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Project:

HPP KOĆUŠA

Content:

ENVIRONMENTAL IMPACT REPORT

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CONTENT

1. INTRODUCTION

1.1. Project objective

Based on the contract between “J.P. Elektroprivreda hrvatske zajednice Herceg-Bosne d.d.” Mostar (EP) and “Pöyry Energy GmbH” (PEAT) signed in February 2006 Pöyry should carry out the consulting services for “Feasibility Study for HPP Koćuša”.

The services are divided in three stages:

- Study of alternatives
- Feasibility Study of selected alternative
- Tender documents

During the study of alternative stage the working team together with the experts of EP tried to find solutions which should satisfy the objectives defined on site. The project scope is a power plant which uses the benefits on the project area and increases the living standard in the area, but at the same time as less as possible disturbs the waterfall and the sensitive environmental (karst) characteristics of the region.

The presented solution represent an economically and technically achievable solution concerning the energy production, by fulfilling the project boundary conditions.

This report is an extension of the Feasibility study - Environmental report and can be used as a separate document.

1.2. Basic project data

The project area is situated at the southern part of Republic Bosnia and Herzegovina south and south-west from Mostar. The region includes the karst catchment of the river Mlade/Trebizat with an orographic area of roughly 850 km^2. It is a typical karstic region with many karst phenomena. The project area has sub-mediterranian climate with hot and dry summers and moderate winters with nearly no days (one or two days annually) with temperature not exceeding 0ºC. The average annual precipitations are rather high, average 1200 to 1500 l/m^2, but with very unfavourable distribution. Less that 10% of precipitations fall during the hot and dry summer.

The Koćuša hydro-electric power plant is located south-west from Mostar and west of the town Ljubuski. It uses the discharge of the Mlade/Trebizat River in a run-of-the-river power plant in the area of Koćuša waterfall. A 534 m long headrace with a short tunnel creates 14.80 m gross head. The powerhouse will therefore use a rated head of 13.60 m for energy generation. In the powerhouse two Kaplan-S units respectively in the alternative two Eco-Bulb turbines will be installed. The tailrace water will be discharged through a short tailrace channel to the Mlade/Trebizat river.

The basic data for the project are:

• Full reservoir level (FRL)	96.00 m a.s.l.
• Minimal reservoir level (MDDL)	94.00 m a.s.l.
• Maximal flood level at Intake (MFL)	97.14 m a.s.l.
• Minimal tail water level	80.26 m a.s.l.
• Operational tail water level	81.20 m a.s.l.
• Gross head	14.80 m
• rated head	13.60 m
• Number of turbines Kaplan -S-Turbines (6 blades) with horizontal shaft without gear	 2
Alternative: Eco – Bulb Turbines	
• Utilizable discharge	2*20 = 40 m^3/s
• Synchronous generator	2*3.2 MVA
• Max. Power output Two units	 2*2.425 = 4.85 MW
• Energy production per year	18.4 GWh/a

1.3. Environmental impact - summary

The following report is divided into thematic areas of possible impacts on the environment and gives a:

- Description of the significant environmental effects
- Description of feasible mitigation measures for minimising, eliminating or offsetting unavoidable effects
- Recommendation of the most appropriate mitigation and/or enhancement measures.

To examine the environmental impact it is necessary to distinguish the character of the impacts related to the temporal sequence of the project. In the following the different aspects of impacts concerning the conditions before and during construction as well as during and after operation are shown together in the context of the thematic area.

To begin with it is essential to list the planned measures in order to be able to refer to the possible impacts on the environment. The selected alternative has been specified as follows:

- The Mlade/Trebizat riverbed will be deepened and regulated only in a small area in the vicinity downstream the power house Koćuša in a length of approximately 40 m.
- The max. operation water level in the reservoir with 96.00 m above sea level (ASL) is given by the elevation of the outlet of the fish farm upstream of Koćuša. Dams will not be necessary.
- The max. flood water level in the reservoir with 97.14 m above sea level (ASL) is also given by the elevation of the outlet of the fish farm upstream of Koćuša. Dams will not be necessary. The existing high flood protection embankments will be heightened only in a short stretch.
- Construction of a weir and intake approximately 220 m upstream the waterfall Koćuša.
- Construction of a small reservoir within the existing flood protection dams with its max. operation level at 96.00 m and a min. operation level 94.00 m ASL.
- Intake structure on the left bank of the weir
- The headrace begins immediately at the intake structure, is a subsurface channel, in total approximately 534 m long.
- After a manifold two buried penstocks with quadratic profile lead to the power house
- The powerhouse is located downstream of the waterfall near on the left bank and contains two sliding gates upstream, two Kaplan-S units with generator and stop-logs to the tailwater. Design discharge is 2*20 = 40 m^3/s which gives 2*2.425 = 4.85 MW power output
- The downstream river dredging for the tail-water is foreseen only in the vicinity of the tailwater outlet in a length of 40 m.
- The environmental conditions for the project define the minimal biologic flow with 3 m^3/s, which was increased by the client Elektroprivreda to 5 m^3/s. This discharge will be released at the weir.

According to the checklist for dams and reservoirs different items (listed in Appendix A) show potential environmental impacts and have been considered in this report. Some of these items must be given careful attention in the planning, design, construction, operation and monitoring of the project in order to minimise and offset adverse effects.

Figure 1: Mlade/Trebizat River downstream of Koćuša waterfall (view direction: upstream)

2. DESCRIPTION OF THE PROJECT AREA

2.1. Location

2.1.1. General

The project area is situated at the south part of Republic Bosnia and Herzegovina south and south-west from Mostar west of the town Ljubuski. The region includes the karst catchment of the river Mlade/Trebizat River with an orographic area of about 850 km^2. It is a typical karst region with many karst phenomena. The project area has sub-mediterranean climate with hot and dry summers and moderate winters with nearly no days (one or two days annually) with temperature not exceeding 0ºC. The average annual precipitations are rather high, between 1200 to 1500 l/m^2, but with very unfavourable distribution. Less that 10% of precipitations falls during the hot and dry summers. In cold winter periods monthly precipitation is about 100 to 190 l/m^2 whereas in summer it decreases to 30 to 70 l/m^2 per month.

The topographic map of the project area is presented in the Appendix.

2.1.2. Topography

2.1.2.1. General

The project area is located in the south part of Republic Bosnia and Herzegovina south and south-west from Mostar. It lies in:

latitude 43° 14' 59˝and
longitude 17° 27' 27˝.

The topography of this area is typical for West Herzegovina region and is part of Dinaric zone. The landscape has hilly character with typical karst features.

The rock around the proposed site is mostly cretaceous limestone and dolomite with some deposits of flysch rock. The folding depressions are filled with younger sediments consisting of different soil types.

The river gives very suitable environment for travertine development. This phenomena dominate the river bed with lower flow speed and areas with waterfalls forming typical travertine barriers like Koćuša waterfall. These barriers are formed as well at the natural but also at the artificial (human made) weirs in river.

The topographic map of the project area is presented in Appendix A.

2.1.2.2. Topographic basis

The topographic basis of the project are:

- Topographic maps of the project region in scale 1:25000.
- Land register maps of the project region in scale 1:2500
- Detailed survey maps of the project areas of special interest such as:

Additional survey works for check or detailing have been performed in the area of the weir and of the power house.

2.1.3. Climate and Meteorology

Most of the obtained data are taken from previous studies.

The catchment area of the river Mlade/Trebizat is situated at the periphery of the Mediterranean climate zone.

Physico-geographical properties of this area (bare karst of distinguished orography) modify the local microclimate from maritime to mountainous. The climate is mesothermal, humid with moderate arid summers. In general it can be said for the mentioned area that the annual precipitation's are between 1200 to 1500 l/m^2. In summary there are about 140 days/year with precipitation. In cold winter period monthly precipitation is about 100 -190 l/m^2, and in summer 30-70 l/m^2 (July 30-40 l/m^2).

The dominant wind blows from the north (local name ,,bura") and south and has mostly middle intensity.

In the area, the air temperature can be characterized by: average 14°C -15ºC, minimum 4°C - 6ºC (January) and maximum 40°C - 45ºC (July-August). Snowfall is very rare.

The mean annual humidity is 72 %. During the vegetation period it lies between 60 to 70 % . In the months July and August maximum humidity is sometimes less than 10 %.

The minimum air temperature below 0° C (being identical to frost occurrence) begins mainly in October and lasts until March. Days with maximum temperature not exceeding 0° C (icy) are rare (about one or two days annually). There are about 45-50 hot days annually with maximum air temperature exceeding 30° C. To determine the air temperature at any geographical point of the project area, the project foresees value of the vertical gradient 0.55° C/100 m ASL.

2.1.4. Hydrology

2.1.4.1. General

Based on the existing study "MHE Koćuša, Predstudija izvodljivosti" made by JP Elektroprivreda, including the data of the hydrological analysis, several comparative hydrological investigations have been made.

To optimize the energetic efficiency of the planned HPP Koćuša and as basis for hydraulic modelling, duration curves and design-flows are shown in this report. These data will be further used.

Figure 2.1: Overview of the project area including the used gauging points

2.1.5. Data

This hydrological study is based on the mean daily flow data's for the period 1968-1987. For this period continuous daily flow measurements of all gauging points in the project area are existing. The period of full 19 years brings some uncertainties in the whole hydrology especially in the extrapolation in case of hydraulic statistics.

The data's of the following reports could be used:

- Report "MHE Koćuša, Predstudija izvodljivosti "
- CD with hydrological data provided by Elektroprivreda

2.1.6. Evaluations

The following hydrological evaluations have been made:

- Duration curves for selected gauging points. The gauging points of this project area with basic data are presented in the following table.

water current	gauging point	catchment area [km]	Q min [m³/s]	Q max [m³/s]	time of operation
Mlade	Klobuk	no information	2.26	214.14	1965 – 2001
Mlade	Grabovo vrelo	828	0.99	217.73	1968 – 1987

Basic hydrological data of the project area

- Hydrographs for the selected gauging points Klobuk and Grabovo vrelo

- Determination of the annual maximum flood discharge for a 100-year flood

Before using the data for analysis, the data had to be checked for their accurateness and accordance. Figure 2.3 shows the gliding annual mean sequence for the data of gauging points Klobuk and Grabovo vrelo. Both curves fit together, no characteristic outlier was found.

The result of this data-check is, that the data are coherent and can be used for the following analysis.

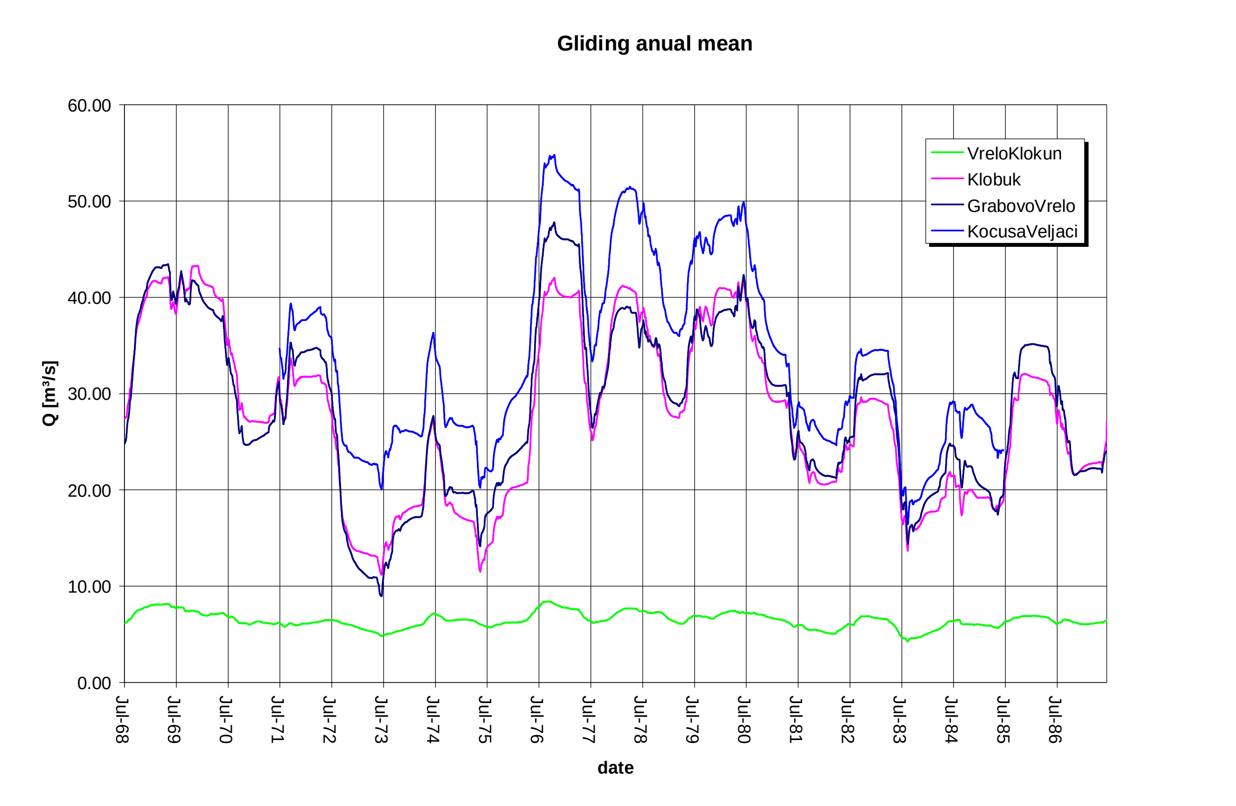


Figure 2.2: Gliding annual mean curves

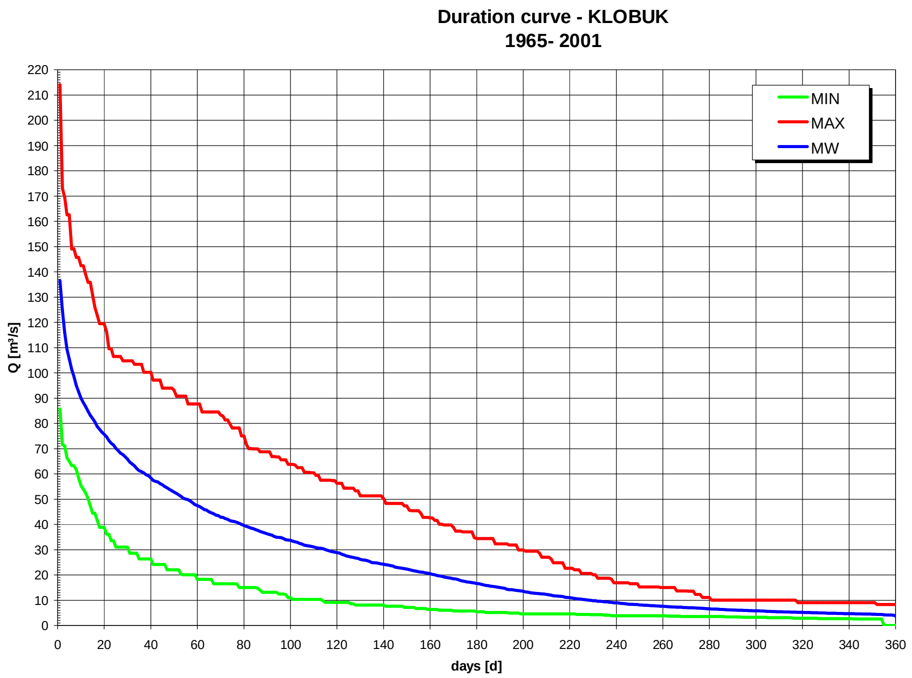
2.1.7. Duration curves

Duration curves have been constructed to be able to compare alternatives with different economic aspects.

Duration curves have been evaluated for the selected gauging points (see Figure 2.4 and 2.5) and are specified in detail in this study.

The gauging points are:

2.1.7.1. Klobuk



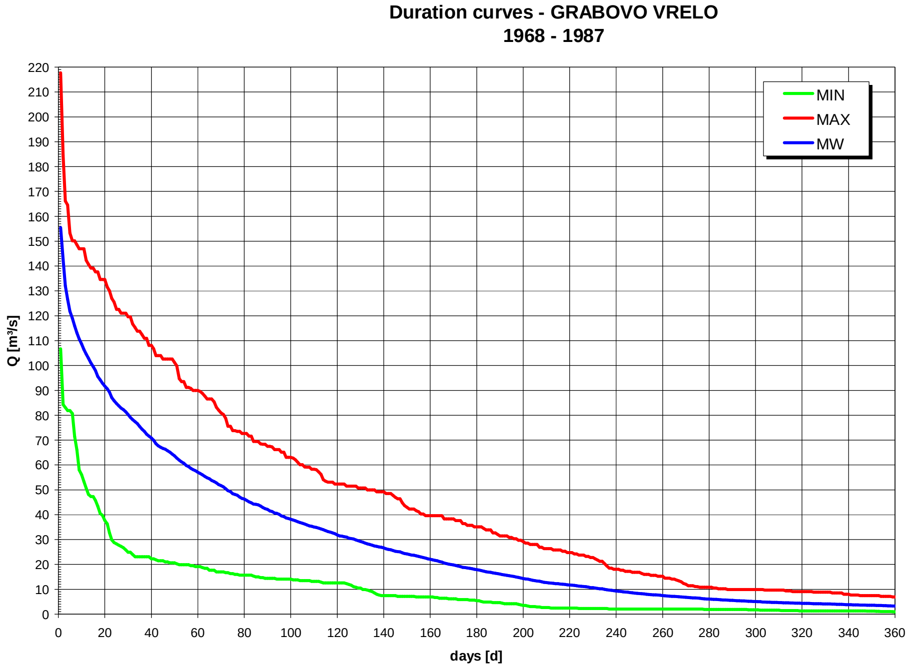
	MAX	MIN
1965	144.56	7.57
1966	162.55	3.61
1967	89.92	4.22
1968	214.14	6.42
1969	169.48	5.13
1970	174.81	3.88
1971	129.26	3.75
1972	178.42	4.28
1973	110.02	3.03
1974	154.05	4.45
1975	122.73	2.85
1976	169.48	3.88
1977	162.55	3.39
1978	138.98	5.83
1979	156.39	5.94
1980	147.89	3.75
1981	131.58	3.99
1982	147.89	5.94
1983	143.91	3.35
1984	171.24	4.61
1985	97.11	4.45
1986	143.91	3.03
1987	137.35	3.35
1988	93.97	4.20
1989	134.78	3.74
1990	116.20	3.23
1991	119.46	4.22
1995	131.91	3.20
1996	148.37	4.11
1997	98.79	2.67
1998	85.72	3.19
1999	120.14	3.89
2000	108.21	2.26
2001	88.57	3.35

Figure 2.3: Duration curves for gauging point Klobuk

Basic data:

- maximum flow reached in 1968 with 214.14 m³/s
- minimum flow reached in 2000 with 2.26 m³/s

2.1.7.2. Grabovo Vrelo



	MAX	MIN
1968	217.73	1.05
1969	169.27	3.34
1970	162.23	0.99
1971	135.11	4.37
1972	147.84	1.30
1973	106.72	1.17
1974	134.57	1.92
1975	130.01	1.92
1976	189.41	6.15
1977	156.49	3.48
1978	149.92	4.26
1979	147.95	3.59
1980	163.45	3.83
1981	134.40	4.10
1982	163.45	3.27
1983	146.00	3.38
1984	164.42	6.78
1985	121.81	2.52
1986	164.42	6.78
1987	121.81	2.52

Figure 2.4: Duration curves for gauging point Grabovo vrelo

Basic data:

- maximum flow reached in 1968 with 305.81 m³/s
- minimum flow reached in 1970 with 0.99 m³/s

The relationship between these data's is shown in the following figure by comparing the mean-curves of both gauging points.

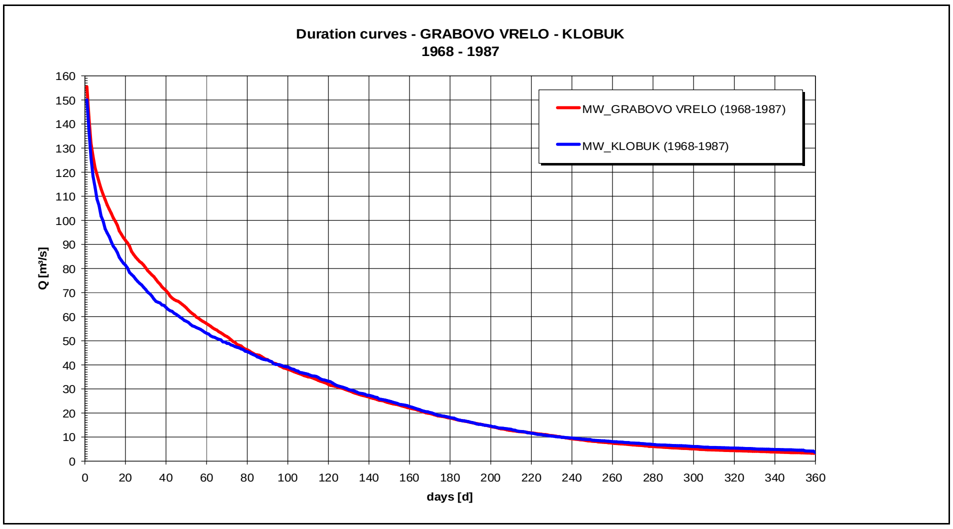


Figure 2.5: Relationship between the Duration curves of Klobuk and Grabovo vrelo

2.1.8. Stream flow hydrograph Grabovo Vrelo

Stream flow hydrographs show different flows over the considered period.

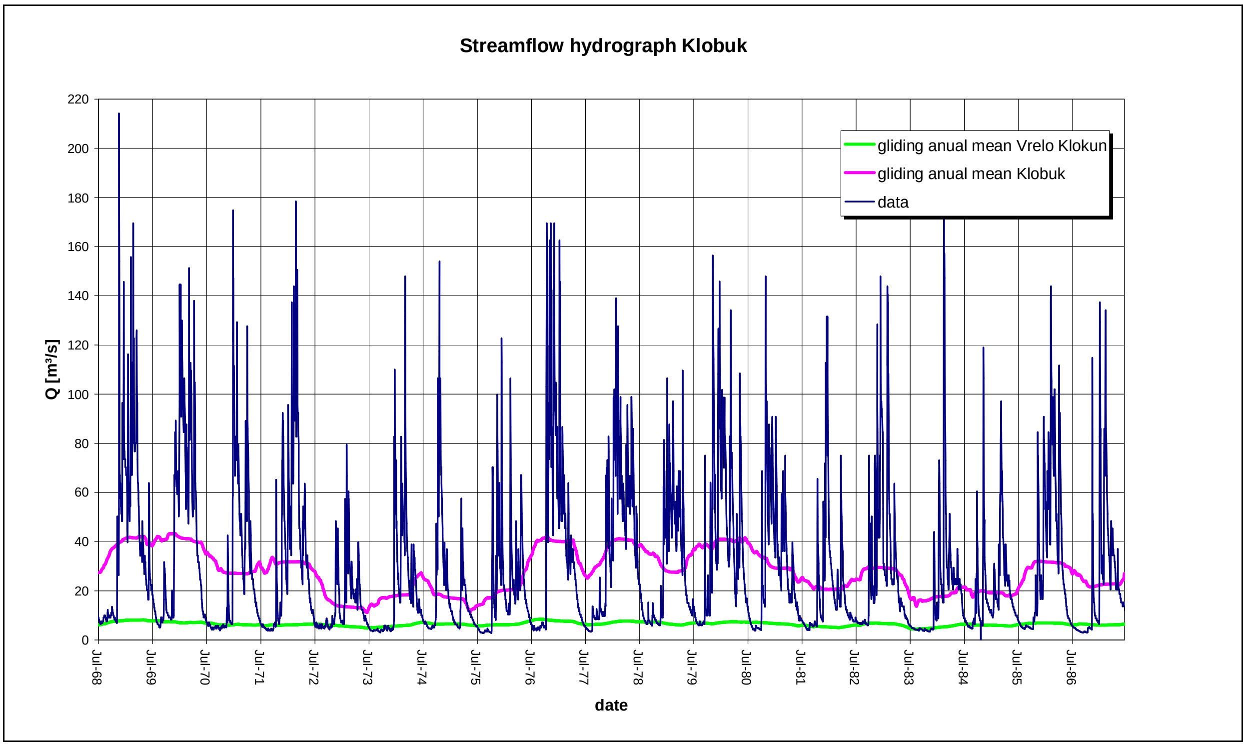


Figure 2.6: Stream flow hydrograph Klobuk

The base flow is about 5 m³/s. During the considered period several flood waters occurred at this river section - most of them occur in winter.

Therefore it is a complex winter-pluvial-regime with maxima in winter and minima in autumn.

2.1.9. Hydrologic statistics

Flood runoff results from short - duration highly intense rainfall, long – duration low intensity rainfall , snowmelt, ...

The best information on flood magnitudes that are likely to occur in future is obtained from observed flow records – what has occurred in the past. The nature of the flood – producing system is so complex that sole use of theoretical or modelling approaches can provide only generalized estimates of the flood regime of a stream or a region.

In most situations, available data are insufficient to precisely define the risk of large floods. To develop a good risk analysis it is in common use to apply practical knowledge of the processes involved completed with efficient and robust statistical techniques.

In hydrology the percentiles or quantities of a distribution are often used as design events.

The return period is often specified rather than the exceed probability. For example, the annual maximum flood flow exceeds with a 1 percent probability in any year, or chance of 1 in 100, is called the 100-year flood.

Fitting a distribution to data sets provides a compact and smoothed representation of the frequency distribution revealed by the available data, and leads to a systematic procedure for extrapolation to frequencies beyond the range of the data set.

Several families of distributions are commonly used in hydrology. These include the normal/lognormal family, the Gumbel/Weibull/Generalised extreme value family, and the exponential/Person/log-Pearson type 3 family.

For this project area, the annual maximum flood flow for a 10-year, 20-year and 100-year flood has to be estimated.

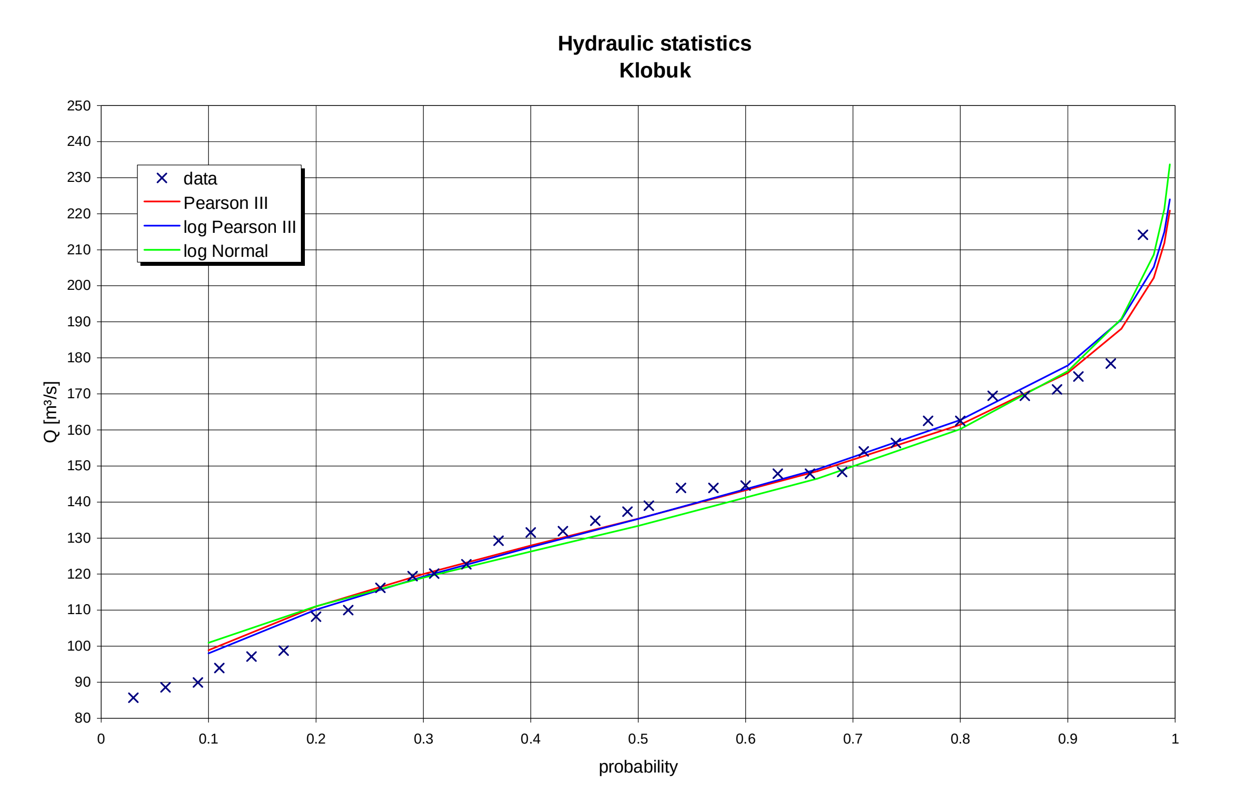


Figure 2.7: Distribution analysis Klobuk

The Pearson type 3 distribution and log Pearson type 3 distribution seem to be the best fittings to the data sets (see Figure 2.8)

Return period	
[year]	Pearson III
200	240
100	228
50	216
20	199
10	185
5	170

Table 1: Return period Grabovo Vrelo

2.1.9.1. Summary

The following hydrological conditions in the project area are typical ones for karst areas:

- very small number of permanent springs
- water currents are often water permeable
- seasonal patterns in discharge
- baseflow could be sometimes absent during the summer months
- sink holes

Approximately 600 m upstream the waterfall in Koćuša there is an outlet channel of a fish farm which should not be influenced by the reservoir. This is a reason that for the maximal reservoir level 96.00 m a.s.l. was selected.

On both river banks there are high flood embankments which protect small fields. These areas are not in intense agriculturally use. After building the power plant these areas will be properly protected against high floods.

2.1.10. Geology, hydro-geology and seismic hazard

2.1.10.1. Existing reports and investigation results

The geological conditions have been investigated in 2006 and the investigation results are summarized in a detailed and elaborated report : MHE KOCUSA IZVJESCE O REZULTATIMA GEOLOSKIH I GEOTEHNICKIH ISTRAZIVANJA by Geotehnika ´94 d.o.o. Mostar. The geological conditions are presented in geological maps and sections to which this report refers.

2.1.10.2. Investigations carried out

A geological investigation program has been carried out. In total

11 drill-holes (B1-B6, P1-P2, TC 1-2 and ST 1) and 2 test pits have been carried out and in addition refraction seismic and geo-electrical investigations have been carried out. The location of the investigations is shown in the drawing K2-3/22 of the above mentioned report and reproduced in Figure 1 and Figure 2.

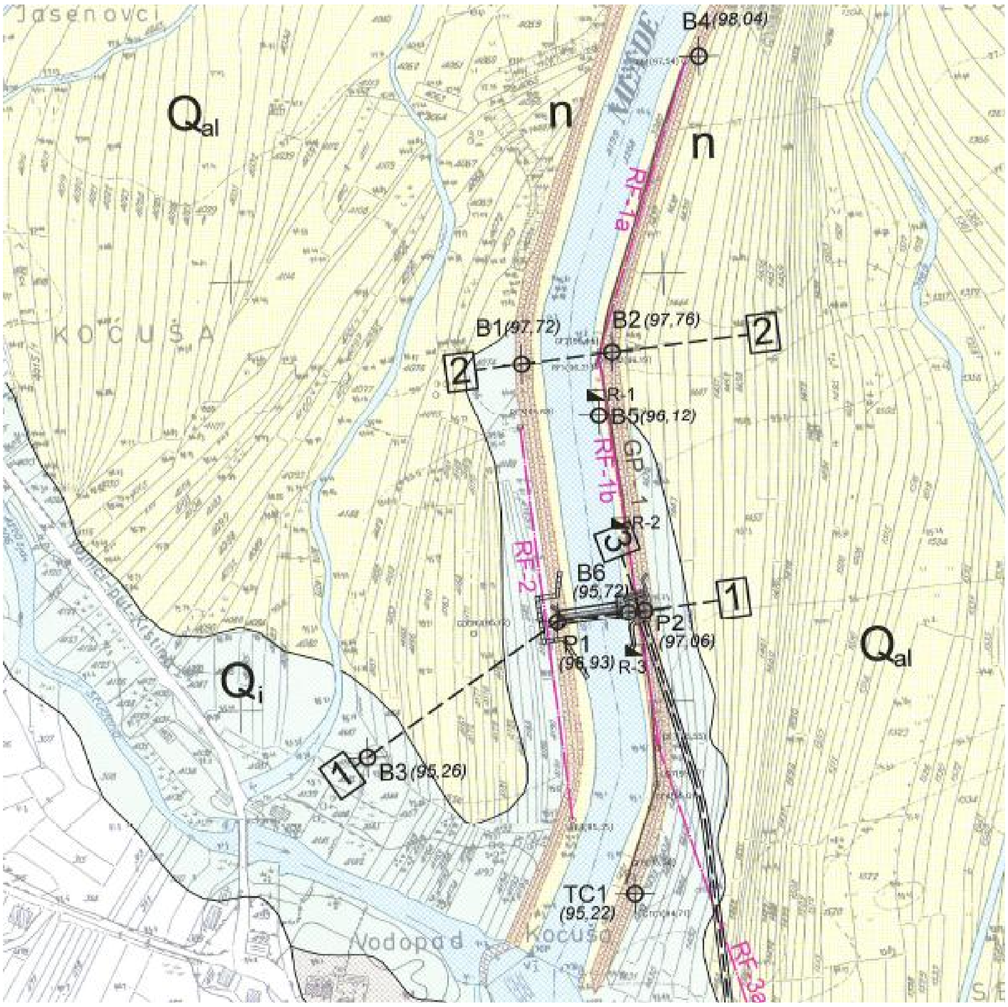


Figure 1: Engineering geological map of weir and surrounding areas including investigation measures, reproduced from K2-3/22

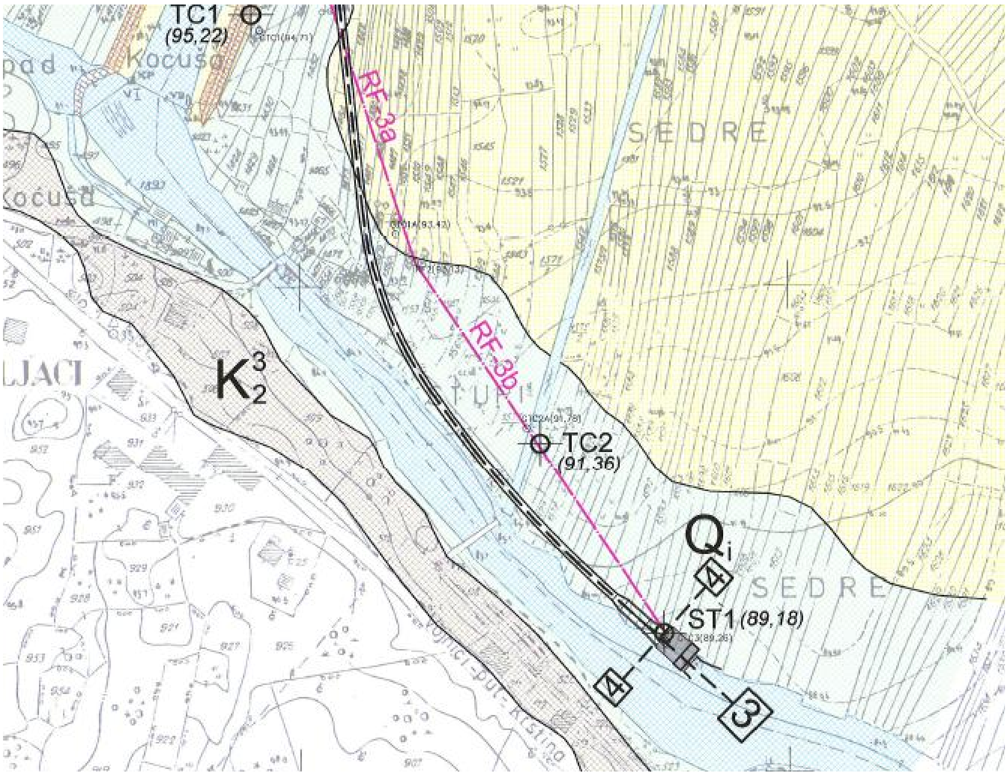


Figure 2: Engineering geological map of power house area including investigation measures, reproduced from K2-3/22.

In addition numerous laboratory tests have been carried out, which are described in the Bosnian report.

2.1.11. Geotechnical conditions

As the geological conditions are described in detail in the Bosnian geological report, the main outlines of the geological sequence at weir axis are described in this report.

At weir axis the conditions have been investigated by the two deep drill-holes P1 and P2, the geological profile of left bank, that corresponds to water intake structure is shown in Figure 3.

It can be seen that the embankment is built up of fill (material type 1) which consists of a mixture of clay sand and angular Travertin stones with a thickness of 2,3-2,8 m.

The fill layer is underlain by Travertin in undisturbed condition till depth 9,6 (left bank) or 7,5 at right bank. The material consist of Travertin pieces in sandy clayey matrix (material type 2a is the more weathered type and 2b the type with fresh Travertin pieces). During drilling no solid core could be obtained from that material, so that it can be assumed, that no solid continuous rock lenses or layers exist like a conglomerate. The SPT tests had test results between 4-23 indicative for loose to dense material.

The next deeper layer (material 3) consists of mixed material generally of sandy-clayey composition with plastic consistence. It is divided in the subtypes 3a-3i. The layers 3a,3d,3e,3g represent the less favourable layers from the engineering point of view because these layers have an significant organic content and the consistency is partly soft. The other layers are without organic content. The SPT test results (regardless of subtypes) are in between 4 and 13, indicative for loose to medium dense material (or in the plastic range).

The rock basement consists of karstified limestone and was encoutered in a depth between 20,3 and 21,0 m (measured from the existing dam crest).

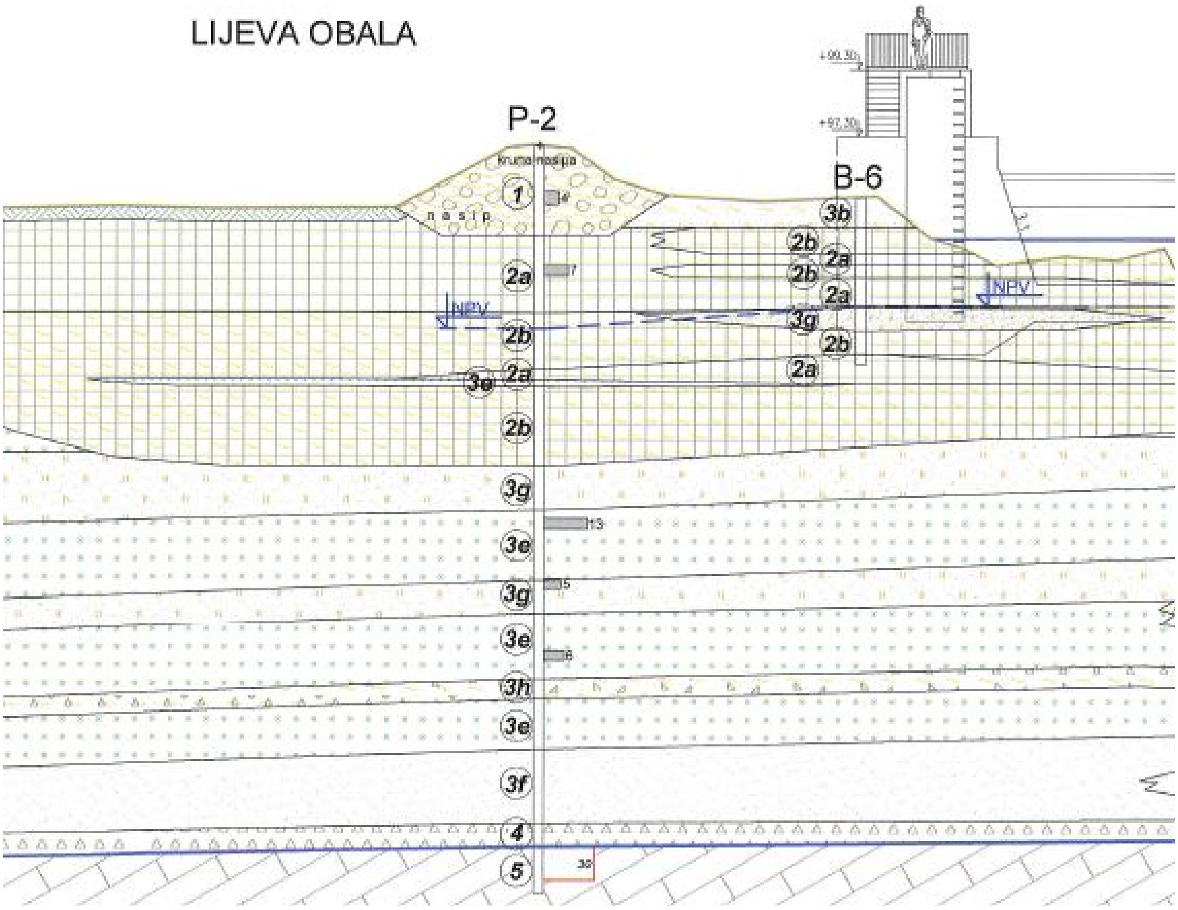


Figure 3: Geological section in weir axis (K2-16 /22), left bank. 1=Fill consisting of clay with Travertin pieces. 2 = Travertin mixed with silt, 3a,3d,3e,3g=sandy, clayey and organic layers, partly soft. 3b,3c,3f,3h,3i=sandy clayey material with plastic characteristics.

The water level was measured at a depth of 3-5 m below terrain with significant differences between nearby holes indicative for lense - like subsoil conditions. Anyhow the groundwater level is significantly below the water level of the river which indicates that the horizontal permeability is significantly higher than the vertical and that the subsoil is drained towards the downstream.

2.1.12. Geotechnical recommendations for the weir area

As described in the Bosnian report the following considerations have been done:

It is of importance to clarify the depth of foundation and the filter stability of the ground.

Regarding the foundation depth it can be concluded from the investigation that it makes no sense to increase foundation depth, because the soil conditions do not improve with depth. It is considered sufficient to place the foundation slab 1 m below the bottom of the riverbed.

In order to avoid erosion below the weir foundation it would be favourable to design a sealing curtain which is tightly connected to the concrete slab. The depth of the curtain below the weir was calculated to be 5 m for a single curtain and 2,5 m if two curtains are carried out.

In addition it is recommended to construct a stilling basin of concrete instead of a rip rap due to erosion problems, even when the stilling basin is small.

2.1.13. Geotechnical recommendations for embankments in reservoir area

The present embankments have been designed as flood protection but they have not been designed as permanent reservoir embankments. Their slope inclination is 1:1,5 and the crest width is 1,5m and no erosion protection exists except the grass cover. This is why the embankments have suffered minor damages in the past and the grass cover has been eroded locally.

Furthermore the dam is a homogenous dam without filter layer and no sufficient observations are available how the embankment behaves during floods, especially long lasting floods.

According to project the embankments have to be raised by 1m and two alternatives can be designed:

Alternative 1: Removal of existing embankment, proper foundation treatment and reconstruct the dam with the existing material and seal with sheet pile walls (or other sealing wall technology like thin wall). This alternative is favoured.

Alternative 2: No removal of existing dam just raising the elevation. After removal of soil cover additional material is added at the inner side of the existing dam and raising the dam crest. In this alternative the execution of an underground sealing will be necessary as well.

Regardless which alternative is selected, the embankments will need an erosion protection on the inner side which should be designed in a safe (not slippery) way.

2.1.14. Geotechnical recommendations for reservoir (river bed)

It has been observed that the top layers in the river bed have a low permeability. It is recommended to excavate the top layer with a thickness of 0,5-1,0 m and also to widen the profile and during that phase check the excavation surface for permeable layers and then to refill the material and compact it.

If the safety has to be increased a geo-membrane can be used especially in areas of higher flow velocity which has to be covered again.

In any case it is important to smoothen the existing depressions in the river bed and at the embankments.

2.1.15. Geotechnical recommendations for headrace channel

The geotechnical conditions are comparable to them in the weir and intake area. The drill-cores of drill-hole TC 2 show generally sandy material with occasionally layers with cohesive characteristics. The travertine (material type 2) is encountered to a greater depth than the head race tunnel excavation and the water level was encountered 10 m below the surface of terrain (during drilling)

It is assumed that the material can be excavated with hydraulic excavator with slope inclination 3:1 (or less for safety reasons), and no problems due to water inflow are expected.

In order to avoid a drainage effect after completion of the works the fill material should be compacted. The excavated material can be used as fill again.

In addition it is pointed out to connect the project components by a road (on left bank) and to connect to Ljubuski Grude main road.

2.1.16. Geotechnical recommendations for power house

The conditions at power house have been investigated by drillhole ST 1 as shown in Figure 4.

The top layer with a thickness of 1,7 m consists of organic sandy clayey material.

From 1,7-10,0 mainly travertine material of sandy silty composition will be met. In between 5,5 and 7,5 rather compact Travertin layers will be met because at that depth the drill-cores did not crumble but maintained their shape with a whitish colour (carbonate cementation). The following material parameter have been defined:

Friction angle:	30°
Density:	20kN/m²
cohesion:	0
water permeability:	low
modulus of compression:	10 Mpa

From 10,0-14,70 sandy-silty soil (material 3) was encountered with poor soil conditions especially at the upper contact. The SPT results were in between 5-8.

Below 14,70 karstified and fractured limestone was encountered. The drill-cores where broken and only very few pieces could be found with a size larger than 10cm, so that the RQD values have been generally zero (the figures in the red squares below show the exceptions).

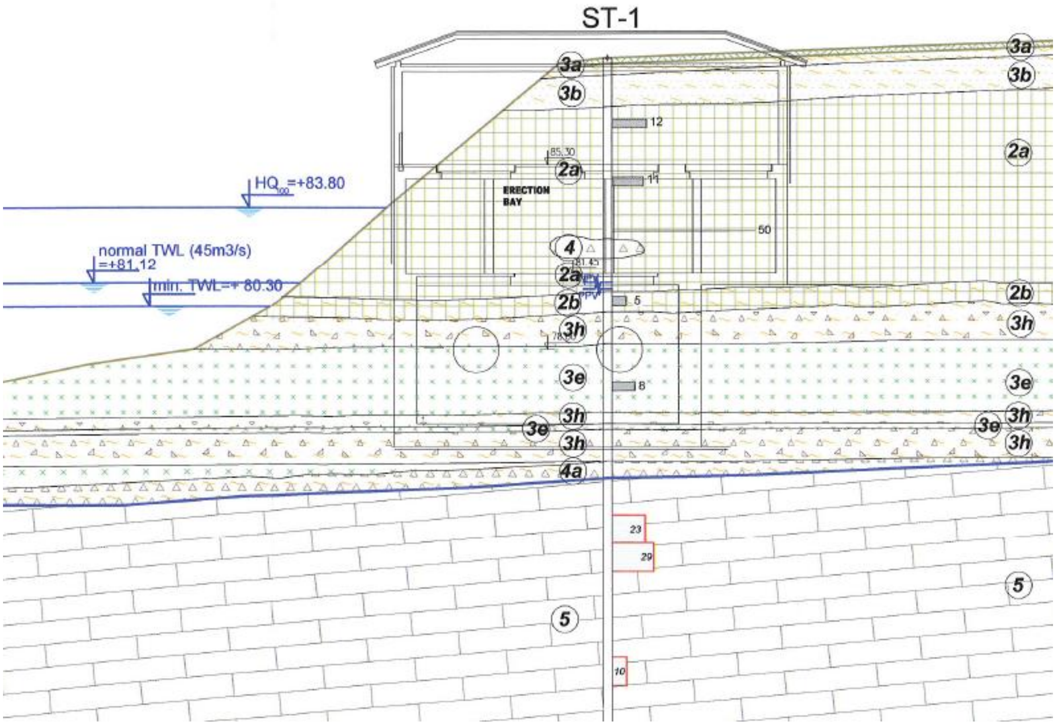


Figure 4: Geological conditions at power house, showing drill-hole ST 1 (dwg. K2-19/22)

Related to construction it is pointed out that the soil layers reach to approximately 6m below water level in the river. It is advised to increase the foundation depth in order to place the foundation slab on rock to avoid uneven settlements.

The distance of the power house to the river should be 5m and it should be protected by a fill.

The stability of the construction pit should be treated with great care due to its height of 15m

2.1.17. Recommendations for the next phase

Weir axis and reservoir: The present investigations have been carried out at the left and right embankment. It is advised to carry out at least 2 drill-holes in the middle of river bed.

Head race channel: Eventually one more drill-hole

Power house: The micro-location of the power house should be checked.

2.1.18. Seismic hazard

The site is located in a prominent seismo-tectonic area. Because of the tectonic processes related to the collision of the Adriatic Platform and the Dinarides, most of the seismicity is found in that part of the country. The seismicity of this part of the Mediterranean Belt has been the subject of research since the end of the last century. Maximum felt intensity maps were published as well as those related to elements of seismic hazard for various return periods. These maps proved to be insufficient for seismic hazard assessment. Because the wider area was shaken by some very large earthquakes in the history, that question was the aim for some international research projects (UNESCO, IDNDR, EC). The more recent ones address the assessment of seismic hazard with deterministic and probabilistic methods. As a basis for that studies earthquake catalogues and the macroseimic database had been updated and revised.

Generally the seismicity is shallow with all earthquakes located within the upper crust. The following summary of seismic hazard mainly follows *Markusic and Herak (1999)*[1], after whom the site is located in the center of the Ston-Metkovic Zone in the southeast and the Dinara Zone in the northwest.

The available catalogs list 7 events with epicentral intensities VIII° MCS or more in the *Ston-Metkovic zone*. The strongest earthquake was the one of 1479 near Metkovic with I=IX° MCS, important is the one from 1996 with a magnitude M_L=6.0. The fault plane solutions indicate predominantly a dip-slip reverse faulting on a NW-SE striking fault. As in adjacent areas the tectonic pressure axis is almost horizontal and oriented in the SW-NE direction.

The *Dinara Zone* is the most active part of the region. Four Events with intensity exceeding I=VIII° MCS are known. The earthquakes occur on faults belonging to reverse fault systems. The largest one was a IX° MCS quake near Sinj, the strongest recent one was that from 1942 near Imotski with M=6.2. Numerous moderate events with M<5.6 occurred in the second part of the century.

Seismic source zone	M_{100}	M_{1000}	M_{10000}	I_{1000}	$a_{max,100}$ (%g)	$a_{max,1000}$ (%g)	$a_{max, 10000}$ (%g)
Ston-Metkovic	5.6	6.5	7.1	VIII-IX	11	23	39
Dinara	6.1	6.9	7.2	IX-X	16	33	42

[1] Markusic, S. and Herak, M. (1999), *Seismic Zonation of Croatia*, Natural Hazards *18*, 269-285

The seismic activity parameters (maximum magnitude for given return periods, converted intensity) for the two zones are given calculated with the maximum likelihood method. The maximum expected horizontal acceleration was computed using a local attenuation relationship for cells of 0.2°x0.2°. The used attenuation relationship corresponds to average soil conditions, meaning that the computed accelerations are approximately twice as large as those on bed-rock level.

As the study has been made on a regional scale the local geological setting and site conditions have to be taken into account in a future study.

2.1.19. Water quality

2.1.19.1. Physical and chemical water characteristics

At present state the water of the Mlade/Trebizat river is used for fish-breeding without any restriction. This is a strong hint for a physical and chemical water characteristic according to at least class II. There are no large industrial pollutants in the watershed area.

However in the periods of lower water level during the summer period the water quality may be lower, due to present fecal pollution which is interlinked with fact that the underground flow most probably swallow the waste waters of the intake area. A second reason for river pollution may also be found in agricultural activities, urbanization and lack of wastewater treatment plants.

2.1.19.2. Biological water characteristics

As already mentioned the water of the Mlade/Trebizat river is used for fish-breeding without any restriction. This is a strong hint for a biological water characteristic according to at least class II.

2.1.20. Water pollution and water quality improvement

There will be some impact on water quality and aqueous ecology. The plant will not generate significant quantities of waste waters/effluents. Any effluent discharges will not exceed the discharge limits for industrial/power plant effluents specified by Bosnian or the World Bank guidelines (whichever are more stringent). The World Bank effluent quality requirements are presented below.

As the power plant will be operated in the run-of-the river mode, the water regime will not be changed due to storage activities. Therefore no influence on water treatment plants existing or planned downstream will occur.

The World Bank Effluent Discharge Limits

Parameter	Maximum value
PH	6-9
Total Suspended Solids (TSS)	50 mg/l
Oil and grease	10 mg/l
Total residual chlorine	0.2 mg/l
Chromium (total)	0.5 mg/l
Chromium (hexavalent)	0.1 mg/l
Copper	0.5 mg/l
Iron	3.5 mg/l
Zinc	2.0 mg/l
Temperature increase at the edge of the mixing zone	Less than or equal to 3°C

2.1.21. Vegetation

During wintertime the karst fields are sometimes flooded. On the other hand precipitation provides insufficient amounts of water during the vegetation period. For this reason the vegetation in the project area is prairie-like. There grow a few bushes along the water course of Mlade/Trebizat river. The lower fields can only be used for not - intensive agricultural production but are utilised as meadows and for pasture production.

Water regime determines the species composition of flora (including macrophytes) in the river stretch of the power plant. As the water regime will not considerably be changed by the operation of the proposed power plant in the run-of-the-river mode, the flora in and around the river bed will not be influenced. Some positive effects may result for the slightly higher water level in the storage basin area, as here even during dry periods water will be stored and available.

Figure 14: Panorama view Mlade Trebizat river in upstream direction

Trees can be found along the water course of Mlade Trebizat river, especially in the vicinity of the waterfall and in the horticultural area and in orchards of Koćuša village.

Figure 15: Typical flora at the riverside

2.2. Social characteristics

2.2.1. Demographic and sociological characteristics

Following data (July 2008 est.) are subject to some error because of the dislocations caused by military action and ethnic cleansing and refer to the total population of Bosnia and Herzegovina.

Population: 4,590,310
Age structure:
0-14 years: 14.7% (male 347,679; female 326,091)
15-64 years: 70.6% (male 1,634,053; female 1,606,341)
65 years and over: 14,7% (male 277,504; female 398,642)
Population growth rate: 0.666%
Net migration rate: 6.28 migrant(s)/1,000 population
Life expectancy at birth:
total population: 78.33 years
male: 74.74 years
female: 82.19 years
Total fertility rate: 1.24 children born/woman

The project area includes the population of the municipalities Bijaća, Cerno, Crveni Grm, Dole, Grab, Grabovnik, Gradska, Greda, Grljevići, Hardomilje, Hrašljani, Humac, Kašće, Klobuk, Lipno, Lisice, Miletina, Mostarska Vrata, Orahovlje, Otok, Pregrađe, Proboj, Prolog, Radišići, Stubica, Studenci, Šipovaća, Treskera, Vašarovići, Veljaci, Vojnići and Zvirići. The communities in the area are mainly rural and mostly inhabited by Croats.

Community	2007	1991 to 2007 [%]
Ljubuski Area	28,340	+25
Ljubuski TownDobrić	Appr. 5,000	

Table 1: Number of inhabitants in the settlements around Ljubuski in 2007

Most people of the region are working in the categories trade and industry. Although dislocations and ethnic cleansing caused a break in the long term demographic development, general tendencies are similar to those before 1992:

- The general population is searching employment outside of the agricultural sector
- Especially young/qualified people move to towns/abroad
- The intensity of agricultural use increases
- Tendency to smaller families

2.2.2. Natural and cultural monuments

As there are no natural or cultural monuments located directly in the project area, in the following some precious places of Bosnia and Herzegovina are mentioned:

The European Commission has published the list of environmental projects which will receive funding under the LIFE-Third countries programme. One of them are the Hutovo Blato wetlands, the famous settlement of the migratory birds, which are situated 20 km from the Neretva river mouth and seashore and approximately 20 km downstream from Mostarsko blato (43°18'N/17°45'E). The wetlands border the Krupa river. The area covers 7411 hectares and has the status of "Nature Park" since 1995. Hutovo Blato had been a shelter for more than 240 species of birds and the waters of the lake are very rich in eel, carp and other fresh water fish.

Type	Name	Location	since
National Park	Kozara	45°01'N/16°59'E	1967
National Park	Sutjeska	43°20'N/18°45'E	1965
Nature Reserve	Prasuma perucica	43°30'N/18°50'E	1954
Regional Nature Park	Jahorina		1954
Regional Nature Park	Trebeno		1954

Table 2: 1997 United Nations List of Protected Areas in Bosnia and Herzegovina

To mention a former cultural heritage in closer vicinity, the medieval fortress ("Kula Herceguša) on the mountain Buturovica near Ljubuški which is a nice landmark and actually under some restoration.

2.2.3. Fishing and hunting

The project area has practically one main permanent water current. As the river Mlade/Trebizat disappears in its course three times and reappears again after a short stretch, there is no continuous fish migration in these rivers. However the fish population is considerably large.

The proposed power plant will be equipped with a fish ladders at the weir and therefore will not influence the fish breeding and –population.

The following fish live in the river Mlade/Trebizat:
- Stream trout (salmo trutta m.fario L) – 70%
- Californian trout (salmo gairdneri Rich) – 30%

On the basis of research made by the Biological Institute PBF – Sarajevo on the river Lištica (which is comparable to Mlade/Trebizat), it can be concluded that it represents a very good habitat for fish, especially salmonid fish.

Hunting is of no importance in the project area.

2.2.4. Agriculture

Due to the physico-geographical properties of this area (bare karst of distinguished orography) the local microclimate varies from maritime to mountainous. The climate is mesothermal, humid with moderate arid summers.

Therefore in Mostar and its surroundings cereals, fruits and vegetables are cultivated and different Mediterranean plants exist. The surroundings of Mostar are rich in grape, cherries, peaches and figs. The whole southern Herzegovina is famous for its tobaccos and vines.

During the winter many of the karst fields are flooded. The project Koćuša will use the existing high-flood protection dams after their refurbishment. This is a further reason why these fields can later be used for intensive agricultural production with virtually no influence by the power plant, or even better thus an enhancement of the conditions for agricultural interests can be expected.

Furthermore precipitation is not sufficient during the vegetation period. Less than 10% of the total precipitation falls during the hot and dry summer. The river Mlade/Trebizat is the only important source of water within the whole area. Irrigation is only done in the immediate neighbourhood of the river. A rather old existing irrigation system with open channels (gravitational system) supplies some hectares of agricultural land along the river.

The expected effect of the power plant on agriculture is therefore of only minor importance, the improved high flood protection may be even in favour of agriculture.

2.2.5. Economical situation

Next to the Former Yugoslav Republic of Macedonia Bosnia and Herzegovina was ranked as the poorest republic in the old Yugoslav federation. Agriculture has been almost completely in private hands, farms have been small and not very efficient, and the republic traditionally has been a net importer of food. Industry has been greatly overstaffed. Bosnia hosted a large share of the former Yugoslavia's military industry. The bitter interethnic warfare in Bosnia caused the production to plummet by 80% from 1990 to 1995, unemployment to soar, and human misery to multiply. With an unstable peace in place, output recovered in 1996-98 at high percentage rates on a low base. But output growth slowed appreciably in 1999, and GDP remains far below the 1990 level. Economic data are of limited use because, although both entities issue figures, national-level statistics are not available. Moreover, official data do not capture the large share of activity that occurs on the “black market”. Implementation of privatisation, however, faltered in both areas. The country receives substantial amounts of reconstruction assistance and humanitarian aid from the international community but will have to prepare for an era of declining assistance.

GDP: purchasing power parity - $29.89 billion (2007 est.)
GDP - real growth rate: 5.5% (2007 est.)
GDP - per capita: purchasing power parity - $6,600 (2007 est.)
GDP - composition by sector:
agriculture: 10.2%
industry: 23.9%
services: 99% (2006 est.)
Electricity - production:
12.22 billion kWh (2005)
Electricity - consumption:
8.574 billion kWh (2005)
Electricity - exports:
3.58 billion kWh (2005)
Electricity - imports:
2.174 billion kWh (2005)
Agriculture - products: wheat, corn, fruits, vegetables; livestock

In the region of Mostar the following industrial production is taking place: metal industry, hydro-power plants, textile, foodstuff, tobacco, timber and wood industry, printing, construction, beverage production.

2.3. Infrastructure

2.3.1. Objects of infrastructure

Existing **flood control** systems are explained in BOOK 1 – Technical and Economical Basis for the Project; HPP Koćuša – Feasibility Study.

Drainage of internal waters from the agricultural areas along Mlade/Trebizat river is enabled naturally by existing water currents and sinkholes.

There is no planned additional **road network** of considerable size in the area of Mlade/Trebizat river.

The project area can be reached on proper **asphalt roads**. The distance to the Adriatic Sea is about 70 km. The airport of Sarajevo is at a distance of about 170 km, the airport of Split is at a distance of about 120 km. The **railroad** Ploče - Mostar (and Sarajevo) runs mostly close to the main road through the Neretva valley. The railway station of Bačevići is situated near the estuary of Jasenica and Neretva. From this point suitable roads enable the access to the site.

The existing **electrical network** with 400, 200, 110, 35 and 10 kV is based on big switch yards at Čula and Jasenica.

It is evident that the reconstruction of the infrastructure which is presently taking place in Bosnia and Herzegovina is of utmost importance for the residents.

2.3.2. Water supply

The main settlement within the catchment area is Ljubuški north-west of Čapljina. Ljubuški is a township with a water supply system for households, industry and public utilities.

Regarding water supply of the region Ljubuški there was a considerable improvement in 2007 and 2008 as the villages Otok, Veljaci, Vojnići, Šipovaća, Orahovlje, Grab, Lisice, Teskera and Hardomilje were included. Actually extension works for water supply will start in the eastern part of the area.

The development of the water supply network is characterised by different technical solutions like gravitation and combined pumping – gravitation systems, supplying a distribution network with pipes made of cast iron, asbestos-cement and recently plastics.

The water supply of settlements outside of the village centres happens via individual cisterns or small water supply systems. These provide water for several houses or small villages. Most frequently they suffice only for the need of single households. In the villages the quantities of water needed for production are usually not provided. Thus the water supply is neither satisfactory in respect to quality nor to the available quantity.

2.3.3. Sewage systems

Only the municipal centre of Ljubuški has a partially constructed sewage system. So far the existing state of pollution within the project area is rather local and not very intense or widespread.

In karstic terrain, however, sewage from higher areas often endangers the quality of spring waters in the lower parts. In the karst water will intensively circulate due to strong underground water currents and even minor contamination can put important drinking water resources at risk. The draughts during summertime further complicate the picture. In summer water to dilute the sewage is not available. It is thus evident that future sewage systems in the area of Ljubuški should be connected and lead to a wastewater treatment plant.

2.4. Project description

2.4.1. Project and structures

The Koćuša hydro-electric power plant is located south-west from Mostar and west of the town Ljubuski. It uses the discharge of the Mlade/Trebizat River in a run-of-the-river power plant in the area of Koćuša waterfall. A 534m long headrace with a short tunnel creates 14.80 m gross head. The powerhouse will therefore use a rated head of 13.60 m for energy generation. In the powerhouse two Kaplan-S units respectively in the alternative two Eco-Bulb turbines will be installed. The tailrace water will be discharged through a short tailrace channel to the Mlade/Trebizat river.

The basic data for the project are:

- Full reservoir level (FRL) 96.00 m a.s.l.
- Minimal reservoir level (MDDL) 94.00 m a.s.l.
- Maximal flood level at Intake (MFL) 97.14 m a.s.l.
- Minimal tail water level 80.26 m a.s.l.
- Operational tail water level 81.20 m a.s.l.
- Gross head 14.80 m
- rated head 13.60 m
- Number of turbines
  Kaplan -S-Turbines (6 blades) with horizontal shaft
  without gear 2
- Utilizable discharge 2*20 = 40 m^3/s
- Synchronous generator 2*3.2 MVA
- Max. Power output
  Two units 2*2.425 = 4.85 MW
- Energy production per year 18.4 GWh/a

The proposed project has been specified as follows:

- Construction of a weir and intake approximately 200 m upstream the waterfall in Koćuša
- Construction of a small reservoir with its max. operation level at 96.00 m and a min. operation level 94.00 m ASL. using the existing high flood embankments, which will be heightened by approximately 1 m
- The max. flood water level in the reservoir with 97.14 m above sea level (ASL) is given by the elevation of the outlet of the fish-farm upstream of Koćuša waterfall. New dams will not be necessary, the existing embankments will be refurbished.
- Intake structure on the left bank of the weir near the Koćuša waterfall.
- After a transition zone the buried headrace channel leads via a short inclined passage to the power house. The headrace has a rectangular profile, is approximately in total 534 m long and completely embedded.
- After a manifold two buried penstocks with quadratic profile lead to the power house
- The powerhouse is located near the river step on the left bank and contains two flat valves upstream, two Kaplan-S units with generator and stop-logs to the tailwater. Design discharge is 2*20 = 40 m^3/s which gives 2*2.425 = 4.85 MW power output.
- The Mlade/Trebizat riverbed will be deepened and regulated downstream the power house Koćuša in a length of approximately 40 m.
- The environmental conditions for the project define the minimal biologic flow with 3 m^3/s, which was increased by the client Elektroprivreda to 5 m^3/s. This discharge will be released at the weir.
- Around the weir a fish – ladder will enable undisturbed fish migration

2.4.2. Technical solution

2.4.2.1. Boundary conditions

The evaluation of the alternatives was performed on an economical (construction cost to energy production), operational and environmental criterion.

The study of alternatives lead to the selected alternative which was designed under following boundary conditions:

- The project area starts after the outlet channel from the fish farm upstream close to the river. The channel has a sill at 96.16 m a.s.l. To avoid any influence due to reservoir operation on the fish farm, the maximum operation water level in the reservoir is set at 96.00 m a.s.l..

- The run-of-river power plant is designed without a reservoir just by filling of the river bed between the existing flood water embankments.

- Considering the environmental conditions for the project at the waterfall minimal water discharge of 3 m^3/s must be guaranteed. The Client increased in the course of the project discussions this discharge to minimally 5 m^3/s. This is a lost water amount for energy production and needs additional equipment for turbine control.

- The weir is incorporated in the existing riverbed. Its position is selected taking into consideration the environmental influences, the geotechnical conditions and reducing its visibility from the waterfall. Two solutions are in general possible: a rubber dam and a flap gate. The solution with rubber dam is selected as better suitable in comparison with standard flap gate.

- The waterway in form of a cut - and - cover closed headrace channel crosses the field in an optimized way following the natural riverbed and then using the shortest way to the powerhouse. Additionally, by the selection of the waterway existing old and historic houses are taken into consideration. The headrace channel will pass trough private and public areas. Construction of the headrace channel will need some temporary expropriation of the agricultural field during the construction time. The Client should ensure the rights that the contractors and later for maintenance purposes of the power plant the area may entered with appropriate compensation in any time.

- The location of the powerhouse is selected 370 m downstream of the waterfall, approx. 100 m down the existing irrigation channel bridge crossing the river. This is a place where the river is loosing the longitudinal slope and any shifting downstream would just increase the construction costs with nearly no positive effect on energy production. Downstream the power plant no significant changes of the river bed shape are expected.

- The access road to the power plant begins at the bridge in Veljaci. The selected solution will need only a widening of the existing field road and will disturb the area with the traffic for the access to the power plant only. During the construction period the main traffic will be guided over a new macadam road from the bridge on the street from Vitina to Veljaci. It leads on the left river flank to the power house area. After the construction this road will be prepared for local traffic.

2.4.2.2. Project parts

The project consists of following main parts:

- reservoir
- weir (rubber dam) and intake structure
- closed headrace channel
- powerhouse

2.5. Civil works

2.5.1. Reservoir

The operation water level of the reservoir is set at 96.00 m ASL, because there shall be no influence on the outlet of the fish farm.. The sill of the outlet to the fish farm has an elevation of 96.16 m ASL. The purpose of the reservoir is to increase the water level and due to its geometry it will have no function to accumulate water. The existing dams have to be heightened for 1.0 to 2.0 m and tightened in the length of approximately 2*300 = 600 m to fulfil the requirements for the new reservoir water level. The exact scope of works for tightening will be decided after execution of the geotechnical investigations in this area. Based on observations during winter season the dams are impermeable for the short period of flood events, which lasts only few weeks. The dam reaction on permanent higher water level (e.g. stability and permeability) have to be studied in detail after having obtained the results of the exploration works. The tightening works in form of a surface sealing seems to be reasonable. The alternative of a thin cut-off wall (“thin wall”) which is constructed using special vibrating equipment as diaphragma has to be investigated in detail.

2.5.2. Weir and intake structure

The weir structure is situated 200 m upstream of the waterfall Koćuša. The layout of the weir is selected to achieve as less as possible disturbance on the Koćuša waterfall. An adjustable weir is designed. The weir is incorporated in the existing riverbed.

Two alternatives were studied and are opportunities in general terms:

- a rubber dam
- a flap gate

The solution with a rubber dam was selected by Elektroprivreda. Advantages of a rubber dam are:

- lower construction effort and therewith lower construction costs
- high economic viability for wide and low dams
- suitability for curved layout
- low maintenance costs (no corrosion, no lubricant)
- low operational costs and minimal auxiliary energy necessary

The movable rubber dam will be used for regulation of the residual water. The biological minimum of 5 m^3/s discharge should be supplied over the rubber dam to the waterfall.

2.5.3. Closed headrace channel

The intake structure will be equipped with stop logs, trash rack, bifurcation to a flushing gate. At the end of the inlet structure a vertical sluice gate in a wet shaft is foreseen. This sluice gate will be used as an operation and revision gate. After the sluice gate a squared reinforced concrete pressure channel with a cross section of 3.80 x 3.80 m is foreseen. The length of the pressure channel is approx. 500 m and the inclination is 1.35 %. The channel bifurcates in two squared channels with a cross section of 2.80 x 2.80 m with 25% inclination and a length of approx. 35 m.

During the study of the alternatives phase different types of penstock have been investigated:

- two thin steel pipes in concrete
- two chamber reinforced concrete pipe
- GFK pipes

As most economical solution a one - chamber reinforced concrete section with 3.8 m side was found. The cross-section is optimized for head loss and velocity for full discharge of 40 m³/s, which gives much less head losses in case of lower discharge. The channel is made of reinforced concrete with wall thickness of 40 cm. Thickness is set as a minimal hydro-technical thickness of waterways.

2.5.4. Powerhouse and tailrace channel

The powerhouse is situated on the left river bank 270 m downstream of the bridge in Veljaci. That place seems the most suitable for approach with minimal headrace waterway length and access. The 100 years flood with one meter freeboard is considered in the powerhouse concept. Architectural concept was adjusted to the local architecture demands.

The powerhouse is designed for 2 horizontal Kaplan-S-turbines directly connected to the generator with a discharge of 2*20 m³/s = 40 m³/s. Each of the two Kaplan-S-turbines has a rated capacity of 2.425 MW. The powerhouse contains all necessary parts for automatic controlled operation and all necessary electrical equipment (auxiliary transformers, low voltage supply switchgears, mobile workshops and erection areas) will be situated in the structure. The main transformer and high voltage switchyard will be situated upstream of the power house. Such building concept increases the construction costs, but decreases the environmental impacts of the power plant (less occupied land, better noise control,…). In an alternative design stage the power house is equipped with 2 bulb turbines (Kaplan type), each with bevel gear and a discharge of 2*20 m³/s = 40 m³/s. The rated capacity was estimated at 2.50 MW each. Switchgears and other electrical equipment were situated in machine floor level and in the basement level. Close to the entrance a control room was located. The main transformer 6KV/10(20)kV was situated on platform on downstream side of powerhouse. This solution had a reduced building volume but the advantages of the smaller building were demolished by higher costs for the turbines and the equipment. The bulb turbines are more expensive. The optimised solution is equipped with the Kaplan-S-turbines. The smaller construction costs and other advantages as same diameter of turbines for HPP Klokun and HPP Koćuša, no bevel gear and therefore less maintenance costs and so on lead to the clear decision for the favourable Kaplan-S-turbines.

Access road to the powerhouse area is designed from the street from Vitina to Veljaci before the bridge over the river. It follows along the left river flank up to the power house area. This is the main access during the construction period. The road from the bridge in Veljaci to the power house and to the weir structure will be reconstructed and upgraded after the construction time.

The powerhouse is designed to be built in an open pit with inclined excavation surfaces. On the right side of the powerhouse a diaphragm wall will be erected for the building period. Later this wall will be the left boundary for the river and the protection for the river bank.

2.5.5. River dredging

To achieve the maximum energy production the riverbed downstream of the powerhouse is planned to be dredged downwards for a length of approximately 40 m.

2.5.6. Access Roads and Bridges

For construction and operation of power plant a short new access road is planned from the existing bridge to the power house respectively in the other direction to the weir.

- Approximately 600 m repaired simple stabilised road, beginning at the existing bridge to the power house and in the other direction to the weir.

2.6. Power plant operation regime

The water recourses in the Mlade/Trebizat river with wet and dry season prescribe the operation regime. The installed capacity of the power plant 2*20 m^3/s defines the following scenarios during the year dependent on the discharge amount on the intake. The mean discharge curve for the proposed solution is shown in Figure 16.

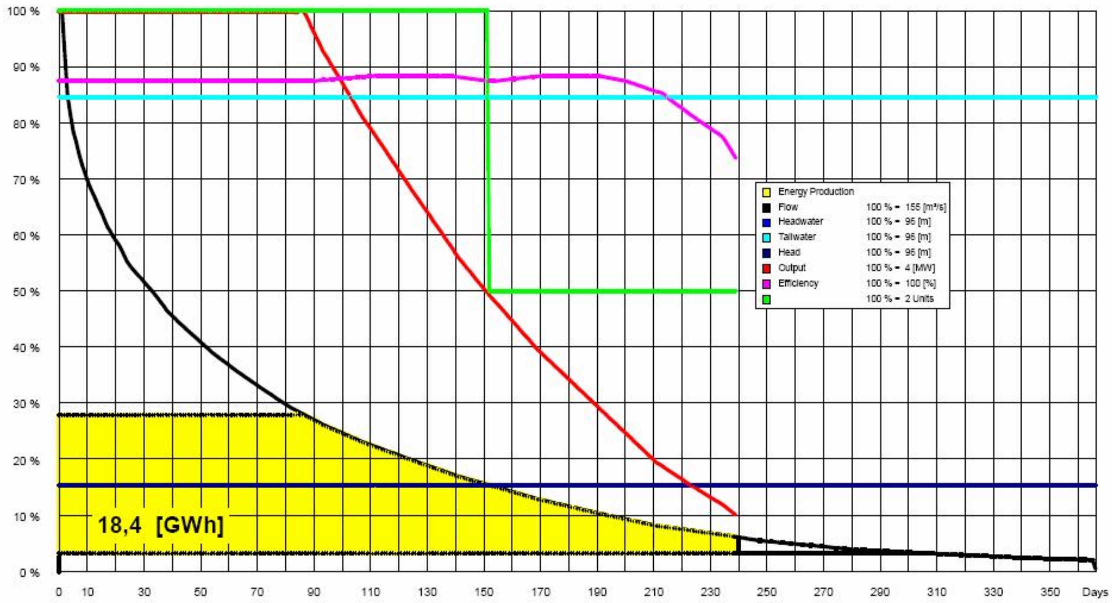


Fig. 16: Mean discharge curve and energy production for MHPP Koćuša

The energy production can be can be categorised in the following groups according to discharge on intake:

Daily Discharge, Q [m^3/s]	Power plant operation
Q > 45.0	Full capacity (2*20 m^3/s) 24 hours/day, 5 m^3/s release at the weir
25.0 < Q < 45.0	Power plant works with both units, 5 m^3/s release at the weir
9.0 < Q < 25.0	Power plant works with one to two units, 5 m^3/s release at the weir
5.0 < Q < 9.0	No unit is working, 9 m^3/s to 5 m^3/s release at the weir
0.0< Q < 5.0	All runoff is released at the weir

The storage opportunities are restricted and the main task for the storage is to enable the operator of the power plant to create a reasonable head for power plant operation. A Kaplan-S Turbine or a Eco-Bulb turbine have only high efficiency rates at working points which are near by the design parameters. From that fact, the operator have to distribute the discharge of the power plant to the units in a way, which promise a good overall efficiency. However the chosen types of turbines have also good efficiency rates at partial load, therefore they may be operated down to 20 % of their nominal capacity.

During the calculations for the optimisation, different water levels in the tail water were observed.

In the wet season in period with discharge higher then 45 m^3/s and with full reservoir surplus water will overflow the weir. With the power plant the discharge from 9 m^3/s up to 40 m^3/s (calculated yearly stream of Mlade/Trebizat) will be used for power generation. As the minimum usable discharge for one turbine is 4 m^3/s, discharges lower than 9 m^3/s (4 m^3/s turbine minimum plus 5 m^3/s biological minimum at the weir) have to be released at the weir.

The results of the operation concept can be summarized as follows:

- The power plant with 2*20m^3/s and 5 m^3/s biological minimum release at the weir will generally have no impact on the flood control in the field.
- Generally the flood volume and flood duration will not be influenced.

2.7. Cost estimation

2.7.1. Construction cost estimation

The standard prices are derived from existing power plants and projects built and constructed in the last years on Middle-European price level. The prices are based on price level at February 2008. In the cost estimation the costs include all direct and indirect costs.

Cost estimation for construction costs are included in the Feasibility Study. The direct construction costs are estimated with € 9.960 Mio.

2.7.2. Project Cost Estimation

The project costs consists of:

- Direct construction costs
- Contigencies
- Other costs
- Owner`s costs

Contingencies are assumed as % of direct construction costs s.a.:

- Civil Works with 10 % of civil works costs
- Mech. + HSS Equipment with 5 % of M & HSS costs
- Electrical Equipment with 5 % of EM costs

Other costs are defined as % of direct construction costs s.a.:

- Land acquisition,.... with 1 %
- Environmental prot. m. with 5 %
- Engineering with 10 %
- Material tests with 1 %

Owner`s costs (administration, commissioning, taxes, ...) are estimated with 10 % of total construction costs and other costs.

Detailed estimation schedule is presented in Feasibility Study.

2.8. Construction Plan

2.8.1. Construction Schedule

The time schedule governing the construction of the HPP Koćuša project can be seen from the schedule enclosed in Appendix of Feasibility study and is commented as follows:

Previous to starting date of construction the design and planning activities needs 8 to 10 months time. This first phase starts with signing of contract for elaboration of Final Design, preliminary investigations and pre-construction works. After design review and the first results of the additional preliminary investigations Detail Design preparation will need 16 months. 2 months before signing of construction contracts the Basic Design will be approved by the Owner. Within this first year all necessary approvals by local authorities shall be obtained.

Parallel to the design activities pre-construction works will start. These works comprises additional investigations, if necessary gauging stations in rivers and springs, building of access road, and preparation of infrastructures to the construction sites.

After signing of construction contracts in month 0 mobilisation and site installation activities starts and will last 3 months. Beginning with months 0 Detail Design will be carried out. Detail Design have to be finished and approved before start of construction of every structural part of the power plant. Together with as-built documentation design activities will last till end of construction and erection.
The main construction works starts with excavation of headrace and power house immediately after site installation. Depending on the season also the first earthworks in the area of the headrace will start and should be performed in 5 months. Concrete works for structures in the field will be executed in sequence of excavation.
The whole power plant system above power house – channels, reservoir, intake, headrace tunnel and penstock - have to be finished till end of month 18 to provide filling.
To allow a solid consolidation of relevant structures s.a. embankments and reservoir impounding in 1 months period is planned.
Works for tailrace river dredging, regulation of Mlade/Trebizat river and river banks shaping should be built in dry season.

The main building structure of powerhouse will be finished in month 13. In month 10 the power house E&M works starts. Mechanical and electrical equipment installation in power house will go in parallel and needs 7 months time. After 5 months installation the first main unit will be tested. With one and a half month distance the second unit will follow.

Upon start up tests the two main units will be put into normal operation in the middle of 2nd year of construction and the electrical energy produced will be fed into the EP grid via the 20 kV high tension transmission line.

Commissioning and taking over of power plant take part in the first two months of the following construction year.

2.8.2. Site Infrastructure, Access Roads for Construction Works

For construction of HPP Koćuša following general sites are proposed:

2.8.2.1. General

The project schedule included in this report is based on the experience of Pöyry Energy GmbH with a lot of comparable projects Austria and other countries.

2.8.2.2. Diversion Works

The diversion works are depending on the embankment heightening and on the dry season for carrying out the civil works for the weir and intake structure.

2.8.2.3. Powerhouse Cofferdam

The powerhouse is situated on the left bank of the Mlade River. This structure will require protection until the concrete structure is completed.

During the construction period a cofferdam with a thin cut-off wall will protect the powerhouse construction. The powerhouse will be built beside the existing riverbed. The floods can pass without an additional diversion. Only the separating wall between powerhouse and river, which will be built as a diaphragm wall up to elevation 86.42 m a.s.l., reduces the cross section of the river while construction time of the diaphragm wall. The diaphragm (cut-off) wall will be excavated down from elevation 86.42 m a.s.l. with heavy equipment. For moving the cut-off-wall-equipment the river flank must be slightly adjusted which has a small contraction of the river as result.

On the upstream and downstream side of the powerhouse a cofferdam with thin cut-off-wall will protect the powerhouse site against flooding. The crest of the coffer dam has a height of 83.50 m a.s.l. (flood event with 5 years annuality).

The upstream and downstream portion of the cofferdam will be constructed from natural fill materials. The structure will consist of a random fill body with a thin cut-off wall in the dam axis which penetrates 0.5m into the rock surface. The riverside will be protected by a layer of heavy riprap.

The final alignment will be determined by the contractor during construction. The contractor will determine how much protected space is required next to the powerhouse for construction work areas.

2.8.2.4. Weir and Intake Structure Cofferdam

Before the works for the cofferdams can start the embankments on the left and right side of the river Mlade must be heightened and tightened. A cofferdam for the job site of the weir and intake structure will be needed upstream and downstream of the pit. The river will be divided with a thin cut-off wall in two parts. First the structures of intake and the left part of the weir will be built under protection of the coffer dams. The flow passes between the cofferdams and the sheet pile wall on the left river part and the right river flank. The upstream and downstream portion of the cofferdam will be constructed from natural fill materials. The structure will consist of a random fill body with a thin cut-off wall in the dam axis which penetrates 0.5m into the rock surface. The riverside will be protected by a layer of heavy riprap.

After construction of the left part of the weir and the intake the cofferdams will be destructed and rebuilt at the right part of the river for protection of the works for right part of the weir and the fish ladder. The sheet pile wall in the centre of the river will be used again. The construction of the cofferdams is the same as described earlier.

The crest level for the cofferdams is set at 95.70 m a.s.l. (flood event with 5 years annuality).

2.8.2.5. Weir and Intake Structure

After excavation the base slab of the intake and the left part of the weir slab will be poured. The side wall of the intake and the separating pier between the intake and the weir follow later. After these works the bridge in front of the trash rack and the cover slab of the intake will be concreted. At same time the flushing channel to the river will be constructed. The installation of the E+M-equipment can be carried out under protection of the coffer dams

After building the left part of the weir and the intake the water will be diverted through the flushing channel with set stop logs upstream of the headrace channel and over the left part of the weir. The cofferdams will protect the job site for constructing the right part of the weir and the fish ladder at the right river flank. The sheet pile wall will be connected to the cofferdams.

After finishing all civil works the rubber dam can be installed in a dry period when the stop logs upstream of the rubber dam are set and the water will be diverted through the flushing gate and the finished headrace channel. Installation of the rubber dam needs one week.

2.8.2.6. Fish Ladder

At the right side of the weir the fish ladder is placed. It will be constructed in the same time as the right part of the weir. The water and floods pass during this construction phase through the left part of the weir.

2.8.2.7. Powerhouse

The excavation starts after erection of the coffer dams and the diaphragm wall. The foundation slab will be poured first, followed by the side walls on the left and right side. Then the embedded steel parts will be set in right place. The turbine with draft tube will be delivered and set in right place. The second stage concrete will poured afterwards to fix the steel elements. Now the upstream and downstream walls can be erected. The control building, the shaft for the upstream stop logs and the top slab will be constructed. The left side wall in the tailrace and the tailrace slab will be erected as last parts of the powerhouse. The finishing works in- and outside of the power house complete the works for the power house.

2.8.2.8. Headrace Channel

The works for the headrace channel start with the construction of the closed headrace channel start from the intake structure and ends with the bifurcation section upstream of the power house.

The sequence for erection is as follows: after the excavation the reinforcement for the foundation slab with the connecting parts to the walls will be prepared and the concrete will be poured in place. Then the reinforced walls will be erected and the last part is the top slab. After concreting works the backfill will be placed and the overlay too.

3. IMPACT ON HUMANS

3.1. Economic impact

3.1.1. Agriculture

There is envisaged virtually no effect of the SHPP Koćuša project for agriculture. No agricultural areas will be used for the tiny storage area.

The yearly flood cannot be caught in the reservoir and has to be released across the weir. It should be mentioned that it may still come to an occasional flood due to the limited size of the reservoir. Temporary occupation of relatively small agricultural areas during construction is inevitable but should not cause any permanent problems.

The existing irrigation facilities will be maintained, the operation of the power plant in the run-of-the-river mode will in no way influence water deduction for irrigation. Koćuša weir is due to its design as a rubber dam easily adjustable for all overflow discharges, therefore even an occasional demand of pumping out of the river stretch (e.g. for fire fighting purpose) can be served easily.

3.1.2. Industry

Construction of HPP Koćuša will create a number of temporary jobs and contracts. Service of the power plant will offer few long term workplaces.

In the first place due to an increase of electrical energy production industry gains means for production. Unfortunately a continuous energy supply cannot be guaranteed.

Energy production of the power plant may not be high enough for development of infrastructural objects and urbanisation of settlements in the plant's area.

3.2. Sociological and psychological impact

The benefits of the power plant (i.e. an increase in employment and a more reliable power supply for households and industry) will result in a sociological and psychological impact. This impact is difficult to quantify but should not be underestimated especially in the context of the exiting memories of the destructive war.

3.2.1. Demographic and sociological characteristics

Fortunately the reservoir is situated in the river area where no settlements are established. Therefore no resettlement has to take place. The power house will be placed in settlement area on an empty site. Constructing the power plant will lead to a positive input by real facts as well as by psychological processes.

To construct the different parts of the power plant it is necessary to claim land. Generally there are no buildings on this land today. Therefore no resettlements are requested. The land owners can be paid off by a one time payment or their land could be leased. The construction of the power plant will in any case result in an increased value of their properties. Possible impairments for the residents (noise) of the neighbouring houses of the power house have to be respected as well.

An increase in the electrical energy production correlates and supports with two demographic tendencies. In connection with an increase in the percentage of old people the population searching employment outside of the agricultural sector will get less motivation to do so on the other hand the growth in intensity of agricultural production will be supported.

3.2.2. Natural and cultural values

The landscape at Mlade/Trebizat area is rather scenic. Due to its remoteness and the adverse natural conditions (flooding during winter, not enough water in the summer) it has a special attraction. There are no large structures of cultural heritage and no areas of natural monuments in the impacted area, however.

The area occupied by the reservoir is rather small in proportion to the whole area. The construction and operation of the power plant will certainly be an intervention in the present state, but taking the moderate construction of dams and the small size of the reservoir into account the natural value of Koćuša will hardly be harmed.

The construction of the power tunnel system, powerhouse or tailrace river dredging is not connected with any losses of ecological or cultural values.

When referring to changes in the landscape the water surface of the reservoir can also be seen as a new quality. Nevertheless a natural aspect of Koćuša waterfall will be changed, as there will be discharged most time of the year only the biological minimum. When describing environmental aestethics of the area it is not true to speak of untouched nature, therefore the loss of scenic values has to be seen in connection with the economical profit.

Because of the relatively low dam height there is no negative visual impairment. The materials used for the erection of the dams are natural building-materials in the first place.

The water surface of the reservoir allows a changed view of Mlade/Trebizat river, whereas the power house is situated in a settled area.

3.2.3. Protection and valorisation of areas of special interest

3.2.3.1 Cultural heritage

There are no large – sized objects of cultural heritage in the project area, which have to be taken into account for planning and construction. However in the area of the power plant just downstream of the weir there is a house of historic interest. This house will not be influenced by the power plant, but it has to be protected during construction works. This will mainly be done by a protection fence and by careful execution of construction works avoiding any heavy vibrations.

3.2.3.2 Mineral resources

In the reservoir area are no values like mineral resources which become inaccessible after inundation of the reservoir, nor are other inundation losses or adverse effects known.

3.2.3.3 Caves

The project area does not contain any accessible caves.

3.2.3.4 Instream ecological values and natural monuments

According to Environmental protection law of B&H, the waterfall of Koćuša belongs to the protected areas. This fact was accordingly considered in the location of the weir which is situated 200 m upstream of the waterfall. This measure minimises the visual impact on the waterfall. Furthermore the selected type of weir enables an easy release of water along the whole length of the rubber gate which will make the weir nearly invisible from downstream even at low discharges.

Therefore the construction of the power plant does not result in any loss of irreplaceable natural resources.

As the travertine barriers need special protection there will be the necessary measures considered in the mode of operation of the power plant

3.2.3.5 Other river values

The main other instream values of the river as recreation (swimming, angling) and the landscape values will not be reduced, but even improved by the greater river water depth in the storage. The impact on the landscape can also be neglected, as the river will remain in the space between the already existing dykes.

3.2.3.6 Conclusion

As explained above the construction of the power plant does not result in any loss of irreplaceable natural resources, but of course protection measures will be necessary.

3.2.4. Environmental planning

In connection with planning and construction of the power plant existing water uses should be structured. Water uses (like irrigation and water supply) should be converted to water rights. Water rights allocation will need careful consideration to avoid water right conflicts. Only via careful management of the water rights the danger of serious social conflicts can be avoided.

The reservoir and the accompanying dams could result in a handicap of the wildlife movement. This could be compensated by the construction of so called „green bridges“ (see 7 Impact on plants and animals).

The power plant and the penstock, which is planned as a sub-surface structure, could be integrated into the environment by subsequently planting trees on the land used.

3.3. Impact on living conditions

During construction the safety of the workers as well as the sanitation at the worker’s camp has to be guaranteed. Hazards to workers health will not exceed the usual conditions and any dangers for residents living in nearby communities are not expected.

Recreational planning for an optimal multipurpose use of the reservoir resulting in an improvement in the quality of life for everybody living in the neighbourhood communities, is limited at present. This could be done in a future project. The potential values and attractiveness of the reservoir water surface for recreation are, however, restricted, due to the small size of the accumulated water surface which might be further reduced during the summer period.

Possible leisure activities as a result of this project are connected with the water accumulated in the reservoir. Leisure activities can only be realised if the reservoir is easily accessible. A further important condition is that the water quality must be preserved. Construction of access roads and leisure facilities would mean a greater depreciation of natural values of the landscape than the dam and the reservoir, which are build using natural materials.

The water supply of settlements along the borders of the project area is not influenced by the project, because the inundation will happen only within the river bed and has almost no influence on the groundwater level in the settled areas, because all settlements were built above the flood water level.

Like in most European rural regions there is a trend to a population decrease in the project area. It may be possible to relieve this trend when the reservoir is build. This is not in the first place due to the working places created by the building and maintenance activities related to the reservoir. Rather an improved structure of the primary, secondary and tertiary sector is to be expected. This complies with western standards and is considered as the demographically more valuable trend.

4. IMPACT ON SOIL AND MORPHOLOGY OF WATERCOURSES

Limestone rock and karst zones cover large areas in European countries. They contain immeasurable resources and riches, such as important underground fresh water reservoirs, grandiose landscapes, typical biodiversity, ornamental caves, archaeological heritage.

Karst protection generally means:

- ♦ Water protection
- ♦ Morphology protection
- ♦ Protection and valorisation of areas of special interest
- ♦ Results of speleological investigations

In connection with the project of HPP Koćuša following assessments have to be made:

- Monitoring of water quality and quantity (see 5. Impact on water)
- Monitoring of erosion and sink-holes

4.1. Impact on the area upstream of the intake structure

Soil properties and the morphology of watercourses will not be changed in the reservoir area and in parts of the Mlade/Trebizat river. The riverbed will be deepened and regulated from downstream of the powerhouse on a length of 40 m. The layout of the watercourse will only be changed in its final part. Dams along Mlade/Trebizat river will be refurbished and increase the safety margin against flooding. These measures can be judged as moderate, especially when considering the benefits.

Due to the fact that Mlade/Trebizat river derives its water from karst springs, the normal sediment load is very low. During rainy periods the water gets usually muddy. Nevertheless silting of the reservoir and the impounded Koćuša river will create no problems. It is still advisable, to report the filling of the storage in the context of water quality and quantity monitoring. Occasionally it may become necessary to remove the accumulated sediments in the reservoir.

During construction of the powerhouse and other parts of the power plant any unnecessary property and environmental damage has to be avoided. The underground of the water course at the site of the reservoir will not be touched because it is planned to extract the small amount of dam material from the bottom of Mlade/Trebizat river .

Of course the construction of the power scheme is a considerable impact on soil properties and the morphology of watercourses at exactly this location. To assess this impact it must be considered, that inundation regularly took place in this area anyhow. Thus the reservoir has mostly the effect of concentrating the water in a smaller area.

The impact of the reservoir on the groundwater level cannot be predicted. Thus it is not possible to conclude whether or not the soil properties of Koćuša will be affected. The groundwater level should be monitored. As the storage is situated in between the already existing high flood embankments, the influence on the groundwater may be expected to be low.

4.2. Impact on the Koćuša waterfall in the river stretch influenced by the power scheme

The discharge situation in the river stretch between the weir and the power house will be altered. Thus it is important to be aware of possible impacts on the stability if the waterfall in the case of rapidly changing discharges. Furthermore protection measures for the travertine barrier in this river stretch have to be obtained.

As the optimal temperature for the accretion of travertine is between 15°C and 20°C with a velocity of 0,5 m/s to 1,5 m/s. The alkali content should be higher than 1.3 mva.

All these parameters will only be marginally changed due to power plant operation. It is estimated that the minimum discharge in the river bed of 3 m^3/s is sufficient for protection of the travertine barrier. In order to enable recovery of travertine the power plant operation has to be stopped for 10 m^3/s or lower discharge and therefore the natural flow will remain entirely in the river bed during July to September.

The basic design of the weir as a rubber dam will enable easy adjustment of the discharges to be released into the river bed. Careful monitoring of the travertine barriers at least in the first years of power plant operation will allow to design a suitable water management to fulfil equally the demand of the protection measures as well as the power plant operation.

The power plant operation regime as proposed is described in detail in item 2.6 of this study and considers fully the above mentioned protection necessities

4.3. Impact on the area downstream of the powerhouse

The power plant will have no substantial effects on the dynamic processes of Mlade/Trebizat river and the connected ground water system. However, the discharge situation in the river stretch between the weir and the power house will be altered. Thus it is important to be aware of possible impacts on the stability of the river banks in the case of rapidly changing discharges.

Possible downstream flow variations in Mlade/Trebizat river will not lead to any disturbance to downstream fisheries, irrigation and other uses.

4.4. Impact on the greater area of HPP Koćuša

In a region which shows a rather high seismological intensity, surveillance of changes due to seismic and microseismic impacts is of interest although an effect of the reservoir is rather improbable.

4.5 Impact on the landscape

All structures as planned consider the specific values of the landscape.

The weir is only approximately 3.5 m high and the storage area is situated within the natural river bed. At the rubber dam there will be a considerable period if the year overflow, therefore it will be nearly invisible.

The intake structure is only 3 m higher than the weir and situated in the left river bank slope, beyond the level of the existing vernacular road.

The the power conduit is a buried concrete structure and therefore also invisible with virtually no impact on land use.

The power house is also designed for the lowest possible elevation, only a minor part which contains some rooms for electrical equipment is visible above the surface. As the power house is situated in a considerable steep slope, from the landside there will be only visible the roof of the small house of the sub-surface machinery hall.

The walls of this visible house will be paved with local stone material.

Therefore the power plant will not influence the characteristics of the landscape.

5. IMPACT ON WATER

5.1. General

The river Mlade/Trebizat has a permanent course and it is unlikely that the water courses downstream will be influenced by the project. The quantity of irrigation water from should not be restricted, which means, that approximately 0.5 m^3/s are to be reserved for irrigation in the summer months June, July and August. Future irrigation projects and their influence on energy production are still objects of consideration.

The spring of the river Mlade/Trebizat, which is the only important spring within the whole area and part of an irrigation system, is actually situated outside of Koćuša project area. Thus no influence on Mlade/Trebizat river must be expected.

The water level of Mlade/Trebizat river waterfall at Koćuša will be influenced (in the most time of the year: reduced) by the SHPP, whereas quantity and quality should remain the same. The water course of Mlade/Trebizat river in the project stretch will not be changed. This measure should not influence the interaction of this part of Mlade/Trebizat river with the environment. The different operation mode during different discharges at the weir as described under item 2.5 will constitute a sufficient protection measure for the travertine barrier of Koćuša waterfall.

The expected effect of the reservoir on surface water is only small. This can be judged positively, but should be closely monitored. The impacts of the altered circumstances concerning the ground water level in the project area will also need monitoring.

Karst regions are objects of continuous changes. In that way the implementation of the power plant system can be interpreted as the enlargement of an existing or the opening of a new sink-hole. The altered situation of inundation will have an effect on the ground water regime on Koćuša. Related to reduced flooding levels and a shorter flooding period the high level of groundwater will last for shorter periods and will be lower in marginal zones. Because Karst regions are extremely permeable, changes due to these effects will be marginal.

The movement of groundwater in karst is difficult to analyse and almost impossible to quantify. Nevertheless it is of great importance to implement practical monitoring. The springs have to be watched carefully

Furthermore the capacity of the karstic sinkholes, the discharge of Mlade/Trebizat river which will not be increased or changed substantially and has to be monitored. Higher discharge of Mlade/Trebizat river or evacuation of the reservoir by the existing outlet are time limited measures which have no substantial effect on the water regime in the Koćuša area, especially after implementation of the necessary safety precautions.

During summer the power station will be operated periodically, because the reservoir will lack water.

Irrigation facilities in Mlade/Trebizat valley (springs, wells, pumping stations, channels and pipelines) should keep their function and should be influenced as little as possible.

The quality of surface and ground waters shall not change. Due to the fast water change the eutrophication hazard in the reservoir is minimal. Eutrophication–related phenomena (aquatic weeds) occur usually only temporary. However, it is evident that waste water from the upstream settlements represent a pollution hazard, as constructed sewage systems are still missing in this region (see also 2.3.3).

A study about the conservation of Mlade/Trebizat river's water cleanliness, waste water intake, and the impact of existing or future sewage treatment plants should be an integral part of a monitoring program.

To control the impacts on water in the project area, a program for monitoring and controlling the quality and quantity of water should be established and the results should be published in a periodical report. It will be necessary to check and adapt this monitoring program during construction of the plant as well as after completion of the project.

However, it is expected that quality and quantity of water will remain more or less unchanged. It is recommended to examine the following components:

- Water quality (chemical, physical, biologic parameters measured at significant sampling points)
- Water quantity (flow and water levels of ground- and surface water measured at significant sampling points; reservoir management)

5.2. Water protection

The groundwater flow in karst is complicated and irregularly. The groundwater flows with a changing, often very high velocity in cavities with changing cross sections and depths.

Because karst groundwater occurrences have a great potential for the future development of drinking water supplies, karst water areas are of utmost importance to society.

Karst waters were used for water supply since the antiquity and today serve– beside local use - for the drinking water supply of large urban entities. Unfortunately karst water is very susceptible to pollution. Water seeping into the karst cavities passes only a thin surface layer within the karst catchment area and undergoes almost no cleaning by passing through cavities which are enlarged via chemical solution processes. Thus, among other measures, the protection of karst water needs careful monitoring of the springs in the catchment areas.

This involves that pollution during the construction time of reservoir and powerhouse should be avoided. During service of the reservoir there are no impacts on the karst water quality expected.

If sewage plants are planned upstream of SHPP Koćuša, the discharge conditions in the area must be considered. An alteration of water quality inside the karst will directly influence the water quality of the accumulated water in the reservoir.

6. IMPACT ON ATMOSPHERE

The impact on the atmosphere by the project involves mainly the changed conditions on behalf of the contact of water surface with atmosphere and the emissions during construction like dust and noise. Basically only marginal consequences on the microclimate have to be expected, because the changes will be quite moderate.

The additional evaporation area will make the microclimate slightly cooler and damper in summer. In winter hardly any additional evaporation area will be produced. If there is any chance, evaporation will be less due to a smaller surface area covered by water. Therefore there will at most be slightly less fog during that time.

The impairment of the atmosphere can thus be considered as negligible, therefore a program for observation and gathering meteorological data in Koćuša will not be necessary.

The noise level in the immediate vicinity of the waterfall and the power house may temporarily decrease because the noise disturbance during water discharge will be slightly lower compared to the current water discharge via the open river. In close vicinity to the powerhouse on the other hand the noise level may be increased during water discharge. However, there has been noise disturbance before and relevant impairment for the direct neighbours to the powerhouse has to be compensated. Additionally, to prevent the powerhouse inside noise pollution the noise reduction measures in powerhouse are necessary.

7. IMPACT ON PLANTS AND ANIMALS

7.1. General

To reach water level in the reservoir it will only be necessary to heighten the dams along the Mlade/Trebizat by approximately 1 m beside the weir structure. Height and slope of the weir dam should not cause any major problem for the majority of animals to cross. However, to mitigate also the psychological obstacle by which wildlife movement is handicapped, the construction of so called „green bridges“ could compensate any possible harmful effect. Furthermore such green bridges can also be recommended, because they can also be used by humans.

During construction of the reservoir and the powerhouse it is important to minimise the negative impacts on plants and animals. If possible the breeding period of the local birds at the Kоćuša site should be considered when planning the time schedule of earthworks. Inevitable impairments will be compensated naturally in the course of time.

Flooding of the existing biotopes, changed conditions for existing biotopes and the possibility of formation of new biotopes, characteristic for lakes will take place only to a rather limited extent.

Notwithstanding this expected minor impact on the biosphere, it may still be useful to plan a study on the environmental impact of the project on the biosphere in the storage area and up- and downstream of the powerhouse to be able to quantify the real effect.

7.2. Impact on Plants

Except direct loss of bush areas in the reservoir area and the area of the powerhouse, other impacts on the flora during operation are expected to be relatively small. It is certain that the implementation of a reservoir reduces the flooded area as well as well as the period of inundation. Due to this and the resulting enhancements for agricultural use a change of species and number of existing plants is to be expected.

Because trees are growing only around the river and in the horticultural area of the village, there is no decrease of forests to be expected.

7.3. Impact on Animals, especially Fish

Basically the general population of animals should remain the same, as there is no major impact on the biosphere. The part of the present biosphere which is taken away by the reservoir, can be populated by amphibians and birds on the other hand.

Except direct loss of some living space for minor animals and some modifications or an interruption of their eventual migration paths in Koćuša, no other impacts are expected.

Because the project area has rather low water currents during summer time, also up to now due to the drying up of the rivers no continuity in the environment of the water residents was guaranteed. Thus the construction of the reservoir is no substantial change to the present situation.

Migrating of different fish species (Salmonidae, Cyprinidae, Anguillidae) will still be the ordinary way of spreading, especially in Mlade/Trebizat river. For the purpose of fish migration a fish ladder is foreseen at the right bank.

As hunting is of no importance in the project area at the moment, there will be no changes concerning this item.

8. SUMMARY

The SHPP Koćuša is planned as a small power plant fitting into the landscape. Due to lack of current data the possible environmental impacts of the project are difficult to quantify. They can altogether be judged as moderate.

From an ecological point of view, the construction of the reservoir within the existing banks of the river bed and the regulation of Mlade/Trebizat river downstream of the proposed power house represent an acceptable intrusion. The discharge capacity of Mlade/Trebizat river will not be substantially be changed, necessary regulation measures will be taken.

The possible impact on groundwater levels and karst springs are more difficult to assess, a water quality and quantity monitoring programme should thus be installed.

Side effects like the increase of areas that can be used for agricultural purposes and the additional supply with electrical energy must be counted as a positive impact. In addition the project will have an important positive psychological influence on the local economical development of the region.

As the power plant will be operated in the run-of-the river mode, the water regime will not be changed due to storage activities. Therefore no influence on water treatment plants existing or planned downstream will occur.

The water regime determines the species composition of flora (including macrophytes) in the river stretch of the power plant. As the water regime will not considerably be changed by the operation of the proposed power plant in the run-of-the-river mode, the flora in and around the river bed will not be influenced. Some positive effects may result for the slightly higher water level in the storage basin area, as here even during dry periods water will be stored and available for the flora in the vicinity.

The natural and the cultural heritage is influenced only to a minimal extent.

According to Environmental protection law of B&H, the waterfall of Koćuša belongs to the protected areas. This fact is accordingly considered in the location of the weir which is situated 200 m upstream of the waterfall. This measure minimises the visual impact on the waterfall. Furthermore the selected type of weir enables an easy release of water along the whole length of the rubber gate which will make the weir nearly invisible from downstream even at low discharges

APPENDIX:

A. Checklist for Dams and Reservoirs/Hydropower

B. Drawings

APPENDIX A：Checklist for Dams and Reservoirs/Hydropower

A. Environmental problems due to project location

1. Resettlement
2. Encroachment on precious ecology
3. Encroachment on historical and cultural values
4. Watershed erosion silt runoff
5. Impairment of navigation
6. Effects on groundwater hydrology
7. Migrating valuable fish species
8. Inundation of mineral resources
9. Other inundation losses or adverse effects

B. Environmental problems related to design

1. Road erosion
2. Reservoir site preparation
3. Water rights conflicts
4. Fish screens

C. Environmental problems associated with construction stage

1. Soil erosion/silt runoff
2. Other construction hazards
   - 2.1. Safety of workers
   - 2.2. Sanitation at worker's camp
   - 2.3. Water-orientated diseases
   - 2.4. Dust/odors/fumes/noise/vibrations
   - 2.5. Quarrying hazards (blasting and hauling)
   - 2.6. Environmental aesthetics
3. Construction monitoring

D. Environmental problems resulting in project operations

1. Downstream flow variations
2. Depreciation of downstream inundation fisheries
3. Downstream erosion
4. Lack of reservoir management
5. Eutrophication (aquatic weeds)
6. Downstream water quality
7. Insect vector disease hazards
8. Estuarine and marine fisheries impacts
9. Reservoir bank stability
10. Operations monitoring

E. Potential Environmental Enhancement Measures

1. Reservoir fishery enhancement
2. Drawdown agriculture
3. Downstream community water supply
4. Downstream aquaculture
5. Forestry/wildlife reserves
6. Recreation

F. Additional considerations for hydropower projects

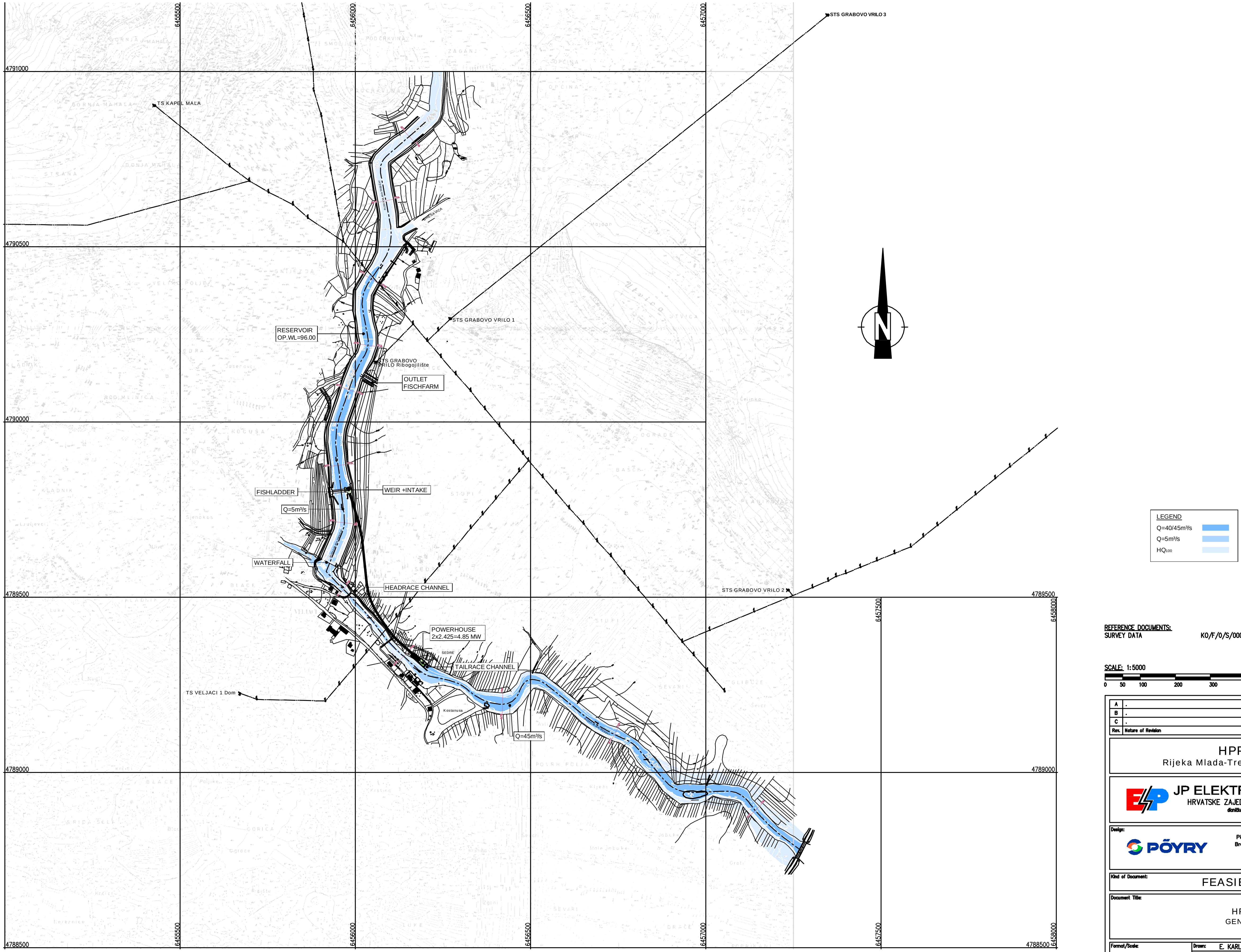
1. Multipurpose management need
2. Rural electrification
3. Transmission lines
   3.1. Encroachment on precious ecology
   3.2. impairment of wildlife movement
   3.3. impairment of environmental aesthetics
   3.4. soil erosion from construction and areas left exposed

G. Critical review criteria

1. Loss in irreplaceable natural resources
2. Accelerated use of resources for short-term gains
3. Endangering of species
4. Undesireable rural-to-urban migration
5. Increase in affluent/poor people gap

APPENDIX B: Drawings

KO_F_0_G_0001	General project area - Layout
KO_F_0_G_0011	General project area - Longitudinal section
KO_F_0_G_0020	General project area – Land Acquisition



REFERENCE DOCUMENTS:

SURVEY DATA KO/F/0/S/0001-0003

SCALE: 1:5000

0 50 100 200 300 400 500m

Rev.	Nature of Revision	Drawn	Date
A	.	.	.
B	.	.	.
C	.	.	.

HPP KOĆUŠA

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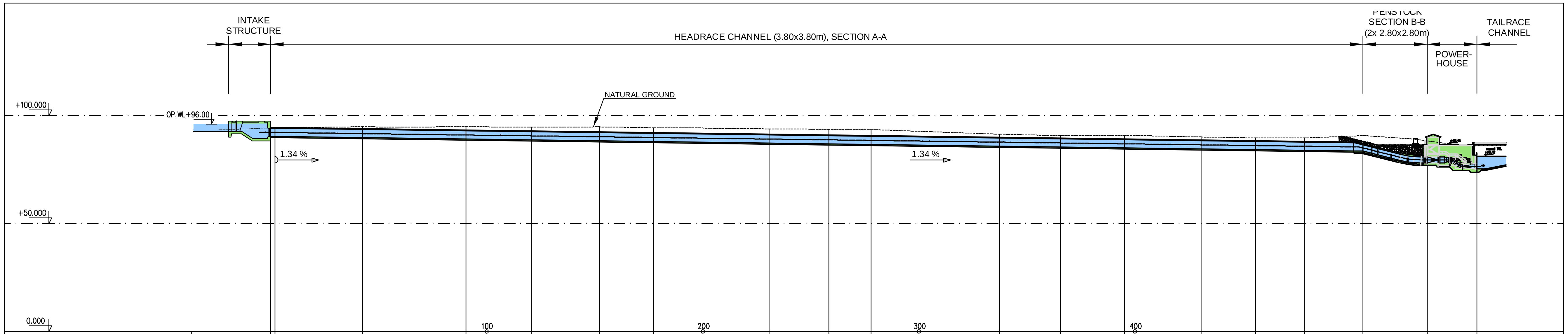
Document Title:

HPP KOĆUŠA
GENERAL LAYOUT

Format/Scale:	A1 1:5000	Drawn:	E. KARLOVITS, A. SCHÖMITZ	Date:	18.12.2006
		Checked:	VALENTIN	Date:	18.12.2006
		Approved:	KLEIN / KRISCH	Date:	18.12.2006
Project No.:	100615	Doc. No.:	KO/F/0/G/0001	Rev. Code:	

LONGITUDINAL SECTION

1 : 1000



CHAINAGE [m]	0.000	2.000	42.40	90.46	120.65	152.18	177.32	230.76	258.38	277.85	337.51	365.63	395.24	430.70	455.94	478.59	504.27	533.96	557.11
LEVEL OF GROUND SURFACE [m]	94.15	94.20	94.74	94.73	94.55	94.68	94.27	93.71	93.59	93.43	91.29	90.59	90.81	90.00	89.57	89.55			
LEVEL OF SYSTEMPOINT [m]	90.20	90.20	89.66	89.02	88.61	88.19	87.86	87.14	86.77	86.51	85.71	85.34	84.94	84.47	84.13	83.83	83.47	78.02	75.17
VERTICAL OVERBURDEN [m]		-0.22	0.88	1.51	1.74	2.29	2.21	2.37	2.62	2.72	1.37	1.05	1.67	1.33	1.24	1.52	1.00	4.90	

SECTION A-A

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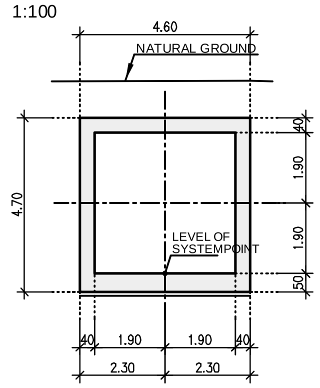

SECTION B-B

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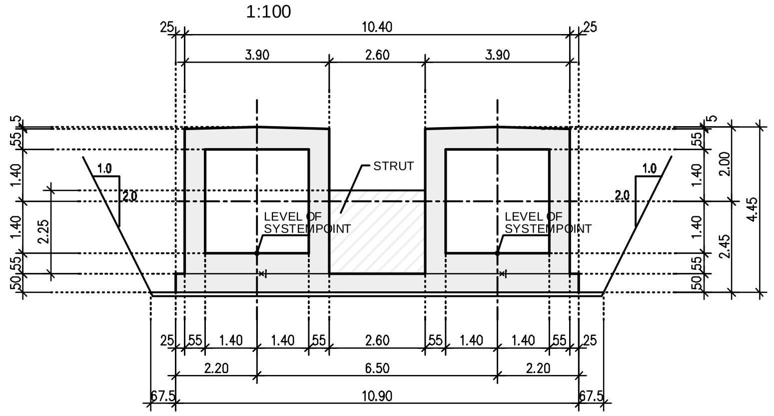

LAYOUT

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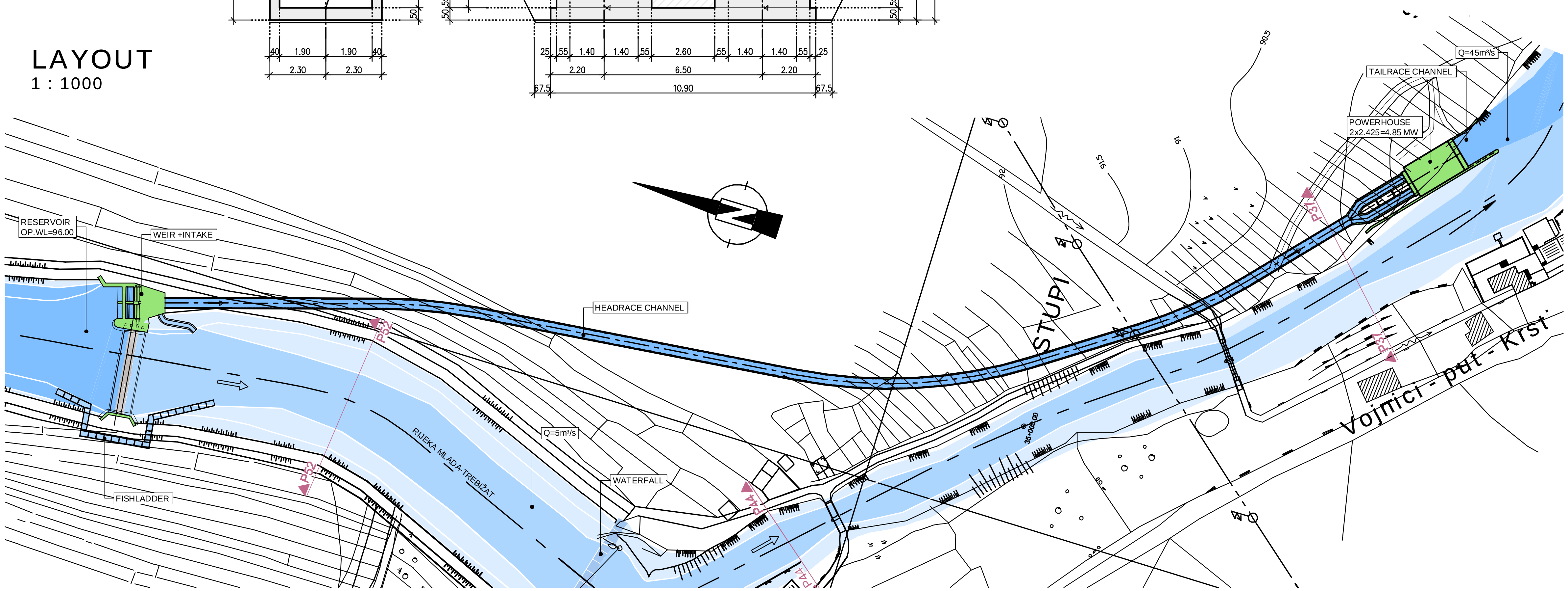

LEGEND
- Q=40/45m³/s
- Q=5m³/s
- HQ100

REFERENCE DOCUMENTS:

RUBBER DAM AND INTAKE STRUCTURE	KO/F/2/G/0001
POWERHOUSE	KO/F/4/G/0001–0004

SCALE: 1:1000 — 0, 25, 50, 75, 100m

SCALE: 1:100 — 0, 2.5, 5.0, 7.5, 5m

Rev.	Nature of Revision	Drawn	Date
A	-		
B	-		
C	-		

HPP KOĆUŠA

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Document Title: HPP KOĆUŠA HEADRACE CHANNEL LAYOUT AND SECTIONS

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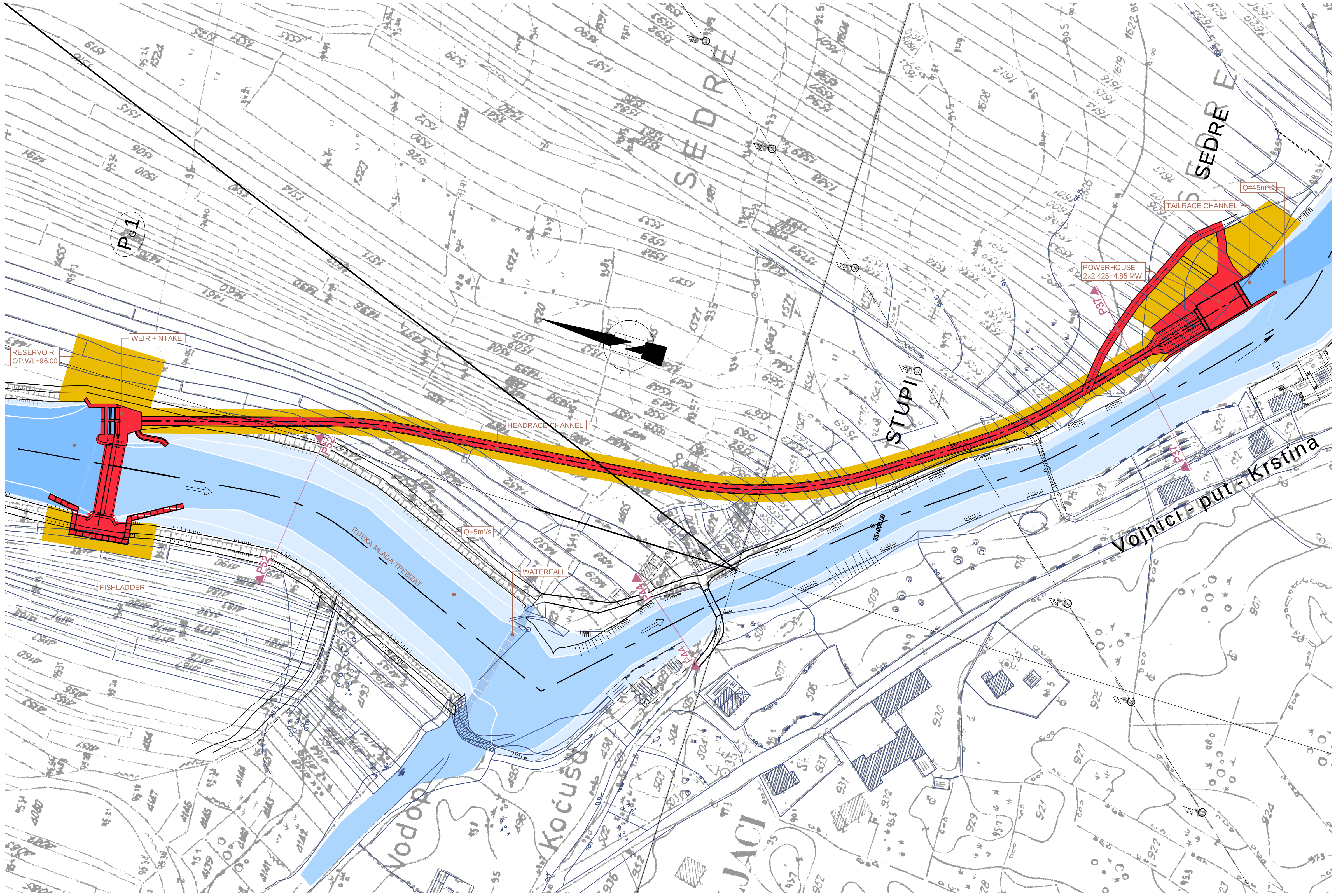
		Approved:	KLEIN / KRISCH	Date:	18.12.2006
Project No.:	100615	Doc. No.:	KO/F/0/G/0011	Rev. Code:	

LAYOUT

1 : 1000



	PERMANENT USE	5200m2
	TEMPORARY USE	6800m2

REFERENCE DOCUMENTS:

RUBBER DAM AND INTAKE STRUCTURE KO/F/2/G/0001
POWERHOUSE KO/F/4/G/0001–0004
HEADRACE CHANNEL KO/F/0/G/0011

LEGEND

Q=40/45m³/s
Q=5m³/s
HQ_{100}

SCALE: 1:1000

0 25 50 75 100m

Rev.	Nature of Revision	Drawn	Date
A	-		
B	-		
C	-		

HPP KOĆUŠA
Rijeka Mlada-Trebižat/Bosna i Hercegovina

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Document Title:

HPP KOĆUŠA
LAND ACQUISITION
OVERVIEW

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		Approved:	KLEIN / KRISCH	Date: 23.08.2007
Project No.: 100615		Doc. No.:	KO/F/0/G/0020	Rev. Code: