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ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR INTERVENTION:

D414 STATE ROAD

Section: Sparagovići – Doli

NON-TECHNICAL SUMMARY

Zagreb, December 2015

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Inserted document (pages 7 to 9 in the original document):

Approval granted to Institute for Design Engineering for conducting professional works of environmental protection issued by the Ministry of Environmental and Nature Protection.

Inserted table (page 10 in the original document):

LIST of employees of Institute for Design Engineering according to which legal requirements for granting approval, issued by the Ministry of Environmental and Nature Protection, for conducting professional works of environmental protection have been fulfilled.

Inserted document (pages 11 to 13 in the original document):

Approval granted to IRES EKOLOGIJA Ltd. Company for conducting professional works of environmental protection issued by the Ministry of Environmental and Nature Protection.

Inserted document (pages 14 and 15 in the original document):

Decision issued by the Ministry of Environmental and Nature Protection (25/8/2015) to IRES EKOLOGIJA Ltd. Company in relation to changes in the list of employees authorized to conduct professional works of environmental protection.

Inserted table (pages 16 and 17 in the original document):

LIST of employees of IRES EKOLOGIJA Ltd. Company according to which legal requirements for granting approval, issued by the Ministry of Environmental and Nature Protection, for conducting professional works of environmental protection have been fulfilled.

1. PROJECT DESCRIPTION

1.1. INTRODUCTION

One of the most important unresolved transport issues in the Republic of Croatia is that of physical separation of the territory of the Republic of Croatia, that is, the territory of Dubrovnik is separated from the rest of the Republic of Croatia by a 14 km-long area located within the borders of Bosnia and Herzegovina (further in the text BIH), that is, within the area of Municipality of Neum.

The issue of isolation of the Dubrovnik area has been discussed for years now, but it was after the proclamation of the independence of the Republic of Croatia that this issue came into the limelight.

For many years, the road traffic between the separate territories of the Republic of Croatia has taken place on the D8 state road (Pasjak Border Crossing – further in the text BC (border of the Republic of Clovenia – Šapjane – Rijeka – Zadar – Split – Klek BC (border of Bosnia and Herzegovina) – Zaton BC (border of Bosnia and Herzegovina) – Dubrovnik – Karasovići BC (border of Monte Negro)) passing two border crossings; to the west: Klek – Neuk BC, and to the east: ZAton Doli – Neum II BC, in accordance with the International Bilateral Agreement on transport of goods and passengers signed between the Republic of Croatia and Bosnia and Herzegovina.

On 1 July 2013, when the Republic of Croatia entered European Union, the legal framework for transport of goods and passengers between the Republic of Croatia, now a full member of EU, and Bosnia and Herzegovina, changed significantly. Furthermore, these conditions became more stringent and the Schengen border regime was introduced, thus impeding the flow of traffic between the separated territory of the Dubrovnik-Neretva County and the rest of the Republic of Croatia.

The European Union recognized the issue of the lack of transport connection between part of Croatian / EU territory and the rest of territory, and solutions to the mentioned issue have been looked for intensively.

In terms of the Transport Development Strategy of Croatia 2014 – 2030 (OG 131/14), the need to connect separate territory of the part of region of southern Dalmatia with the rest of the Croatia territory was assessed as a strategical interest of the Republic of Croatia. As the optimal solution of the planned transport connection, the Strategy has mentioned the construction of the Pelješac Bridge and new road communication through the territory of the Pelješac peninsula.

In July 2015, the Feasibility Study for transport connection of separate territory of the Republic of Croatia was presented. As the optimal alternative of transport connection, this Study mentions the Bridge: mainland – Pelješac, L=2.40 km, with a link to the D8 state road through a newly constructed state road passing through the territory of the Pelješac peninsula.

Within the context of the comprehensive transport connections between the Dubrovnik area and rest of the Republic of Croatia, the proposed Intervention, along with the section Bridge: mainland – Pelješac with access roads represents key segment, as it results in a traffic route that shall connect the entire Croatian territory exclusively through its territory. Broadly speaking, this traffic route is closely related to finishing A1 Motorway within the area of the Dubrovnik-Neretva County because a direct connection of Dubrovnik with this traffic route is ensured through the link of A1 Motorway to this very traffic route (Doli junction) by means of a high-serviceability road.

At this stage of the project development, the Intervention of constructing state road finishes where the road links to the route of D8 state road in the settlement of Doli. At this stage, the crossing with the D8 state road (direction from Ston) is planned a T-junction. As the route shall be further defined towards the junction at A1 Motorway, the junction in question shall become grade-separated.

In the following period, it is necessary to plan further development of the Intervention (construction of A1 Motorway and link of the state road to the mentioned motorway) because, according to the current solution, the entire traffic towards Dubrovnik coming from A1 Motorway and future road designed for the traffic of motor vehicles is channeled to the D8 state road from the settlement of Doli towards Dubrovnik, which in terms of its elements (horizontal and vertical elements, passing through settlements) does not fulfill the needs of a high-level of serviceability required by this transport route.

The planned Intervention starts immediately before the border of the Republic of Croatia on D8 state road, from which an access road towards the bridge in the area of Komarna and Cape Međed branches off, to pass through the area of Pelješac and connect again to the D8 state road in the area of the settlement of Doli. In total, the Intervention is roughly 32.5 km long.

The Intervention is divided into two sections: Bridge: mainland – Pelješac with access roads that are roughly 14.48 km long, and the section of Sparagovići – Doli, roughly 18.0 km in length.

The subject matter of this Study of environmental impact is the Sparagovići – Doli section.

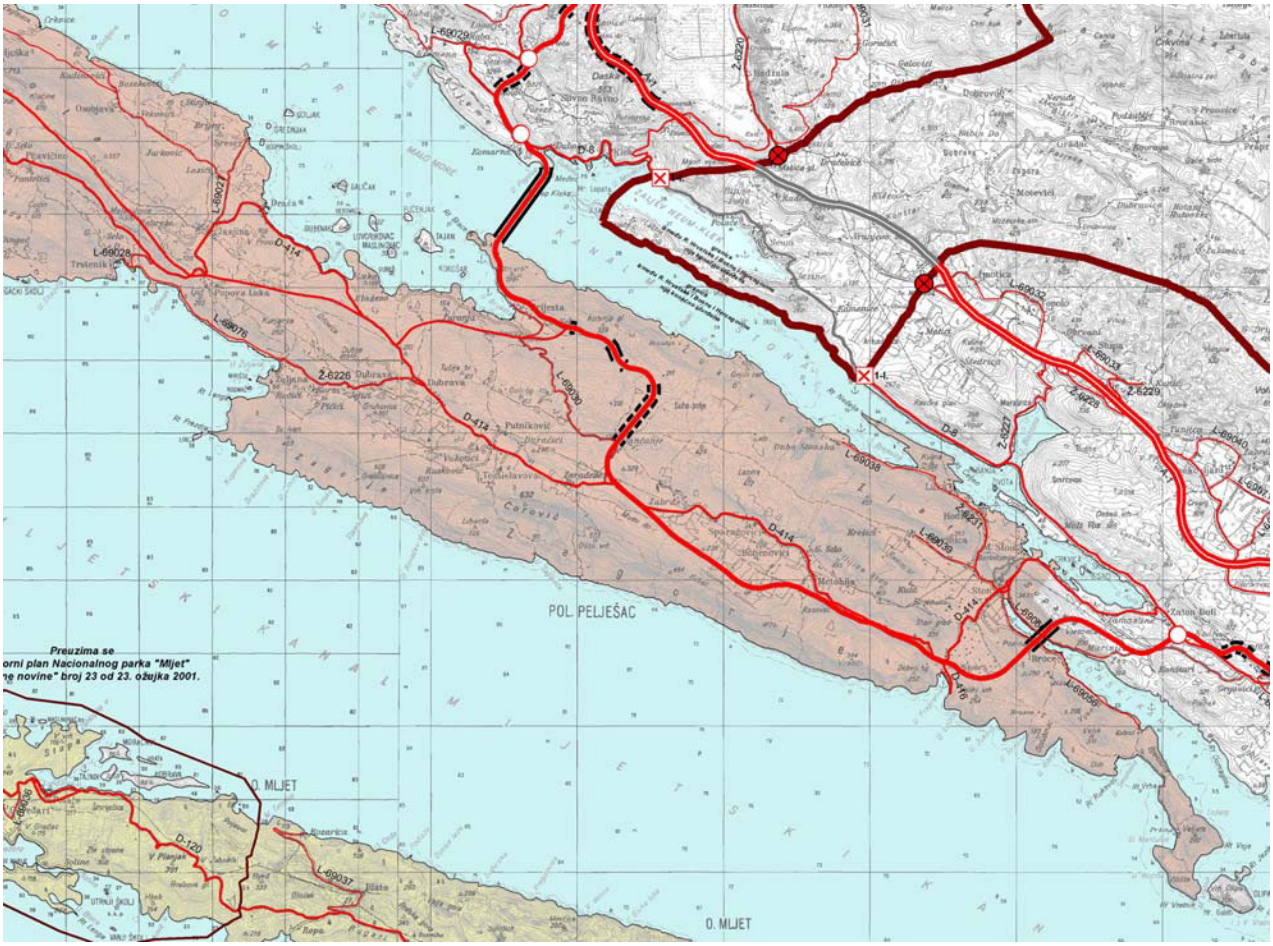

Figure 1.1.1. The planned Intervention of connecting the separate territories of the Republic of Croatia in accordance with the Spatial Plan of the Dubrovnik-Neretva County

1.2. CHRONOLOGY OF PROJECT DOCUMENTATION DEVELOPMENT

The idea of connecting the separate territory of the Dubrovnik-Neretva County with the rest of the Croatian territory has been the subjects of many official talks since 1997, and it was in 2000 when it gained its official statues by being covered in the Spatial Plan of the Dubrovnik-Neretva County.

The works on construction of the Pelješac Bridge initiated in 2007, but they were official brought to a halt in 2012. The bridge project documentation was developed in parallel with the preparation of the project documentation for the road passing through the territory of the Pelješac peninsula.

The first route alternative was a one-carriageway road, for which the acceptability assessment for the environmental network was carried out in the course of 2015. Furthermore, the Decision regarding the acceptability of the Intervention for the environmental network (Class: UP/I 351-03/05-02/00054, Zagreb, of 13 December 2005) was obtained, as well as the Building Permit (Class: UP/I 350-05/06-01/00072, Zagreb, of 7 February 2007), which was prolonged and eventually expired in the meanwhile.

In the course of 2008, there were some changes in the planned road classification (road with two separate carriageways was proposed instead of with one), leading to changes in the project documentation.

Due to the introduced changes in the project documentation, the Opinion issued by the Ministry of Environmental and Nature Protection from 2008 stated that the acceptability assessment of the planned Intervention for the ecological networks had to be carried out.

In view of the current political developments, further development of the project was halted. However, since 2010, this Intervention has again assumed importance and new potential solutions to the route of the future state road passing through the territory of the Pelješac peninsula have been proposed. The above mentioned new solutions take into consideration the optimal technical solution in accordance with most recent standards and related impacts on the aspects of environmental protection, which have changed in relation to the acceptability assessment conducted in 2005 due to the compliance of the Croatian legislation with that of the European Union.

1.3. DESCRIPTION OF ROAD ROUTE

In terms of the alignment layout, this route is based on the route for which the mentioned expired Building Permit was issued in 2007. After that, another route alternative was developed that, because of more favorable driving-dynamics and geo-technological elements, passes through the tunnel of Supava. Therefore, in 2010, the Preliminary Design C3-7093-IR/A was developed for that route, and the route was introduced into the Spatial Plan of the Dubrovnik-Neretva County.

In relation to the new Preliminary Design, the route maintained its basic elements for which the Location Permit was issued in 2007 and it was optimized and improved in order to meet the requirements dictated by the terrain. The alignment layout of the road is entirely in compliance with the applicable Spatial Plan of the Dubrovnik-Neretva County from 2012.

The route starts in the area of Dančanje, close to the settlement of Sparagovići (on the existing D414 state road) and ends on the existing D8 state road, in the vicinity of the settlement of Doli. The total length of the Intervention amounts to roughly 18.1 km.

Basic technical data about the route:

The route is designed as 1st category state road with a task to link on the regional and state level (in accordance with the Ordinance on basic conditions regarding traffic safety aspects to be met by public roads outside settlements and their elements, OG 110/2001).

Design speed:	V_p = 90 km/h
Minimal and maximal permitted elements:	
Maximum longitudinal grade:	S_{max} = 5.5%
Minimal horizontal curve radius:	R_{min} = 350 m
Minimal concave radius of vertical curves:	R_{min} = 3.500 m
Minimal convex radius of vertical curves:	R_{min} = 5.200 m

Minimal and maximal elements applied:

Maximum longitudinal grade:	S_{max} = 4.7%
Minimal horizontal curve radius:	R_{min} = 350 m
Minimal concave radius of vertical curves:	R_{min} = 3.900 m
Minimal convex radius of vertical curves:	R_{min} = 6.000 m

Cross section elements:

• Carriageway width:	2x3.50 = 7.00 m
• Marginal strip width:	2x0.50 = 1.00 m
• Hard shoulder width:	2x2.00 = 4.00 m
• Berm width:	2x2.50 = 5.00 m
	Total: **12.00 / 13.00 m**

The cross section of the designed road is mono-pitched, and it amounts to 2.5% where the route is a straight line, and in curves this depends on the radius length.

The clearance over the route is min. 4.8 m from the highest alignment elevation.

From km 5+770 to km 6+780, a lane for slower moving vehicles is planned, L=1010 m.

The following components of pavement structure are planned:

• Wearing course – SMA 11 PmB, 3.5 cm thick
• Binder course – AC 16 bin, PmB, 5.0 cm thick
• Bituminous bearing course – AC 22 base, BIT 50/70, 7.0 cm thick
• Mechanically compacted bearing course – 40.0 cm thick.

The final components shall be defined in the Main Design, in accordance with the relevant road load.

Junctions

• Prapratno junction – crossing with the D416 road (grade-separated junction) at km ≈10+215
• Crossing with the D8 state road (Y-junction) at km ≈17+665

Crossings and overpasses

• Zamaslina crossing (L=ca 350 m)	km ca 17+000
• Crossing of agricultural path	km ca 1+050
• Crossing of agricultural path	km ca 4+200

Accompanying routes

• Relocation of D414 road	(L=ca 580 m)	ca from 9+700 to 10+215
• Relocation of D416 road	(L=ca 235 m)	km ca 10+215
• Prapratno parallel path	(L=ca 365 m)	ca from 10+215 to 10+570
• Polakovica parallel path	(L=ca 610 m)	km ca 11+785
• Supava fire truck access road	(L=ca 340 m)	km ca 14+920
• Relocation of L69066	(L=ca 755 m)	ca from 16+200 to 16+900

Drainage

The technical solution for water protection proposes that runoff waters from pavement surfaces are collected and diverted from the pavement surfaces by means of controlled waterproof drainage system, and eventually purified by means of separation tanks.

All watercourses and flash floods crossed by the route of the road shall be drained through the roadbed by means of concrete pipes and culverts of adequate type.

Structure drainage shall be conducted by means of a controlled system, from where water shall be drained into the road drainage system.

In the area where the alignment is placed in embankment, from km 0+000 to km ≈6+390, at roughly every 200 m, certain number of concrete culverts of specific type, dimensions 50x50 cm, is proposed according to the Main Design. The mentioned culverts are not designed for the purpose of drainage, but they shall be used as animal passages. The exact layout of the proposed culverts shall be defined in further stages of design development.

Structures

- ***Retaining walls***

There are four retaining walls planned within the intervention area:

- Retaining wall (L= ca 25 m) ca from 7+250 to 7+275
- Retaining wall (L= ca 340 m) ca from 7+800 to 8+140
- Retaining wall (L= ca 110 m) ca from 8+325 to 8+435
- Retaining wall (L= ca 75 m) ca from 9+860 to 9+935

- ***Viaducts and bridges***

There are four structures planned within the intervention area:

- Prapratno viaduct (L= ca 206 m) ca from 9+403 to 9+609
- Underpass at Prapratno junction km ca 10+220
- Ston Bridge (L= cca 485 m) ca from 13+065 to 13+550
- Zamaslina underpass km ca 17+000

- ***Tunnels***

There are two tunnels planned within the intervention area:

- Polakovica tunnel (L= ca 1265 m) ca from 11+785 to 13+050
- Supava tunnel (L= ca 1320 m) ca from 13+600 to 14+920

Adjacent service areas and temporary structures

Within the Sparagovići – Doli section, adjacent service area – Sparagovici PUO of D type is planned at km ≈3+450. The mentioned PUO is located at a distance of ca 10 km from Blaca PUO, also of D type, located on the previous route, immediately after the Pelješac Bridge.

Due to the specific requirements of construction of the Intervention, two locations for temporary structures are planned for the purpose of construction sites:

- At km ca 11+500 – immediately before the start of Polakovica tunnel;
- At km ca 15+200 – immediately after the exit from Supava tunnel.

At the same locations, there is a possibility of temporary site stockpile for the excavation material until the material is processes and used for the route or permanently disposed.

Traffic control and management center is planned at the Zaradeže junction within the previous route, at ca 500 m before the start of the Sparagovići – Doli section.

Disposal of excess material

According to the Preliminary Design, preliminary calculation of the amount of excavated material is as follows:

- Route excavation works.....ca 700 000 m^3
- Tunnel excavation works.....ca 320 000 m^3
  TOTAL.....ca 1 020 000 m^3

According to the preliminary geo-technical investigation works, one part of the excess of excavation material shall be disposed in the immediate vicinity of the route through backfilling depression (km ca 1+000, 2+000, 2+200, 2+300, 7+300, 10+500, 11+000). Backfilling of existing depressions along the route shall be carried out in compliance with the landscaping design.

Eventual excess of excavation material not used for construction works shall be disposed of in accordance with the Ordinance on handling the excess of excavation material during construction works that represents mineral raw material, OG 79/14.

Road equipment

Road equipment (road safety barriers, reflective delineators, horizontal and vertical positioning of traffic signs) is designed in accordance with regulations and standards applicable to this area of works.

Road lighting is designed in accordance with applicable recommendations, regulations and rules.

Traffic analysis

The planned route represents an alternative to the existing state road (D414) passing through Ston, as provided for in the Spatial Plan of the Dubrovnik-Neretva County. In terms of its functions, that route should take over the long-distance transport (within the County: through traffic and origin-destination traffic, and part of traffic of the interior) from the current D8 Adriatic Highway and part of D414 Pelješac Highway.

Within the investigated area, the most important road is D8 state road, the so-called Adriatic Highway, which takes most of the traffic in this area. Besides linking the County area with the rest of the Republic of Croatia and further on with Europe, the mentioned road ensures the connection between the County and its neighboring countries – Bosnia and Herzegovina and Monte Negro, and, moreover, through them the connection with the other countries of Southeastern Europe.

Almost all state and county roads within the investigated area are connected to this road.

However, the connection between the area of Pelješac and Korčula and the road network of the Dubrovnik-Neretva County is not satisfactory, and the planned road (including the previous section of the Bridge: mainland – Pelješac) shall replicate the role of the D8 state road and part of D414 state road but at a much higher level of serviceability. As a result, the County area shall become more attractive in terms of travel types characteristic to road transport. This primarily refers to the tourist travel.

In 2003, thorough analyses of the traffic patterns in the investigated area of the County were conducted. These analyses covered D8 state road from Ploče to Karasovići BC, and D414 and D223 access roads. The analyses included origin-destination surveys of motor vehicle drivers, and calibration and classified traffic counting in survey areas and other selected areas within the investigated road network.

Based on the conducted analyses, travel matrices for road motor vehicles were formed between 107 zones in total on the level of average annual daily traffic (AADT). The travels were classified according to the vehicle type and travel objectives (passenger vehicles), that is, according to the load type.

The distribution of the anticipated amount of travels in total on the network model with investment was carried out for each year in which a change in the rate of traffic increase for the period 2014 – 2046 was observed. Travel demand models were defined for the road network with road infrastructure within the area of mainland – Pelješac – mainland as its backbone.

Travel demand forecasts were provided:

1. By means of the method of scoring factors unique to each increase in zone that generates and attracts travels;

2. By applying increase factors obtained from rates of expected traffic increase, with changeable rates of increase from 2014 to 2046, within the following intervals:

	Annual rate %			
Traffic activity forecasts	**2014-2020**	**2020-2030**	**2030-2040**	**2040-2046**
Public road traffic	1.8	1	0.5	0.6
Passenger vehicle	3	1.3	0.5	0.1
Goods vehicle	2.3	1.9	1.5	0.7

Table 1.3.1. Traffic forecast and rate of goods vehicles

Year	ASDT	AADT	Goods vehicle (%)
2019	12.219	5.480	11.1
2046	28.104	9.868	9.5

The construction of the Pelješac Bridge shall distribute the mentioned traffic load between the traffic that shall continue to flow along the D8 state road and a larger amount of traffic that shall be directed over the bridge towards the Pelješac peninsula, thus increasing the level of service, shortening travel time, decreasing vehicle operating costs, and increasing the level of safety, resulting from a drop in the number of road traffic accidents occurring on the state road between Komarna and Zaton Doli. Significant savings in travel time and vehicle operating costs shall be achieved through avoiding

the double border between the Republic of Croatia and Bosnia and Herzegovina, particularly in view of the implementation of the future Schengen border regime on the mentioned border crossings.

2. ALTERNATIVE SOLUTIONS OF INTERVENTION

During the preparation of Preliminary Design for the route, several potential alternatives to the solution were developed. Following in-depth analyses, two alternatives were selected to be thoroughly reviewed.

Alternative 1 represents the route for which Location Permit was already obtained in 2007 (Class: UP/I-350-05/06-01//00072) and prolonged in 2009.

Alternative 2 represents the selected route covered in this Environmental Impact Assessment Study.

The two alternatives were analyzed on the basis of their technical characteristics, potential environmental impacts and construction possibilities.

Since the Location Permit for the route (Alternative 1) had been previously obtained, this route was introduced into the Spatial Plan of the Municipality of Ston (OJ of the Dubrovnik-Neretva County, 9/10).

As subsequent analyses indicated that the second Alternative should be selected (Alternative 2), the route of that Alternative was introduced into the amendments of the Spatial Plan of the Dubrovnik-Neretva County (OJ of the Dubrovnik-Neretva County, 7/10), as well as into the amendments of the Spatial Plan of the Municipality of Ston (OJ of the Dubrovnik-Neretva County, 5/15).

Alternative 1

The route starts (at km 0+000.00) in the area of Dančanje close to the settlement of Sparagovići (on the existing D414 state road). From there the route passes through the area of Prapratno (at km ≈10+000.00) to enter the Polakovica tunnel at km 11+900.00. Next, after passing over the Ston Bridge, the route runs over south slopes of Supava to reach its end at the Doli junction on D8 (at km 17+890.94).

The route is 17.89 km long.

The Location Permit was initially obtained for this Alternative, but it expired in the meanwhile.

The disadvantages of Alternative 1 compared to Alternative 2 can be seen in the following aspects:

- **Construction – bridge over the Ston Channel:**

  As this area of Croatia is seismically most active, the seismic loading shall be one of the critical aspects while defining construction features of the bridge, where again Alternative 2 gains advantage due to the following:

  - Superstructure that is lighter in weight (490/645 = 75%)
  - Plan view of the bridge in Alternative 1 is extremely unfavorable, because, in case of longitudinal earthquake, earthquake forces cannot be equally distributed between all pier locations. Consequently, strong and unfavorable effect of global rotation of the bridge superstructure around the vertical axis is produced. Due to the issue of longitudinal earthquake, the use of dampers is planned in all pier locations. The bridge is longer (roughly 645 m) compared to Alternative 2 (roughly 485 m), and as such it is more cost-effective.

The related construction works are more complicated and harder that what is the case in Alternative 2.

- Since the road is classified as the road for exclusively motor vehicle traffic with design speed of V_p=90 km/h, using the route of the existing road would imply a larger reconstruction of the horizontal elements of the road as its current condition dos not fulfil the necessary requirements set out in the applicable Ordinance on basic conditions regarding traffic safety aspects to be met by public roads outside settlements and their elements (OG 110/2001). Due to the configuration of the terrain, arable land and certain structures, within that area, the reconstructed D414 could follow the corridor of the existing road only to a lesser extent. The route of the planned road primarily has a through-traffic function with an interval between Zaradeže and Prapratno junctions of roughly 10.5 km, between which there are no possibilities of joining or leaving the route. Since there are surface areas of valuable agricultural land (vineyards) within the subject area of the existing D414 state road, the access to the mentioned surface areas from the road reserved exclusively for the motor vehicle traffic would be impossible and consequently, the construction of alternative access corridors would be necessary.

  The construction of the proposed section shall result in a significant reduction of the through-traffic load within the section of the existing D414 state road, thus causing the route to become more active in terms of tourist activities (cycling trails, visits to numerous wineries and vineyards within the area f settlements of Metohija, Boljenovići and SParagovići). At the same time, the existing route communication between the settlements in the interior of Pelješac and Ston would remain intact.

- **Construction – route:**

Laying out of the route over south, extremely steep slopes of Supava requires very deep side-hill cuts and through cuts. Apart from the fact that their execution implies complicated construction works due to the questionable geo-mechanical stability, such construction shall devastate the natural features of Supava and have adverse impacts on the surrounding landscape.

Due to extremely high through cuts, very expensive rehabilitation of slopes shall have to be planned, including: nets, anchor bolts, steel cables, and walls of crushed stone.

- **Exploitation:**

Such laying out of the route resulted in the unfavorable control of alignment (alignment grade is steeper, and vertical curves are of shorter radii than in Alternative 2), thus producing a negative effect in terms of driving-dynamics aspects.

Alternative 2

The route of Alternative 2 has been outlined in detail in Chapter 1 of this Study. This route solution proposes construction of two tunnels (Polakovica and Supava) compared to one traffic porposed by Alternative 1. Due to this, the development costs for Alternative 2 are seemingly higher (taking into consideration greater length of the bridge

over the Ston Channel and the costs of through cut and its protection along the slopes of Supava in Alternative 1, the estimated costs for the two Alternatives are closely equal), but this alternative resolves a series of issues occurring as a result of laying out of the route along the south slopes of Supava.

Furthermore, Alternative 2 has a more favorable maximum used longitudinal grade of 3.4% compared to Alternative 1.

As the selected alternative of the route, Alternative 2 was introduced into the Spatial Plan of the Dubrovnik-Neretva County, and consequently, into the amendments to the Spatial Plan of the Municipality of Ston.

3. DESCRIPTION OF INTERVENTION LOCATION AND ENVIRONMENTAL DATA

3.1. INFORMATION ON LOCAL GOVERNMENT AND SELF-GOVERNMENT UNITS

The Intervention: D414 state road, section: Sparagovići – Doli is roughly 18.00 km long and entirely located in the area of the Dubrovnik-Neretva County, Municipality of Ston. The route passes through Cadastral Municipalities of Dančanje, Zabrđe, Sparagovići, Boljenovići, Ston, Broce and Zaton Doli.

3.2. ANALYSIS OF INTERVENTION COMPLIANCE WITH SPATIAL PLANNING DOCUMENTATION

The proposed Intervention: D414 state road, section: Sparagovići – Doli is located in the area defined by the following spatial planning documentation:

1. **Physical Planning Program of the Republic of Croatia** (Ministry of Physical Planning, Building and Housing, Department of physical planning, 1999, amendments to the Physical Planning Program of the Republic of Croatia (OG 84/13));

2. **Transport Development Strategy of the Republic of Croatia 2014-2030** (OG 131/14);

3. **Spatial Plan of the Dubrovnik–Neretva County** (OJ of DNC no 6/03, 3/05-complying, ~~3/06~~*, 7/10, 04/12.-corr. and 9/13 and 2/15- complying), (* - Judgment from High Administrative Court of RC, Number: Usoz-96/2012-8 of 28/11/2014, OG 10/15 of 28/1/2015));

4. Spatial Plan of Municipality of Ston (OJ of DNC, 9/10, 5/13-corr. and 5/15).

3.3. CHARACTERISTICS OF NATURE

3.3.1. Biodiversity

Protected areas of nature

The route is located within the area of two protected areas of nature:

- Significant landscape: Uvala Prapratno od km cca 8+900 do km cca 10+500;
- Special Reserve: Malostonski zaljev od km cca 14+000 do km cca 18+728

Ecological network

The proposed Intervention passes through two areas included in the ecological network and important for habitats and species:

- **HR3000163 Stonski kanal**
- **HR2001364 JI dio Pelješca**

and through one area important for birds:

- **HR1000036 Srednjedalmatinski otoci i Pelješac**

On the basis of analyzed potential impacts of the planned Intervention, and taking into consideration the characteristics and location of the Intervention and its position within the ecological network areas, the Ministry of Environmental and Nature Protection, within the procedure of the Preliminary assessment of the acceptability of the Intervention for the ecological network, has evaluated that the Intervention might exert a negative impact on the target objectives and integrity of the ecological network. In relation to this, a Decision (Class: UP/I612-07/14-60/101, Reg. no: 517-07-1-1-2-14-4) was issued on 27 October 2014, in Zagreb, stating that the Main acceptability assessment for the ecological network was mandatory. In compliance with the Regulation, the Main assessment forms a separate chapter within the Environmental Impact Assessment Study.

Habitats and vegetation

According to the Map of habitats, within the wider Intervention area, the following types of habitats are located:

- A.4.1.1.1. *Phragmites australis ("vulgaris")*
- A.4.1.1.3. *Scirpetum lacustris;*
- A.4.1.1.6. *Typhetum angustifoliae;*
- A.4.1.1.7. Community of *Scirpetum maritimi;*
- A.4.1.2.9. Community of *Cyperetum longi*;
- C.3.6.1.1. *Brachypodio-Cymbopogonetum hirti*;
- C.3.6.1.3. *Oryzopsetum miliaceae*;
- D.3.1.1.1. *Rhamno-Paliuretum*;
- D.3.4.2.1. *Erico-Cistetum cretici*;
- E.3.5.5. *Fraxino orni-Quercetum virgilianae*;
- E.8.1.1. *Fraxino orni-Quercetum ilicis*;
- E.8.1.2. *Quercetum ilicis-virgilianae;*
- E.8.1.3. *Myrto-Quercetum ilicis*;
- E.8.2.5. *Erico-Arbutetum*;
- E.8.2.7. *Querco ilicis-Pinetum halepensis*;
- F.2.1.1.1. *Echinophoro-Elymetum farcti*;
- F.3.1.1.1. Community of *Euphorbio-Glaucietum flavi*;
- F.4.1.1.2. *Limonietum anfracti*;
- G.3.2.3.5. Biocensis of muddy sands of sheltered coasts with *Zostera noltii* as predominant species;
- G.3.5.1. Biocenosis of community of *Posidonia oceanica;*
- I.1.1.1.1. Community of *Asplenio-Umbilicetum horizontalis*;
- I.1.2.1.3. Community of *Fumario-Cyperetum rotundi*;
- I.1.2.2.1. Community of *Hordeetum leporini*;
- I.1.5.1.2. Community of *Sambucetum ebuli*;
- I.5.2. Olive groves;
- J.3.3.1. Drystone walls (old walls).

Plant species

According to the Flora Croatica database (further in the text FCD), almost 1100 of plant species have been identified on the Pelješac peninsula.

In Red Data Book of Vascular Flora of Croatia (Nikolić and Topić, 2005), within the RB category (critically endangered species), there are nine species detected on Pelješac, whereas there are 14 of them within the EN category (endangered species). Finally, there is a total of 18 species within the VU category (vulnerable species), and 41 endemic species on Pelješac.

Within the wider area along which the route passes:

1. There are no species from **CR** category (critically endangered species);
2. There are six species from **EN** category (endangered species);
3. There is a total of five species from **VU** category (vulnerable species);
4. 15 plant species from the category of near threatened species (**NT**) belong to the category of protected plant species;
5. There may be 22 **endemic** plant species.

Fauna

Typical representatives of fauna along the edges of meadows and maquis are population of field mice *(Apodemus agrarius*), fat dormouse (*Glis glis*) and Stone Marten (*Martes foina*), and in olive groves and gardens, southern white-breasted hedgehog (*Erinaceus concolor*) can be found. Several types of bats, which are active at dusk, live in cracks in rocks and in caves, whereas Italian wall lizard (*Podarcis sicula*) and sharp-snouted rock lizard (*Lacerta oxycephala*), being an endemic species of the Adriatic coast, are characteristic to rocky habitats.

Invasive species

According to the FCD, there are 21 invasive species within the wider Intervention area.

Removal of vegetation along the route of the planned road shall result in the creation of new open habitats, favorable for appearance and spread of numerous invasive species. It is precisely on these anthropogenic habitats where invasive species have an advantage over indigenous species.

Among animal species, the following ones are characteristic to the area of the Pelješac peninsula: golden jackal (*Canis aureus*) with the biggest number of specimens in Croatia precisely within this area, small Asian mongoose (*Herpestes javanicus auropunctatus*), mouflon (*Ovis aries musimon*) and wild boar (*Sus scrofa*).

Inserted document (pages 31 to 33 in the original document):

Decision issued by the Ministry of Environmental and Nature Protection (27 October 2014) to the Competent Authority, Croatian Roads Ltd., authorized by Institute for Design Engineering, stating that the Main acceptability assessment of the proposed Intervention for the environmental network is mandatory.

3.3.2. Geodiversity

Within the investigated area, the closest protected area of geological heritage importance, Gromača Cave at a distance of 23 km southeast from the proposed Intervention. Due to large distance from the proposed Intervention, impacts on this protected area are not expected and, consequently, this area has not been further analyzed in the Study.

3.4. ENGINEERING-GEOLOGICAL, SEISMOTECTONIC AND HYDRO-GEOLOGICAL PROPERTIES

3.4.1. Geological properties of the investigated area

Wider area of Ston and Pelješac peninsula is characterized by Cretaceous, Paleogene and Quaternary deposits. In its entire length, the designed route passes through carbonate sediments. In general, the investigated area along the designed route (according to the Basic Geological Map of Croatia – further in the text OGK) can be divided in limestones and dolomites of Lower and Upper Cretaceous epoch.

Shape and intensity of occurrence of certain relief forms, as well as their size, are a consequence of interdependent geological, pedological and climate characteristics. Relatively high hilly ridges with elongated valleys cut between them represent a typical relief of the Pelješac peninsula.

Within the intervention area on the Pelješac peninsula, the surface cover has been influenced by the development of various activities (agriculture, forestry, construction), and, in turn, their development has been affected by interdependent relationships (soil, relief, water, climate), cultural and technological achievements, as well as social relationships evolving in this area throughout history. Nowadays, the surface areas of narrow terraces covered in vineyards and located at higher altitudes are neglected and overgrown with natural vegetation, whereas large surface areas of natural vegetation are being cleared and new vineyards are being planted by means of modern machinery. Consequently, once very widespread agricultural production in the valleys has been reduced.

To a large extent, the planned route passes through forest land, through areas of grassland, shrub land and areas of sparse vegetation and other natural areas. It also passes, to a small extent, through agriculturally productive land and constructed areas, as well as through areas affected by anthropogenic impacts.

3.4.2. Engineering-geological properties of the investigated area

Engineering – geological phenomena and processes

According to the available literature, within the closer route area, no significant instabilities have been recorded.

Engineering – geological types of sediments

Engineering – geological properties of the rock mass are determined by the properties of intact rock (type of rock, uniaxial compressive strength, Hoek material constant), by structure and tectonic setting and exogenous engineering – geological processes.

Table 3.4.1. Distribution of engineering-geological types of sediments according to chainage

CHAINAGE		ENGINEERING – GEOLOGICAL TYPE OF SEDIMENT	DESIGNATION
FROM	TO		
0+000	2+000	Upper Cretaceous - Turonian	K_2^2
2+000	11+600	Upper Cretaceous – Senonian	K_2^3
11+600	12+200	Lower Cretaceous – Hauterivian, Barremian	K_1^{2-4}
12+200	12+400	Lower Cretaceous - Albian	K_1^5
12+400	12+750	Lower Cretaceous - Hauterivian, Barremian	K_1^{2-4}
12+750	13+100	Lower Cretaceous - Albian	K_1^5
13+100	14+000	Upper Cretaceous - Cenomanian	K_2^1
14+000	16+800	Upper Cretaceous - Turonian	K_2^2
16+800	18+072	Upper Cretaceous - Senonian	K_2^3

3.4.3. Seismotectonic properties of the investigated area

In terms of tectonic properties, there are two basic tectonic units within the wider intervention area:

- High Karst overthrust
- Ston – Pelješac peninsula tectonic unit, corresponding to parautochthonous

High Karst overthrust is composed of Mesozoic rocks, with rudist limestones and dolomites ($K_2^{2,3}$) of Turonian and Senonian located immediately next to its front. Folded and flaky structure of tectonic unit of Ston – Pelješac peninsula is overlaid with the Turonian and Senonian sediments and consists of sediments of Lower and Upper Cretaceous epoch, and of Paleogene. In its entire length, the route passes along the tectonic unit of Ston –Pelješac peninsula and very close to the High Karst overthrust.

Taking into consideration regional and local seismic activity, the proposed location of the route is in the area of extreme seismic activity.

Earthquakes in this area are the result of moving of the structural complex of the Adriatic carbonate platform (Adriaticum) under (subduction) the structural complex of the Dinarides (Dinaric). The direction of subduction is south-north. As a result of resisting these movements, there is a relatively wide area of intense compression being created along Biokovo. Rocks are folding and faulting in depth, and moving inversely along the faults reaching up to the surface. These processes are followed by occurrence of earthquake. Gravity gradient zones indicate bigger movements of rock masses at depth along Biokovo. The seismotectonically active zones are steeply inclined at depth. The strongest earthquake occur in zones reaching a depth of 10-20 km. Even within the regional structural unit of Adriaticum, therr have been earthquakes mostly related to the Pelješac – Dubrovnik fault and to the fault parallel to the island of Mljet.

3.4.4. Hydro-geological properties of the investigated area

In terms of hydro-geological properties, all weathered carbonate rocks within the route area belong to the group of carbonate rocks characterized by high permeability, possibility of fast infiltrating of precipitation from terrain surfaces, and by fast underground streams, apart from Quaternary deposits within the area of Ston where thick sediment layers of clayey material that are practically impermeable prevail.

Due to the mentioned properties, there are no permanent watercourses in the area of Pelješac peninsula, and the function of dewatering is carried out by underground channels and groundwater. In some areas, after heavy and short-lasting rainfall, intermittent short-lasting flows occur on the surface. After flowing for a definite time, these flows soon drain into the permeable rocks. Watercourses within the investigated area mostly emerge from areas at higher altitudes (NW of Ston Field), largely from the Hill of Ilija from where they flow into three different directions: Bays of Brijesta and Bjejevica, the Ston Channnel, and Bay of Prapratna.

Important water phenomena are related to the Ston Field, where tapped source of Studenac located at the edge of the Ston Field feeding the Ston water supply system with between 15 and 20 l/s (Table 3.4.6.). Marking of groundwater flows has resulted in tracing watercourses flowing from north-west, from the central part of the Pelješac peninsula. Besides the Studenac spring, within the area of Ston Field, the so-called Roman well has been captured. The water from the Roman well is directed through gravity-fed Roman pipelines to the fountain placed at the heart of Ston. During 1980s, the Roman well was captured again, and its intake during the pump trial was around 20 l/s, but it has never been used for the public water supply system. Today this intake structure is still ready to be included into the public water supply system. Apart from the mentioned water capture zones, there is a large number of irrigation wells in the Ston Field. The Roman well has shown that the impermeable clay cover in the Ston Field is 18 m thick, and that, in a specific way, it prevents freshwaters from the carbonate massif from flowing freely towards the sea, and springing of water occurs along the edge of this horizontal impermeable layer. At the same time, the horizontal barrier prevents the intrusion of seawater into the aquifers, thus ensuring that these springs do not become salinated even during long and dry summer periods.

Hydro-geological properties of sediments

In terms of hydro-geological properties, the route area is characterized by as follows:

- Well karst aquifers – cavernous-fracture porosity – K_2^2 i K_2^3
- Medium karst aquifers – cavernous-fracture porosity – K_1^{2-4} i K_1^5 i K_2^1

Besides the above-mentioned elements in the Ston Field (which is not within the route area), thick deposits of clay material that are practically impermeable – intergranular porosity.

Impermeable quality of geological layers

In its entire length, the planned route is located in the area of karst carbonate rocks belonging to the ***type of well-permeable*** carbonate rocks with the possibility to absorb precipitation from surface terrains and with relatively fast groundwater flows.

3.5. WATER BODIES IN THE INTERVENTION AREA

Surface waters

The investigated area of Intervention belongs to the Adriatic Basin District.

Within the zone of immediate impact, that is, within the area of the Pelješac peninsula, there are no permanent surface watercourses. Intermittent torrential streams occur on the surface which flow directly into the sea and have no direct relation to the sub-basin of River Neretva.

The largest watercourse of such a type is Stream Perunski located within the zone of wider intervention impact. Other intermittent watercourses in the area of Municipality of Ston are: Žuljana, Zamijače, Brijesta, Zabrđe, Boljenovići, Žukovica, Dobra Stonska, Zaneum, Studenac and Broce. Along the stretch from ≈6+000 km to ≈8+400 km, the route is placed immediately next to the bed of the torrential watercourse of Zaneum, which shall have to be regulated at certain points on that stretch. There are no marked permanent or temporary watercourses along the rest of the route.

According to the River Basin Management Plan 2013 – 2015 (OG 82/13), there are data on the status of temporary surface water bodies - **JKRN945003** (Stream Perunski) and **JKRN945006** (Brijesta) within the location of the planned Intervention.

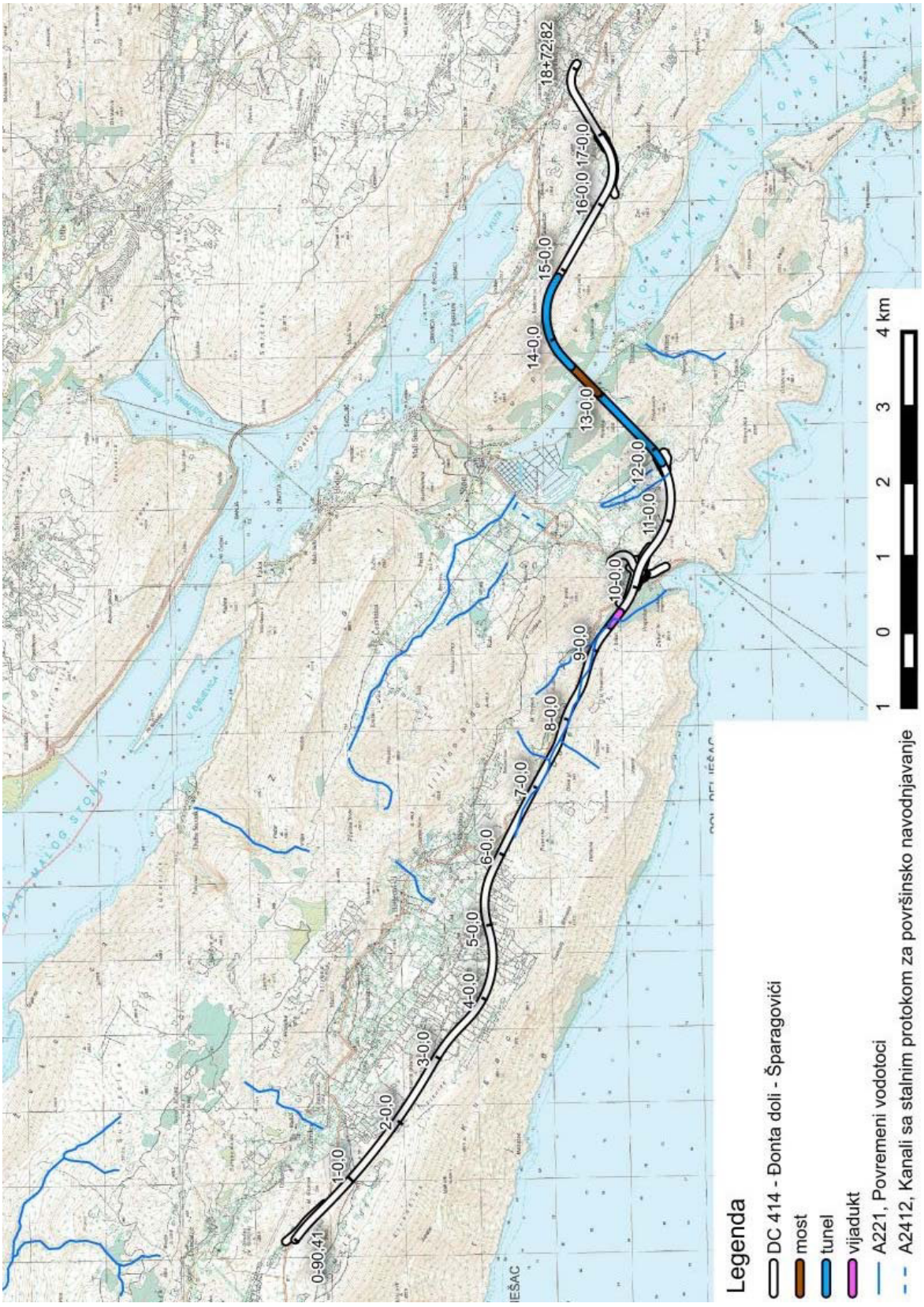

Figure 3.5.1. Intermittent torrential streams in the intervention area

Status of temporary water bodies of JKRN945003 and JKRN945006 is presented in Tables 3.5.1. and 3.5.2

Table 3.5.1. Status of water body JKRN945003 (type T27A)

Status		Parameters	Assessment of status	Limit values of parameter concentration for*	
				Assessed status	**Good status**
Ecological status	Chemical and physico-chemical elements supporting the biological quality elements	BPK_5 (mg O_2/l)	High	< 2,0	< 2,6
		KPK-Mn (mg O_2/l)	High	< 4,0	< 5,6
		Total nitrogen (mgN/l)	High	< 1,5	< 2,1
		Total phosphorus (mgP/l)	Good	0,1 - 0,26	< 0,26
	Hydromorphological status		Moderate	20% - 40%	<20%
	Overall status related to chemical, physico-chemical and hydro-morphological elements		Moderate		
Chemical status			Good		
*according to the Regulation on water quality standards (OG 89/2010)					

Table 3.5.2. Status of water body JKRN945006 (type T19A)

Status		Parameters	Assessment of status	Limit values of parameter concentration for*	
				Assessed status	**Good status**
Ecological status	Chemical and physico-chemical elements supporting the biological quality elements	BPK_5 (mg O_2/l)	High	< 2,5	< 3,6
		KPK-Mn (mg O_2/l)	High	< 4,0	< 5,6
		Total nitrogen (mgN/l)	High	< 1,5	< 2,1
		Total phosphorus (mgP/l)	High	< 0,15	< 0,26
	Hydromorphological status		High	< 0,5%	<20%
	Overall status related to chemical, physico-chemical and hydro-morphological elements		High		
Chemical status			Good		

Status	Parameters	Assessment of status	Limit values of parameter concentration for*	
			Assessed status	**Good status**
*according to the Regulation on water quality standards (OG 89/2010)				

Groundwater

The entire area of Pelješac and Dubrovnik is located within the grouped water body of JKGIKCPV_11-Neretva. Within the area of wider intervention impact, only source zones of the grouped water body of Neretva are located in Croatia, and its major part is located on BIH.

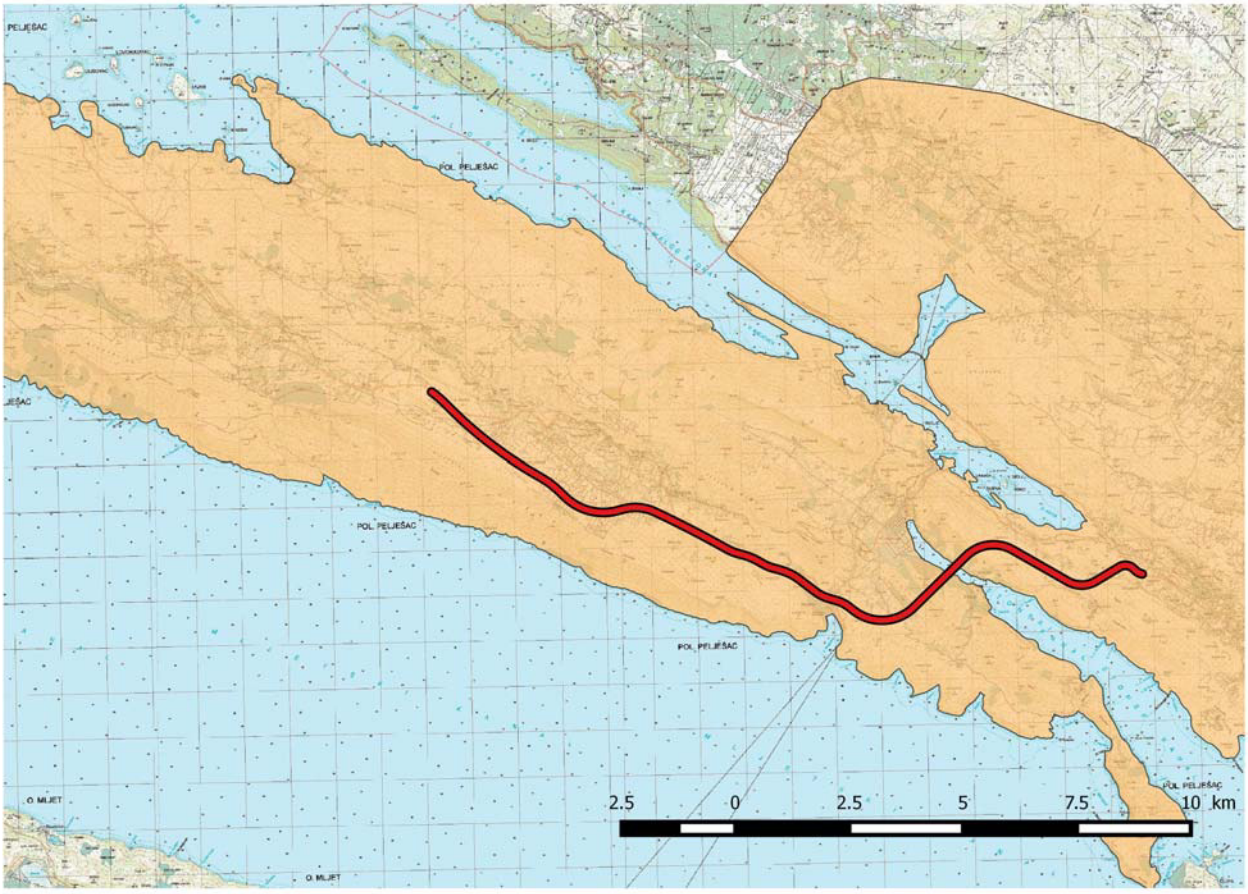

Figure 3.5.2. Area of grouped water body of JKGIKCPV_11-NERETVA in the intervention area

Table 3.5.3. Basic data for water body

Designation	JKGIKCPV_11
Name of the grouped groundwater body	Neretva
Porosity	Fracture and cavernous, intergranular
Surface (km^2)	2 037,20
Average annual inflow of groundwater ($*10^6$ m^3/god)	854
Natural vulnerability	High to moderate
Ecosystems depending on the groundwater (according to the national ecological network)	Prološko Mud Badnjevica Canyon Vrljika Side channel along Vrljika Red Lake Blue Lake Vrljika Field Lake Neretva Delta Ston Field Paleombla-Ombla Snježnica and Konavosko Field
Ecosystem type	Water
State to which the grouped water body belongs to	Republic of Croatia

Status of the grouped water body of JKGIKCPV_11-NERETVA:

Table T3.5.4. Status of the grouped water body of **JKGIKCPV_11-NERETVA**

Status	Assessment
Chemical status	Good
Quantity status	Presumably poor
Overall status	Presumably poor

Coastal waters

Coastal waters of type O423 prevail within the wider zone of the Intervention (Pelješac peninsual).

The status of the coastal water body of O423-MOP is presented in Table 3.5.5:

Table 3.5.5. Status of the coastal water body O423-MOP (type O423)

Status		Elements	Assessed status
Quality elements	Quality status	Phytoplankton	High/reference
		Concentration of nutrient salts	High / reference
		Oxygen saturation	High / reference
		Concentration of chlorophyll a	High / reference
		Macro-algae	High / reference
		Posidonia oceanica	High / reference
		Benthic invertebrates	High
Hydromorphological status*			High
Ecological status			High
Chemical status			Good
Overall assessed status			Good

***expert assessment**

Public water supply well area in the intervention area

Lack of water is a characteristic of larger part of Pelješac peninsula, as well as of Municipality of Ston, which does not dispose of permanent springs or watercourses, besides a few found and captured groundwater springs of low intake that are used only for local purposes. The issue of drinking water supply is one of the crucial issues of this area. Ston along with the surrounding settlements (Mali Ston, Hodilje, Luka, Stonska Duba, Broce, Prapratno) has got a functional water supply system.

The water supply system is supplied through the Studenac spring located in the Ston Filed. The current intake capacity of the spring (10 l/s) does not meet increasing demands. Detailed hydro-geological survey of the Oko spring has shown that new quantities of water (15 l/s) would fulfill the demands of this area.

In its entire length, the Intervention D414 State road, section: Sparagovići – Doli passes outside the area of sanitary protection of water supply.

Risk of floods

In accordance with the Main Flood Defense Plan (Croatian Waters, July 2015), the wider investigated area belongs to the area of small basins of Neretva – Korčula and Dubrovnik coast and islands, area of Pelješac Bujica.

The protection of the route from runoff gravitating from basin areas along the route is provided by means of parallel ditches with culvert systems that drain the runoff water under the road and discharge it into the terrain or bed of the Zaneum watercourse.

3.6. CLIMATE CHARACTERISTICS AND AIR QUALITY

According to the Köppen climate classification system, the intervention area as well as the area of the entire Pelješac peninsula belongs to the region of Csa climate type, that is, is characterized by a Mediterranean climate with hot summers measured within the standardized period of 1961 to 1990. General characteristics of this climate are hot summers with little precipitation and short mild winters with the largest amount of annual precipitation.

Air temperature

According to the data obtained at the nearest weather station, Ston, average annual temperatures is 15.2 °C. The average temperature in the hottest month, July, is 24.8 °C, whereas it is 7.1 °C in the coldest month, January. The monthly average maximum value for the hottest month is 30.5°C, whereas the average minimum value of the coldest month is 2.9 °C.

Precipitation

The annual average amount of precipitation recorded at the Ston weather station is 1414 mm, and the quantity of precipitation in the driest month is less than 40 mm. Within the area of Dubrovnik and Trsteno, the total annual amount of precipitation is rather high, 1073.2 mm in Dubrovnik and 1122.4 mm in Trsteno. On average, there are around 110 precipitation days a year, with the exception of summer months when it rains every third day.

Wind

According to the data obtained at the nearest weather station, Ston, among winds, the most common is jugo – SE (most frequent in the Channels of Mljet and Ston), bora – NE (most frequent and strongest on the north coast), and mistral – NW in the Channels of Pelješac and Mljet. Rare gusts of bora from the area of the Ston Channel (so called stončica) are dangerous (because of morphology of the terrain it is directed towards NNW-SSE).

3.7. CLIMATE CHANGES

Greenhouse gas emissions

In 2011, the total emission of greenhouse gases in the Republic of Croatia was 28 256 kt corresponding to 6.5 t/capita (average in EU-27 was 9.2 t/capita in 2011). The energy sector, along with the transport sectors, contributes most to the emission of greenhouse gases.

In 2011, the transport sector represented 28.4% of the total emissions produced by the energy sector and 20% of the total nationwide emissions. The biggest percentage of emissions produced by the transport sector comes from road traffic (95.1% of the transport sector).

Forecasts of greenhouse gas emissions by 2030 are shown within the framework of the 5th National Report of the Republic of Croatia prepared in accordance with the United Nations Framework Convention on Climate Change. The overall forecasts have been made for three different scenarios: 'without measures', 'with measures' and 'with additional measures'. According to these forecasts for the period of 2012 – 2025, the emissions of greenhouse gases shall increase in spite of the implementation of measures.

More precisely, these forecasts predict a mild increase in the emission in the transport sector even in case of the 'with measurers' scenario, which includes the measures proposed by the Croatian Energy Strategy.

Climate variations in the wider intervention zone

This paragraph lists annual and seasonal variations in the area surrounding Dubrovnik, from 2004 to 2014 for parameters of temperature and precipitation compared to the period of 1961 to 1990. Throughout the investigated period, even extreme climate variations have been recorded. Furthermore, climate changes in future climate have been analyzed and presented through two 30-year intervals (period from 2011 to 2040, and period from 2041 to 2070).

The analysis of maps of climate trends in the period from 2003 to 2013 has shown a significant increase in temperature compared to the climate average values of period from 1961 to 1990.

Forecasts for changes in air temperature

The climate changes in the future climate patterns within the area of the Republic of Croatia obtained by means of climate simulations developed by the Regional Climate Model system RegCM according to the A2 scenario (Source: Meteorological and Hydrological Service of Croatia) have been analyzed for two 30-year intervals:

- Period from 2011 to 2040 represents near future and it is of most significant interest for the users of climate information while making long-term plans for climate change adjustments.
- Period from 2041 to 2070 represents middle of 21st cent. when, according to the A2 scenario, a further increase in the carbon dioxide concentration (CO2) in the atmosphere is expected, thus indicating that the climate change signal is stronger.

According to the RegCM results for the Croatian territory, the ensemble average simulation indicates an increase in the air temperature in both periods in all seasons. Increase amplitude is higher in the second period, but it is statistically important for both periods. The increase in the average daily air temperature is higher in summer (June-August) than in winter (December-February).

Forecasts for precipitation changes

Changes in the precipitation in near future (2011 – 2040) are very small and limited only to smaller areas. Furthermore, they vary in positive/negative sign according to the season. According to the A2 scenario, the major change in precipitation can be expected along the Adriatic Coast in fall when RegCM indicates a decrease in precipitation compared to the maximum of roughly 45-50 mm in the southern Adriatic.

However, this decrease in the amount of fall precipitation is not statistically significant. In that period of future climate trends (2041-2070), changes in precipitation in Croatia are somewhat more important. In view of that, there is a decrease in precipitation expected during summer in both mountainous and coastal regions of Croatia.

These drops in precipitation reach values of 45-50 mm and they are statistically significant. In winter, an increase in precipitation in north-west Croatia and along the Adriatic coast can be expected, but this increase is not statistically significant.

3.8. NOISE

One of the negative impacts of the construction of the road is increase in levels of noise in the area surrounding the road. Such an impact can be exerted in both construction and operational phase. During the construction stage, the noise is produced by constructing machinery and, potentially, by rock blasting, whereas during the operational stage, its main source is traffic. The noise impacts during the construction works are temporary and most often limited to only several months, whereas the noise produced by traffic flows is permanent and ongoing (24 h/day).

Compared to the levels of noise generated during construction works which are hard to predict because they depend on the applied technologies, the levels of noise produced once the road is in use can be calculated with high accuracy. The noise generated on the road depends on the quantity and structure of traffic, as well as on the technical characteristics of the road.

Based on the results obtained from these calculations, the zones in which the levels of noise exceed the permissible level of 50 dB have been identified. As a result, locations where noise protection walls shall be constructed have been determined. The construction of noise protection walls is preliminary planned on one location:

- from km ≈9+932 to km ≈9+996 – right ..... l=ca 64 m

3.9. ECONOMIC CHARACTERISTICS

3.9.1. Soil and agricultural land

Pedogenetic properties

Within the area of the planned construction of the bypass rood of Ston (D414) – (Sparagovići – Doli), it is necessary to stress several pedogenetic factors, namely, the type of base rock as one of the most important factors. The western part of the road access route passes through an area of limestone rock, whereas towards its final part, that is, its eastern part, the route passes through an area of limestone dolomitic rock mass. Therefore, the dominant base rock consists of limestones and dolomites.

In view of the geomorphological properties, the investigated route of the bypass road is to a large extent located on a very steep terrain with an inclination of 30% and even higher. As an important factor in the distribution of water within this area, the relief plays a significant role in the soil pedogenesis. In this specific case, micro-relief has a strong impact on the origin and formation of the soil, which has led to the formation of automorphic soil on the investigated terrain.

Pedophysiographic properties

There are automorphic soils within the entire route location. Amon them, there are rendzina, calcocambisol and vineyards as examples of anthropogenic soil.

Productivity potential and quality of soil

According to the research conducted within the Project of Regionalization of fruit production in the Republic of Croatia, taking into consideration environmental constraints and specific requirements of certain fruit kinds, the area of agriculturally productive land in Croatia is divided into five regions, namely: East-Pannonian, West-Pannonian, Mountain, Northern Adriatic and Dalmatian region. For the Dalmatian fruit region, within which the proposed route is located, surface areas facilitating the growth of specific fruit kinds have been defined (apples, pears, plums and cherries, peaches, apricots, sweet cherries, hazels, walnut, blackberries, strawberries, blueberries, almonds, figs, and citrus fruits).

In addition, a regionalization of medicinal and aromatic crop production in Croatia has also been conducted, based on which Croatia has been divided into 3 regions and 9 sub-regions. In this case, the proposed route belongs to the southern sub-region of the Adriatic region.

Within the wider investigated area, limited surface areas of agriculturally productive land and lack of water have hindered the agricultural development through history. Viticulture has developed most, followed by olive cultivation and growing of fruits and vegetables, and livestock farming to a certain extent, as well as the production of tobacco. Additional and seasonal activities implied collecting medicinal and aromatic plants. More throughout history than nowadays, vast pasture areas have been used for livestock farming (goats, sheep). Pedoclimatic and ecological properties of the soil enable undertaking of agricultural activities only within a limited area of the municipality. Particularly valuable agriculturally productive area is that of Brijesta Field and Ston Field, as well as Žuljana hollow and Crna Gora and Ponikve on Pelješac. However, there are also some smaller agriculturally productive surface areas that are worth mentioning in this context (field, smaller fields, coves, hollows) and that are located in the vicinity of certain settlements.

Roughly 3000 t of grapes are produced annually in the area of the Municipality of Ston. In fertile years, the yield of olives trees amounts to roughly 300 t of which around 36000 l of olive oil is obtained. Tangerines are grown on roughly 50 ha of land and their annual yield is around 800 t.

3.9.2. Forest ecosystems and forestry

To a larger extent, the route of the planned road passes through area of state forests and forest lands.

The state-owned forests and forest land within the route area and impact zone of 1000 m from the route are under the jurisdiction of Croatian Forests, Forest Management branch office of Split, forest management authorities of Dubrovnik.

The route of the D414 state road, section: Sparagovići – Doli runs through three commercial properties: Commercial Property of *Štedrica* (further in the text G.J. *Štedrica*), Commercial Property of *Česvinica* (further in the text G.J. *Česvinica*), and Commercial Property of *Zagorje* (further in the text G.J. *Zagorje*).

According to the purpose of forests and forest land, G.J. *Štedrica,* G.J. *Česvinica* and G.J. *Zagorje* fall into the category of forests for commercial purposes (*Myrto-Quercetum ilicis, Fraxino orni-Quercetum ilicis, Quercetum ilicis-virgilianae,*

Querco ilicis-Pinetum halepensis, Querco-Carpinetum orientalis, Ostryo-Quercetum ilicis), and forests for limited commercial purposes (*Stipo-Salvietum officinalis, Pistacio-Juniperetum phoeniceae).*

Within the area of G.J. *Štedrica,* G.J. *Česvinica* and G.J. *Zagorje,* the surface areas of state-owned forest land stretching around the Pelješac state road are covered in *Querco-Ostryetum carpinifoliae* and *Querco-Carpinetum orientalis.*

In view of the economic values of forests, these forest lands are covered in valuable types of forest trees whose economic value is expressed through the value of timber, and through the value of generally beneficial functions of forests (further in the text OKFŠ).

The relief has affected the creation of specific climate patters, which consequently influenced the development of forest vegetation within the route area and impact zone (buffer 1000 m), where the following forest communities can be found:

- *Myrto-Quercetum ilicis*
- *Fraxino orni-Quercetum ilicis*
- *Quercetum ilicis-virgilianae*
- *Querco ilicis-Pinetum halepensis*
- *Querco-Carpinetum orientalis*
- *Ostryo-Quercetum ilicis*
- *Stipo-Salvietum officinalis*
- *Pistacio-Juniperetum phoeniceae*

Risk of fire

In July 2015, the first three kilometers of the future route were destroyed by fire. According to the forest fire risk mapping, this area is designated as the area of very high risk of fire, along with the part of the route located 4 km ahead of the Prapratno junction, that is, section from the Prepratno junction to Polakovica tunnel. The remaining part of the route is in the area of high risk of fire.

Forest soil

There are 4 types of soil identified within the investigated area and intervention impact zone (buffer 1000 m). They are:

- Black soil on limestone and dolomite (Calcomelanosol)
- Brown soil on limestone and dolomite (Calcocambisol)
- Rendzina
- Red soil (Terra rossa)

3.9.3. Game and hunting

Within the investigated area of the future route, there are four designated hunting grounds: XIX/12 – ZAGORJE, XIX/114 – KUNA, XIX/115 STON and XIX/4 PRIMORJE, which are entirely located within the Dubrovnik-Neretva County.

In future, additional hunting structures shall be constructed to fulfil the requirements for hunting ground management, since sufficient number of such structures has not been provided so far (watering holes). In future, these structures will have to be maintained in terms of a 10-year period.

3.9.4. Tourist industry

At the end of 2010, the Dubrovnik-Neretva County has initiated a series of project activities related to the development of the comprehensive Strategy for Development of Tourist Industry specifying the following key objectives:

- Resolving dilemmas and controversies arising from the previous period,
- Dividing the entire county area into tourist clusters whose structure shall be completely consistent with the experiential structure,
- Defining a tourist industry growth model for the County and its clusters,
- Introducing tourist industry management model.

Nowadays the tourist industry of the Dubrovnik-County can be distinguished in terms of higher category (Dubrovnik and Cavtat) and in terms of lower category (rest of the County). Gradually, the tourist industry should be shifted from the city to the rest of the Dubrovnik clusters (Župa and Primorje), Pelješac, Korčula and Mljet. The quality level of other clusters should be improved through an increase in general competitiveness, accommodation quality and through new tourist infrastructure.

In spite of the fact that several clusters have true potential, no significant results have been achieved. The tourist industry represents a product with highest growth potential over the following 10 years, at first through the connection with other products, and later as a stand-alone product. Nautics, MICE (meetings incentives, congresses and exhibitions), and Touring (short holidays among by-products) demonstrate the biggest potential.

The Strategy for Development of Tourist Industry of the Dubrovnik-Neretva County by 2020 clearly defines the important role that Pelješac completing the objectives for both the Pelješac cluster and wider county area.

3.10. INFRASTRUCTURE

Construction areas

The planned route does not run directly through built or unbuilt areas, besides in the Prapratno junction area at km ≈10+500 where the corridor runs immediately along the zone designated as unbuilt construction area. The closest built construction areas are located at a distance of roughly 500 m in the settlements of Metohija and Zaton Doli, which is located at the end of the route.

Zones for commercial and tourist purposes

In the area of Prapratno junction, from km 9+700 to km 10+200, the route passes next to the planned zone intended for tourist purposes and located within the Prapratno Camp.

Within the route section, from km 16+200 to km 16+800, the route passes in the immediate vicinity of the planned zone intended for commercial purposes.

Gradual launch of various services usually offered along the road route (petrol stations, cafes, etc.) may be expected once the route is constructed. As a result, this shall create possibilities for opening new industrial and community zones as well as lead to the development of small and medium-sized enterprises, in particular if we take into consideration favorable location of the road and lack of similar contents in its surroundings.

Traffic infrastructure

Since one part of the new route runs along the corridor of the existing route of the D414 state road which shall continue to be operational, a 700 m-long section of the road shall have to be relocated at the very start of the section, and a 580 m-long section within the Prapratno junction area.

At km 10+200 (Prapratno junction the route of the road crosses the D416 state road (Prapratno (D414) – Prapratno ferry port)

Within the area of the Ston Channel, the route passes via Ston Bridge over two local roads that are located along the channel coast. At km 13+100, the route passes over the route of L69056 local road (Ston (D414) – Broce – Kobaš), and at km ≈13+380 over the L69066 local road (Ston – Supavo – Doli (D8)). At km ≈17+000, the route passes along the corridor of the L69066 local road whose roughly 750 m-long section is at that location relocated and via Zamaslina crossing linked to the existing route network.

At the end of the section, at km ≈17+665, the route connects to the route of D8 state road by means of a T-junction. In case of implementation of the project for construction of A1 motorway towards Dubrovnik and of the connection between the D414 state road and the mentioned motorway, the junction in question shall be reconstructed as grade separated.

Existing and planned infrastructure systems

The route passes through a relatively uninhibited area, but since most of the existing infrastructure systems in this part of the Municipality of Ston is located within the corridor of the existing state road or are located in the direction Ston – Prapratno Bay, there are spots where the route of the future state road crosses with the existing or planned infrastructure systems.

All relocations of the mentioned elements of the infrastructures systems shall be conducted in compliance with the requirements issued by the competent authorities in the further stages of project documentation development.

3.11. CULTURAL AND HISTORICAL HERITAGE

Within the intervention area, the following structures have been identified as cultural heritage:

- **Pod mirine** – late Antiquity defensive wall

- Archaeological zone at the distance of 500 m from the route; not directly affected

- **Tumuli**

- Archaeological zone immediately next to the route at km ≈15+900; directly affected

- **All Saints' Church on Broca cemetery**

- Sacral structure at km ≈13+150, not directly affected

- **Church of St. Srđ**

- Sacral structure above the existing D414 on a hill above Mline and Prapratno; not directly affected

- **Tumuli**

- Archaeological site at km 5+100 and 5+500; directly affected

- **Tumuli**

- Archaeological site between km 3+200 and 3+500; not directly affected

- **Crkvena glavica – hill fort**

- Archaeological site at km ≈2+700, 500 m distant from the route, not directly affected

- **Tumuli**

- Archaeological zone from km ≈0+850 to km 1+000; directly affected.

3.12. LANDSCAPE CHARACTERISTICS

According to the Landscape Regionalization of Croatia in relation to the landscape characteristics, the intervention area belongs to the Coastal areas of Central and Southern Dalmatia. This region is characterized by a coastal mountain range and number of offshore islands. At the root of the coastal mountains, the landscape mostly consists of a narrow and green flysch zone, whereas most islands are characterized by rather large forest cover. Biokovo cliffs and wooded Makarska hinterland impressively dominate the landscape as main landscape values.

The Dubrovnik-Neretva County stands out due to the diversity of its ecological systems and habitats. Since this area has been isolated for many years, even today its numerous natural values remain intact. In this context, natural and cultivated landscapes can be differentiated, as well as a wealthy cultural and historical heritage, shaping the identity of this area. The Pelješac area is protected in many categories, so there are ecological network sites within the wider intervention area, as well as significant landscape (Prapratno Bay), Special Reserve at Sea (Malostonski Bay), protected coastal area, and particularly valuable areas of natural landscape.

The main characteristics of this area are hilly terrain, natural slopes, intact natural vegetation and very sparse anthropogenic elements, as well as clear panoramic views. The area consists of a long stretch of largely inclined slopes providing marked contrast to the flat surface of the valley. The balanced relationship between certain landscape elements and natural cover as the prevailing element contribute to the creation of a uniform and harmonious landscape scenario. The landscape peculiarities of this area are preserved relief and natural surface cover.

Due to its inaccessibility, the area is characterized by a high degree of natural conservation, thus ensuring practically intact indented coastline, forest cover and dynamic relief. Furthermore, this area is part of natural and cultural heritage. Settlements do not dominate the landscape but are embraced by the landscape. Taking into consideration the specific character of this area influenced by the relief, important natural and visual characteristics and insignificant number of anthropogenic elements of predominantly traditional type, it can be stated that the estimated landscape values of this area are very high.

3.13. SOCIOLOGICAL CHARACTERISTICS

According to both surface and population, the Dubrovnik-Neretva County is among smaller Croatian counties. The county's surface area covers 1.780.86 km^2 of the land territory, and according to the last official census taken in 2011, it has 122.568 inhabitants. Based on that, the Dubrovnik-Neretva County covers 3.15% of the country's land territory, whereas 2.64% of the total Croatian population inhabits this area. In terms of its territory, the county is organized in 22 local government and self-government units, that is, in 5 cities/towns (Dubrovnik, Korčula, Ploče, Metković and Opuzen) and 17 municipalities (Blato, Dubrovačko primorje, Janjina, Konavle, Kula Norinska, Lastovo, Lumbarda, Mljet, Orebić, Pojezerje, Slivno, Smokvica, Ston, Trpanj, Vela Luka, Zažablje and Župa dubrovačka).

Sociological characteristics of Municipality of Ston

The Municipality of Ston is located in the south-eastern part of the Pelješac peninsula. According to its territory surface, it is the third largest municipality (169.59 km^2), and according to the last census taken in 2011, it has 2.410 inhabitants, 843 households, and 1.884 residential units. The county's population density is very low, amounting to only 15.36 inhabitants per km^2. The municipality consists of 18 independent settlements, and they are: Boljenovići, Brijesta, Broce, Česvinica, Dančanje, Duba Stonska, Dubrava, Hodilje, Luka, Mali Ston, Metohija, Putnikovići, Sparagovići, Ston, Tomislavovac, Zabrđe, Zaton Doli, Žuljana. The center of the municipality is a settlement bearing the same name as the county, Ston.

The demographic trend is negative, and there has been a decrease in population by more than a third over last 60 years.

According to the main groups of activities conducted in the Municipality of Ston (census in 2001, more recent data are unavailable), the structure of active population is pretty stable. The share of the population active in secondary sector (226 or 22.92%), tertiary (253 or 25.66%) or quaternary (251 or 25.46%) sector is equal whereas there are 135, that is 13.69%, employed in the primary activities. Such data are unknown for 121 inhabitants (12.27%) or they are unemployed.

In terms of its economy, the Municipality of Ston belongs to the group of less developed areas. The following economic activities are stimulated on this territory:

- Primary: agriculture, fishing and seashell farming (mariculture),
- Secondary: smaller production and processing industrial plants, and construction activities,
- Tertiary: beginnings of transport activities, trade, tourist industry, catering industry, and other types of service industry.

The backbone of the economy of the Municipality of Ston is mariculture occupying the most important place in the economic structure of municipality. This primarily refers to the cultivation of oysters and mussels in the Malostonski Bay, but also to the breeding of white fish in cages. Furthermore, this area has had the tradition of production of sea salt (sea salt plant of Ston). The secondary activities are developed mainly as processing plants for agricultural products (first of all, grapes and olives). The largest amount of grapes is processed in the wineries of the agricultural cooperative of Putniković, whereas olives are mostly processed in the cooperative oil mill in Brijesta.

4. DESCRIPTION OF ENVIRONMENTAL IMPACTS DURING CONSTRUCTION WORKS AND USE OF INTERVENTION

4.1. IMPACT ON NATURAL FEATURES

Nature protected areas

- **Protected landscape Uvala Prapratno –** impact as new visual element in the environment
- **Special reserve Malostonski zaljev –** no impact expected

Ecological network

- **HR2001364 JI dio Pelješca**
  - Impact on reptile target species: *Zamenis situla* and *Testudo hermanni*; direct habitat lose as well as fragmented habitat and higher possibility of roadkill.
  - Habitat conversion of 9340 9340 Vazdazelene šume česmine (forest of *Quercus ilex*) with the area of 8.52 ha, which is 0.09% ecological network area
  - Habitat conversion 5210 5210 Mediteranske makije i kojima dominiraju borovice *Juniperus spp.* (Mediteranian maquis with *Juniperus spp.)* with an area of 2.78 ha, which is 0.11% of the ecological network area
- **HR3000163 Stonski kanal**
  - The bridge will cross this area with 2 piers (size 14.4 m^2) in the channel
  - Temporary impacts during pier installation (water turbidity) in 1120* Naselja posidonije (community of *Posidonia)*
  - Direct habitat exclusion due to pier installation within the habitat 1160 Velike plitke uvale i zaljevi (large shallow inlets and bays), permanent conversion of 28.8 m^2 from the total area of 566.37 ha
- **HR3000167 Solana Ston**
  - There is no negative impact expected on target species *Aphanius fasciatus* as well as on the target habitat site of *Sarcocornetea fruticosi*, directly connected to the Ston saltworks, located 780 m from the intervention location.
- **HR1000036 Srednjedalmatinski otoci i Pelješac (POP)**
  - 23.15 ha of bird habitat within the ecological network area shall be converted, which is 0.028% of the total area.
  - The construction of road will not cause any habitat fragmentation as birds can migrate between separated areas.

Habitats and vegetation

Impact on habitats and biological diversity can be manifested as:

- Permanent habitat conversion in the intervention area due to the road construction;
- Permanent increase in habitat fragmentation;
- Temporary disturbance of ecological process in the wider area.

Specific impacts of using the access road on biological values, in the wider area, can be manifested as:

- Permanent disturbance of the surrounding habitats quality due to the light pollution;
- Permanent disturbance of the surrounding habitats quality due to the noise pollution;
- Increased chemical pollution (exhaust gases, mineral oils) of both underground and surface habitats.

Species

Negative impacts are expected due to:

- Decreasing possibility of specific fauna migration as well as increasing fauna roadkill due to increased traffic flows;
- Threats to strongly protected and protected flora and fauna species;
- Devastation of both underground and surface habitats within the construction area.

Geodiversity

No geomorphological objects or phenomena have been detected within the construction area.

4.2. DESCRIPTION OF IMPACTS ON SURFACE WATERS AND GROUNDWATERS

Intervention impacts on the parameters of the surface waters status

Within the area of the planned intervention, according to the River Basin Management Plan for 2013 – 2015 (OG 82/13), there are data on the status of intermittent surface water bodies **JKRN945003** (Peruanski potok) and **JKRN945006** (Brijesta). Both watercourses are situated in a distance larger than 2 km from the construction area and due to the terrain configuration, wastewaters from the future road cannot flow directly into either of the watercourses.

- **Intervention impact on ecological status of the surface water bodies**
    - **Biological elements**

    The estimated status of biological elements of the surface watercourse JKRN945003 (Perunski potok) is very good and of JKRN945006 (Brijesta) is also very good.

Due to the intervention construction, no major impacts on biological elements of the above mentioned water bodies are expected. Minor impacts are expected during the construction of regulation system of the Zaneum stream as the existing bed shall be relocated. Since this is a temporary watercourse without existing data on the status of the water bodies, concrete quantification of the impact is not possible.

- **Hydromorphological elements**

The estimated status of hydromorphological elements of the surface watercourses **JKRN945003** (Perunski potok) is **moderate** and of **JKRN945006** (Brijesta) is **very good**.

No additional impacts on the hydrological regime, flow continuity and morphological conditions of the above mentioned watercourses are expected as a result of the intervention construction.

Major impact on hydromorphological elements of the watercourse Zaneum is expected as a result of its regulation.

- **Main physical and chemical elements**

The estimated status of main physical and chemical elements of the surface watercourses **JKRN945003** (Perunski potok) is **good** and **JKRN945006** (Brijesta) is **very good**.

Due to the intervention construction, no changes in parameters of the main physical and chemical elements (temperature, oxygen regime, pH status, acid neutralization capacity) are expected. The functionality of the ecosystem and achieving necessary values defined for biological quality elements shall be ensured.

- **Intervention impact on chemical status of the surface water bodies**

Estimation of chemical status of the surface water bodies **JKRN945003** (Perunski potok) and **JKRN945006** (Brijesta) is **good status achieved**.

The use of controlled drainage system with separators in crucial road sections shall ensure a controlled emission of treated wastewaters from the road with the concentration of specific pollutants within the limits prescribed by the Regulation on Water Quality Standards (OG 73/13).

The intervention construction shall not have any additional impacts on chemical status of the above mentioned surface water bodies. The estimation of the chemical status will remain **good chemical status achieved.**

Project impact on the parameters of the underground water status

The entire area of Pelješac and Dubrovnik is situated in the area of grouped water body JKGIKCPV_11-NERETVA.

- **Intervention impact on quantity status of the groundwater bodies**

Quality status of the grouped water body JKGIKCPV_11-NERETVA is estimated **presumably bad**.

The intervention construction shall not cause any changes in hydrological regime of the surface watercourses, in the volume and dynamics of flows and consequently in the connection to underground aquifer.

Since the current quantity status of the above mentioned aquifer is estimated **presumably bad**, no changes in the estimated status are expected even after the project implementation.

- **Intervention impact on chemical status of the underground water bodies**

The data analysis of groundwater body chemical status, received from Croatian Waters, showed that the groundwaters of grouped water body of JKGIKCPV_11-NERETVA in wider area have **good chemical status**.

The use of proposed controlled drainage system with separator in crucial road sections (from km ca 11+500 to km ca 16+500) will ensure controlled drainage of treated wastewaters from the road with the concentration of specific pollutants within the limits prescribed by the Regulation on Water Quality Standards (OG 73/13).

The chemical status of groundwaters within the wider area of the intervention impacts is estimated **good** even after the project implementation.

Project impact on the parameters of the coastal water body status

- **Intervention impact on ecological status of the coastal water body**

  - **Biological elements**

The estimation of biological elements (composition, number and average mass of phytoplankton, nutritious salt concentration, oxygen saturation, chlorophyll concentration, and other water flora) of coastal water body O423-MOP is **very good**.

There is only one location where the road shall be in direct contact with coastal waters and that is the location of the bridge above the Ston channel with two piers planned in the very channel. The surface area of the piers is 14.4 m^2 and is relatively insignificant considering the area of Ston bay, so no additional impacts on biological elements of the coastal water body are expected.

  - **Hydromorphological elements**

Hydromorphological status of the coastal water body O-423-MOP is estimated **very good**.

Potential impact on hydromorphological elements can be exerted by the piers of the bridge above Ston channel installed in the channel itself. The surface area of each of the piers is 14.4 m^2, are they are installed in a way to avoid causing any disturbance to the existing water flow regime, course or current velocity.

Additional impacts on depth, structure, sediment of the coastal seabed, and structure and status of tide zones are not expected.

It is predicted that even after the intervention construction, that is, after the construction of the bridge above the Ston channel, the hydromorphological status of coastal waters will still remain **very good**.

  - **Main physical and chemical elements**

The estimation of the main physical and chemical element status of the coastal water body is **very good/reference.**

It is expected that the intervention construction shall not cause any changes in the values of main physical and chemical elements (sea temperature, oxygen regime, transparency, salinity). Additional functionality of the ecosystem and achieving needed values specific for biological quality elements are expected. Minor impacts resulting in water turbidity during pier construction works are expected. However, these impacts are short-lasting and limited to the period of construction.

- **Intervention impact on chemical status of the coastal water body**

  The estimation of current chemical status of the coastal water body is **achieved good status**.

  The use of controlled drainage system with separators in crucial road sections shall ensure a controlled emission of treated wastewaters from the road with the concentration of specific pollutants within the limits prescribed by the Regulation on Water Quality Standards (OG 73/13). It is necessary to add that the drainage of treated wastewaters from the road into the coastal waters is not planned but through absorbing wells into the underground, so no additional impacts on the chemical status of the coastal water body are expected and the estimated status will be **achieved good chemical status** even after the construction.

Intervention impact on sanitary protection zone

The nearest water source in the wider construction area is Studenac spring in Ston Field. The planned road shall pass outside the sanitary protection zone of the mentioned spring, and at the location where the road is nearest to the IV. sanitary protection zone, a closed drainage system is planned with water purification system and controlled water drainage into the underground. As a result, it is estimated that the Intervention shall not have affect the above mentioned water source.

4.3. IMPACTS ON CLIMATE AND AIR QUALITY

Intervention impact on the climate and microclimate

Impacts on climate and microclimate are not expected. All impacts are local.

Intervention impact on air quality

Within the Preliminary Design, mathematical modelling of air pollution has been conducted and possible traffic impacts on pollution level on the road section DC414 Šparagovići – Doli has been estimated.

The calculation results show that even the highest estimated values are still significantly below the quoted limit values, for both NOx and floating particles. Therefore, the road traffic will not have any major impact on the changes in atmosphere quality within the area between settlements of Sparagovići and Doli on Pelješac peninsula.

4.4. IMPACTS ON NOISE LEVELS

According to the noise level calculations, the construction of the noise protection wall is envisaged, on the location of the road section from km ca 9+932 to km ca 9+996 – right side.

Intervention impacts during preparation and construction

Within the project area as well as within the project impact area, the noise will affect environment as soon as the first construction works are initiated, including construction machines and machinery as temporary source of noise.

The main sources of noise are expected:

- Construction machinery,
- Road transport vehicles,
- Drilling, mining, building.

Intervention impacts during traffic flows

Noise and vibrations coming from the constructed structure, after becoming fully operational, which will spread within the intervention location and intervention impact area, are expected from sources as follows:

- Truck traffic in arrival and departure
- Personal vehicles in arrival and departure.

It is necessary to mention the maintenance of wearing course as the precondition to prevent additional negative impacts.

4.5. IMPACT ON ECONOMIC CHARACTERISTICS

Intervention impact on the ground and agricultural land

Within the impact zone of 100 m, the total land area on the route of bypass road with possibility of agricultural use is 176.7 Ha, while within the zone of permanent conversion of 30 m, this area is 53.03 Ha. However, the permanent conversion of the land within the corridor of 30 m will affect 44.6 Ha of land due to the construction of Prapratno viaduct and Polakovica (Supava) tunnel. The major part of the agricultural land is classified as permanently not suitable land (N-2 category).

The permanent conversion shall affect 44.6 Ha of land, that is, 14883 m of the road. From the area of 44.6 Ha, to 6.72 Ha of agricultural area the permanent conversion will affect P-3 land, while on 37.87 Ha the conversion will affect N-2 land area. The area of negative impacts from either side of the road is 104.18 Ha in total, of which 15.68 Ha is agricultural P3 land and the rest of 88.5 Ha is N2 land area (picture 4.5.1.). Parts of the route, referring to viaduct, tunnels and the bridge (18.07% of the route) will not permanently convert the land nor will they have any negative impacts on the agricultural surface areas, since the route will pass above (viaduct) or under (tunnels) these areas.

The construction of the bypass road shall result in fragmentation of certain number of agricultural parcels, that is agricultural plots. Since agricultural land of P3 class is present to a lesser extent within the planned route, certain protection measures shall be taken. Due to the emission of pollutants within the impact area, the negative impact of the Intervention on the technological processes will have a significant influence on the agricultural land owners who are

involved in ecological agriculture, because the ecological agriculture is not possible and not allowed in the immediate vicinity of the route. It is expected that above mentioned negative impacts on the technological process in agriculture will be manifested, first of all in the change in use of the agricultural lands within the impact zone, in the way that the land within the impact zone will not be used for agricultural production.

Intervention impact on forest ecosystem and forestry

The construction of the state road and its use will result in negative impacts and influences on natural forest ecosystems arising from the construction projects and traffic flows on the new road section. The negative impacts and influences cause forest ecosystem degradation and most frequently are reflected in:

- need for deforestation,
- erosion and loss of biological diversity
- risk of introducing invasive species
- habitat changes, disturbance of species and ecological functions due to construction activities and permanent human presence
- fauna disturbance due to increased motor vehicle traffic,
- production and illegal waste disposal in forests
- danger of possible forest fires.

The construction of the road section shall result in a permanent loss of forest land within the whole road section. Certain number of sections and units will be cut off consequently which will cause difficulties regarding their access and area management.

Intervention impact on forest ground

This Intervention will cause forest fragmentation, so a direct negative impact is expected due to the disturbance of forest ecosystem stability, felling and fragmentation. Land fragmentation has a very clear negative impact on the water regime of the soil, especially in the forest ecosystem.

The retention barriers should be constructed in the basins, in order to stabilize slopes and beds of watercourses, which are currently unstable due to geological and geomechanical factors. Weather conditions, especially extreme weather conditions, cause erosion of slopes and beds of watercourses, including area instability. Apart from the barriers, the biological works (afforestation etc.) should be dealt with in order to ensure additional stabilization of the entire area of watercourses – streams.

It is recommended that the construction site area should be limited in size in order to minimize the area of forest land covered by construction machinery. The consequence is loss of the area where soil as natural body has the role of habitat as well as other ecological functions.

During use, due to the increased number of vehicles within the construction area, negative impacts related to increased emission of heavy metals and hard particles are possible.

Intervention impact on forest vegetation

The negative intervention impact is manifested in forest habitat fragmentation and permanent loss of forest area as well as in damage to state-owned forests and forest land located within the route area. The habitat fragmentation shall lead to the creation of new edges, that is, trees that used to grow on the internal part of the stand shall be moved to the edges of the forest. A direct negative impact on forest vegetation is expected through a decrease in the population, and, at the same time, in surface areas of specific mentioned plant communities. The degradation of natural habitats and climate zone vegetation could cause spreading of allochthonous (foreign, invasive) vegetation.

The construction of access roads, material disposals, parking places etc. will cause temporary or permanent damage to the surrounding area.

New conditions will demand urgent revision of forest management plans for economic units along which the route passes. The permanent felling of forest habitat will result in changed habitat conditions, and that may cause significant loss of forest vitality.

Intervention impact on game and hunting

The planned route passes along four hunting ground areas, so the road construction will cause permanent loss of efficient hunting ground areas, thus disturbing the stability of forest ecosystem and balance.

Due to the loss of hunting ground areas, multiple loss will be sustained through: loss of income deriving from tourist hunting (questionable due to game migration), increased damage to the economy (agriculture and forestry), and damage to game (game poaching).

During the construction works, intensive use of access roads and paths may lead to an increase in roadkill. During the execution of construction works and using access road, major attention should be dedicated to the impacts of construction works on habitat loss. The road will have a powerful impact on all game animals, so certain time will be needed to create normal condition between habitats and game.

Each infrastructure construction project carried out within the hunting ground area has primarily a negative impact on that area. Such impacts can be temporary or permanent. Temporary impacts refer to disturbing of game in their habitat and biological-ecological cycle. They are usually connected to disturbances caused to hunting area stability, resulting from noise, vibrations and human presence. Consequently, the game animals run away from the construction site area. If the construction works are executed during breeding seasons, the impact on the population will be increased. Night construction works have an additional negative impact on game population in the construction site area.

Due to the expected increased traffic flows and the fact that the road will not be fenced, increased roadkill is possible.

Intervention impact on tourism

In the Strategy for Development of Tourist Industry of the Dubrovnik-Neretva County, the Pelješac area is identified as the area with great but so far weakly used tourist potential. Improving the quality of tourist offer and traffic connections will lead to a gradual expansion and relocation of the concentration of tourist activity from the dominant position in Dubrovnik to the rest of the County (with emphasis on Župa, Primorje, Pelješac, Korčula, Mljet).

For the purpose of more efficient traffic connection of Pelješac and better tourist offer, great emphasis is placed on the development of ports for nautical tourism and the reconstruction of the Dubrovnik airport.

The construction of Pelješac Bridge and new D414 state road through the Pelješac area will positively affect the tourist offer of this part of the Dubrovnik-Neretva County in terms of its improvements, and in terms of achieving planned objectives regarding tourist industry development within both the Pelješac area and the rest of this area. The implementation of this project will make the Dubrovnik area much more accessible in terms of (road) transport, and, consequently, changes in tourist arrivals are expected. In other words, increase in number of arrivals by car and buses are expected, thus changing the perception of the Dubrovnik area as a destination accessible exclusively by plane or cruiser.

4.6. IMPACTS ON POPULATION AND SPACE REGARDING TRAFFIC FLOWS

Intervention impact during construction

Negative impacts on population and settlements will be manifested during road construction due to increased construction machinery on the existing roads in settlements – increased noise and dust levels. There is a risk of damaging the existing roads due to heavy vehicle maneuvering, covering roads with mud etc., and consequently, creating difficulties in the communication of local population. During the construction works, higher employment rate for workers in building sector is expected.

Intervention impact during use

The new road connects the Croatian south with other parts of Croatia. Its construction, along with the construction of the Pelješac Bridge and of the road linking the bridge to the new road (subject of this project) will have positive impacts on increased traffic flows and better traffic connection of the Croatian south with other parts of Croatia as well as within the Dubrovnik-Neretva County. The project implementation will result in connecting the entire territory of Croatia into a single transport unit, which will undoubtedly have a positive political effect on the local population as they have felt separated from the rest of the country for years.

The construction of this road is a precondition for further development of this area, with respect to the economic development and new employment opportunities. Due to faster transport of goods and services between two separated territories, competition and quality of local activities will increase.

4.7. IMPACTS ON CULTURAL AND HISTORICAL HERITAGE

Intervention impact during construction

The density and layout of archaeological sites within the direct impact zone make this cultural category specially threatened. Dense archaeological site topography opens up possibilities for findings of new archaeological sites during the execution of earthworks. Therefore, preliminary archaeological reconnaissance of the route area is necessary, and, in compliance with the results, preliminary archaeological research is necessary before earthworks are commenced.

The analyzed designed route of the state road, section: Sparagovići – Doli passes along an extremely valuable area rich in cultural property. In addition, this is a vital area which requires higher road standards and living quality due to the fact that this area will have a big traffic role in the future. All above mentioned speaks of the fact that the planned roads are needed and necessary to realize, provided that all area protection standards are met.

From 0+000 to 6+300, the route passes peripherally or enters into the archaeological zone. From 17+200 to its end, the route is also located within the archaeological zone. At chainages 10+000, 12+500, 15+500 and 16+000, individual archaeological sites are located along the route.

Other mentioned archaeological sites and cultural property are not directly affected by the route layout, but they will be under expert supervision due to their closeness and importance.

Intervention impact during use

During use, no impacts on cultural and historical heritage are expected.

4.8. IMPACTS ON LANDSCAPE FEATURES

The average estimation of area vulnerability is a result of natural elements, estimated as highly vulnerable, and of highly dissected relief on which the planned Intervention can have a moderate impact. The lower estimation of area vulnerability is a result of the characteristics of area through which the route passes and frequency of structures in terms of tunnels, which defines the project impact as moderate and negligible.

The analysis of area vulnerability according to the route chainages gives an insight into potentially critical sections of the route.

According to mainly anthropogenic landscape typology and moderately dissected relief, from chainage 0+000 to 6+000, the impact is estimated as negligible with low area vulnerability.

According to mainly natural landscape typology and highly dissected relief, from chainage 6+000 to 11+485, impact is estimated as significant with high area vulnerability.

From Polakovica tunnel (chainage 11+785 to 13+050), across the bridge (from chainage 13+065 to 13+550) and to the end of the Supava tunnel (from chainage 13+600 to 14+920), no impacts are estimated, therefore no area vulnerability.

From chainage 17+100.00 to Doli junction on D8, the route runs mostly along the plain terrain with anthropogenic characteristics, so the impacts are estimated as negligible with very low vulnerability.

Vulnerability sub-model overlapping and visual exposure of the parts of the route which are visually exposed has resulted in a higher final estimation of area vulnerability, whereas in other parts of the route which are not so exposed visually, the estimation of area vulnerability is lower. The final average estimation of area vulnerability is still within the limits of average vulnerability, but somewhat lower, pointing to moderate visual exposure of the intervention.

In accordance with conducted analysis and final conclusions on the impact of the planned intervention on landscape component of the environment, the following protection measures are proposed:

- As an integral part of the Main Design, for the implementation of the planned fast road intervention, landscaping designs - main and implementation projects made by licensed expert (landscape architect) are mandatory;

- After completion of the construction works, all areas damaged by construction activities shall be repaired in accordance with landscaping design where biological recultivation is envisaged;

- During further stages of design development, new environmentally adapted structures shall be designed, respecting the traditional architectural elements, in order to fit into the environment (bridge across Ston channel). Furthermore, when selecting material, the authenticity of cultural and natural landscape elements of the intervention area shall be respected. It is necessary to maintain the area characteristics and its identity;

- During the execution of earthwork, humus surface layer shall be stockpiled and used for later biological recultivation in the process of rehabilitation of cuts and embankments;

- The existing vegetation in peripheral parts of the planned intervention shall be maintained to the greatest possible extent, especially that of autochthonous species, to decrease the impacts on wider area and due to the visual barrier to the planned intervention;

- Within the project area, the buffer zone is planned by means of planting vegetation which will additionally decrease the visual exposure of the planned intervention, especially regarding the traditional landscape views. Thereby, a transition zone to the natural areas stretching along in the wider intervention area shall be ensured;

- In the technical project documentation, the construction of retaining walls shall be planned by using gabion blocks made of autochthonous and authentic stone material from the project location;

- Specific characteristics (climate, pedology, etc.) and area conditions do not allow rehabilitation of embankments in the classical way (grassing), so the landscaping project shall consist of technical and biotechnical solutions for surface layer (composition, structure) and vegetation cover (low perennial autochthonous species, soil cover) as well as of the construction technology that will provide slope stabilization and visual inclusion of the embankment slopes into the surrounding landscape;

- Since the high embankment next to the Prapratno junction is visually highly exposed, the additional technical documentation has to define the best technical and biotechnical solution decreasing this visual impact;

- During the further stages of technical documentation development, special attention shall be given to shaping (form, color and texture) and material for noise protection wall, in order to achieve the best possible inclusion into the environment.

4.9. INFRASTRUCTURE IMPACTS

Intervention impact during construction

The route of the road passes along a relatively uninhabited area, but since the majority of the existing infrastructure systems in this part of the Municipality of Ston is located within the existing state road corridor or stretches in the

direction of Ston – Prapratno bay, the future state road shall cross the existing or planned infrastructure systems at certain locations.

According to that, moderate intervention impact on the existing and planned infrastructure systems is expected, excluding on road infrastructure with significant positive impact due to all road infrastructure reconstruction and renewal in the closer intervention area.

Intervention impact during use

All relocations of the mentioned infrastructure system elements shall be carried out in accordance with special requirements issued by competent authorities during further project documentation preparation. Ensuring effective protection of the existing infrastructure systems shall prevent any additional impacts on their conditions during the use of road.

4.10. INTERVENTION IMPACTS ON CLIMATE CHANGES

Considering the intensity of traffic flows taking place on the intervention location compared to the current condition, it is possible that there shall be increased emissions of greenhouse gasses resulting from burning of fossil fuels. Taking into account that the project implementation will cause only traffic redistribution from the existing D8 state road to the new road, increased emissions of greenhouse gasses to the extent that could have significant impact on climate changes are not expected.

4.11. CUMULATIVE IMPACTS ON THE INTERVENTION BRIDGE: MAINLAND – PELJEŠAC WITH ACCESS ROADS AND D414, SECTION: SPARAGOVIĆI – DOLI

The Interventions Bridge: mainland – Pelješac with access roads and D414 state road, section: Sparagovići – Doli were analyzed in two separate environmental impact assessment studies and two separate environmental impact assessment procedures were carried out. This chapter analyses possible cumulative impacts on the level of a unique project, 32.5 km in total length, from D8 state road (in Komarna) to D8 in the Doli area.

Biodiversity

The roads construction will cause habitat fragmentation, because parts of natural habitats shall be divided into smaller portions due to the linear construction of objects. The constructed objects will become an obstacle for small animal species using these habitats, respectively strictly protected species as target objectives for this ecological network site, as well as hunting animals.

At the beginning of the Intervention (before the bridge towards Pelješac), the area is significantly under anthropogenic impact, so significant cumulative impact with existing and planned projects is not expected in this area. Most of the Intervention passes along Pelješac, so taking into account the existing and planned road infrastructure objects, it is realistic to expect the biggest cumulative impact within this area. Due to mitigation measures, defined during environmental impact assessment, cumulative impact is reduced to the level of moderate and acceptable negative impact. Due to relief and morphological characteristics of the terrain, in some parts of the intervention bridges will be

constructed (Pelješac L=2404m, Dumanja Jaruga I L=488m, Dumanja jaruga II L=80m, Ston L=485m), viaducts (Doli L=156m, Prapratno L=206m), tunnels (Kamenice L=499m, Debeli Brijeg L=2467m, Polakovica L=1265m, Supava L=1320m). The total length of the mentioned objects is ca 9370 m, representing 29% of the project Intervention. The mentioned objects do not represent obstacles in movement of species. Through tunnels and under the bridges and viaducts, habitat fragmentation is avoided and undisturbed passing of animal species is ensured. According to the project documentation, underpasses (3) and crossings (3) are planned, which in turn shall contribute to decreased habitat fragmentation. Further, for the area of side hill cuts and through cuts, external drainage system as the protection for runoff waters is envisaged. Culverts will be adjusted to enable passing of animals, thus decreasing habitat fragmentation and roadkill. Additionally, special passages (for small mammals, reptiles and amphibians) will be designed within embankments of the road. The distance between each passage shall not be greater than 200m.

Cultural and historical heritage

The intervention area is categorized as preserved and organized area dating to the periods of historical settlements and architectural heritage, which is, because of its representation, value and cultural importance, one of the main factors of the spatial identity. Environmental Impact Assessment Studies recognize cultural and historical structures as well as archaeological zones (existing and potential). Accordingly, appropriate protection measures are prescribed.

Impacts on archeological heritage can be positive in terms of encouraged archaeological surveys within the area of immediate impact, and in terms of a more efficient presentation of the heritage (along the existing cultural values) and, consequently, its improved condition.

Socio-economical characteristics

The new road connects Croatian south with other parts of Croatia. Its construction will result in improved traffic flows and better transport connection between the Croatian south and other parts of the country and within the Dubrovnik-Neretva County. The project implementation will lead to the transport connection of the entire Croatian territory and, consequently, will have cumulatively significant positive economical and political impact on the local population. The road construction is a precondition for development of the area, as well as for economic development and increase in the employment rate. Due to faster transport of goods and services between areas that have so far been divided, competition and quality of local services will be increased.

Landscape characteristics

The planned Intervention, as a new construction object, will be a part of cumulative impact with existing transport infrastructure as well as with other linear infrastructure objects. On the other side, compared to the existing road, the planned road is relocated from central parts of settlements, primarily Ston, which will result in higher residence quality.

Noise

During the execution of construction works, temporary cumulative impact of the noise produced by motor vehicles on the existing road and by construction machinery will occur. In addition, during the construction of bridges (Pelješac across the Malostonski Bay and Ston across the Ston channel), there shall be temporary cumulative impacts of noise due to submarine works and noise produced by vessels.

Greenhouse gases

Due to increased traffic flows on Pelješac, the use of new road will result in higher emission levels of greenhouse gases. Cumulatively, significant impact is not expected regarding the emission of greenhouse gases, which will not change within the intervention area.

4.12. POTENTIAL TRANSBOUNDARY IMPACTS

The main project impact on transboundary area refers to transport segment. All transit traffic between the southern part of the Dubrovnik-Neretva County and the rest of the Croatian territory takes place over the territory of Bosnia and Herzegovina (Municipality of Neum), this project implementation will result in significant decrease in the transport congestion, which will consequently have a positive impact on the life quality within the neighboring area, as well as on pollution generated by transit traffic.

5. MAIN ASSESSMENT OF INTERVENTION ACCEPTABILITY FOR ECOLOGICAL NETWORK

5.1. GENERAL INFORMATION

5.1.1. Main Assessment objective

The planned intervention includes the reconstruction (relocation) of existing D414 state road on the Pelješac peninsula from the settlement of Sparagovići to the connection with existing D8 state road near the settlement of Doli. The alternative with better driving dynamics and geotechnical conditions, according to which the bridge passes across the Ston channel from where the route passes via tunnel through Supava and Polakovica and, additionally, via viaduct near the Prapratno bay, has been elaborated. The total length of the road relocation is 18.1 km.

Some parts of the Intervention pass through two ecological network sites with several sites in the vicinity. Ires ekologija Ltd. Company carried out a study for ecological network screening procedure. Analyzing possible significant negative impacts of the planned Intervention on the target objectives and ecological network coherence, the Ministry of Environmental and Nature Protection assessed that for the planned Intervention, due to its characteristics, coverage and spatial placement, the possibility of possible significant negative impacts on target objectives and ecological network coherence cannot be excluded and issued the Decision to proceed with the Main Acceptability Assessment for ecological network (Class: UP/ 612-07/14-60/101, Reg. no: 517-07-1-1-14-4, of 27 October 2014). The Decision is enclosed in 3.3.4 – 3.3.6., on pages 63 – 65 of this Study. The aim of the Main Assessment procedure is to identify potential individual and cumulative impacts on target species and ecological network coherence within the intervention area or in its vicinity, to identify probability, duration and frequency, strength and area of possible individual and cumulative project impacts on ecological network target objectives. It is necessary to propose mitigation measures to mitigate negative impacts on target objectives and ecological network coherence, as well as to propose monitoring program and reporting on target objectives condition and ecological network coherence.

5.2. INFORMATION ON ECOLOGICAL NETWORK

The Intervention passes through two ecological network areas important for species and habitats (**HR3000163 Stonski kanal** and **HR2001364 JI dio Pelješca**) and through one area important for birds (**HR1000036 Srednjedalmatinski otoci i Pelješac**). Within closer and wider intervention area, five ecological network areas are located:

- **HR4000015 Malostonski zaljev**
- **HR3000167 Solana Ston**
- **HR3000426 Lastovski i Mljetski kanal**
- **HR3000162 Rt Rukavac – rt Marčuleti**
- **HR4000028 Elafiti**

Table 5.2.1. Ecological network areas in the wider intervention area

Code and ecological network name	Distance from the planned intervention (m)
Areas important for species and habitat types (POVS)	
HR3000163 Stonski kanal	**In the area**
HR2001364 JI dio Pelješca	**In the area**
HR4000015 Malostonski zaljev	**780**
HR3000167 Solana Ston	**780**
HR3000426 Lastovski i Mljetski kanal	**90**
HR3000162 Rt Rukavac – rt Marčuleti	**2720**
HR4000028 Elafiti	**5860**
Areas important for birds (POP)	
HR1000036 Srednjedalmatinski otoci i Pelješac	**In the area**

5.2.1. HR2001364 JI dio Pelješca

The ecological network area HR2001364 JI dio Pelješca occupies the area of 14073.53 ha. It is the area with typical waterless karst, with prevailing maquis, forested areas, sparse pastures and barren rocks. Real Mediterranean vegetation (holm oak, Dalmatian pine, maquis, shrub land, wild medicinal and aromatic plants, vine, olive and other fruits and vegetables) reflects environmental conditions and is the best indicator of climate and soil conditions. On greater heights (above 350 m) it passes into Sub-Mediterranean vegetation.

Table 5.2.2. Ecological network area HR2001364 JI dio Pelješca

HR2001364 JI dio Pelješca	Natura 2000 code	Area (ha)/number of specimen	Data quality	Area/number compared to representation in Croatia (%)
Target objectives:				
tortoise (*Testudo hermanni*) NT – almost endangered species		/	Missing data	< 2
Leopard snake (*Zamenis situla*) DD – insufficiently known species		/	Missing data	2 - 15
Holm oak forests (*Quercus ilex*)	9340	7373	bad	2 - 15
Rocks and cliffs of the Mediteranean coast covered with endemic species *Limonium* spp.	1240	20	good	< 2
Mediteranean macchia dominated by juniper *Juniperus* spp.	5210	1000	bad	2 - 15
Eumediterranean grasslands *Thero-Brachypodietea*	6220*	2000	good	2 - 15
Mediterranean forest endemic pines	9540	394	medium	< 2

5.2.2. HR3000163 Stonski kanal

HR3000163 Stonski kanal ecological netwok site is situated on the south-eastern part of the Pelješac peninsula. Target objectives are large shallow inlets and bays (1160) and *posidonia* (1120) as priority habitat type according to the Habitat Directive.

Table 5.2.3. Ecological network area HR3000163 Stonski kanal

HR3000163 Stonski kanal	Natura 2000 code	NKS code	Area (ha)/number of specimen	Data quality	Area/number compared to representation in Croatia(%)
Target objectives:					
Large shallow inlets and bays	**1160**	**G.3.2.3., other habitat types (F.1.2.1., G.2.1.1. and etc.) if inside large shallow inlets and bays, K.3.**	**56637**	**good**	**< 2**
Posidonia beds (*Posidonion oceanicae*)	**1120**	**G.3.5.1**	**170**	**bad**	**< 2**

5.2.3. HR1000036 Srednjedalmatinski otoci i Pelješac (POP)

HR1000036 Srednjedalmatinski otoci i Pelješac (POP) ecological network site is proclaimed as special protection area (SPA) for birds. It includes Hvar, eastern part of Korčula and Pelješac peninsula, and covers 82687 ha. The biggest part of the area consists of forests and holm oak maquis, one quarter is Mediterranean bush and 10% Mediterranean dry grasslands. The rest are vineyards and olive groves as well as mosaics of cultivated areas and countryside. Among other open habitats, sea bays and coastlines, sea cliffs and rocky coasts, islets, rocks, reefs and inland cliffs, are represented. Among twenty target bird species, 13 are breeding birds, 2 are migration birds and 5 are wintering birds.

Table 5.2.4. Ecological network area HR1000036 Srednjedalmatinski otoci i Pelješac (POP)

HR1000036 Srednjedalmatinski otoci i Pelješac	pecies status*	Number of specimen in the area	specimen/ pairs	Data quality	Number compared to representation in Croatia (%)
Target objectives:					
Alectoris graeca (jarebica kamenjarka)	g	120 - 250	p	bad	< 2
Anthus campestris (primorska trepteljka)	g	100 - 200	p	bad	< 2
Aquila chrysaetos (suri orao)	g	1	p	medium	2 – 15
Bubo bubo (ušara)	g	30 - 40	p	bad	2 – 15
Caprimulgus europaeus (leganj)	g	700 - 1300	p	bad	2 – 15
Circaetus gallicus (zmijar)	g	7 - 10	p	bad	2 – 15
Circus cyaneus (eja strnjarica)	z	25 - 40	i	bad	2 – 15
Falco columbarius (mali sokol)	z	2 - 3	i	bad	2 – 15
Falco peregrinus (sivi sokol)	g	3 - 5	p	bad	2 – 15
Gavia arctica (crnogrli plijenor)	z	1 - 3	i	bad	< 2
Gavia stellata	z	1 - 3	i	bad	< 2

(crvenogrli plijenor)					
Grus grus **(ždral)**	**p**	**3000**	**i**	**bad**	**2 – 15**
Hippolais olivetorum **(voljić maslinar)**	**g**	**10 - 25**	**p**	**bad**	**2 – 15**
Lanius collurio **(rusi svračak)**	**g**	**2500 - 3500**	**p**	**bad**	**< 2**
Larus audouinii **(sredozemni galeb)**	**g**	**8 - 10**	**p**	**medium**	**2 – 15**
Lullula arborea **(ševa krunica)**	**g**	**25 - 50**	**p**	**bad**	**< 2**
Pernis apivorus **(škanjac osaš)**	**p**	**1000**	**i**	**bad**	**2 – 15**
Phalacrocorax aristotelis desmarestii **(morski vranac)**	**g**	**10 - 30**	**p**	**bad**	**< 2**
Sterna hirundo **(crvenokljuna čigra)**	**g**	**2 - 5**	**p**	**bad**	**< 2**
Sterna sandvicensis **(dugokljuna čigra)**	**z**	**2 - 5**	**i**	**bad**	**< 2**

***g – breeding bird, p – migration bird, z- wintering bird**

5.2.4. HR3000167 Solana Ston

Ston Saltworks is one of the oldest saltworks in Europe. It dates from the 14th century and it has not changed since and as such represents stable habitat.

Table 5.2.5. Ecological network area HR3000167 Solana Ston

HR3000167 Solana Ston	Natura 2000 code	NKS code	Area (ha)/specimen number	Data quality	Area/number compared to representation in Croatia(%)
Target objectives:					
Aphanius fasciatus **(obrvan)**			/	Missing data	2-15
Mediterranean and thermos-Atlantic vegetation of halophilic bushes (*Sarcocornetea fruticosi*)	**1420**	**F.1.1.3.1.- F.1.1.3.3.**	**1**	**bad**	**>15**

The minimum distance between the ecological network area **HR3000426 Lastovski i Mljetski kanal** with target species good dolphin (*Tursiops truncatus)* and the intervention area is only 90 m. Due to the nature of the project (road reconstruction) near the channel, impact on this target species is not expected so the impact on this area is not analyzed in the EIA Study.

Ecological network areas **HR4000015 Malostonski zaljev**, **HR3000162 Rt Rukavac – rt Marčuleti** and **HR4000028 Elafiti** are sufficiently distant and relief isolated from the intervention area. There is no negative impact expected, so these areas are not analyzed in the EIA Study.

5.3. DESCRIPTION OF ECOLOGICAL NETWORK CONSERVATION OBJECTIVES THAT ARE UNDER POTENTIAL IMPACT OF INTERVENTION

5.3.1. HR2001364 JI dio Pelješca

SPECIES:

- **Tortoise (*Testudo hermanni*)**

Description and distribution in Croatia

We can find it on rocky pastures, garrigue and maquis and forests in Mediterranean and warmer zone of hornbeam and with gardens. In Croatia it is distributed along the coast and on islands Cres, Krk and Lastovo.

Causes of threat

Habitat fragmentation and loss due to agricultural intensifying and spreading, urbanization and fast tourist infrastructure development, collecting specimen for domestic animals trade. Large numbers of specimen are killed on the roads.

- **Leopard snake (*Zamenis situla*)**

Description and distribution in Croatia

This is a species characteristic of the Mediterranean maquis. Mostly below 500 m above sea level but it can be found and up to 1600 m above sea level. It can be found mostly on sunny places especially with stones and rocks with little vegetation, on the edges of fields and roads, stone walls, bushes, sometimes in swamps. It can be found in settlements. It is active during day, sometimes in sunset. It avoids high temperatures on the ground by climbing the walls, stones and bushes. In Croatia it can be found on the coast and on many Croatian islands.

Causes of threat

Fast disappearance, habitat degradation and fragmentation due to urbanization, tourist infrastructure development and intensified agricultural activities, including machine grinding of karst habitats. Direct killing of specimen while crossing the road or warming on the road surface. Hunting for illegal domestic animal trade. Usual killing because of confusion with poisonous snakes.

HABITATS:

- **9340 Holm oak forests (*Quercus ilex*)**

Description

Mediterranean forests with holm oak (*Quercus ilex*). Rarely developed as high forests, more often more or less degraded as dense maquis.

Causes of threat

These forests are degraded as maquis or garrigue due to cutting in the past. Other common threats are forest fire, converting forest areas into other cultures, damage as a result of browsing and pasturing, urbanization.

- **5210 Mediterranean maquis with *Juniperus spp***

Description

The habitat covers Eu-Mediterranean and Sub-Mediterranean societies of woody shrubs with Juniperus. Juniperus gives a uniform look, although in the ground layer, flora composition may differ considering climate conditions (Eu-Mediterranean, Sub-Mediterranean), more or less rainfall, edaphic conditions (shallow or deep soil, alkaline or washed soil).

Causes of threat

Maquis is successional stage of grassland toward forest. These areas are growing bigger and are not threatened.

- **9540 Mediterranean forests with endemic pine**

Description

Aleppo pine forests (*Pinus halepensis*) very often inhabits warm open Eu-Mediterranean zone habitats. Often is hard to distinguish natural forests with old planted stands. So those old planted stands are included here, unlike young obviously planted stands.

Causes of threat

Forest fires, expansion of urban areas, land conversion in agricultural (vineyards, olive groves).

5.3.2. HR3000163 Stonski kanal

HABITATS:

- **1160 Large shallow inlets and bays**

Description

Large shallow inlets and bays are largely indented, generally have lower freshwater influence. Generally are more sheltered from wave action, with difference areas: from sediment to stone base and very expressed benthos association zonation. Characteristic association in large shallow inlets and bays is biocenoses of silty stands of protected coasts (G.3.2.3.). Biologically large shallow inlets and bays are important because of different species finding food and spawning, and shallow parts are important for birds. With surrounding land habitats they form a complex whole, so according to NKS are marked as K.3. Large shallow inlets and bays – Complex habitats. Within these habitats, all other sea habitats can be present. Characteristic species for this habitat type are seagrass *Cymodocea nodosa* and *Zostera noltii*, different Bivalvia, Gastropoda, Polychaetes and Dekapod Crustaceans.

Causes of threat

Due to its position in protected inlets, habitat is exposed to human influence. Coastal reclamation, building, pollution and intensive use of closed inlets for the purpose of small harbors, make this habitat endangered. Additional impact is increased in summer due to large numbers of tourists. The habitat consists of relatively small areas so it is considered threatened.

- **1120* Posidonia beds (*Posidonion oceanicae*)**

Description

Seagrass, Mediterranean endemic species. Dense beds are spread from five meters to forty meters in depth, in infralittoral, with plenty of light, on coarse sands with more or less silt, somewhere even on the stone. It is considered that these beds cover more than quarter of Mediterranean infralittoral photophilous area. The species is important as primary producer, and its habitat is feeding area, reproduction area and shelter for a large number of organisms. Here is plenty of food for herbivores and carnivores as well as for organisms who feed through filtration. In upper layer plenty of light and oxygen can be found, hence *Posidonia* beds biomass and biodiversity is very big, so it is very important type of Mediterranean and Adriatic habitat. *Posidonia* beds, growing in clean and clear sea, and narrow coastal strip, are much more developed in the central and southern Adriatic than in the northern Adriatic.

Causes of threat

Vessels anchoring in *Posidonia* beds cause damage, so beds become vulnerable to wave destruction. The *Posidonia* beds are threatened due the occurrence and uncontrollable spreading of invasive species like tropical green algae *Caulerpa taxifolia* and *Caulerpa racemosa*. They use the same living area as *Posidonia*, and do not have enemies in Adriatic. *Posidonia* beds are threatened by different activities like: submarine outfalls of wastewater, reclamation, fish and shellfish farms, gas stations, marines, harbors, trawling, where increased amount of organic matter is expected.

5.3.3. HR1000036 Srednjedalmatinski otoci i Pelješac

SPECIES:

- ***Alectoris graeca*** **(jarebica kamenjarka)**

Description and distribution in Croatia

Species from Galliformes family which inhabit littoral from the sea level to the highest mountain tops; inhabits open habitats.

Causes of threat

Habitat loss and hunting.

- ***Anthus campestris*** **(primorska trepteljka)**

Description and distribution in Croatia

Species from Passeriformes family, wintering in Africa and India. Inhabits dry, open, rarely vegetated, sandy or small stone landscapes. In Croatia breeds in coastal area.

Causes of threat

Habitat loss due to afforestation or intensive agriculture.

- ***Aquila chrysaetos*** **(suri orao)**

Description and distribution in Croatia

Breeding in coastal and mountain Croatia. The most densely populated in northern coast, including stone parts. In Croatia breeds in coastal area.

Causes of threat

Extinction of traditional cattle breeding, excessive hunting, poaching, poisoning, electrocution, construction of wind farms, increased tourist industry and recreational activities.

- ***Bubo bubo*** **(ušara)**

Description and distribution in Croatia

The biggest European and Croatian owl. Prefers inaccessible areas like rocky habitats with caves and gorges, open forest type, taiga, wooded steppe, river valleys. Primary is a night bird and will hunt daily only if there is really very few preys in the area. The prey is hunted actively, flying close to the ground or treetops. During the day usually is resting high on the trees. Lives a lonely life and mates during mating season.

Causes of threat

Globally is not endangered species, inhabits very large area, but the population number is in constant moderate declining.

- ***Caprimulgus europaeus*** **(laganj)**

Description and distribution in Croatia

Widely distributed and numerous breeding bird in this area. Lives in the area with scattered trees as well as in open forests and on the forest edge.

Causes of threat

Globally is not endangered species because inhabits very large area.

- ***Circus cyaneus*** **(Eja strnjarica)**

Description and distribution in Croatia

This species habitat types are open: fields, meadows, open forests, swamps and reed beds. The most densely populated in intact, open habitats with dense low vegetation. Breeds in open grounds, peatlands, young conifer plantations, often near the swamp areas. During migration and winter season, hunting on cultivated fields, swamps, coastal swamps and swamp meadows, is usual.

Causes of threat

Swamp areas disappearance, traditional cattle breeding extinction, intensified agriculture, hunting, poaching.

- ***Falco peregrinus*** **(Sivi sokol)**

Description and distribution in Croatia

Breeding bird in coastal, mountain and Pannonian Croatia. The most densely populated in Mediterranean Croatia, from Dubrovnik area to Kvarner islands, from Zagora to small islands. Inhabits different habitats, from open to forest areas, in inland and by the sea. This species population attends the area HR1000036 Srednjedalmatinski otoci i Pelješac with 7-10 breeding pairs.

Causes of threat

Hunting and poaching, intensified agriculture, pesticides, decreased medium sized birds population, due to intensified hunting, tourism and recreational activities.

- ***Hippolais olivetorum*** **(voljić maslinar)**

Description and distribution in Croatia

Inhabits warm, open oak forests, shrubs, olive groves, orchards, plantations and similar areas with scattered trees and bushes. It can be found from Dubrovnik area to Zadar.

Causes of threat

Causes are not precisely known, it is probably because of traditional agriculture and orchard extinction and intensified agriculture.

- ***Lanius collurio*** **(rusi svračak)**

Description and distribution in Croatia

Songbird inhabits open and mixed habitat types. It can be found on grasslands with bushes and small trees, large forest areas, mosaic village landscapes (combination of open habitats and small woody plants). Songbird is a migration bird, wintering in Africa, breeding in Croatia.

Causes of threat

Disappearance of hedges and shrubs between agricultural areas where it breeds. Using of pesticides decrease number of insects thus its food is decreased.

- ***Lallula arborea*** **(ševa krunica)**

Description and distribution in Croatia

Lives in small flocks in open areas with scattered trees, on the forest edges, glades and mountain meadows. Breeding starts in the middle or the end of April.

Causes of threat

Intensive agriculture, habitat fragmentation, succession.

5.3.4. HR3000167 Solana Ston

SPECIES:

- ***Aphanius fasciatus*** **(obrvan)**

Description and distribution in Croatia

Aphanius fasciatus tolerates varying salinity and can survive in salt bays, shallow, more salted coastal ecosystems and inland freshwaters, otherwise unfavorable for other fish species. It can be found on the Adriatic coast, but discontinuously. It is recorded in Ston and Pag saltworks, Zrče bay on the island of Pag, Pantan near Trogir and Nin.

Causes of threat

Threatened due to salt swamps and brackish water habitats disappearance, illegal coastal construction and increased coastal pollution.

HABITATS:

- **1420 Mediterranean and thermos-Atlantic halophilic vegetation (*Sarcocorenetea fructicosi*)**

Description

This habitat is represented by bushy perennials vegetation (*Sarcocornetea fruticosi*) on salty marshes. Sometimes habitats are used as pastures. Mentioned plant associations are found along Mediterranean coast, also on the Adriatic coast on Krk, Cres, Rab and Pag islands, Pantan near Trogir, and on Solaris and Zablaće (Šibenik) coastal area.

Causes of threat

Low marshes do not represent desirable places for beaches so are filled with construction material while constructing the road, parking places or heliport. Some associations are endangered due to collection of decorative species.

5.4. DESCRIPTION OF IMPACTS ON THE ECOLOGICAL NETWORK

- **HR2001364 JI dio Pelješca**

- Impacts on reptiles target species: leopard snake (*Zamenis situla*) and tortoise (*Testudo hermanni*) due to its direct habitat fragmentation and loss, as well increased roadkill.

- 9340 Holm oak forests (*Quercus ilex*) conversion in the area of 8.52 ha, which is 0.09 % of this habitat type inside ecological network area.

- 5210 Mediterranean maquis with *Juniperus spp* conversion in the area of 2.78 ha, which is 0.11% of this habitat type inside ecological network area.

- **HR3000163 Stonski kanal**

- The bridge passes through this area, with its two piers surface 14.4 m^2 , located in the channel.

- Temporary impacts during pillars installation (water turbidity) are expected in 1120* *Posidonia* beds

- Direct habitat deduction due pillars installation in the habitat area 1160 Large shallow inlets and bays, will cause permanent conversion of 28.8 m2 from the total area 566.37 ha.

- **HR3000167 Solana Ston**

- Negative impact on the target species *Aphanius fasciatus* as well as a target habitat type Mediterranean and thermos-Atlantic halophilic vegetation (*Sarcocornetea fruticosi*), directly connected to Ston Saltworks basins, which is 780 m distant from the intervention area.

- **HR1000036 Srednjedalmatinski otoci i Pelješac (POP)**

- Conversion of 23.15 ha birds habitat inside ecological network area, which is 0.028% from the total area.

- Existing road will not cause the habitat fragmentation because birds can migrate between divided areas.

Conclusions

In view of the considered impacts of the Intervention, referring to the relocation of the existing D414 state road located on the Pelješac peninsula near the settlement of Sparagovići to the link with the existing D8 state road near the settlement of Doli, potentially negative impact on target objectives for ecological network important species and habitat types **HR2001364 JI dio Pelješca** and **HR3000163 Srednjedalmatinski otoci i Pelješac** and special protection area (SPA) **HR1000036 Srednjedalmatinski totoci i Pelješac (POP)** has been detected.

Within ecological network area **HR2001364 JI dio Pelješca**, leopard snake (*Zamenis situla*) and tortoise (*Testudo hermanni*) target species are the most vulnerable due to this Intervention. The habitat is fragmented and permanently lost, and due to expected increased traffic flows, there may be an increase in roadkill. The target habitat types within the Intervention area will be permanently conversed, but the surface of conversed areas in relation to the total surface area of the ecological network area is insignificant.

The bridge passes through ecological network area **HR3000163 Stonski kanal** with two piers installed in the target habitat **1160 Velike plitke uvale i zaljevi** (Large shallow inlets and bays). The area of the permanently occupied habitat is 2 x 14.4 m^2 which is insignificant in relation to habitat representation within the ecological network. Temporary impacts which cause water turbidity due to the pier installation will not have a significant negative impact on the habitat.

HR3000167 Solana Ston is hydrologically closed environment and will not be affected by the Intervention.

Due to the Intervention, 0.028% of the special protection area (SPA) **HR1000036 Srednjedalmatinski otoci i Pelješac** will be conversed. The total habitat area, which will be less suitable for birds, is larger concerning the edge effect (buffer) from the road, which will cause partial habitat fragmentation. If the Intervention is carried out during target species reproductive season, the nests within the intervention location will be endangered. Since the converted habitat areas are not significant and birds migrate normally to the surrounding areas, the Intervention will not have significant negative impact on the ecological network target objectives provided that protection measures are implemented.

5.4.1. Adverse effects mitigation measures for ecological network

1. To allow target species (tortoise and leopard snake) migration from both sides of fragmented habitat, it is necessary to plan a sufficient number of passages on either side of the embankment in certain sections of the road. Furthermore, the maximum distance between each passage is 200 m. These passages under the roadbed and external drainage culverts shall be planned to allow small animals to use it:

- Objects shall be square, with minimal dimensions 0.5 x 0.5 m,

- The base and the walls shall be made out of concrete,

- The base shall be planned to enable a dry corridor for animals passing even when there is some water,
- Exit channel walls shall be performed in combination of concrete and stone, with wall grades 30-45^0, so that the channel can be adequate for animals,
- Objects shall be planned to prevent animals from crossing the road, but to direct them to drainage culverts/passages. Fence implementation (holes size 2-4 cm^2) and planting shrub vegetation around openings will ensure that animals are directed,
- Space inside the culvert and passages for small animals shall be regularly controlled and cleaned, to ensure animal movement.

2. During the construction of noise protection walls, transparent panels shall be used, designed with opaque markings with a maximum distance of 5 m between each. Due to its visual neutrality and transparency, birds tend to collide into the panels. This problem can be solved by coloring the panels, thus achieving the contrast, or by putting different patterns to signal the barrier presence.

3. Preliminary intervention works shall not be carried out during the breeding season of bird target species and reptiles, in the period between October 1st and January 31st.

4. On the locations where the route is crossing the electric power objects, the following measures shall be implemented if local conditions allow so:

- If connecting of underground cables is not possible, the design of power-transmission line shall be such so as to prevent larger birds, as they stretch out, from touching the live wire and creating closed circuit. The distance between lines shall be at least 140 cm, as well as the distance between lines and the supporting pillars.
- Lines shall be installed in one vertical plane to decrease the possibilities of bird collision.
- Lines shall be marked to be more visible to birds.

5. Proposed monitoring and reporting program on target objectives and ecological network coherence:

- The frequency of roadkill shall be monitored, and as a result of one-year monitoring, analysis on roadkill locations and animal taxonomy shall be made. If needed, additional protection measures shall be defined;
- Monitoring and determining the condition and number of species population (during one-year monitoring program) for leopard snake (*Zamenis situla*) and tortoise (*Testudo hermanni*);
- Results and analysis of all monitoring activities, potential recording of target species roadkill, shall be delivered to the central state authority responsible for nature protection after the monitoring is finished, taking into account the assessment of potential additional mitigation measures and/or changing the existing ones.

The Intervention is acceptable for ecological network and for target species with the highest potential impact, provided that the mitigation measures are implemented to avoid possible negative impacts.

6. PROPOSED ENVIRONMENTAL PROTECTION MEASURES AND MONITORING PROGRAM

6.1. PROPOSED PROTECTION MEASURES DURING PRELIMINARY AND CONSTRUCTION WORKS

General environmental protection measures

1. Prior to the start of the construction works, the project documentation shall provide for locations for disposal of the construction and waste material, parking places and maneuvering machinery with an aim to minimize damages to the area.

2. Frequent and controlled disposal of municipal and hazardous waste in prescribed manner shall be provided, any temporary or permanent waste material disposal in the surrounding area shall be prohibited, and impermeable waste containers shall be ensured, according to the Ordinance on Waste Management (OG 23/14, 51/14).

3. During the execution of construction works and site organization, precaution measures shall be implemented to avoid water and surrounding area pollution with oil and fuels, bitumen and other hazardous and noxious substances. Precaution measures include locations envisaged for refueling, storage of hazardous substances, waste collecting and sanitary systems. The intervention area is located within the karst area, and, consequently, municipal and hazardous waste disposal shall be carried out properly and every occasional or permanent waste disposal in the surrounding area shall be prohibited, and impermeable waste containers shall be provided. Within the construction area, oil and fuels storage is not allowed. Filling machines with oil and fuel shall be performed from the tanks on the impermeable plateau with curbs and grease separators.

4. For the purpose of the construction site, existing roads and paths shall be used.

5. On the construction site, sanitary and technical conditions for workers shall be assured. Authorized companies shall take care of the sanitary waste waters.

6. Handling flammable materials and tools causing sparks shall be conducted in accordance with the regulations, to avoid possible fires and assure needed fire prevention.

7. Material needed for the road construction shall be purchased from the legal quarries and, to the maximum extent possible, excavation material obtained during preparation of the terrain and route construction works shall be used.

Spatial and traffic flow protection measures

8. Existing road and path networks, which will be used during the construction period, shall be maintained, and after the construction is completed, shall be restored to their original state.

9. In further design phases, the Investor shall prepare the Study for temporary traffic regulation, which will define the traffic points on the existing traffic system and secure all collision points during the intervention construction.

10. Before exiting on the main road, obligations related to washing all machinery pneumatic and caterpillar tires shall be met.

Protection measures for natural features

Flora and fauna

11. The existing vegetation in the areas that will not be directly affected by construction works, shall be kept, especially autochthonous trees and bushes, as reptiles habitats, birds nesting places and small mammals shelters.

12. Removal of vegetation cover shall not be performed during breeding seasons, that is, from September to February.

13. Besides the planned number of objects along the route (bridges, tunnels, viaducts, culverts and crossings), a sufficient number of crossings for small animals under the roadbed shall be planned in sections where the road is in dual embankment. These passages and external drainage culverts shall be designed so as to enable small animal species (amphibians, reptiles and small mammals) to use them.

14. During construction, invasive species within the construction area shall be removed.

Target species and habitats – ecological network

15. To allow target species of tortoise and leopard snake to migrate from both sides of fragmented habitat, it is necessary to plan a sufficient number of passages on either side of the embankment in certain sections of the road. Furthermore, the maximum distance between each passage is 200 m. These passages under the roadbed and external drainage culverts shall be planned to allow small animals to use it:

- Objects shall be square, with minimal dimensions 0.5 x 0.5 m,
- The base and the walls shall be made out of concrete,
- The base shall be planned to enable a dry corridor for animals passing even when there is some water,
- Exit channel walls shall be performed in combination of concrete and stone, with wall grades 30-45^0, so that the channel can be adequate for animals,
- Objects shall be planned to prevent animals from crossing the road, but to direct them to drainage culverts/passages. Fence implementation (holes size 2-4 cm^2) and planting shrub vegetation around openings will ensure that animals are directed.

16. During the construction of noise protection walls, transparent panels shall be used, designed with opaque markings with a maximum distance of 5 m between each. Due to its visual neutrality and transparency, birds tend to collide into the panels. This problem can be solved by coloring the panels, thus achieving the contrast, or by putting different patterns to signal the barrier presence.

17. Preliminary intervention works shall be carried out off the breeding season of bird target species and reptiles breeding season, in the period between October 1st and January 31st.

18. On the locations where the route is crossing the electric power objects, the following measures shall be implemented if local conditions allow so:

- If connecting of underground cables is not possible, the design of power-transmission line shall be such so as to prevent larger birds, as they stretch out, from touching the live wire and creating closed circuit. The distance between lines shall be at least 140 cm, as well as the distance between lines and the supporting pillars.
- Lines shall be installed in one vertical plane to decrease the possibilities of bird collision.
- Lines shall be marked to be more visible to birds.

Geological heritage

19. If during the execution of construction works fossils, minerals and speleological objects protected as natural values are discovered, the government body responsible for nature protection shall be informed about this and necessary measures to protect the discovered objects from destruction, damage or theft shall be undertaken.

Cultural and historical protection measures

20. Since the density of the archeological finds on the route suggests the possibility of new findings, which have not been identified based on field surveys, it is necessary to conduct protective archeological research before the execution of construction works, and in case of any new findings, documentation and protection of these shall be required.

21. During the execution of earthworks, the conservation supervision with an aim to determine the vulnerability of potential localities shall be provided, and protective archeological investigations will be conducted where necessary.

22. Before construction works, a review of the route shall be carried out, from chainage 0+000 to chainage 3+000, since this part of the route caught fire in July 2015, so there is a possibility for discovering new archaeological sites.

23. Before construction works, submarine archaeological reconnaissance shall be carried out within the entire area of the underwater section of the Ston bridge construction.

Protection measures for economic features

Soil and agriculture

24. Any manipulation with fuel, oil, paint, solvents and other chemicals used in construction in a way they could penetrate the ground shall be prevented.

Forestry, game and hunting

25. Permanent cooperation with expert services of hunting rights holders, with an aim to prevent roadkill and protect game animals, shall be provided.

26. During the preparation of the Main Design, forest management basis shall be used in the part where reference is made to the forest infrastructure. In addition, fire maps for the use of existing and planning of access roads shall be used as well.

27. After clearcutting is conducted, logs have to be removed, all timber has to be cleared, and all damaged and broken trees have to be cut so as to avoid turning them into sources of infection. The remaining herbal and grass material shall be composted.

28. At chainages where the route passes the forest are, the forest rehabilitation shall be performed by using autochthonous tree species, according to forest management basis.

29. Planning and using of temporary landfills in the forest shall not be permitted.

30. The space above the tunnels of Polakovica and Supava, as well as the crossings under the Prapratno viaduct, Ston bridge and Zamaslina crossing shall be used for the passage of tall game animals.

Air protection measures

31. During the intervention construction, access unpaved roads shall be watered to decrease the amount of suspended particles caused by wind and vehicles.

32. No load (unproductive time) of machinery shall be minimized for the purpose of reducing exhaust gas emissions.

33. All construction machines and equipment shall be maintained properly in accordance with manufacturers' specifications. An authorized mechanic shall review the equipment and the proper condition of equipment shall be determined prior to their use.

Water protection measures

34. Within the zone of increased risk of groundwater pollution, from km ca 11+500 to km ca 16+500, the closed drainage system shall be applied. Since the route passes outside the sanitary source protection zone, dispersed drainage system for runoff waters shall be used in other sections of the route.

35. The protection of construction site area from possible negative impact of flash floods shall be provided.

36. Within the framework of the Main Design for water drainage, the Ordinance on the operation and maintenance of drainage system for runoff water and contaminated waters under normal and exceptional circumstances shall be prepared.

Noise and light pollution protection measures

37. All outdoor lighting shall be carried out with appropriate quality of light and blinds to disable horizontal and vertical light scattering, according to the EU Directive on prevention of light pollution.

38. Machinery and vehicles shall be regularly controlled and maintained, to prevent possible increased levels of noise during working processes.

39. Noise barriers shall be performed as opaque or if transparent, with enough stickers to prevent bird collision.

Infrastructure protection measures

40. During the design phase, it is necessary, with relevant infrastructure companies, to determine the exact location and technical solutions for the infrastructure crossings on the locations where the route will pass across such infrastructure.

Landscape protection measures

41. As the integral part of the project documentation for the planned intervention implementation, landscaping studies shall be prepared by an authorized expert – landscape architect in the phases of Preliminary Design and Main Design preparation.

42. After completion of the construction works, all areas damaged by construction activities shall be rehabilitated and cleaned in compliance with the landscaping project providing the solution of biological recultivation.

43. During further phases of design development, the shape of new objects should be spatially adapted taking into account the elements of traditional architecture and in order to ensure their inclusion into the area (bridging the Ston channel). While selecting material, the authentic characteristics of this cultural and natural landscape area as well as its identifying features shall be respected.

44. During the execution of earthworks, surface humus layer shall be deposited and used for the later biological recultivation during the rehabilitation of cuts and embankments.

45. The existing vegetation in the peripheral areas shall be maintained to the maximum possible level, especially autochthonous species. Therefore, the impact on the wider intervention area will be reduced and visual barriers will be formed.

46. Within the project area, the buffer zone is planned by means of planting vegetation which will additionally decrease the visual exposure of the planned intervention, especially regarding the traditional landscape views. Thereby, a transition zone to the natural areas stretching along in the wider intervention area shall be ensured.

47. In the technical project documentation, due to the implementation of retaining walls, the use of gabion blocks made out of autochthonous and authentic stone material from the location area shall be planned.

48. Since specific characteristics (climate, pedology…) and area conditions prevent embankment area rehabilitation (grassing), the landscaping project shall propose technical and biotechnical solutions for creating soil cover layer (composition, structure,…) and vegetation cover (low perennial autochthonous species, ground covers). In addition, the construction technology performing the function of stabilizing the slopes and of visual enclosure of embankment slopes into the landscape shall be proposed.

49. Further technical documentation shall define the best technical and biotechnical solution to reduce the visual impact of the Intervention within the Prapratno junction area.

50. In further technical project documentation, special attention will be payed to modelling (form, color, and texture) and wall materials, so the new structure can be blended into the environment as much as possible.

Accident protection measures

51. In cases of accidents, where water hazardous and harmful substances are suddenly and uncontrollably discharged into the road surrounding area, activities in accordance with the County Intervention Environment Protection Plan and Operational Plan with measures for sudden and accidental water pollution shall be undertaken.

Protection measures to mitigate climate changes impacts

52. Local materials will be purchased if possible and/or recycled.

53. Equipment with new technologies will be used, if conditions allow.

54. For the generators on construction site, alternative fuel shall be used as propane, solar or electric energy.

55. On the construction site, the use of compact fluorescent bulbs, ensuring daily computer turn-off and replacement of heating and cooling systems with more efficient ones in terms of energy shall result in reduced use of electricity.

6.2. PROPOSED PROTECTION MEASURES DURING USE

Nature features protection measures

56. During maintenance of green belts along the route, all invasive plant species shall be removed.

57. The accessibility of concrete culverts shall be controlled and maintained, as well as the accessibility of the crossings for small and medium mammals as well as reptiles and amphibians.

Protection measures for cultural and historical heritage

58. Monitoring program for changes in heritage condition shall be provided, and additional protection measures for archaeological sites shall be carried out, due to possible new construction works in the area of direct and indirect impact.

Water protection measures

59. Regular road and drainage system maintenance, including cleaning and monitoring of functionality of external and internal drainage system. In addition, waste water treatment system with proper waste disposal (residue) produced after runoff waters are treated shall be regularly maintained.

60. During road maintenance in winter period, ecologically acceptable agents for the purpose of water protection shall be used. Accurate prediction of road pavement conditions shall ensure minimal use of agents.

Spatial and traffic flow protection measures

61. For traffic safety, vegetation along the edge of the road (shoulders, slopes) shall be regularly maintained.

6.3. PROPOSED ENVIRONMETNAL MONITORING PROGRAM

Monitoring water status

Monitoring environmental status during construction works and traffic flows

Respecting the principle of combined approach to water protection, the environmental monitoring program consists of monitoring wastewater emissions after purification, and monitoring relevant parameters of the water body status. The parameters selected for monitoring road wastewater are those that can be found in wastewater considering the type of the construction intervention, and they are monitored in accordance with applicable regulations (Regulation on the emission limit values for wastewater, OG 80/13 and 43/14, Regulation on water quality standards, OG 73/13).

Emission monitoring

After the wastewater is purified and before being discharged into the recipient, the following parameters should at least be monitored: physicochemical parameters, BPK5, KPKCr, TOC, total hydrocarbon, pesticides, PAH, copper, zinc, cadmium, total chromium, manganese, nickel, lead, iron, sulfate and total phosphorus.

Limit values and frequency of monitoring are prescribed by specific regulations.

Monitoring the status of conservations objectives and integrity of the environmental network

The roadkill frequency should be monitored, and after a one-year monitoring program, the analyses about roadkill spots and taxonomic group of injured animals should be conducted, and, consequently, further protection measures should be defined where necessary.

Monitoring and defining the status and number of species population (to be conducted for one year) of Leopard Snake (*Zamenis situla*) and of Hermann tortoises (*Testudo Hermanni*).

After the monitoring program is completed, the results and analyses of all activities related to the monitoring and potential injuries of target species shall be recorded and submitted to the central state authority competent for environmental protection issues, including the mandatory assessment of whether additional mitigation measures and/or changes in current measures are necessary.

6.4. PROPOSALS OUTLINED IN ENVIRONMENTAL ACCEPTABILITY ASSESSMENT

Every environmental component has been thoroughly analyzed within this Study, thus ensuring optimal insight into the state of the environment and enabling an in-depth impact assessment.

The planned Intervention: D414 state road, section: Sparagovići – Doli, L=18.09 km, is in its entire length located within the area of the Dubrovnik-Neretva County, the area of the Municipality of Ston. The Intervention passes through the following cadastral municipalities: Dančanje, Zabrđe, Sparagovići, BOljenovići, Ston, Broce and Zaton Doli.

The route is partly located within two protected areas:

- Significant Landscape: Uvala Prapratno, from km ≈8+900 to km ≈10+500
- Special Reserve: Malostonski zaljev, from km ≈14+000 to km ≈18+000

The planned Intervention shall affect the area of the protected landscape of Prapratno Bay since it will become a new visible element of this area. Taking into consideration current activities conducted within this protected area (ferry port, car camping, new tourist zones that are planned) and the loss of one part of forests due to fire, on a cumulative basis, the construction of the route shall contribute to the reduction of landscape values of Prapratno Bay, for which the issue of reviewing the status of protection had been raised even before the proposed Intervention was planned.

As the second protected area, Malostonski Bay shall not be significantly affected by the construction of the planned route since the route is located along its peripheral land area. Therefore, there are no expected impacts on the marine part of the Bay, being the key protection objective.

Based on the analysis of the list and distribution of flora and fauna recorded in the Red List of threatened plant and animal species of the Republic of Croatia, within the wider intervention area, it has been found that the construction and use of the planned road shall have a moderately negative impact on flora and fauna due to reduced possibilities of migration of population of certain groups of animals, as well as due to increase in roadkill caused by higher traffic density.

The roads are serious impediments to many groups of animals in terms of their free movement and spots of increased rate of mortality, which should be expected when small animals are in question (beetles, amphibians, reptiles, smaller birds and smaller mammals). In reference to larger mammals, safer driving regimes have to be ensured through the installation of adequate warning signs. In that sense, a moderately negative impact can be expected on the fauna of birds, smaller and medium mammals, as well as on reptiles.

Due to the relief and morphological characteristics of the terrain, Ston Bridge (L=485 m), Polakovica tunnel (L=1265 m) and Supava tunnel (L=1320 m) are planned to be constructed at specific locations of the route. The mentioned structures do not represent any obstacles to free moving of species. In other words, there shall be no habitat fragmentation over the tunnels and under the bridge or viaducts, as unobstructed passage of animal species shall be enabled at these locations. The project documentation proposes construction of passages ensuring minimum habitat fragmentation. Furthermore, external drainage system is planned within the area of cuts and embankments as protection against runoff water from the surrounding hills. The drainage system is planned in terms of concrete channels along the foot of embankment and on the top of cuts through which the runoff water shall be carried below the roadbed. The culverts shall be adjusted so as to ensure that they can be used by small animals, thus minimizing the impacts on habitat fragmentation and roadkill. In addition, in certain sections of the road, special passages for small mammals, reptiles and amphibians shall be designed on either side of the embankment with a maximum distance of 200 m between each passage.

The disposal of excess material into depressions does not present a permanent impact as the disposed material is natural and these areas shall be restored, by means of recultivation and/or succession and again become favorable for the species inhabiting them.

The proposed Intervention runs along two sites of the ecological network which are significant for species and habitats (**HR3000163 Stonski kanal** and **HR2001364 JI dio Pelješca**), and through a site which is significant for birds (**HR1000036 Srednjedalmatinski otoci i Pelješac**).

Within the ecological network site of **HR2001364 JI dio Pelješca,** the most threatened target species of reptiles are Leopard Snake (*Zamenis situla*) and Hermann tortoises (*Testudo Hermanni*). This is so because, apart from directly losing one part of their habitats, they shall also be fragmented, and there shall be increased probability of roadkill of these species. The stretch of 10150 m of the planned length of the route passes through the area of the ecological network site of HR2001364 JI dio Pelješca. The largest section of the route runs through the target habitat **9340 Vazdazelene šume česmine** (forests of evergreen oak, *Quercus ilex*) and **5210 Mediteranske makije u kojima dominiraju borovice Juniperus spp.** (Mediterranean maquis with Juniperus spp.). It is expected that laying out of the route shall cause change in use of 8.52 ha, that is 0.09% of the habitat of 9340 Vazdazelene šume česmine (forests of evergreen oak, *Quercus ilex*)

within the ecological network, and 2.78 ha, that is 0.11% of the target habitat of 5210 Mediteranske makije u kojima dominiraju borovice Juniperus spp. (Mediterranean maquis with Juniperus spp.) within the ecological network.

The bridge with its two piers, each with a surface of 14.4 m^2, shall pass over the area of the ecological network site of **HR3000163 Stonski kanal,** more precisely, the piers shall be located within the very channel. The target habitat of **1120 Naselja posidonije** (habitats of *Posidonia oceanica*) has not been detected either within the area of the planned Intervention or in its near surroundings. Furthermore, temporary impacts, such as turbidity of water during the pier foundation works shall not have an adverse impact on the mentioned target habitat if there are any in the wider area.

A permanent negative impact on the habitat of **1160 Velike plitke uvale i zaljevi** (great shallow inlets and bays) shall result from direct habitat exclusion due to the construction of bridge piers. The total surface area of this habitat is 566.37 ha, and 28.8 m^2, that is 4.5 x 10^{-4} % of the habitat in question shall undergo change in use.

The stretch of 10150 m of the planned route is located within the area of the ecological network site of **HR1000036 Srednjedalmatinski otoci i Pelješac.** A permanent change in use is expected for 23.53 ha of bird habitats within the area of the mentioned ecological network site. This means that 0.028% of the total surface area of the mentioned site shall undergo this change. The road shall not lead to significant habitat fragmentation because birds can migrate normally between separated areas.

The construction and use of the road shall have a negative impact on the flora and fauna due to reduced migration possibilities of certain groups of animals, increased roadkill during traffic flows, jeopardizing the highly protected and protected plant and animal species, and devastating habitats existing on the ground and under the ground within the route location.

Specific impacts of the use of the route on habitats within the wider intervention area can be reflected in a permanent deterioration of the habitat quality of the habitats existing on the ground and under the ground due to light pollution and increase in chemical pollutants (exhaust gases, mineral oils).

Within the wider zone of intervention impacts, that is, in the area of the Pelješac peninsula, there are no permanent surface watercourses. There are only intermittent torrential streams that are categorized as public watercourses or watercourses flowing directly into the sea and having no direct relations with the sub-basin of River Neretva. Among such watercourses, the largest is surface water body of JKRN945003 Perunski potok (Perunski stream) located within the wider intervention area. Since the route is located at a distance of several km from the mentioned surface water body, the intervention impact on its ecological and chemical status is not expected.

The Intervention is located within the area of the grouped body of groundwater of JKGIKCPV_11_NERETVA. No additional impacts on the quantity status of the groundwater body, assessed as possibly bad, are expected. Furthermore, additional impacts on the chemical status of the groundwater body, assessed as good chemical status, are also not expected.

The ecological and chemical status of the coastal water body of O423-MOP has been assessed as very good and no additional impacts are expected on that water body.

During the construction and use of the road, there shall be no impacts on the climate, as all impacts are local.

By means of the mathematical modelling of air pollution, it has been determined that limit values of air pollutants for the predicted traffic load are lower than what is prescribed. Since the route passes mostly through uninhibited area,

there should not be any significant impacts on the level of noise, except during the execution of construction works, but such impacts are only temporary.

A permanent change in use of 44.6 ha of land is predicted within the route of the road. The largest portion of agricultural land is taken up by land belonging to the category of not suitable soils, that is, N-2 category.

The construction of the road shall lead to the fragmentation of certain number of agricultural parcels, that is, plots. Since the agricultural land classified as P3 is to a smaller extent located within the planned route area, adequate measures have to be taken in order to protect it.

The negative impact on the forests shall be reflected in the fragmentation of forest habitats, permanent loss of the forest surface area, and damage caused to state-owned forests and forest land within the route area. The habitat fragmentation shall lead to the creation of new edges, that is, trees that used to grow on the internal part of the stand shall be moved to the edges of the forest. A direct negative impact on forest vegetation is expected through a decrease in the population, and, at the same time, in surface areas of specific mentioned plant communities.

The route of the planned Intervention passes through 4 hunting grounds, so its construction shall result in a permanent loss of hunting ground surfaces, and, consequently, this shall lead to the disruption of balance and stability of forest ecosystem.

Extremely positive impact is expected on the tourist industry of both the Pelješac peninsula and the entire target area of the Dubrovnik-Neretva County, primarily due to easier access to the whole area. In future, the improvement in the quality of tourist offer and significant development of tourist industry within the Pelješac area can be expected.

The implementation of the project shall exert a strong positive impact on the economy of the Dubrovnik-Neretva County, primarily because of improved transport connections. The improved transport connections, along with reduced transport costs and pace of freight traffic, shall set foundations for further economic development and increase in competitiveness and quality of local services, thereby generating new jobs.

The density and layout of the archaeological sites within the zone of immediate impact male this category of cultural heritage extremely threatened. The density of archaeological finds within this area opens up possibilities of discovering new archaeological sites during the execution of earthworks. Due to this, archaeological reconnaissance of the route is necessary, as well as the archaeological research before excavation works.

Considering the predominantly anthropogenic typology of the landscape and moderately dissected relief, the impact on the landscape within the intervention area between km 0+000 and ≈6+000 is assessed as negligible. From km ≈6+000 to ≈10+000, the impacts on the landscape characteristics are assessed as significant, primarily due to a large number of very high cuts and embankments in that area. From Polakovica tunnel all the way to the end of the route, it has been assessed that the Intervention shall not have any impacts on the surrounding landscape. According to the above mentioned, the assessed intervention impact on the landscape characteristics is moderate, and the final vulnerability of the intervention area has been assessed as moderate, thus assessing the planned Intervention as acceptable in relation to the landscape characteristics.

The route of the road runs through a relatively sparsely populated area, but as most of the existing infrastructure systems in this part of the Municipality of Ston are located within the corridor of the existing state road or are stretching in the direction of Ston – Prapratno Bay, the route of the future road crosses the existing or planned infrastructure

systems at some locations. Due to that, the intervention impact on the existing and planned infrastructure systems is assessed as moderate. This does not refer to the road infrastructure which shall, to a considerable extent, be positively affected because apart from the construction of the new road, all road infrastructures within the closer intervention zone shall be reconstructed and renovated.

The analysis of costs and benefits through evaluating financially measurable impacts has shown the overall benefits deriving from the bridge construction (reduced to the net present value). The acceptability assessment in terms of evaluating financially immeasurable impacts caused by the Intervention is positive.

Taking into consideration all assessed impacts, environmental protection measures, and monitoring program for environmental status, the management of environment during the execution of construction works and during traffic flows has been prescribed in detail.

In conclusion, from the perspective of this Study, the Intervention D414 state road, section: Sparagovići – Doli has been assessed as environmentally acceptable, provided that stipulated protection measures are implemented.

7. INDICATOR OF DIFFICULTIES

While preparing this Environmental Impact Assessment Study, there have not been any particular difficulties since all necessary desk studies, Preliminary Design and Main Design have been available, as well as the adequate database. Furthermore, field research has also been carried out for certain environmental components.

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5. Ordinance on the Environmental Pollution Register (OG 35/08)
6. Ordinance on Waste Management (OG 23/14, 51/14)
7. Regulation on Construction Waste Management (OG 38/08)
8. Ordinance on Waste Oil Management (OG 124/06, 121/08, 31/09)
9. Ordinance on Emission Limit Values for Wastewater Discharges (OG 80/13, 43/14 and 27/15)
10. Regulation on the Methodology for Monitoring the Agricultural Land Condition (OG 43/14)
11. Regulation on the Manner of Keeping Records on the Change of Use of Agricultural Land (OG 149/13)
12. Regulation on the Protection of Agricultural Land from Pollution (OG 09/14)
13. Regulation on Agro-technical Measures (OG 142/13)
14. Ordinance on criteria for determining particularly valuable arable (P1) and valuable arable (P2) agricultural land (OG 151/13)
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16. Ordinance on Measures for the Protection from Outdoor Noise Sources (OG 156/08)
17. Ordinance on Air Quality Monitoring (OG 155/05)
18. Ordinance on the Appropriate Assessment of the Ecological Network (OG 146/14)
19. Rulebook on conservation objectives and basic conservation measures for birds within the ecological network (OG 15/14)
20. Regulation on conformity assessment, documents of conformity and marking of construction products (OG 01/05)
21. Ordinance on the habitat types, habitat map and endangered and rare habitat types (OG 88/14)
22. Ordinance on special conditions for performing inspection of impermeable constructions for wastewater treatment and drainage (OG 1/11)

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24. Regulation on Strictly Protected Species (OG 144/13)
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32. Ordinance on the Protection of Agricultural Land against Pollution (OG 9/14)
33. Ordinance on Forest Management (OG 79/15)
34. Regulation on the Methods for Monitoring of the Damage on Forest Ecosystems (OG 76/13, 122/14)
35. Ordinance on the Protection of Forests against Fire (OG 33/14)
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2. Water Framework Directive 2000/60/EC

10. GRAPHICAL APPENDIXES

10.1.	General layout	1:25000	Sheet 1
10.2.	Situation	1:5000	Sheet 1 - 3
10.3.	Longitudinal cross section of the route	1:5000/500	Sheet 1 - 3
10.4.	Normal cross section of the route		Sheet 1