HRVATSKA ELEKTROPRIVREDA d.d.

OMBLA HYDRO POWER PLANT

ENVIRONMENTAL IMPACT STUDY - SUMMARY

Translation from Croatian language

ELEKTROPROJEKT d.d.

Zagreb, July 1999

HRVATSKA ELEKTROPRIVREDA d.d.

OMBLA HPP

Environmental Impact Study - Summary

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This Summary is made pursuant to the Conclusion adopted at the second meeting of the Expert Commission of the Government of the Republic of Croatia for The Ombla HPP Environmental Impact Assessment. The second meeting was held on 11 June 1999 in Dubrovnik. On the meeting Decision was reached on public access to The Ombla HPP Environmental Impact Study.

0.1 INTRODUCTION

0.1.1 GENERAL

This Summary is a brief presentation of the Ombla HPP Environmental Impact Study. The Summary is to serve as a basis for providing information to a broad circle of stakeholders on the existing status of environment in the narrow and wider area envisaged for hydro power plant accommodation, potential environmental impact of the hydro power plant, protection measures aimed at mitigating such environmental impact and environmental status monitoring program in the pre-construction, construction and post-construction phase of the planned facility.

The objective of Study elaboration is environmental impact assessment for the planned project. The assessment is carried out in order to protect the environment. Special attention was paid to securing high quality water supply of the City of Dubrovnik and its wider area, slope stability in plant's surroundings and slope stability in Mokošica settlement, water quality protection, and protection of natural and cultural values, impacts during the construction and in the post-construction period and protection measures.

The Ombla hydro power plant differs from conventional hydro power plants primarily due to the following properties:

- it has a natural underground reservoir;
- the water pressure needed to harness the water for energy purposes is built-up by the construction of an „underground dam“ with the rock massif as dam's body.

The Ombla HPP project

- is consistent with the Physical Planning Program of the Republic of Croatia (OG No 50/1999)
- meets basic prerequisites for sustainable development of the Republic of Croatia
- is consistent with the Spatial Plan of the Municipality of Dubrovnik of 1986.

The system has the following main intended uses and values:

- electricity generation from a renewable, inexhaustible resource (water) that does not pollute air, water and soil, and does not have adverse impact on human health;
- economically more efficient and secure high quality water supply of the City of Dubrovnik and its wider area;
- improved conditions for tourist development through the improvement of energy and water supply conditions in the wider area of Dubrovnik;
- new employment opportunities during the construction and operation of the planned hydro power plant.

A PROJECT AND SITE DESCRIPTION

A.1 PROJECT PURPOSE

A.1.1 INVESTMENT RATIONALE AND OBJECTIVES

The basic objectives of hydro power plant's construction are the following:

- the Ombla River harnessing for energy purposes
- improvement of water supply of the City of Dubrovnik and wider, tourist-oriented Dubrovnik area, with a possibility of water transport to greater distances without the use of pumps, and the resolution of past problems connected with increased water turbidity during heavy precipitations.

A.2 SITE DESCRIPTION

A.2.1 BASIC DATA ON THE OMBLA SPRING

Catchment area	- south-eastern part of East Herzegovina - a part of Dalmatian hinterland surrounding the City of Dubrovnik
Catchment surface area	more than 600 km^2
Current water regime	discharge by about 10 m^3/s lower compared to average discharge prior to the construction of Trebišnjica HPP structures
Planned construction of Dabar HPPs	will not have any impact on current discharge of the Ombla, Nevesinje and since they belong to the Neretva catchment area
The Ombla Spring area	- main spring at the elevation of 15 m below sea level accounts for major water quantities, especially in the dry period - Baba and Crkvica springs show increased activity only during high waters, and emanate at the elevation of about 2.5 m a.s.l.

A.2.2 SYSTEM OF CAVES IN SPRING'S HINTERLAND

Spring cave	discovered	in 1985
	length	80 m
	width	40 m
	height above water table	8 m
Large cave	location	in the hinterland of the main spring
	distance from the spring	520 m
Vilina Pećina cave	location	
	upper floor	between 130 m and 150 m a.s.l.
	central floor	between 50 m and 80 m a.s.l.
	main entrance	at 137.00 m a.s.l.

A.2.3 UNDERGROUND RESERVOIR CHARGING AND EMPTYING IN NATURAL CONDITIONS

In view of hydrogeological characteristics, the Ombla catchment area can be subdivided in two sections:

- section to the north of the dolomite barrier
- section to the south of the dolomite barrier.

The northern, porous section is built of limestone and covers about 90% of the total catchment area. The rainwater accumulates in the underground, forming an underground reservoir. To the south, the underground reservoir is enclosed by a poorly permeable dolomite barrier. However, the central portion of this barrier is damaged and releases the water into the southern part of the catchment area. Downstream from the dolomite barrier is an area of limestone rocks which on the southern side lean against a narrow belt of dolomite rocks reclining on a thick layer of impermeable flysch.

Figure 1 Ombla HPP location on Rijeka Dubrovačka

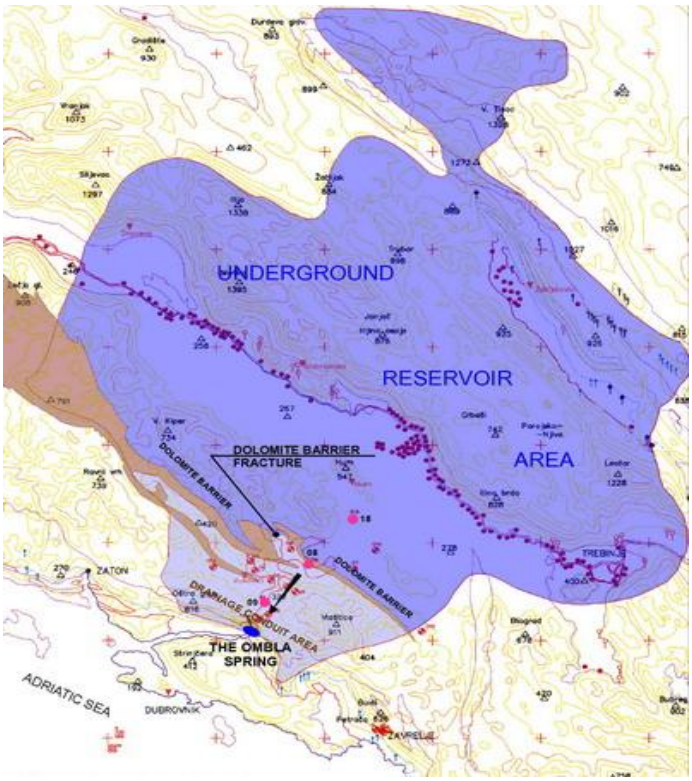


Figure 2 Basic schematics of the underground reservoir of the Ombla Spring

The underground reservoir located in the northern part of the catchment area is filled by rainwater and emptied through the damaged dolomite barrier and the main drainage conduit at the Ombla Spring in the southern part of the catchment area.

The southern part of the catchment area is filled by rainwater, which is very quickly evacuated through a low-laying main conduit and a secondary drainage system. Therefore, the majority of discharge at the Ombla Spring is created by the precipitation from the hinterland, to the north of the dolomite barrier.

A.2.4 METEOROLOGY AND CLIMATE

Climate

- area between the sea coast and Popovo Polje	mediterranean
- area above 400 m a.s.l.	continental

Average several-year air temperature

- Dubrovnik	16.3°C
- Trebinje	14.1°C

Mean several-year precipitation

- Dubrovnik	1238 mm
- Hum	2037 mm

The highest wind speed in Rijeka Dubrovačka bay	95 km/hour

A.2.5 HYDROLOGY AND DEPOSITS

Maximum measured discharge in the period from 1962 to 1990	106 m^3/s
Maximum 100-year return period discharge	113 m^3/s
Mean annual discharge	23.90 m^3/s
Minimum recorded discharge in the period from 1962 to 1993	2.83 m^3/s
Minimum 100-year return period discharge	2.40 m^3/s

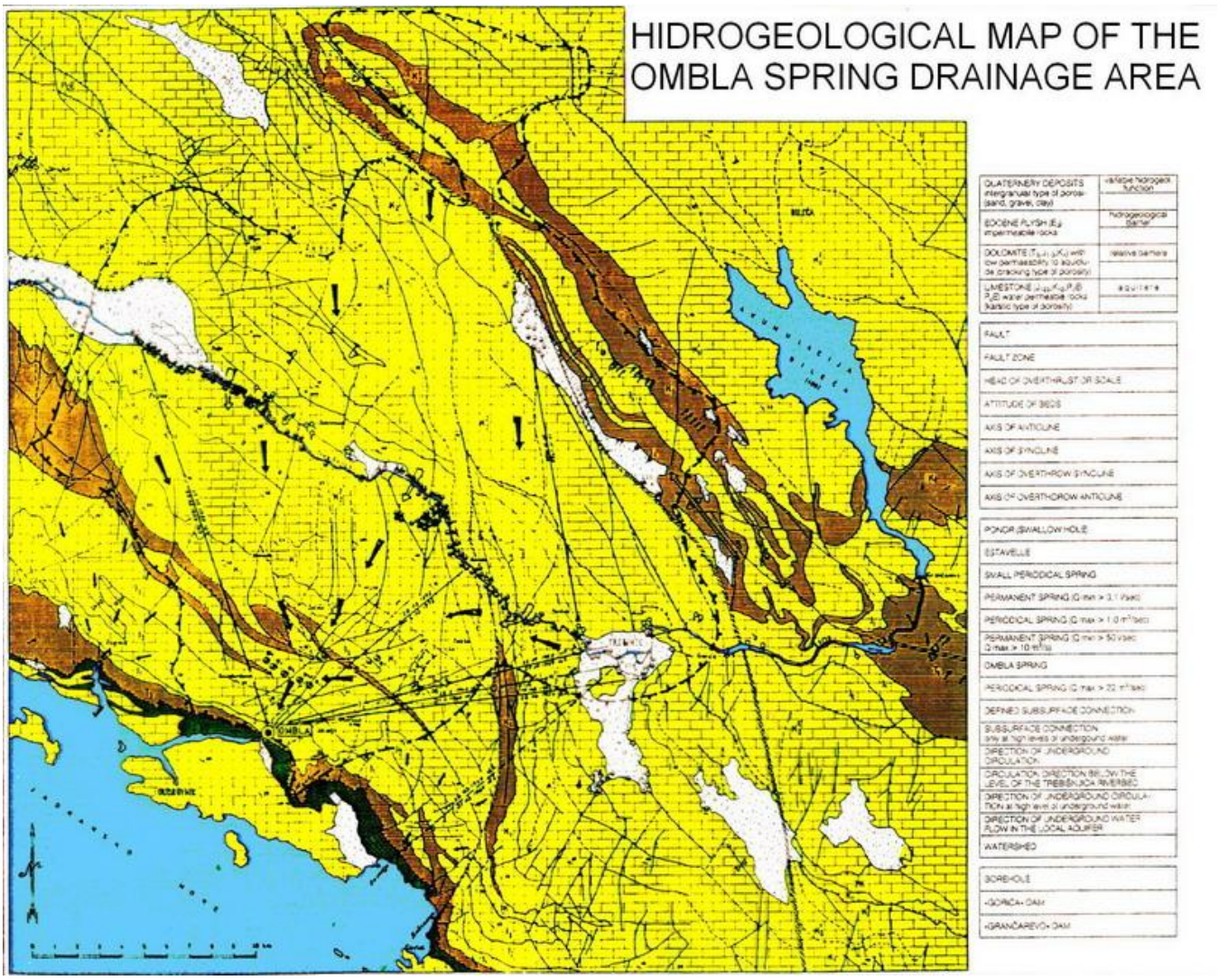


Figure 3 Hydrogeological map of the Ombla catchment area

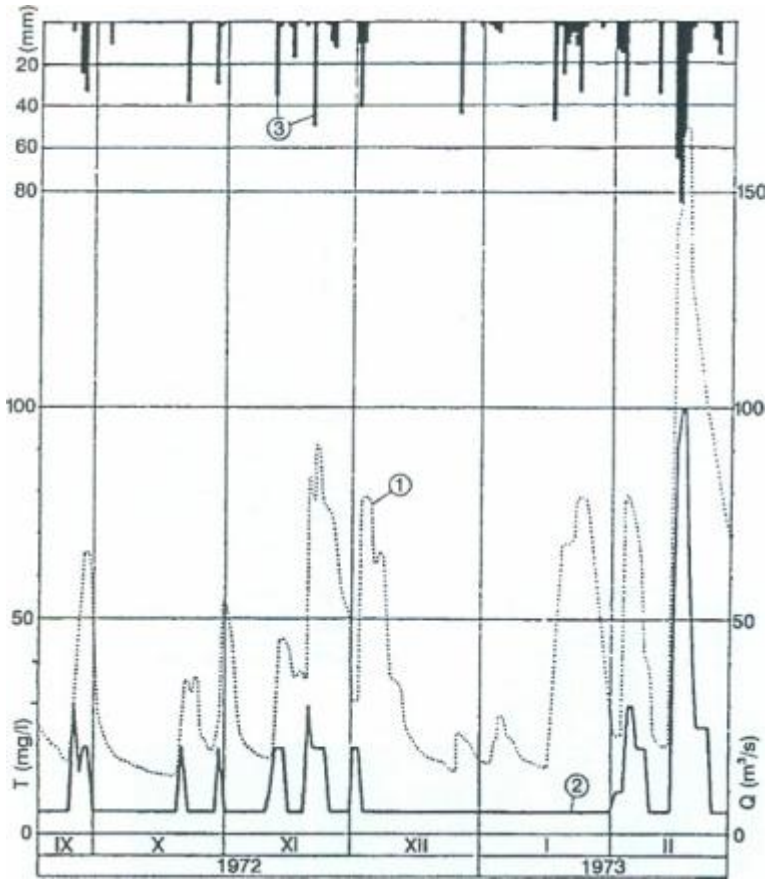


Figure 4 Relation between precipitation, discharges and water turbidity at the Ombla Spring

An important phenomenon of the Ombla watercourse is temporary water turbidity.

This phenomenon is solely linked to heavy precipitation, i.e. it is a result of sediment rising within the zones of faults and buried cave conduits due to increased discharge velocity caused by incoming water waves. The permissible drinking water turbidity limit is 10 mg/l $Si0_2$.

A.2.6 GEOLOGY

The following geological formations are present in the catchment area:

- porous, highly permeable limestone rocks
- poorly permeable dolomite rocks
- impermeable flysch.

A.2.7 SEISMOLOGY

Maximum expected natural earthquakes (Richter scale) are as follows:

- in the area of Rijeka Dubrovačka bay	6.5 intensity (Richter scale)
- in the area towards the town of Cavtat	7.0 intensity (Richter scale)

A.2.8 GEOMECHANICS AND SLOPE STABILITY

Slope inclination in flysch (degrees):

- major part	from 0 to 10
	from 10 to 20
- insignificantly	from 20 to 30

Security factors against subsidence	between 1.79 and 2.99
Past natural earthquakes in the studied area	have not activated new landslides

A.2.9 WATER QUALITY

A.2.9.1 Physico-Chemical and Bacteriological Water Properties

Cave – future water intake: Water samples taken at this location are of satisfactory quality, except for the following properties:

- BOD_5 (biological oxygen demand) at low and medium discharges
- phthalates at low discharges
- turbidity, colour, suspended solids, iron and aluminium at high discharges
- number of bacteria in 1 ml/37°C and 22°C at all discharges.

Spring cave: Water samples taken at this location are of satisfactory quality, except for the following:

- BOD_5, organochlorine insecticides HCH-isomeres and phthalates at low discharges
- bacteriologically, the water is less loaded with faecal bacteria.

The Ombla Spring: The water samples taken at this location are of satisfactory quality, except for the following:

- BOD_5 at low and medium discharges
- phthalates at low discharge, and in one case total oil values were insignificantly increased
- bacteorologically, the water is loaded with faecal and sulphite-reducing bacteria, and Salmonella Group C1, namely Salmonella Thomson, was isolated from one water sample taken at high discharges.

In water samples collected during high discharges at the Ombla Spring (78-83 m^3/s) the following parameters were increased:

- continuously	turbidity, colour and suspended solids
- temporary	iron and aluminium
- once	consumption of potassium permanganate and BOD_5

A.2.9.2 Biological Water Properties

Cave – future water intake: At this location no organisms were found that

- live on the bottom (benthos)
- float on the water (plankton)
- swim freely in the water (nekton)

Spring cave: In the Spring Cave the representatives were found of the following species:

- two fauna species connected with bottom
- one fish species (nekton)

The Ombla Spring: The Ombla Spring has the most diverse living organisms, so that the representatives of the following species were found:

- benthos
- plankton
- nekton.

The majority of recorded species are indicators of I., I. - II., and II. Class water.

A.2.10 POLLUTION SOURCES AND WATER PROTECTION

Potential pollution sources outside national territory are:

- City of Trebinje
- Popovo Polje field
- Ivanića settlement, destroyed during the Homeland War

Potential pollution sources in Croatia are:

- waste disposal site “Grabovica”, which is to be rehabilitated by the year 2002 pursuant to the Waste Management Act (OG No 123/1997).

A.2.11 PROTECTED NATURE AND HISTORICAL LANDMARKS

Wider area of the Ombla Spring:

- Rijeka Dubrovačka
- Močiljska cave

Narrow area of the Ombla Spring

- the Chapel of the Annunciation.

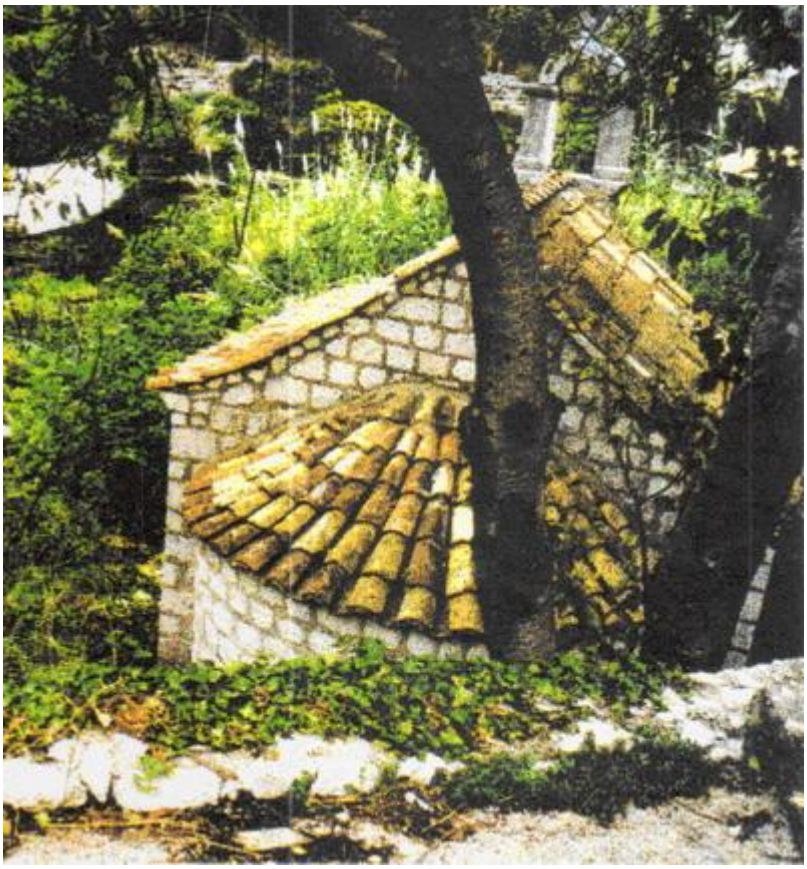


Figure 5 The Chapel of the Annunciation

A.2.12 SETTLEMENTS AND POPULATION

The Ombla catchment area encompasses:

- 176 settlements
- about 50 000 inhabitants

In the area of Rijeka Dubrovačka there are

- by the right riverbank — Mokošica settlement
- on the eastern side — the Komolac zone

A.2.13 FACILITIES AND INFRASTRUCTURE

Highways and regional roads:

- Jadranska magistrala (the Adriatic Highway) Split - Dubrovnik
- regional road from the Adriatic Highway to the Ombla Spring
- regional road from the Adriatic Highway to Mokošica settlement
- regional road from the Adriatic Highway to Komolac

Water supply

- About 98% of population on the territory between St. Jakov settlement to the east and Mokošica settlement to the west of the City of Dubrovnik are supplied by the public water supply system.

Daily water consumption per capita prior to the year 1991 amounted:

- inhabitants 84 l
- inhabitants + tourists /private accommodation/ 178 l
- inhabitants + tourism + other industry 309 l

Sewerage system

- The City of Dubrovnik and partially the settlements Slano and Kupari are connected to the public sewerage system.

Electricity

- Dubrovnik HPP with annual power output between 1.0 and 1.6 billion kWh

A.2.14 FLORA AND FAUNA

All structures of the planned Ombla HPP, except for the control building, are located in the underground, so that the accommodation area has no terrestrial vegetation.

The surfaces by the future hydro power plant are composed of karst terrain with macchia, and the major part of the catchment area is uninhabited rocky ground partly covered by grass vegetation and ground (low) vegetation.

Of terrestrial fauna, important is the bat colony by the Vilina Pećina cave.

Biological communities of aquatic ecosystems are extremely poor in species, especially vertebrates. The underground community, if there is one, is systematically connected with a far wider area than the area of influence of the future Ombla HPP.

A.2.15 PROTECTED FLORA AND FAUNA SPECIES

- the cave to accommodate the future water intake, Spring Cave and the Ombla Spring — no protected species with permanent the habitats were found
- mainland — all bats abiding in the Vilina Pećina cave

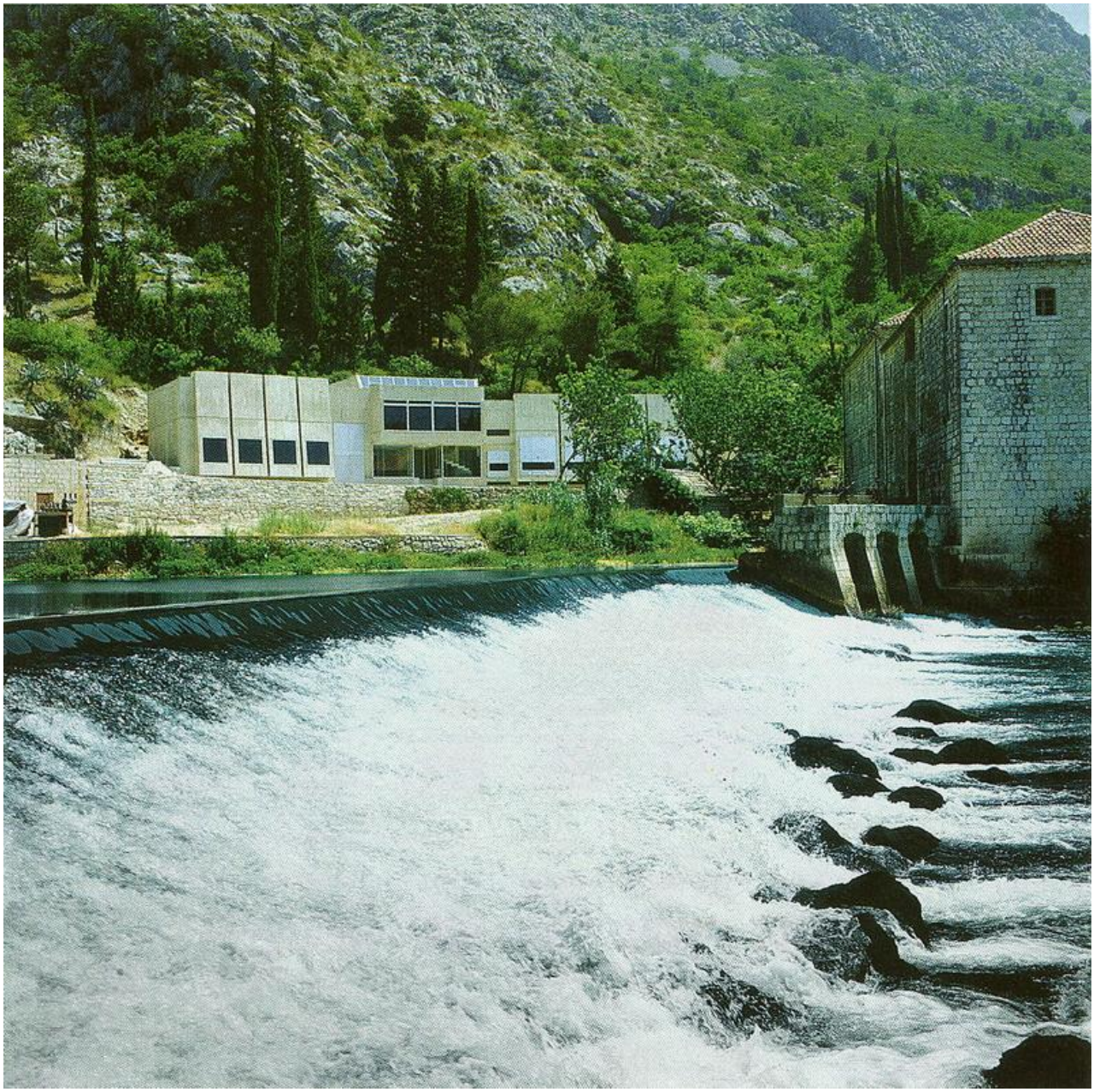


Figure 6 View of the spillway threshold between the Spring Pond and Rijeka Dubrovačka, and the pumping station

A.2.16 ECONOMY

Industry

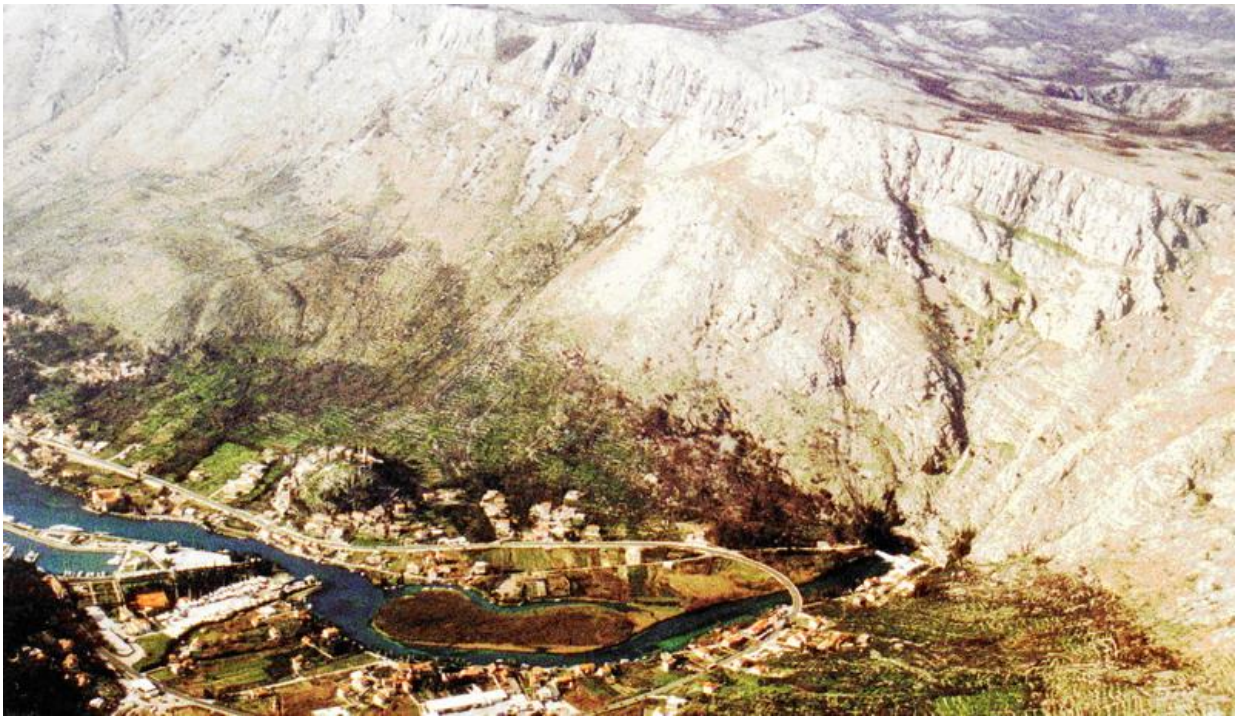
- Industrial plants in the Ombla catchment area are concentrated in the town of Trebinje

Tourism

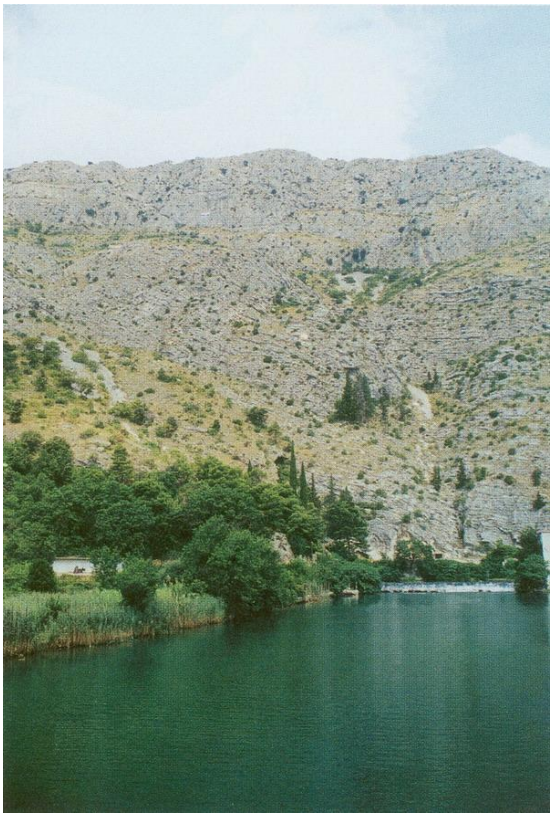
- Tourism is the basic economic activity in the City of Dubrovnik and its wider area.

Agriculture

- The construction of the Trebišnjica hydro system enabled more intensive agricultural production in the karst fields of the Ombla catchment. Such production implies the use of mineral fertilisers and plant protection products, which represent a threat to the Ombla water quality.



1. View of the upstream part of the catchment
2. Vegetation in the southern part of the catchment
3. Protected vegetation in the spring area.



A.3 PROJECT DESCRIPTION

A. 3.1 GENERAL

The basic concept of the Ombla HPP derives from the idea to harness the waters emanating from a very abundant Ombla spring with mean annual discharge of Q_{mean} = 23.9 m^3/s, in power generation.

Basic characteristics of the Ombla HPP are the following:

- installed discharge	60 m^3/s
- installed capacity	68.5 MW
- number of generating units	4
- rated turbine discharge	- 2 x 24 m^3/s - 2 x 6 m^3/s
- mean annual output at medium discharge	
- Qmean = 23.9 m^3/s	223.1 GWh
- evacuation structures are sized at	Q_{100} =113 m^3/s
- (two structures, one spare)	
- construction period	4 years

A.3.2 TECHNICAL DESIGN

A.3.2.1 General

Natural characteristics of the site and the requirement not to disrupt the natural surroundings of the Ombla Spring, as well as the concept of the plant itself were critical for siting practically the entire Ombla hydro power plant in the underground. The only exception is the control building which can be well fitted into the spring area landscape.

Main functional units of the Ombla HPP are the following:

- underground reservoir with natural intake conduits
- underground dam
- structures for water harnessing in power generation
- water evacuation structures
- water supply structures.

All functional units, except for the underground reservoir and underground intake conduits which are natural, should be accommodated into space, sized and constructed.

A.3.2.2 Location of the Ombla HPP as a Whole

The disposition of structures was predetermined by the location of water intake structures, the grouting curtain and power house stilling basin since they are conditioned only by natural characteristics of the Ombla River site. For functional reasons, all underground structures related to the waterworks are located on the east side, and those related to the hydro power plant on the west side (Figures 7 and 8). All hydro structures are arranged along the shortest straight line leading from the Large Cave to the Spring Pond, respecting the geological structure of the area along the route.

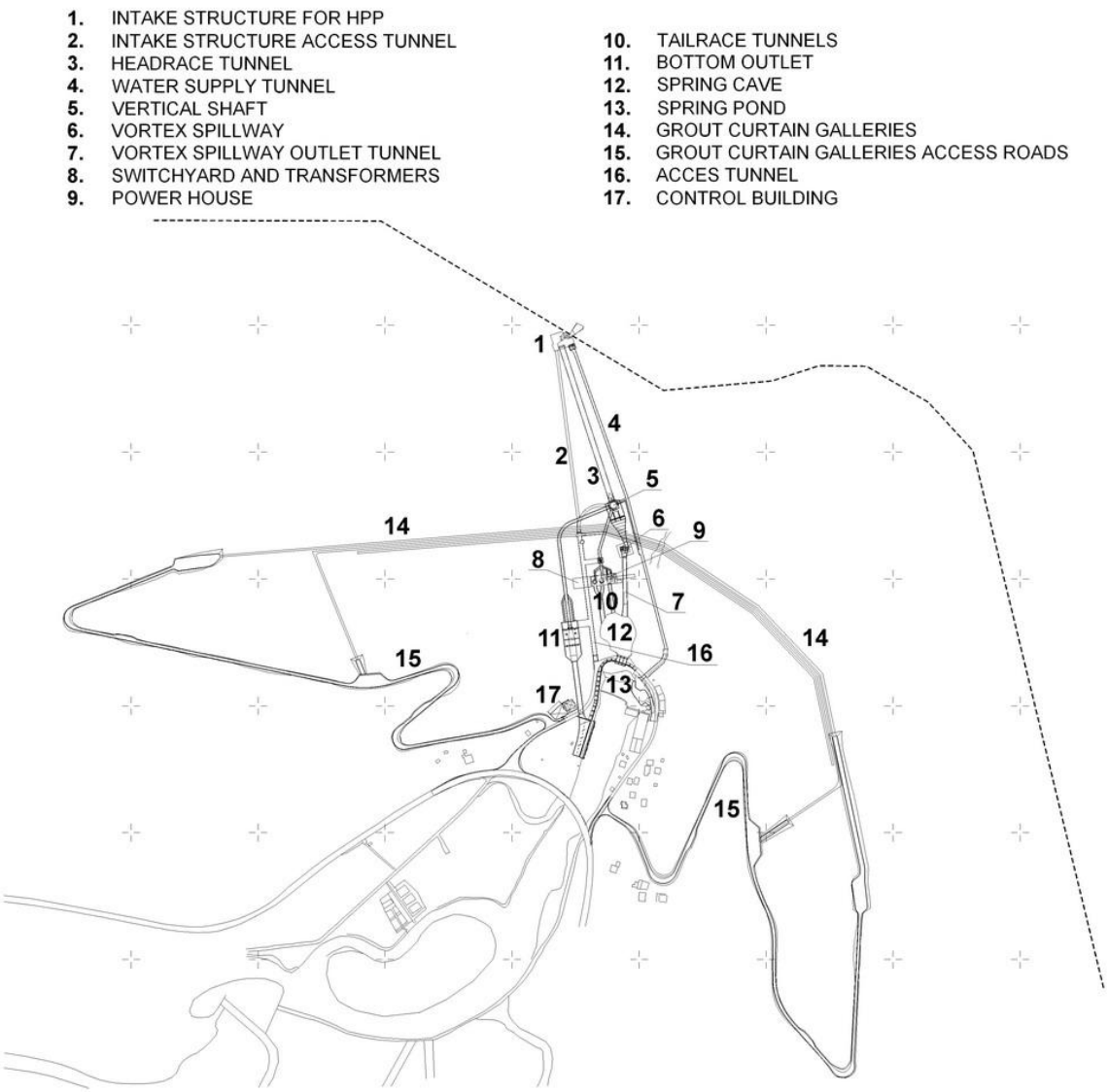


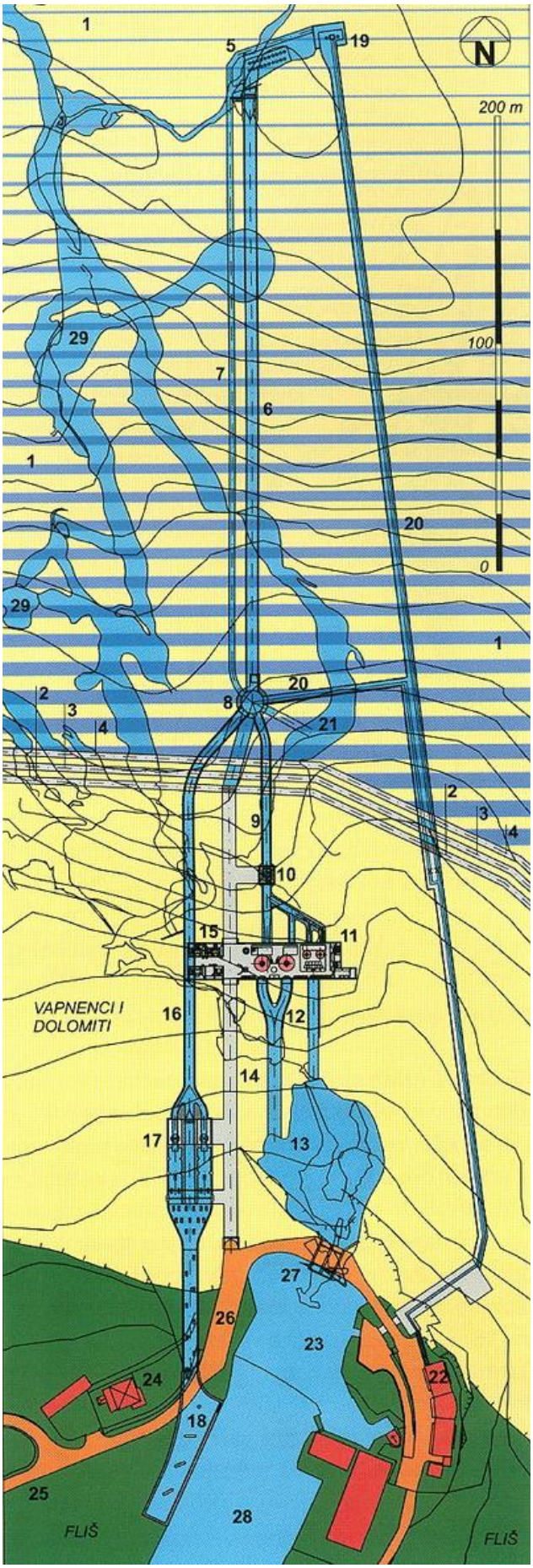
Figure 7 Layout of plant structures

Location of water intake structures: Water intake for the Ombla HPP is located some 500 m upstream from the spring, in a natural cave situated above the main natural intake conduit. Water intake for the waterworks will be separated from the water intake for the power plant. In this way, uninterrupted high quality water supply will be ensured during the construction of the hydro power plant since the water intake is about 300 m far upstream from the works performed on the grout curtain.

Location of the grout curtain: The grout curtain is an upstream, impermeable part of the „underground dam“, whereby the rock massif represents dam's body and takes over the total load of water pressure impounded at the elevation of 130 m a.s.l. The curtain leans on an impermeable flysch barrier. It is constructed from three grouting galleries set up at the elevations of 5.0 m to 10.0 m a.s.l., 65.0 m a.s.l. and 132.0 m a.s.l.

Location of the power house stilling basin: The composition and structure of the terrain, the location and dimensions of the Ombla spring cave and the requirement to preserve natural environment of the spring zone were critical for the selection of the spring cave as the location accommodating power house stilling basin and power house tailrace tunnels. Consequently, the plant is completely hidden under the ground.

Figure 9 presents longitudinal cross-section through the Ombla HPP, and Figure 10 gives longitudinal cross-section through the grout curtain.



1. UNDERGROUND RESERVOIR
2. GROUT CURTAIN AND GALLERY No 1
3. GROUT CURTAIN AND GALLERY No 2
4. GROUT CURTAIN AND GALLERY No 3
5. INTAKE STRUCTURE FOR HPP IN LARGE CAVE
6. HEADRACE TUNNEL
7. INTAKE STRUCTURE ACCESS TUNNEL
8. VERTICAL SHAFT
9. PENSTOCK
10. PENSTOCK GATE HOUSE
11. POWER HOUSE
12. TAILRACE TUNNELS
13. POWER HOUSE STILLING BASIN IN SPRING CAVE
14. ACCESS TUNNEL
15. SWITCHYARD AND TRANSFORMERS
16. BOTTOM OUTLET
17. BOTTOM OUTLET GATE HOUSE WITH DISSIPATION CHAMBERS
18. BOTTOM OUTLET SPILLWAY CHAMBER
19. WATER SUPPLY INTAKE STRUCTURE IN LARGE CAVE
20. WATER SUPPLY TUNNEL
21. WATER SUPPLY INTAKE TUNNEL IN FOSSIL CAVE
22. PUMPING STATION
23. SPRING POND
24. CONTROL BUILDING
25. ACCESS ROAD TO THE HPP
26. PARKING LOT AND ACCESS PLATFORM
27. OUTLET STRUCTURE
28. RIJEKA DUBROVAČKA
29. FOSSIL CAVES

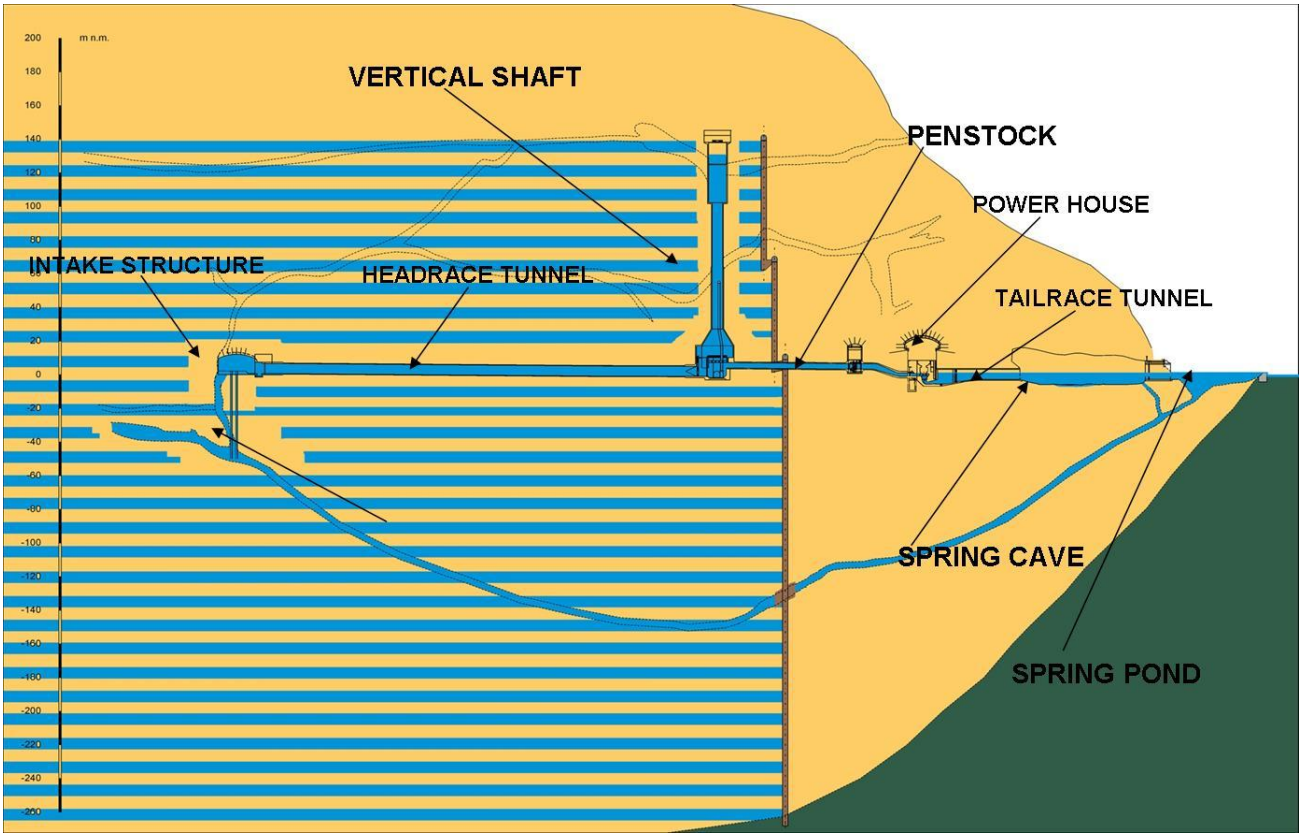


Figure 9 Longitudinal cross-section through the plant

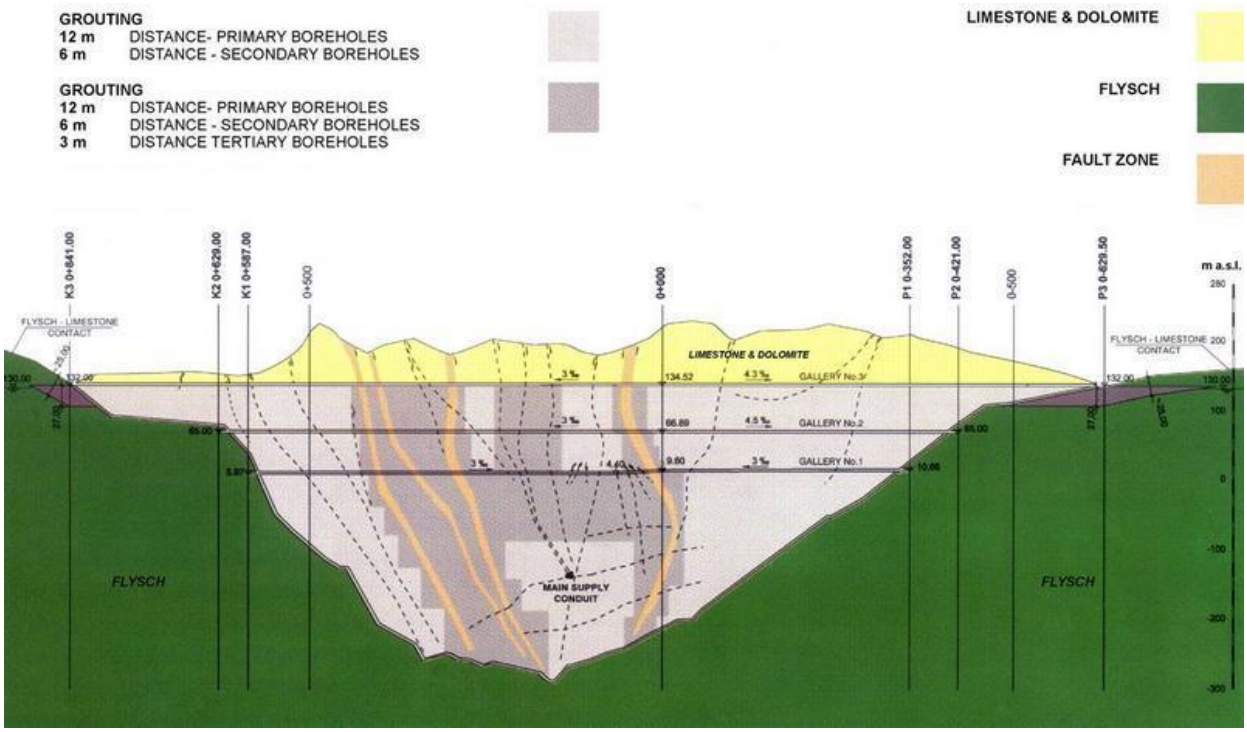


Figure 10 Longitudinal cross-section through the grout curtain

A.3.2.3 Technical Concept

The Ombla HPP intake structure is located some 550 m upstream from the spring, in a natural cave situated above the main natural intake conduit which conveys over 90% of inflow into the Ombla spring.

The headrace tunnel connects the intake structure and the vertical shaft. The tunnel of 5 m diameter and with 30 cm thick concrete lining is 250 m long. Parallel to the headrace tunnel there is a smaller intake structure access tunnel.

The vertical shaft is a central collecting and distribution structure of the entire Ombla HPP hydrotechnical system. The headrace tunnel, bottom outlet, penstock and access tunnel meet in the vertical shaft, which also interconnects with a branch of the Dubrovnik Waterworks. The vertical shaft's diameter varies from 10 m in the bottom section to 3 m in the top section, and spreads from the elevation of – 1.0 m a.s.l. to 135 m a.s.l. The location of the shaft is closely connected with its function. The shaft is used as an air relief shaft and is therefore located at the headrace tunnel and penstock junction. Additionally, in order to interconnect all the fossil caves at higher altitudes and to enable water intake for the Dubrovnik Waterworks from the cave on the elevation of 55 m a.s.l., the shaft is positioned so as to enable the cross-cut connections between fossil caves at all floors up to the elevation of 135 m a.s.l. When the Ombla flow rates are low or when the water level upstream from the underground dam falls to the sea level, the vertical shaft serves as a facility at which water flow will be diverted and individual tunnels closed in order to carry out inspections or repairs. The gate gallery is located within the vertical shaft at the altitude of 11 m a.s.l. wherefrom individual tunnels are sealed off. When the power plant is in operation, the gates are submerged. The gallery is connected with the access tunnel and the pressurised door separates it from the reservoir.

The bottom outlet, going from the vertical shaft to the discharge into Rijeka Dubrovačka, is placed completely under the ground. It has a double function: in addition to being a bottom outlet it will also be used as an emergency spillway and turbine discharge regulator, and for water evacuation during and after the construction of the Ombla HPP. It has been sized so as to evacuate a 113 m^3/s discharge, which corresponds with the 100-year return period discharge. The bottom outlet consists of a 4.0 m diameter, 172 m long tunnel, main gate house with two Howell-Bunger valves and one sliding gate, dissipation chambers, a gate house with two auxiliary gates, a 53 m long tailrace tunnel of horse-shoe cross-section and a spillway chamber at the Rijeka Dubrovačka banks. Howell-Bunger valves are of 2.28 m diameter and of 113 m^3/s capacity each. In front of each valve there is an auxiliary butterfly valve of 2.3 diameter. In the central part of the gate house there is a 4.0 m x 4.5 m sliding gate used during the construction of the plant when bottom outlet operates as a bypass tunnel and during operation when natural flow conditions have to be restored.

The penstock conveys water from the vertical shaft to the turbines. It is designed as a 15 mm thick steel pipe of 3.2 m diameter, concreted into the rock. The gate house with a butterfly valve is placed 68 m far from the vertical shaft. Downstream from the gate house the penstock branches into four branches and descends into the power house up to the turbine inlet butterfly valves.

The power house and the 110 kV switchyard are placed in the same cavern, opposite each other and separated by the access tunnel, at the distance of 126 m from tunnel entrance. The tunnel also serves as driveway and personnel entrance for both facilities. At the elevation of 9.4 m a.s.l. the access floor houses operating and assembly areas with a bridge crane. Four generating units with accompanying equipment are accommodated below the power house floor– two generating units with Francis turbine of rated discharge Q,=24 m^3/s and 30 MVA synchronous generators, and two generating units of rated discharge Q|= 6 rn^3/s and 8 MVA synchronous generators.

A 110 KV SF_e – GIS design switchyard is located above the unit transformer opposite the power house at the elevation of 16.5 m a.s.l. The connection between the unit transformer and the switchyard is carried out by means of three-phase SF_6 gas-filled enclosed conductors. The connection of the power plant to the transmission system is carried out by means of 110 kV power cables in the 110/35/10 kV Komolac substation. Backup power supply of power plant's auxiliary consumption is envisaged from the local distribution network.

After passing through turbines, the water is conveyed through the tailrace tunnel to the natural spring cave accommodating the power house stilling basin. The cave goes about 60 m into depth, is about 40 m wide and 10 to 15 m high. The water flows from the spring cave through the outlet structure into the spring pond and over the spillway into the Rijeka Dubrovačka. Thus, the power plant is completely hidden under the ground and only the outflow at main spring is visible in the spring pond area, which visually corresponds to the present natural condition.

The grout curtain coupled with downstream rock massif and damming structures in the caverns and underground conduits creates an „underground dam“, impounding water to the elevation of 130 m. The dam perimeter leans against an impermeable flysch barrier. The grout curtain area is about 300 000 m^2 and its maximum height is about 410 m. The construction will be performed from three grouting galleries set up at the elevations of 5.0-10.0 m a.s.l.; 65.0 m a.s.l. and 132.0 m a.s.l.

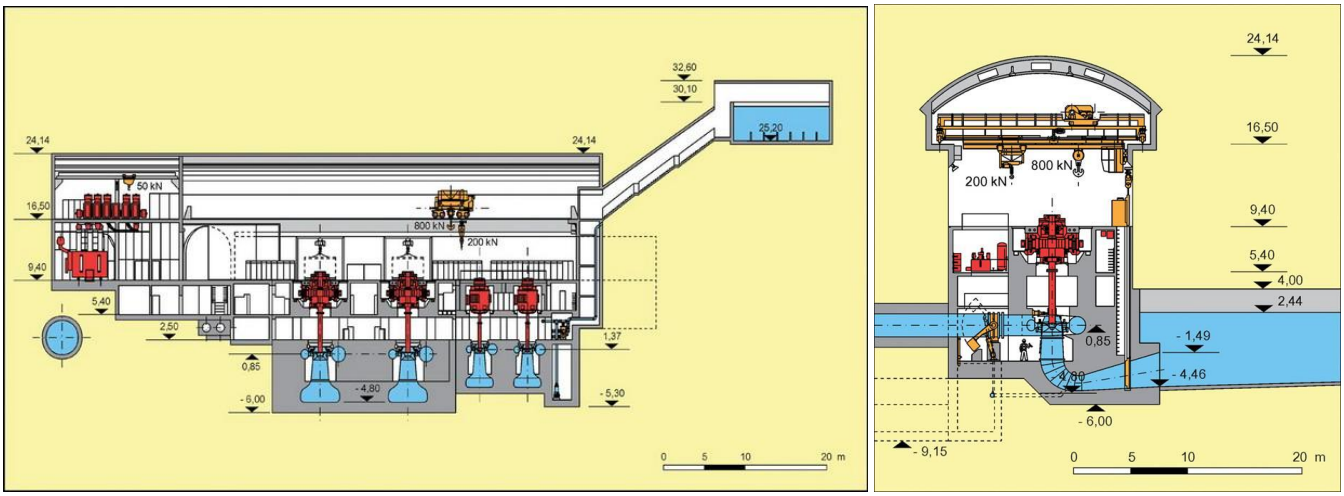


Figure 11 Cross-sections through the power house

A.3.2.4 Access

Access roads: Newly designed roads on the left and the right flank of the dam profile are envisaged as access roads to the entrance into grouting galleries at the elevation of 65.00 m a.s.l. and 132.00 m a.s.l. After the construction of the Ombla HPP, the roads will serve for the control and servicing of grouting galleries.

The reconstructed road round the Ombla River spring will serve as an access road to the hydro power plant and to the entrance into plant's access tunnel and therefrom to the gallery located at the elevation between 5.00 m and 10.00 m a.s.l. The access road to the hydro power plant (access tunnel) is connected to the Dubrovnik – Mokošica highway.

Access tunnel: The access tunnel is the main entrance into the underground, i.e. access to the power house, switchyard, bottom outlet valves, penstock valve, regional waterworks intake structure valve, bottom grouting gallery and vertical shaft. The tunnel serves as air relief for the bottom grouting gallery and bottom outlet dissipation chambers.

A.3.2.5 Water Intake for the Dubrovnik Waterworks

Existing status: The existing water intake is located in the Ombla spring pond. The capacity of the water intake is 360 l/s.

Water intake during the construction of the Ombla HPP: Prior to the construction of the Ombla HPP the water intake will be relocated to the distance of about 500 m from the outlet or 300 m upstream of the grouting curtain, to the cave extension named „Velika Dvorana“ (Large Cave).

In this way water turbidity will be avoided during construction. The water intake capacity is 560 l/s, which is about 1.6 times the present capacity.

Water intake after the construction of the Ombla HPP: After the construction of the Ombla HPP, water intake used during the construction can be used together with the water intake located at the central floor of the Vilina Pećina cave. The water intake capacity is 1500 l/s, which is about 4 times the present capacity.

A.3.3 WATER EVACUATION

The water intake and evacuation system consists of the following:

- water intake in the Large Cave
- headrace tunnel
- vertical connection shaft
- bottom outlet with stilling basin.

A.3.3.1 Water Evacuation during the Construction of the Ombla HPP

Water evacuation during the construction is envisaged through the bottom outlet which will serve as a bypass tunnel.

A.3.3.2 Water Evacuation after the Construction of the Ombla HPP for the Needs of Inspection and Repair

For the needs of water intake tunnel inspection, water is evacuated from the Large Cave through the headrace tunnel and the bottom outlet. For the needs of intake system inspection, waters from the Large Cave are evacuated through the water intake tunnel and the bottom outlet.

A.3.3.3 Water Evacuation in Case of an Average

In case that sudden emptying of the underground reservoir is required, the reservoir is emptied through the Howell-Bunger valve sized for 100-year water discharge (Q_{100} = 113,0 m^3/s). Since two valves are envisaged, one valve serves as a stand-by valve.

A.3.3.4 Operation of Water Evacuation System with Power Plant in Operation

At inflows lower or equal to the installed discharge, with the hydro power plant in operation, the entire inflow passes through the turbines. In case that the inflow is higher than the installed discharge, surplus inflow will bypass the turbines.

A.3.4 CONSTRUCTION TECHNOLOGY APPLIED TO UNDERGROUND STRUCTURES

The smooth-wall blasting (pre-splitting) method with controlled vibrations will be applied to the construction of all tunnels and underground premises. The New Austrian Tunnelling Method will be applied to supports.

Horizontal artificial ventilation is envisaged during construction works, so as to enable continuous aeration of the cave system. Bringing fuel and lubricants in the underground premises will not be permitted. Electric drive is envisaged for drilling, grouting and concrete laying machinery. Transport vehicles do not have electrical drive, but are adequately fitted so as to prevent fuel leakage. The replacement of fuel and lubricants on transport vehicles will be performed at Komolac site. The replacement will be carried out atop of tanks specially equipped for this purpose.

1. UNDERGROUND RESERVOIR
2. GROUT CURTAIN AND GALLERY No 1
3. GROUT CURTAIN AND GALLERY No 2
4. GROUT CURTAIN AND GALLERY No 3
5. INTAKE STRUCTURE FOR HPP IN LARGE CAVE
6. HEADRACE TUNNEL
7. INTAKE STRUCTURE ACCESS TUNNEL
8. VERTICAL SHAFT
9. PENSTOCK
10. PENSTOCK GATE HOUSE
11. POWER HOUSE
12. TAILRACE TUNNELS
13. POWER HOUSE STILLING BASIN IN SPRING CAVE
14. ACCESS TUNNEL
15. SWITCHYARD AND TRANSFORMERS
16. BOTTOM OUTLET TUNNEL
17. BOTTOM OUTLET GATE HOUSE WITH DISSIPATION CHAMBERS
18. BOTTOM OUTLET SPILLWAY CHAMBERA
19. WATER SUPPLY INTAKE STRUCTURE IN LARGE CAVE
20. WATER SUPPLY TUNNEL
21. WATER SUPPLY INTAKE TUNNEL IN FOSSIL CAVE
22. PUMPING STATION
23. SPRING POND
24. CONTROL BUILDING
25. ACCESS ROAD TO HPP
26. PARKING LOT AND ACCESS PLATFORM
27. ACCESS ROAD ON LEFT FLANGE
28. ACCESS ROAD ON RIGHT FLANGE
29. RIJEKA DUBROVAČKA
30. FOSSIL CAVES

Figure 12 Ombla HPP drawing

A.3.5 OPERATING REGIME OF THE HYDRO POWER PLANT

The Ombla hydro power plant will operate in run-of-river regime. In case that the inflow is larger than the installed discharge and in case that due to power system requirements surplus inflow should bypass the turbines, bottom outlet serves as a discharge regulator. The Howell-Bunger valve and generating units will then jointly operate in a way to avoid water level oscillations in the vertical connection shaft when changes occur in the operating regimes.

The basic rule is to always discharge natural inflow, i.e. the amount of water inflowing from the underground at that particular moment.

A.3.6 CONSTRUCTION COSTS

Cost estimate within the Preliminary Design is dated 1 June 1998, and totals 532 792 119.00 HRK. As at 1 June 1998, the exchange rate HRK – DEM was 1 DEM = 3.6 HRK.

B EVALUATION OF PROJECT ACCEPTABILITY

B.1 OVERVIEW OF POTENTIAL IMPACTS

The evaluation of the Ombla HPP project acceptability basically derives from the relation of benefits and drawbacks caused by the construction of this multipurpose hydrotechnical facility.

Therefore, this chapter describes all benefits and all potential environmental impacts of the proposed facility during its construction and operation and in the post-operation period.

Potential adverse impacts are those impacts that would emerge without the application of technical or other protection measures. Such impacts are abated or mitigated by the application of certain technical or other protection measures.

B.1.1 BENEFICIAL IMPACTS

The construction of the Ombla HPP will provide for the following:

- secure source of electricity from a renewable source of energy in the centre of consumption, with the output of about 223 GWh in an average hydrological year;
- more efficient and sanitary safe water supply of the City of Dubrovnik and its wider area;
- water intake capacity of about 1500 l/s, which is approximately 4.0 times the present capacity;
- new employment opportunities during construction and operation of the hydro power plant.

B.1.2 IMPACT DURING CONSTRUCTION

No impact on climate, surface waters, pollution sources and water protection, fishery, stability of flysch slopes, structures, traffic connections, sewerage system, electric power, landscape, sociology and demography and economy is expected during the construction.

Impacts during construction relate to the following:

B.1.2.1 Impact on Water Supply

Considering extensive civil works and grouting in the underground, prior to the start of construction new water intake should be constructed upstream of the present water intake for the Dubrovnik Waterworks in the extension of the cave named „Large Cave“, at the distance of about 500 m from the exit and about 300 m upstream of the envisaged grout curtain. In this way possible water turbidity caused by negligent grouting cannot be reflected on the quality of water abstracted for the Dubrovnik Waterworks.

B.1.2.2 Impact on Flora and Fauna

Potential impacts on aquatic flora and fauna are possible only with respect to the communities abiding in the spring area, due to the formation of lake caused by water evacuation through the bottom outlet, which is essential during the execution of work on the grout curtain.

However, decreased water discharge through the spring pond, with maximum duration of two months, will have no impact on the composition of living organisms. Only the increased development of biofouling can be expected, composed mainly of lower plants.

As regards terrestrial flora and fauna, possible adverse impacts are possible only on the bat community abiding in the Vilina Pećina cave. Due to increased noise, the bats will be disturbed and will have to search for new habitats.

B.1.2.3 Impact on Protected Flora and Fauna Species

An adverse impact on protected flora and fauna species is reflected only in the disturbance of bats abiding in the Vilina Pećina cave, during their rest or stay during flyover.

B.1.2.4 Impact on Nature and Cultural Values

Of natural and cultural values, only the Chapel of the Annunciation can be damaged during the construction of the planned Ombla HPP. Such damage can be incurred only during the construction works on the spillway threshold of the spring pond.

B.1.2.5 Impact Caused by Dust and Noise

Dust will be created during construction works on access roads. Due to terrain humidity, underground work will result in very small dust quantities.
Similarly, noise will be generated during works performed on access roads, originating both from machinery and from terrain mining. However, during underground works noise will not be heard in the hydro power plant's environment.

B.1.3 IMPACT DURING HYDRO POWER PLANT OPERATION

During plant's operation no impact is expected on

- climate
- surface waters
- pollution sources and water protection
- fishery
- stability of flysch slopes
- earthquakes
- structures, traffic connections and sewerage system
- landscape
- cultural and natural values
- dust and noise.

Impacts during hydro power plant's operation relate to the following:

B.1.3.1 Impact on Groundwater Quality

B.1.3.1.1 Impact on physico-chemical water properties

The impoundment of groundwater to the elevation of +130 m a.s.l. will significantly reduce its flow velocity. At smaller inflow velocities, suspended solids will be deposited, and at larger runoff velocities deposited particles will be washed out. However, the increase in turbidity at high water is already present, so that the current water quality at the Ombla Spring will not be deteriorated by the construction of the underground reservoir.

Due to constant water temperature and gradual charging and emptying of karst cavities, the reduction of balancing carbon dioxide in water is not expected nor is the creation of plugs or other barriers to water flow in the newly constructed underground storage.

Since the economy in the Ombla catchment area is underdeveloped, potential water pollution is reduced. Also, since „old“ water will always outflow from the reservoir, there is no threat from the lack of oxygen in the reservoir on condition that large quantities of organic waste do not occur in the catchment area, which is not connected with the construction of the planned hydro power plant.

B.1.3.1.2 Impact on bacteriological water properties

Due to longer water inflow time and increased self-purifying capability, the number of bacteria in the Ombla waters will be reduced.

B.1.3.2 Impact on Water Supply

The Ombla HPP will not have adverse impact on the quantity of water for the Dubrovnik Waterworks. After the construction of the underground reservoir, water intake will be relocated from the Large Cave to the cavity located on the central floor of Vilina Pećina cave, at the elevation of 55 m a.s.l., in which even lower turbidity is expected. Potential water intake capacity is 1500 l/s, which is about 4.0 times the present capacity.

The construction of the Ombla HPP will not only provide for sanitary safer but also for economically more efficient water supply, since the water will be conveyed to the present reservoir of city waterworks by gravity, i.e. without need for energy consumption which now contributes to the price of water with 0.166 HRK/m^3, totalling about DEM 250 000 in 1990.

B.1.3.3 Impact on Soil, Flora and Fauna

The impact of the Ombla HPP on soil, flora and fauna is reduced to minimum since the entire hydro power plant, except for the control building, is accommodated in the underground.

The bat community that will leave the Vilina Pećina cave during construction will most probably re-inhabit the same cave after the Ombla HPP construction, since the cave opening is about 7.0 m above maximum pool elevation.

The envisaged works after hydro power plant's commissioning, provided that the flowability at the Ombla River spring is maintained within set limits, will not have adverse impact on living organisms inhabiting the spring pond and the Rijeka Dubrovačka.

B.1.3.4 Impact on Protected Flora and Fauna Species

No flora and fauna species protected by law were found in the Ombla River system. Protected bat species at the location of Vilina Pećina cave will return to their original habitat after the completion of construction.

B.1.3.5 Impact on the Purpose and Use of Space

All structures of the Ombla HPP, except for the control building, are located under the ground, so that the construction of the planned hydro power plant has no significant impact on the change of purpose and use of space. Only the access roads to the grouting galleries will occupy small surface areas of uncultivated land, mainly rocky ground.

B.1.3.6 Impact on Facilities and Infrastructure

The Ombla HPP will have positive impact on water supply and power generation.

B.1.3.7 Sociological and Demographic Impacts

Positive impacts of the Ombla HPP: secure source of energy, secure water supply, opening of 24 new jobs and possibility of tourist development are positive impacts from sociological and demographic point of view.

B.1.3.8 Impact on Economy

Safe water supply and permanent source of high quality energy enable the development of tourism as principal industrial branch of Dubrovnik-Neretva County.

B.1.4 IMPACTS IN CASE OF EXCEPTIONAL CIRCUMSTANCES

The stability analysis of High Karst rock mass has shown that the rock mass is stable under all conditions. This means that in case of exceptional circumstances, e.g. strong earthquakes, the Ombla HPP floodwater will not endanger the downstream area.

On presumption that an average of the constructed dam occurs, no conventional flood wave will be created. Instead, a small amount of water runoff will occur with a discharge restricted by the karst underground conductivity. This means that the water accumulated in conduits and cavities would have to spend a large amount of own energy to overcome the resistance in karst conduits and fissures, which would result in a „leakage“ from the rock mass rather than a conventional flood wave.

Furthermore, if the plug in the headrace channel gets penetrated, the present natural condition would be restored and water discharge would not exceed natural flow rate since it would be restrained by the capacity of the headrace channel.

B.1.5 IMPACTS IN THE POST-OPERATION PERIOD

The Ombla HPP is foreseen as an abiding facility.

B.2 EXPLICATION OF THE MOST ADEQUATE OPTION

The Ombla HPP differs from conventional hydro power plants first of all since:

- it has a natural underground reservoir
- sufficient water pressure for the Ombla River harnessing in energy generation is achieved by the construction of an „underground dam“, with the rock massif as dam's body.

Consequently, considering the configuration of terrain and specific features of the structure, the most acceptable solution in case of the Ombla HPP is an underground hydro power plant. As regards pool elevation, additional explorations have confirmed that it can be increased from 100 m a.s.l. to 130 m a.s.l.

B.3 OVERVIEW OF PROTECTION MEASURES

B.3.1 GENERAL

Environmental protection measures should be planned in advance and efficiently implemented prior to the construction, during the construction and during the operation of the Ombla HPP, in accordance with effective legislation.

The basic prerequisite for the construction of the planned Ombla HPP is safe high quality water supply to the City of Dubrovnik during the construction, during regular operation and during the emptying of the underground reservoir.

B.3.2 ENVIRONMENTAL PROTECTION MEASURES IN THE PRE-CONSTRUCTION PERIOD

B.3.2.1 General

Prior to the commencement of work, the following activities should be carried out:

- use mass media to inform interested general public on the construction of the proposed hydro power plant and expected environmental impacts;
- ensure the availability of data on water quality and hydrological, hydrogeological, biological and cultural characteristics of the area in order to assess environmental impacts during the construction and operation of the Ombla HPP;
- identify construction materials and construction methods to avoid all negative consequences arising therefrom;
- foresee and apply measures to prevent the spreading of noise from the construction site above permissible limit levels;
- along with the development of the Implementation Design, develop the Technical Observation Project for the proposed plant;
- make sure through regular control that the adopted organization of construction, choice of equipment and material, accommodation of process plants, administration and social standard building, provision of required infrastructure, selection of adequate machinery and its adequate servicing and the chosen work technology do not have adverse impact on the water quantity and quality, regular operation of the waterworks, flysch slope stability, earthquakes and natural and cultural values in the surroundings of the planned Ombla HPP.

B.3.2.2 Water Protection Measures

The basic measure for drinking water protection is the establishment of protection zones (OG No 22/1986). The activities on the establishment of the Ombla Spring sanitary protection zones that were launched in accordance with the conclusions reached by the Ombla HPP Preliminary Environmental Impact Study Assessment Commission were suspended during the Homeland War since the major part of the Ombla catchment is located outside Croatia's national territory. However, the establishment of sanitary protection zones is not essential for the construction of the planned hydro power plant, and the resolution to this very important problem is only but encouraged by the construction of the hydro power plant.

Nevertheless, until sanitary protection zones are established, independent of the construction of the planned hydro power plant, the following measures should be applied:

- protection of the catchment area against pollution
- water treatment before use.

In order to implement the first measure cooperation is required between the Republic of Croatia and Bosnia and Herzegovina.

B.3.2.3 Water Supply

Since during the Ombla HPP construction extensive civil works and grouting works will be carried out in the underground upstream of the present water intake, prior to the commencement of such work new, unaffected water intake should be constructed upstream. It will be located in the cave extension named “Large Cave”, situated some 500 m upstream of the current water intake and about 300 m upstream of the planned grout curtain. In this way potential water turbidity caused by uncontrolled leakage will not have an impact on the quality of water abstracted for the Dubrovnik Waterworks.

B.3.2.4 Slope Stability

Although it has been assessed that the construction of the planned Ombla HPP will have no adverse impact on the stability of flysch slopes, groundwater table in this area should be regularly overseen.

B.3.2.5 Protection of Flora and Fauna

The protection of flora and fauna relates to the protection of bats inhabiting Vilina Pećina cave. Since they may be disturbed, they should be chased away by smoke introduced into the cave area.

B.3.2.6 Protection of Cultural Landmarks

Of cultural landmarks, the Chapel of the Annunciation is the only one that can potentially be affected and only during the execution of works on the spillway threshold. Therefore, the Chapel should be protected under the supervision of conservators prior to the commencement of work in order to prevent its damage.

B.3.2.7 Landscape Protection

Access roads to the grouting galleries at the elevations of 5.0; 65.0 and 134.0 m a.s.l. should be constructed on the west side in the direction from Komolac. Although the route passes through the uninhabited area, it should be maximally adjusted to the configuration of terrain to achieve its maximum blending into the landscape.

A part of excavated, mainly clayey material, that will not be used in road construction can be used to cover up the Grabovica waste disposal site or for the reclamation of the existing queries, which should be agreed upon with competent institutions prior to the start of work.

B.3.2.8 Organisation of Construction

Construction camp and process plants: Due to the configuration of terrain in the surrounding of the Ombla spring, the construction camp and sub-plants cannot be accommodated in this area. Therefore, they will be located in the area of Komolac.

Material and fuel sources: Cement will be delivered to the harbour by ships and reloaded into tank trucks and transported to the cement works silo in Dubec. Adequate space should be provided for the storage of material.

The contractor will decide on whether fuel and lubricants supply will be provided from the nearby pumping station or this issue will be resolved by buried tanks and the pumps mounted on such tanks. In the latter case, fuel and lubricants storage should be constructed.

Regulations governing the storage of fuel and lubricants should be adhered to, regarding the separation of such facilities from other structures, fire protection, earthing, etc.

The use of the generating set for making concrete should be negotiated with the existing crushing and separation plant in Dubec, located about 8 km far from the Ombla spring.

Construction time schedule: The construction of the Ombla HPP will last four years. Considering the fact that the majority of work is performed under the ground, the construction season will last throughout the year, i.e. 12 months.

In addition to technological requirements of the construction site, the schedule of works is conditioned by the requirements relating to construction terms and conditions. This primarily relates to the requirement to provide for secure clean water supply to the City of Dubrovnik during construction.

Accommodation of process plants, administration and social standard buildings: Although the infrastructure in the settlement of Komolac is not completely built, this location has been selected for the accommodation of process plants and administration and social standard buildings based on the assessment that it will cause minimum devastation of the area.

Earth and rock material deposits: More than 80 % of excavated material (217 629 m^3) will not be stored. Instead, a part will be used for the construction of roads and the plateau around the control building and a part as construction material for processing, which has already been agreed upon with the Dubec cement works. Therefore, a new query need not be opened prior to the start of work. The remaining, mainly clayey material and waste-rock in the amount of about 37 000 m^3 can be used to cover the waste disposal site or to reclaim existing queries, which should also be agreed upon with competent institutions.

B.3.3 ENVIRONMENTAL PROTECTION MEASURES DURING PROJECT CONSTRUCTION

B.3.3.1 General

The Ombla HPP project developer should provide for the flowing:

- supervise the contractor, ensuring that adequate machinery is used during construction, in line with adopted project documentation and respecting all laws and regulations;
- ensure adequate construction, geotechnical and water management supervision during construction works and insist on prescribed control of workmanship and built-in material;
- ensure professional supervision of a competent institution regarding cultural monuments;
- supervise that the selected equipment, material and work technology do not have adverse impact on the quantity and quality of groundwater and surface waters, slope stability and seismicity, and natural and cultural values in the surroundings of the Ombla HPP;
- control that no servicing of machinery or fuel storage takes place at the construction site;
- oversee that the excavated material be either built-in or deposited at a pre-determined location;
- during the construction of the hydro power plant, organize constant health control for all employees and undertake all necessary sanitary measures, under constant supervision of inspection services, to prevent water pollution.

B.3.3.2 Water Protection Measures

Water protection measures are identical to the water protection measures in the pre-construction period.

B.3.3.3 Water Supply

The construction of a new water intake structure in the cave extension named “Large Cave” prior to the construction of the hydro power plant ensures secure, high quality water supply of the City of Dubrovnik and its wider area during the construction.

B.3.3.4 Slope Stability

Slope stability protection is identical to the protection of flysch slope stability in the pre-construction period.

B.3.3.5 Protection of Flora and Fauna

The protection of living organisms during the construction of the planned Ombla HPP relates to the protection of protected bat species that inhabit the area of Vilina Pećina cave. In order to prevent the extinction of these mammals during the construction, their entrance into the cave should be prevented. This will be achieved by chasing bats away with smoke.

B.3.3.6 Protection of Cultural Landmarks

Of cultural landmarks in this area, the only cultural monument that can potentially be affected is the Chapel of the Annunciation, and this can occur only during the construction works performed on the spillway threshold in the spring pond.

Therefore, the authorised conservation institution should constantly oversee the Chapel during the construction work in order to eliminate potential adverse impacts on time by undertaking adequate measures in accordance with the regulations on the protection of cultural monuments.

Furthermore, during the execution of earthwork, the supervision of archaeologists from a competent protection institution should be ensured, so that potential finds of remnant structures and objects of scientific and material value do not get destroyed or stolen.

B.3.3.7 Landscape Protection

The protection of landscape during the construction relates to the preservation of structures constructed prior to the start of work.

The excavated material that cannot be used in road construction or concrete manufacturing should not be disposed in the area of Rijeka Dubrovačka and other protected areas, but stored at the pre-determined location earmarked for this purpose.

B.3.3.8 Protection against Dust and Noise

The basic measure to prevent the occurrence of dust during construction of access roads is the moistening of surfaces on which work is performed.

In order to reduce noise from mining activities on road routes, construction explosives should be rationally used and a special study developed with this regard.

B.3.3.9 Maintenance of Facilities and Infrastructure

During the execution of construction works, the project developer has the obligation to maintain all structures and infrastructure constructed for the needs of construction, residence and control.

Furthermore, the project developer is obliged to repair all potential damage inflicted to the existing roads during construction works.

B.3.4 ENVIRONMENTAL PROTECTION MEASURES DURING PROJECT OPERATION

B.3.4.1 General

Basic principles of reliable environmental protection during the operation of the Ombla HPP are as follows:

- constantly check the impermeability of the natural reservoir and grout curtain, especially during the first charging of the underground reservoir and initial loading of the underground dam;
- use the water intake that served for water supply during construction, until the required pool level is obtained in the reservoir;
- elaborate a rule book on hydro power plant operation under normal and exceptional conditions.

B.3.4.2 Water Protection Measures

Water protection measures during the operation of the planned Ombla HPP are identical to water protection measures in the pre-construction period.

B.3.4.3 Water Supply

As already stated, the basic prerequisite for the construction of the planned hydro power plant is secure supply of the City of Dubrovnik and its wider area with the water of minimum water quality identical to the water quality prior to the construction of the planned plant. Therefore, parallel to the construction of the planned hydro power plant, new water intake should be built in the cavity located on the central floor of Vilina Pećina cave at the elevation of approximately 55.00 m a.s.l. A small-scale water turbidity is expected to occur during heavy precipitation which is even now, prior to construction, accompanied by high level of suspended solids.

After the commissioning of the hydro power plant, permanent guarding service should be organized in agreement with the Dubrovnik Waterworks and adequate measures undertaken to prevent water pollution.

B.3.4.4 Slope Stability

Slope stability protection is identical to the protection of flysch slopes stability in the pre-construction period.

B.3.4.5 Surface Water Protection

Variable operating regime of the Ombla HPP will not have adverse impact on the waters of Rijeka Dubrovačka bay since water tables of Rijeka Dubrovačka are under direct influence of the sea level.

Potential adverse impact in the Ombla spring area with the hydro power plant 0out of operation, which will be only during plant's overhaul, should be resolved by discharging natural water inflow, which is sufficient to preserve the existing living organisms of this karst spring.

During other periods, with the hydro power plant in operation, the discharge in the Ombla spring area will equal the natural inflow into the reservoir, except for the case when the inflow is larger than the installed discharge. In such case, surplus inflow should be discharged into Rijeka Dubrovačka over the bottom outlet.

B.3.4.6 Water Protection and Pollution Sources

Water protection in the Ombla HPP catchment area during the operation of the project is identical to the water protection in the pre-construction and construction period.

B.3.4.7 Protection of Flora and Fauna

All structures of the planned Ombla HPP, except for the control building, are underground structures and will have no adverse impact on terrestrial flora and fauna.

The existing living organisms in the Ombla spring area and Rijeka Dubrovačka can be preserved by maintaining the flowability within set limits, both during the operation of the hydro power plant and when hydro power plant is out of operation.

B.3.4.8 Protection of Protected Species

Protected bat species which used to inhabit Vilina Pećina cave prior to project construction, will re-inhabit the cave after the completion of work, and no special protection measures are required with this regard.

B.3.4.9 Protection of Cultural Landmarks

After the completion of works, potential damage to the Chapel of the Annunciation should be repaired. The repair work should be performed in accordance with the regulations governing the protection of cultural monuments.

After the construction of the access road to Vilina Pećina cave, the cave should be explored. Based on the results of such exploration, the cave presentation program should be developed in cooperation with other authorised institutions in the field of protection.

B.3.4.10 Protection against Dust and Noise

The basic protection measure against the occurrence of dust in the surroundings of the planned hydro power plant in case of additional work is the moistening of surfaces on which such work is performed. In case of mining, rational use of construction explosives is required.

To reduce the noise originating from the ventilation device, the device has to be regularly maintained.

B.3.4.11 Landscape Protection

As already stated, all the structures of the planned Ombla HPP are underground structures and have no impact on the aesthetic properties of the landscape. However, the area between the Adriatic Highway and the spring pond on the right side of the spring will be arranged as a park.

Access roads to the grouting galleries should be regularly maintained after the completion of work.

In the Ombla spring area, constant natural outflow should be provided to enable the existence of living organisms in the Ombla spring area and Rijeka Dubrovačka.

B.3.4.12 Landscaping

External landscaping encompasses the works in the immediate vicinity of the control building, horticultural landscaping of the environment by planting autochthonous vegetation of the Ombla HPP area, and building of stone support and boundary walls.

Coastal road round the spring pond used during the construction should also be arranged after construction to improve the present access to the Adriatic Highway.

B.3.4.13 Construction Site Facilities and Infrastructure

The project developer is obliged to remove or properly arrange all the structures constructed for the needs of construction work, residence and control during the construction.

The project developer is obliged to repair all potential damage to roads inflicted during the execution of required work.

B.3.5 PROTECTION MEASURES IN EXCEPTIONAL CIRCUMSTANCES

The basic measure for the protection of the environment of the planned Ombla HPP in exceptional circumstances and during technical observations and repairs is timely and correct water evacuation from the underground reservoir.

Water supply in exceptional circumstances: In order to provide water supply from the Ombla watercourse to the consumers in exceptional circumstances and to meet increased future water demand, the existing New Pumping Station should be retained. In such circumstances, water supply to consumers will be carried out in the same way as prior to the construction of the planned Ombla HPP.

B.3.5.1 Water Evacuation after the Construction of the Ombla HPP for the Needs of Inspection and Repair

In case of inspections and potential repairs on the grout curtain or other structures located in the underground reservoir, the reservoir will be initially emptied through the Howell-Bunger valves, after which the sliding gate will be opened, creating the conditions for water discharge that are identical to the conditions during the construction of the hydro power plant.

For the needs of water intake tunnel inspection, the water from Large Cave should be evacuated through the headrace tunnel and the bottom outlet, and for the needs of headrace tunnel inspection the water from the Large Cave should be evacuated through the water intake tunnel and the bottom outlet.

B.3.5.2 Water Evacuation in Case of an Average

In case of an average, i.e. in case of such condition which requires sudden emptying of the underground reservoir, the reservoir will be emptied through Howell-Bunger valves. Since the accumulated amount of water is very small, natural flow conditions can be restored in a few minutes time.

B.3.6 ENVIRONMENTAL PROTECTION MEASURES IN THE POST-OPERATION PERIOD

As already mentioned under item B.1.5, the Ombla HPP is foreseen as an abiding structure, so that environmental protection measures need not be prescribed for this phase.

B.4 DRAFT ENVIRONMENTAL STATUS MONTORING PROGRAM

B.4.1 GENERAL

The environmental impact of the Ombla HPP cannot be determined without data on the status of environment in the zone accommodating the planned facility.

Therefore, environmental status monitoring should start prior to the construction of the planned hydro power plant so as to develop a database required for the identification of zero status, i.e. the status prior to the start of construction. This is the only way in which changes during the construction and after plant's commissioning can be reliably detected.

Furthermore, certain additional research work should be carried out prior to the construction i.e. for the final design. Also, regular technical observations of the planned facility are required.

However, this draft environmental status monitoring program is focused only on the ecological aspect, while research work required for the final design and regular technical observations have been elaborated in other volumes.

B.4.2 ENVIRONMENTAL STATUS MONITORING IN THE PRE-CONSTRUCTION PERIOD

B.4.2.1 Meteorology

Although the planned construction will not have an impact on meteorological phenomena, it is proposed that basic meteorological station be installed at hydro power plant’s exit. The measurement of basic climatological elements should start at this station prior to the start of construction of the planned facility: precipitation, air temperature, air humidity, evaporation, winds and cloudiness.

B.4.2.2 Hydrogeology

The proposal of required investigations relates to the monitoring of groundwater levels. Spatially, groundwater level should be measured in the area of the grout curtain, at the junction of rock and flysch and in the wider flysch area lateral to the grout curtain.

B.4.2.3 Seismology

Although the Ombla HPP will have no impact on the occurrence of earthquakes, due to the fact that the entire area of Dubrovnik is an earthquake prone area, the earthquakes on this territory should be monitored.

B.4.2.4 Slope Stability

Regardless of the conclusion that the rising of groundwater level in the hinterland of the planned hydro power plant will not have an adverse impact on the stability of flysch slopes, the groundwater level in this area should be regularly monitored prior to the construction of the planned project.

B.4.2.5 Water Quality

Water quality monitoring at different water levels should continue in order to establish the most reliable database on water quality prior to the construction of the planned hydro power plant. This is a condition without which no reliable assessment of the impact of the planned hydro power plant on water quality is possible, both during its construction and in the post-operation period.

Depending on the water level, water quality testing of the Ombla spring should continue in Large Cave, Spring Cave and at the Ombla spring.

The tests should encompass physico-chemical and bacteriological properties of water at all stations, and at the station located at the Ombla spring the composition of living organisms should also be tested.

Of physico-chemical and microbiological parameters, the analysis should cover all parameters monitored to date.

Physico-chemical and bacteriological parameters should be tested at least once per month, and biological parameters four times a year.

B.4.2.6 Water Protection and Pollution Sources

Water protection against pollution on the territory of the Republic of Croatia is a legal obligation and is not connected with the construction of the planned facility.

Therefore, the planned construction only initiates the resolution of this problem, not only in the part of the catchment area located on national territory, but also in the part of the catchment area located on the territory of Bosnia and Herzegovina, which calls for interstate cooperation.

Potential pollution sources in Croatia include the unarranged waste disposal site „Grabovica“, and on the territory of Bosnia and Herzegovina the settlement of Ivanića, intensive agriculture on Popovo Polje, traffic roads and the wastewaters of the town of Trebinje.

B.4.3 ENVIRONMENTAL STATUS MONITORING DURING PROJECT CONSTRUCTION

During project construction the following should be continued:

- meteorological monitoring
- hydrogeological monitoring
- seismological monitoring
- monitoring of flysch slopes stability
- water quality monitoring
- water protection
- oversight of cultural values.

Additionally, water level at the Ombla spring pond should be regularly monitored during the reconstruction of the spillway threshold, during the construction of envisaged hydro power plant structures and after the erection of temporary spillway threshold.

B.4.4 ENVIRONMENTAL STATUS MONITORING AFTER PROJECT COMPLETION

After project construction, monitoring activities should continue identical to activities during project construction.

C DATA SOURCE

1. Ombla HPP – Preliminary Environmental Impact Study, Elektroprojekt d.d., Zagreb, 1989
2. Ombla HPP – Environmental Impact Study, Elektroprojekt d.d., Zagreb, 1999

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