**HRVATSKE VODE**

**Flood protection system in the basin of the Krapinica**

**tributaries forming the hydrotechnical node Đurmanec**

**D. STUDY CONCLUSION (SUMMARY)**

**D.1 ELABORATION OF THE MOST ACCEPTABLE PROJECT ALTERNATIVE**

The purpose of the planned project is flood protection, particularly of the endangered settlement Đurmanec, agricultural surfaces and roads as well as area along the Krapinica river, downstream from Đurmanec and the town Krapina.

In the designs developed so far, the protection is aimed to achieve by construction of retarding areas to keep a part of floodwater in the upstream, uninhabited parts of the basin, and by appropriate regulations of watercourses in the downstream sections of the watercourses. The regulations planned in these designs have already been executed, or their execution is under way. The required protection level from floods of the 100-year period will be achieved by construction of four retarding basins: Smiljanova Graba, Lukovščak, Mala Ravninščica and Velika Ravninščica.

The planned project includes four retarding basins for flood protection on the watercourses Smiljanova graba, Lukovščak, Velika Ravninščica and Mala Ravninščica. The basins Smiljanova graba and Lukovščak are located in the Municipality Đurmanec, while the basins Mala Ravninščica and Velika Ravninščica are in the Municipality Jesenje. Both municipalities belong to the Krapina-Zagorje County.

The planned projects are anticipated in the Spatial plan of the Krapina-Zagorje County, Spatial plan of the Municipality Jesenje and the final draft Spatial plan of the Municipality Đurmanec.

In the concerned area, the most frequently flooded is the centre of Đurmanec*.* The settlement Đurmanec is located 4 km upstream of the Krapina river, and includes a narrow valley of the watercourse Krapinica (Maceljčica). Đurmanec is flooded by the Krapinica, its right tributary Putkovec which flows into the Krapinica in the very centre of the settlement, and the watercourse Ravninska which flows into the Krapinica 500 m downstream. In the recent years, flood caused damages have increased due to enlargement of the settlement in the flooded area.

Based on the study *Regulation of the stream Krapinica (Maceljčica)* *river bed in the*  *Đurmanec area from km 24+073 to km 27+069*, Vodoprivreda – Zagorje, (2006), regulation of the Krapinica river bed started in 2006. A river bed regulated in this way is capable of accepting a water wave of the 25-year return period. By construction of the retarding basins Smiljanova graba and Lukovščak, the Krapinica river bed through the settlement Đurmanec will be capable of fully accepting the reduced water wave of the 100-year return period.

**D.2 POSSIBLE IMPACTS**

* During the preparations for the project, geodetic surveys, geomechanical investigation work and survey of the “zero” state will be carried out in the field. These works and the equipment with which they are performed generally have no impact on the environment. However, during investigative drilling for purposes of designing of the planned dams, devastation of plant cover and soil pollution (in case of uncontrolled leakage of machine oil or fuel into the ground) may occur.
* Impacts during construction are timed to one or two construction seasons. During construction of planned dams and replacement roads, devastation of plant cover and habitats will occur on the construction sites due to movements of construction machinery. Vegetation cover may further be endangered by potential uncontrolled disposal of excess construction material and other waste along the construction site. Considering the limited area of impact, it is assessed that the project will not endanger any recorded plant or animal species.
* The noise of construction machinery and movements of people will disturb wild game which will have to seek out more peaceful, safer places, whereas construction works will have a consequence of short-term local air pollution due to exhaust fumes created by construction machinery (sulphur dioxide and soot) as well as dust which will rise during excavation. Since these are relatively small construction sites and short construction periods, it is estimated that this impact will not be significant.
* Hydrogeological impacts are limited to a narrow area surrounding the intervention (several meters from the river bed of the watercourse i.e. flooded zone of the retarding basin and impounded area of the dam), and as such are not significant for the greater environment.

- Hydrological impacts are related to reduction of large discharges of the Krapinica river by construction of retarding basins, which will ensure to the settlement Đurmanec as well as the downstream town Krapina the protection level from floods of 100-year return period, which are all positive impacts. The retarding basins will not have impacts on low or medium water.

* Construction of retentions will cause permanent change of land use within some construction work zones (construction of dikes, dams, roads within areas of the retarding basins). Within retarding areas, occasional loss and change of land use will occur, while there will be neither loss of soil functions nor changes of land use in areas in the impact zone of the intervention (100 m).
* Construction of retentions and dams will cause reduction in the power of the water wave, significant reduction of erosion in the downstream part of the river bed, but accumulation of eroded material in the retarding basin area as well. Due to such small area, this material will be possible to collect and purposefully use. Beside their contribution to reduction of soil erosion by water, the constructed retarding basins will prevent spilling of the watercourse i.e. floods in the downstream part of the river basin, which will make soils along the watercourses significantly more favourable for use in agriculture.
* The loss of state forest surfaces which will occur due to construction of the planned facilities is relatively small and related only to the areas of dams and access roads. The loss of private forest surfaces which will occur due to construction of the planned facilities is even smaller than in the case of state forests.
* During the use of the retention system, it is expected flooding within the retarding basins will be temporary and short-term (only a day or two). Such flooding of the vegetation will not cause more significant changes, probably even no changes at all, since part of the vegetation which is currently present in this area is adapted to wetland habitats. Within the retarding areas there will be no long-term retention of water and collected sediment will be regularly cleaned, so that appearance of a layer of muddy sediment on the soil surface which would lead to changes in the structure of vegetation in view of colonization and increase in the share of species originating from nutrient richer soils, primarily some weed and ruderal plant species, is not expected.
* - The filling of the retarding basins with water will be occasional and extremely fast, i.e. there will be no regularity. Due to this irregularity of occurrence, animals will not have the opportunity to adapt or avoid the onrush of water, as is the case with natural, regular occurrences. Accordingly, this will result in the loss of a certain number of animals such as birds, mammals, reptiles and numerous insects. However, due to the fact that there are no species in this area which do not reside in other areas as well, this negative impact will be only locally significant.
* The impact during the use on wild game and hunting relates to a temporary loss of hunting productive areas used for construction of the dams equalling 0.44 ha. Earthworks and other works accompanied by noise of heavy machinery and movements of people will disturb wild game which will have to seek out more peaceful, safer places. Therefore, the hunting concession holder on the location of the future access roads will suffer damage through reduction of revenue generated from hunting tourism due to migrations of wild game, increased damages on the unit (agriculture and forestry) and wild game.
* It can be expected that the retarding basin Smiljanova graba, due to its being open towards the valley and settlement Smiljanova Graba, will have certain impact on the visual values of the landscape. In case of the retarding basin Lukovščak, it is expected that the dam construction and improvement of its surrounding area will lead to improvement of the present visual landscape value. Since the planned retarding basins Mala Ravninščica and Velika Ravninščica are located in the narrow valleys of the streams of the same name and within a closed forest unit, the dams and other parts of the retarding basins will be hidden from view, and so will not affect visual landscape values.
* Construction of the planned project will protect the currently endangered area (particularly the settlements Đurmanec and Smiljanova graba) from flooding. It is, therefore, estimated that the planned flood protection system can be considered as an improvement of the living conditions for the local population, i.e. its impact is estimated as very positive.

- The four retarding basins are planned outside areas which are anticipated in the spatial plans for extension of any settlement within the river basin of the Krapinica and its tributaries. It is, therefore, considered that the planned system of retarding basins

will in no way unfavourably affect the populated settlements or their future development and expansion. Indirect impact will be evident in the change of water regime which to achieve protection of the settlements in the river basin from flood. Indirect impact of the planned retarding basins on the settlements is thus assessed as very positive.

* No unfavourable impacts from the use of retarding basins are expected on water supply and sewerage, electrical power and gas supply, or telecommunications.

- Extraordinary circumstance that may occur is a dam break at the time when retarding areas are full. However, the design and construction of the system of earth structures is created in such manner that the risk of dam break is reduced to the lowest possible measure. Potential impacts depend on water levels within a retarding basin. If such event occurred when retarding basins are empty, negative impacts would be negligible. If a dam break occurred at the time of maximal water levels in the retarding basins, the water wave would probably cause increased erosion and lateral instability of the river bed downstream of the dam, with a series of negative consequences. However, considering the size of the retarding basins, the consequences would be serious, but not disastrous. The occurrence of a flood of larger than 100-year return period to which the structures are dimensioned may cause larger or smaller damages to the watercourses, but not to a dam which is dimensioned to a flood of 1000-year period.

**D.3 ENVIRONMENTAL PROTECTION MEASURES**

**D.3.1 Environmental protection measures before the start of construction**

* Before the start of construction, all necessary investigation work for construction start must be carried out, so that all noticed problems related to foundation or construction could be adequately corrected in the design.
* During design, attention should be paid improvement of boundary parts of the construction site in order to prevent falling down of trees on the newly created edges or landslides. This particularly refers to the contact zones between the retarding basin dams and the surrounding area.
* In the landscape improvement project, anticipate autochthonous plant species.
* In the landscape improvement project, anticipate grassing of upstream and downstream dam slopes.
* In the landscape improvement project, determine the manner of vegetation maintenance around regarding areas.
* In the design, plan lining of flood protection structures with rough stone material or turf cubes.

**D.3.2 Environmental protection measures during construction**

* During dam construction, limit movements of heavy machinery to the smallest possible area.
* Disposal of waste material or urban waste must be carried out frequently and in a controlled manner at legal landfills, i.e. any temporary or permanent disposal of waste materials in the environment must be banned, and leak proof containers for waste provided.
* Maintenance of machinery shall be carried out in a manner to ensure that harmful substances, such as motor oil or oil from hydraulic systems of machinery does not enter the environment, primarily soil or watercourse, in an uncontrolled manner.
* When performing earthworks, separately dispose topsoil for later use on improvement of dam and dike slopes.
* Immediately after cutting through occupied forest area, forest order shall be established by removal of tree stumps, process and remove all felled wood stock. Hereby attention must be paid that all damaged and broken trees are felled and removed so that they do not become a source of contagion. Establishment of forest order will enable the remaining trees, particularly those on newly created edges, to

create a new protective edge of stands quicker, which will be able to protect the stands from direct, but also indirect harmful impacts.

* During construction, a special attention must be paid to handling of highly flammable materials and open flame to prevent forest fires. All regulations and procedures for protection from forest fires must be complied with. This primarily relates to the retarding basin Smiljanova draga, which is located in a coniferous forest area, and the retarding basin Lukovščak, which is in in contact with coniferous vegetation in the vicinity of the planned dam and on the route of the planned access road.
* In cooperation with the hunting concession holder, relocate existing hunting facilities (shooting stands, feeding sites) to different locations, or replace them by new ones.
* It is necessary to be careful not to destroy the habitats of the fernt *Matteuccia struthiopteris* during the construction of the dam Smiljanova Graba, and the habitat of *Equsetum hyemale* during the construction of the dam Mala Ravninščica*.*
* Implement technical and biological measures to facilitate development of natural vegetation along the retarding areas. In places where natural succession of the surrounding space under temporary impact of the project is not possible, the space must be returned to its original state by rehabilitation.
* Start construction of the planned retarding basins by executing replacement roads at the retarding basins Smiljanova graba, Lukovščak, Mala Ravninščica and Velika Ravninščica to prevent disruption of existing traffic routes.
* Damages to the existing roads which occurred during construction must be rehabilitated after the completion of construction works at the expense of the investor.
* During construction of the earthen dam of the retarding basin Mala Ravninščica, in case of any archaeological findings, the competent Conservation Deaprtmetn must be immediately informed, and all activities must be stopped until the authorized archaeologist determines further measures.

**D.3.3 Environmental protection measures during use**

* During utilization of the system, care must be taken of its monitoring (monitoring of system correct state of the system and state of sediment in the retarding basins) and regular maintenance in order to prevent damages to the dams and dikes, which would cause unforeseen erosion processes.

- It is necessary to regularly clean the unused area of the retention due to sediment, and purposefully use the sediment from it.

* During maintenance of main facilities of the retarding basins (dam, outlet, sediment cleaning), attention must be paid that during works forest vegetation is damaged as little as possible.
* Vegetation surrounding retarding areas must be maintained during utilization according to the landscape improvement project.

**D.3.4 Environmental protection measures after the end of use of the project**

The flood protection system is planned as a permanent structure, whose end of use is not planned in near future. The end of use by removal of the facilities would cause the water regime to return to the present state. Therefore, this study is not proposing any protection measures.