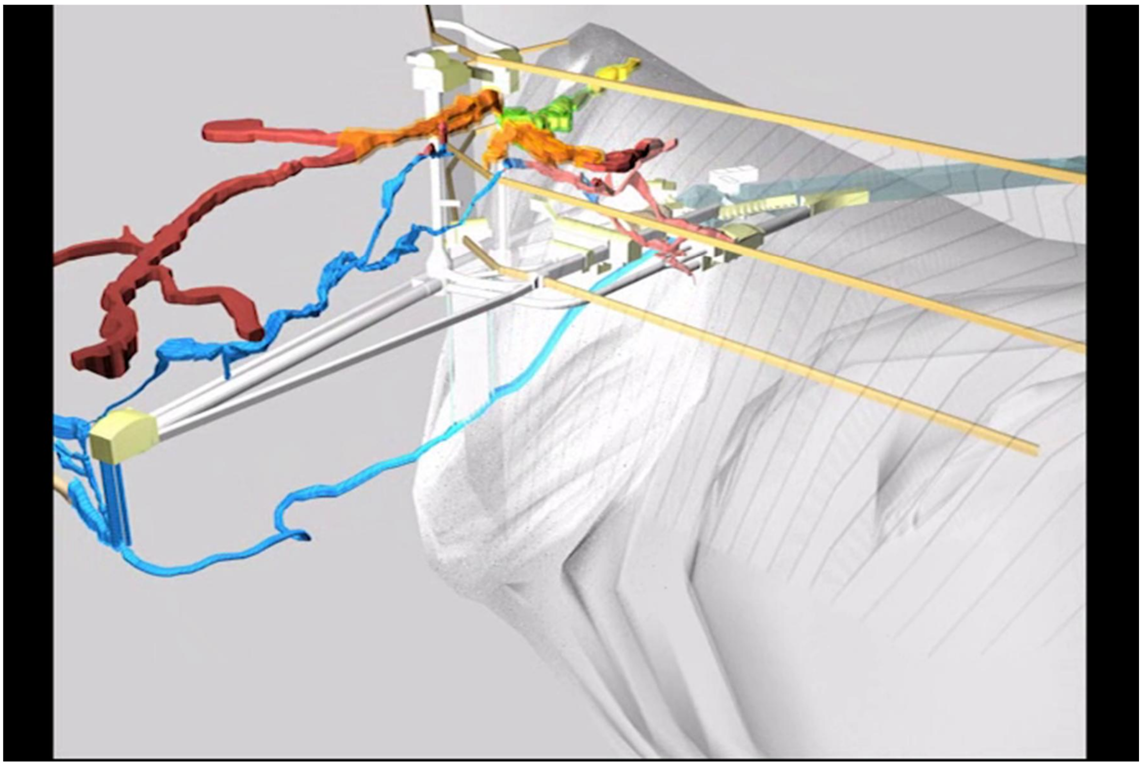


Internal Looking South East

Cave System with Bat Usage Zones (See Figure 4.2) Highlighted and Ombla HPP Series (2 screenshots):

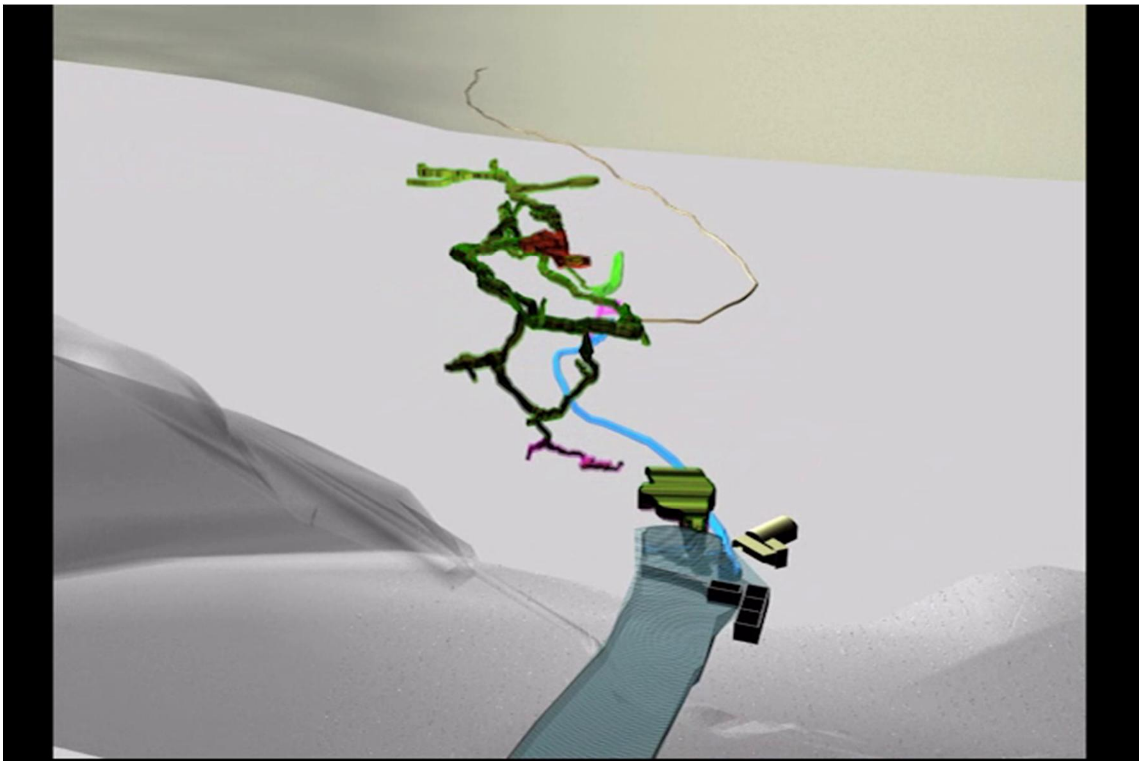


Internal Looking West

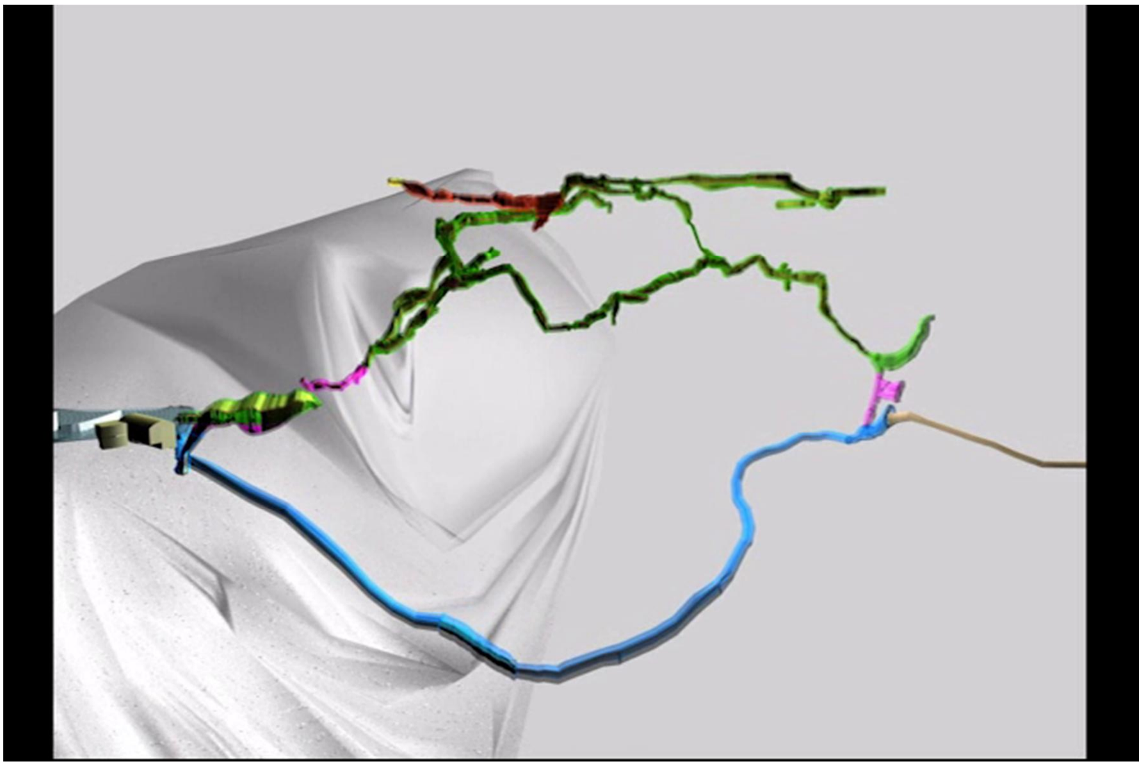


Internal Looking South East

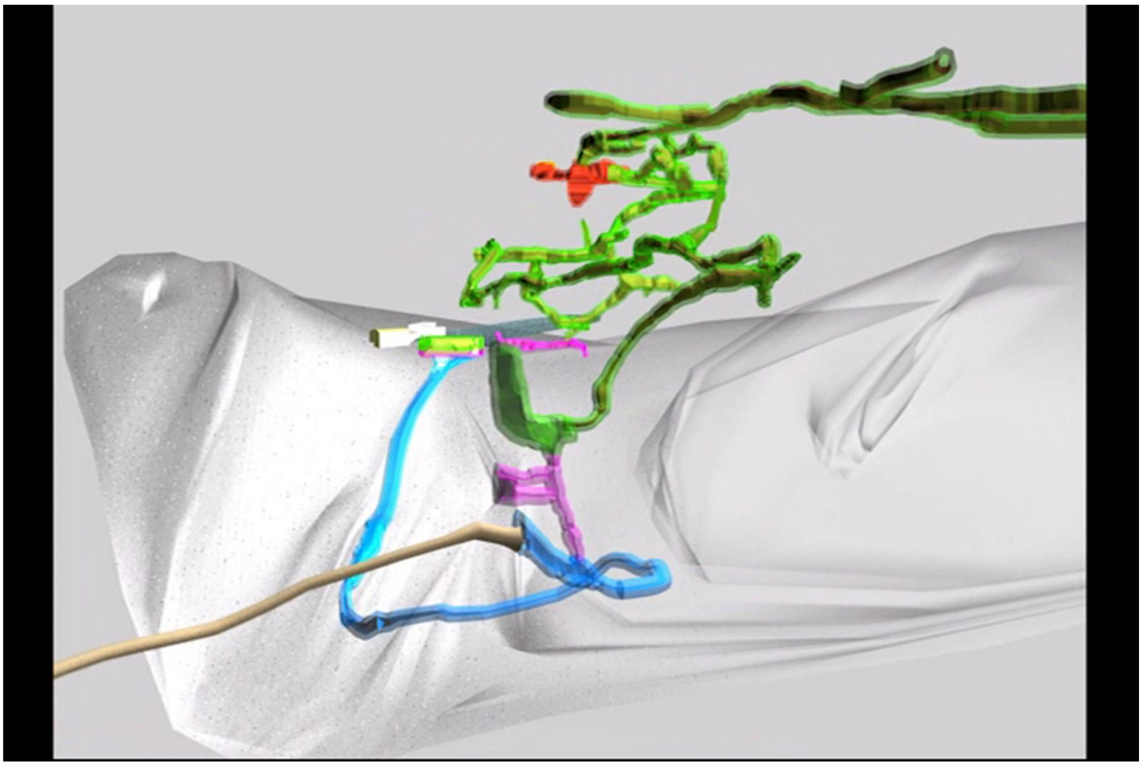
Cave System with Cave Habitat Zones Highlighted (See Figure 4.1) Series (4 screenshots):



Internal Looking North



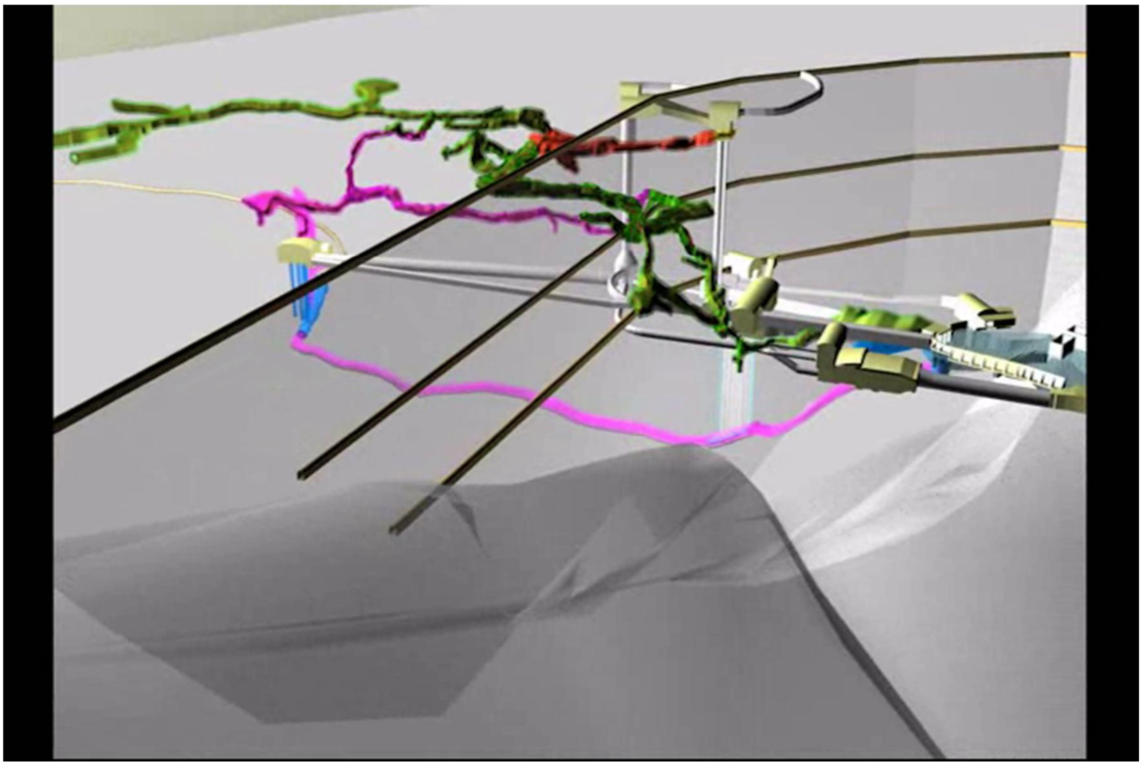
Internal Looking West



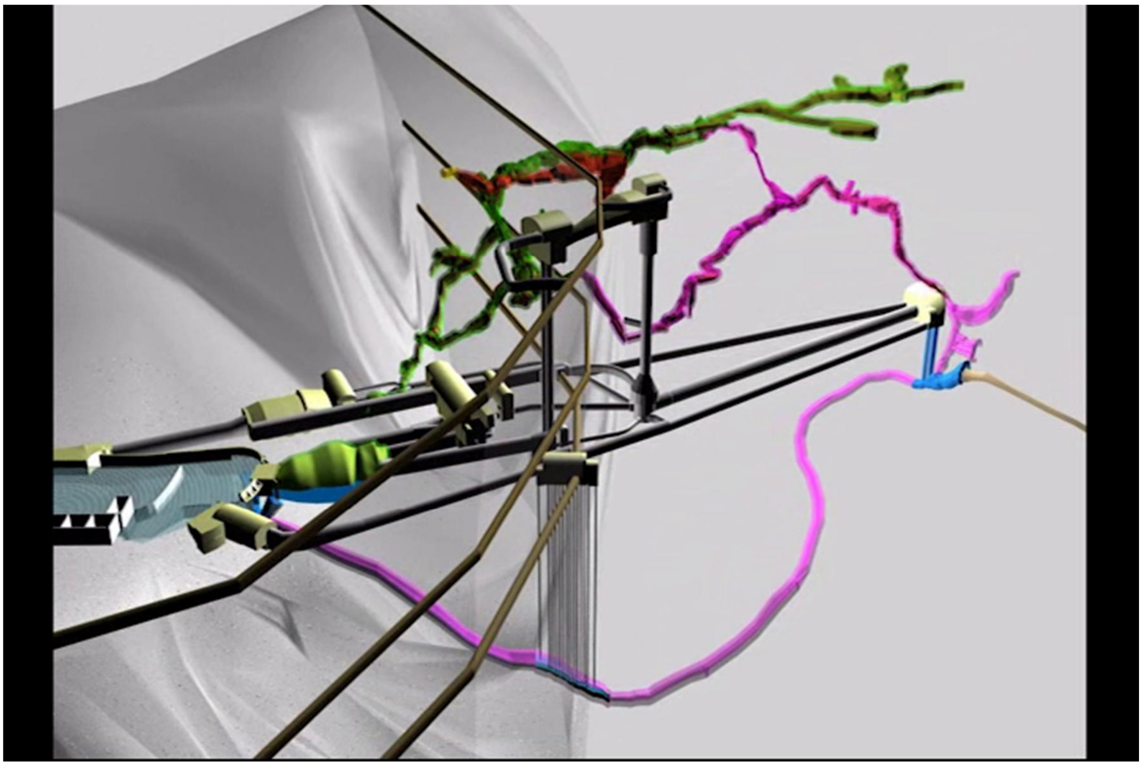
Internal Looking South

Internal Looking East

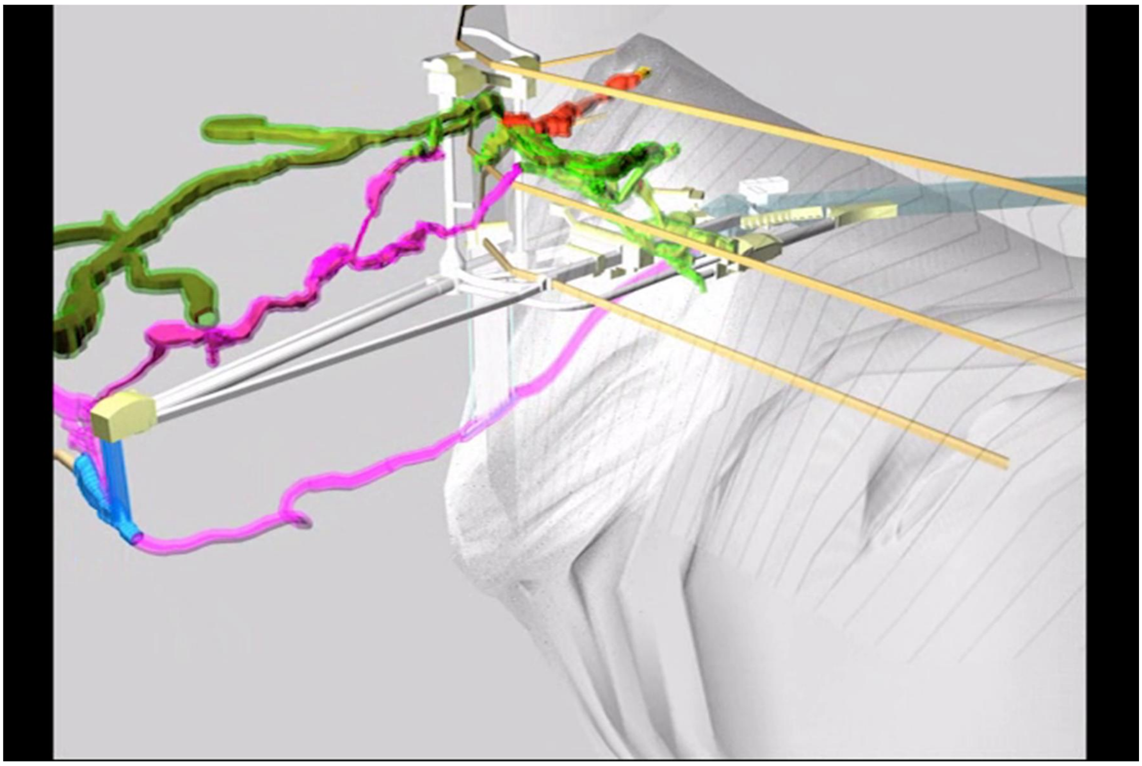
Cave System with the Changed Cave Habitat Zones (See Figure 4.1) Highlighted and Ombla HPP Series (3 screenshots):



Internal Looking East

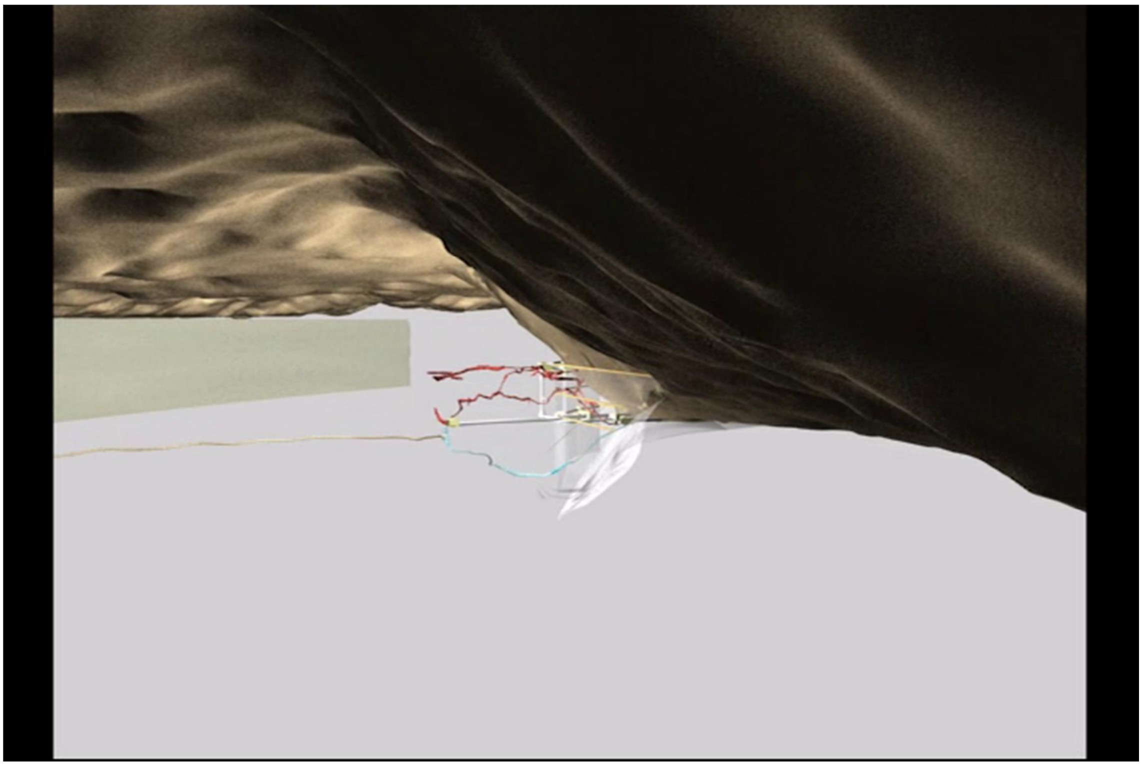


Internal Looking West



Internal Looking East

Cave System with Underground Terrain:



Internal Looking East

Appendix F: Stakeholders

DUBROVNIK					
1.	„DEŠA“ – DUBROVNIK, HUMANITARNA I MIROTVORNA ORGANIZACIJA	Put Frana Supila 8, 20000 Dubrovnik	T 020/420-145 M 098/1733-647 F 020/411-033	desa@du.t-com.hr	**Jany Hansal**
2.	DRUŠTVO REEDUKACIJSKO VOLONTERSKO OKUPLJALIŠTE MLADIH BONSAI	Don Frana Bulića 9 20000 Dubrovnik	095/8796-186	majacal@yahoo.com www.mladibonsai.hr	**Antonio Bratoš, predsjednik** **Andrea Šalinović, tajnica**
3.	DRUŠTVO PRIJATELJA PRIRODE „DUB“ – DUBROVNIK	Don Frana Bulića 4 20000 Dubrovnik	T 020/313-041 F 020/313-041	rea@du.t-com.hr	**Jerko Brešković, predsjednik Udruge**
4.	DUBROVAČKA ART UDRUGA BEZ GRANICA	Između polača 11 20000 Dubrovnik	T 020/323-277 M 098/285-398 F 020/323-891	udrugadart@gmail.com	**Dubravka Brangjolica-Kristović, predsjednica Udruge**
5.	EKOLOŠKA UDRUGA „ČIOPA“	Iva Vojnović 42 20000 Dubrovnik	T 020/332-390 M 091/5683-316	info@ciopa.hr www.ciopa.hr	**Joško Puttilli, predsjednik Udruge** **Đivo Vlahušić, dopredsjednik**
6.	UDRUGA „GRAD“	Z. Frankopanska 2 20000 Dubrovnik			**Branka Franičević**
DUBROVAČKO PODRUČJE					
7.	ECO VIMBULA	Gornji Prijevor bb 20236 Mokošica	098/1718-516	nikolarudenjak@net.hr	**Andro Rudenjak, predsjednik** **Mato Protić, dopredsjednik** **Nikola Rudenjak, tajnik**
8.	EKOLOŠKA UDRUGA „EKO CENTAR ZELENO SUNCE“, MOKOŠICA	Od Izvora 74 20236 Mokošica	T 020/453-850 F 020/453-850	eko-centar@du.t-com.hr	**Jadranka Šimunović, predsjednica** **Goran Tomaši, dopredsjednik**
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