TheEuropean Union's 2011 IPA Programme for the Republic of Serbia

Modernization of Railways – Project documentation for the railway bypass around Niša

EuropeAid/131854/C/SER/RS

CRIS 2013 / 323 - 409

PRELIMINARY DESIGN
Construction of a single track railway bypass around Niš

Environmental and Social Impact Assessment (ESIA)
29.01.2016.

This project is funded by
The European Union

A project implemented by a consortium led by:
CeS.COWI
and its partners:
NET ENGINEERING SUDOP PRAHA

GENERAL DOCUMENTS

1.1.1. COVER PAGE

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

Investitor:	Infrastruktura Železnice Srbije a.d. Nemanjina 6, Beograd
Objekat:	Jednokolosečna obilazna pruga oko Niša na lokaciji GO Crveni Krst (KO Trupale, KO Popovac, KO Medoševac, KO Niš Crveni Krst) GO Medijana (KO Brzi Brod) GO Pantelej (KO Niš Pantelej, KO Kamenica, KO Donji Matejevac 1, KO Donja Vrežina, KO Gornja Vrežina, KO Malča) GO Niška Banja (KO Prosek-Manastir, KO Sićevo)
Vrsta tehničke dokumentacije:	IDP Idejni projekat
Naziv i oznaka dela projekta:	Assessment Study of Environmental Impact
Za građenje / izvođenje radova:	rekonstrukcija i nova gradnja

Pečat i potpis:

CeS COWI d.o.o. CeS.COWI * BEOGRAD *

Projektant:
CeS COWI d.o.o.
član konzorcijum CeS COWI – NET– SUDOP
Južni bulevar 1a, Beograd
Dragan Milić, direktor

Dragan Milić 1611079751-2104976710255
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Pečat i potpis:

Inženjerska komora Srbije * Snežana M. Bošković * dipl. građ. inž. 312 F282 07 * Odgovorni projektant *

Rukovodilac studije:
Snežana Bošković, dipl.građ.inž.
Broj licence IKS 312 F282 07

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DN: l=Beograd, cn=Snežana Bošković 477360450-01039757268 12
Date: 2016.10.11 21:26:25 +02'00'

Obrađivači Studije:
Snežana Bošković, dipl.građ.inž.
Andrijana Mladenović, dipl.građ.inž.
Tatjana Simić, dipl.građ.inž.
Ljuban Jerosimić, dipl.građ.inž.
Aleksandar Trifunović, dipl.inž.saob.

Broj tehničke dokumentacije:	A10105 - CRIS 2013 / 323 – 409 – 543/13 No 06/16
Mesto i datum:	Beograd, 26.01.2016.

1.1.2. CONTENT OF DESIGN FOR ASSESSMENT STUDY OF ENVIRONMENTAL IMPACT

1.1.1.	Cover page of Design for Assessment Study of Environmental Impact
1.1.2.	Content of Design for Assessment Study of Environmental Impact
1.1.3.	Decision on designation of engineer in charge
1.1.4.	Statement of designer in charge
1.1.5.	Textual documentation
	1 Introduction 2 Details of location for execution of works 3 Project description 4 Overview of the Main Alternative Considered by th Main Contractor 5 Overview of the State of the Environment on Site and in the Immediate Vicinity 6 Description of potential significant environmental impact 7 Environmental Impact Assessment in Case of Accidents 8 Description of Measures Envisaged to Prevent, Reduce and Remedy Any Harmful Environmental Impact 9 Environmental Impact Monitoring Programme 10 Non-Technical Brief Overview of Data Provided under Items 2) to 9) 11 Data on Technical Deficiencies or Lack of Adequate Professional Knowledge and Skills or Inability to Obtain Adequate Data
1.1.7.	Graphical documentation

1.1.3. DECISION ON DESIGNATION OF ENGINEER IN CHARGE

Na osnovu člana 128a. Zakona o planiranju i izgradnji ("Službeni glasnik RS", br. 72/09, 81/09-ispravka, 64/10 odluka US, 24/11 i 121/12, 42/13–odluka US, 50/2013– odluka US, 98/2013–odluka US, 132/14 i 145/14) i odredbi Pravilnika o sadržini, načinu i postupku izrade i način vršenja kontrole tehničke dokumentacije prema klasi i nameni objekata ("Službeni glasnik RS", br. 23/2015 I 77/2015.) kao:

O D G O V O R N I P R O J E K T A N T

za izradu STUDIJE O PROCENI UTICAJA NA ŽIVOTNU SREDINU za izgradnju jednokolosečne pruge za obilaznicu oko Niša koja je deo IDEJNOG PROJEKTA za izgradnju jednokolosečne pruge za obilaznicu oko Niša na lokaciji:

GO Crveni Krst (KO Trupale, KO Popovac, KO Medoševac, KO Niš Crveni Krst)
GO Medijana (KO Brzi Brod)
GO Pantelej (KO Niš Pantelej, KO Kamenica, KO Donji Matejevac 1, KO Donja Vrežina, KO Gornja Vrežina, KO Malča), GO Niška Banja (KO Prosek-Manastir, KO Sićevo)

određuje se:

Snežana Bošković, dipl.građ.inž. br. licence 312 F282 07

Projektant: CeS COWI d.o.o.,
član konzorcijum CeS COWI – NET– SUDOP
Južni bulevar 1a, Beograd

Odgovorno lice / zastupnik: Dragan Milić

Pečat: Potpis:

CeS COWI d.o.o. CeS.COWI * BEOGRAD *

Broj tehničke dokumentacije: A10105 - CRIS 2013 / 323 – 409 – 543/13 No106/16
Mesto i datum: Beograd, 26.01.2016.

1.1.4. STATEMENT OF DESIGNER IN CHARGE OF DESIGN FOR CONSTRUCTION OF SUBSTRUCTURE FOR RAILWAY BYPASS AND STATIONS, WATER PROTECTION WITH DRAINAGE SYSTEMS

Odgovornog obrađivača Studije o proceni uticaja na životnu sredinu koja je deo IDEJNOG PROJEKTA Za izgradnju jednokolosečne pruge za obilaznicu oko Niša na lokaciji GO Crveni Krst (KO Trupale, KO Popovac, KO Medoševac, KO Niš Crveni Krst),GO Medijana (KO Brzi Brod), GO Pantelej (KO Niš Pantelej, KO Kamenica, KO Donji Matejevac 1, KO Donja Vrežina, KO Gornja Vrežina, KO Malča), GO Niška Banja (KO Prosek-Manastir, KO Sićevo)

Snežana Bošković, dipl.građ.inž

I Z J A V LJ U J E M

1. da je projekat izrađen u skladu sa Zakonom o planiranju i izgradnji, propisima, standardima i normativima iz oblasti izgradnje putne i železničke infrastrukture i pravilima struke;
2. da su pri izradi projekta poštovane sve propisane i utvrđene mere i preporuke za ispunjenje osnovnih zahteva za putnu i železničku infrastrukturu i da je projekat izrađen u skladu sa merama i preporukama kojima se dokazuje ispunjenost osnovnih zahteva.

Odgovorni projektant: Snežana Bošković, dipl.građ.inž
IDP
Broj licence: 312 F282 07

Pečat:

Potpis:

Snežana Bošković 47736045 0-010397 5726812

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Broj tehničke dokumentacije: A10105 - CRIS 2013 / 323 – 409 –543/13 No106/16
Mesto i datum: Beograd, 26.01.2016.

ИНЖЕЊЕРСКА КОМОРА СРБИЈЕ

ЛИЦЕНЦА

ОДГОВОРНОГ ПРОЈЕКТАНТА

На основу Закона о планирању и изградњи и
Статута Инжењерске коморе Србије

УПРАВНИ ОДБОР ИНЖЕЊЕРСКЕ КОМОРЕ СРБИЈЕ
утврђује да је

Снежана М. Бошковић

дипломирани грађевински инжењер
ЈМБ 0103975726812

одговорни пројектант

грађевинских конструкција објеката нискоградње

Број лиценце
312 F282 07

У Београду,
13. септембра 2007. године

ПРЕДСЕДНИК КОМОРЕ
Проф. др Драгослав Шумарац
дипл. грађ. инж.

Број: 12-02/189765
Београд, 12.10.2015. године

На основу члана 75. Статута Инжењерске коморе Србије ("СГ РС", бр. 88/05 и 16/09), а на лични захтев члана Коморе, Инжењерска комора Србије издаје

П О Т В Р Д У

Којом се потврђује да је Снежана М. Бошковић, дипл.грађ.инж.
лиценца број

312 F282 07

за

одговорног пројектанта грађевинских конструкција објеката нискоградње

на дан издавања ове потврде члан Инжењерске коморе Србије, да је измирио обавезу плаћања чланарине Комори закључно са 13.09.2016. године, као и да му одлуком Суда части издата лиценца није одузета.

М.П.

Председник Инжењерске коморе Србије

Проф. др Милисав Дамњановић, дипл. инж. арх.

Information about General Contractor

1.	General Contractor: **JSC for railway infrastructure management** **„Infrastruktura železnice Srbije“** Acting managing director: _____ **Dušan Garibović, B.Sc.Econ.**	
2.	Company address: **Nemanjina 6** **Belgrade**	
3.	Contact person: **Anita Dimoski, transport engineer**	Telephone: 011 36 18 334
4.	E-mail: anita.dimoski@srbrail.rs	Fax: 011 36 16 773
5.	Processed by: **CeS COWI doo**	
6.	Company address: **Južni bulevar 1A , Beograd**	
7.	Contact person **Snežana Bošković, civil engineer**	Telephone: 011 38 350 40

1.1.5. TEXTUAL DOCUMENTATION

The European Union's IPA 2011 Programme for Serbia

EuropeAid/131854/C/SER/RS

Modernization of Railways – Project documentation for the railway by-pass around Niša

CRIS 2013 / 323 - 409

PRELIMINARY DESIGN
Construction of a single track railway bypass around Niš

Assessment Study of Environmental Impact

1.1.5. Textual documentation

29.01.2016.

Document no.	CRIS 2013 / 323409_PD_Volume 1/1.2.5-III_ Textual documentation
Version	2
Date of issue	14.07.2016.
Prepared	Tatjana Simić (NKE)
Checked	Stefano Cibin (PE)
Approved	Jitka Doubkova (TL)

Content figures

Content tables

List of Abbreviations

APB	Absolute Permissive Block
AO	Administrative Order
B/C	Benefits over Costs ratio
BP	Business Plan
CA	Contracting Authority
CARDS	Community Assistance for Reconstruction, Development and Stabilisation
CBA	Cost Benefit Analysis
CELENEC	European Committee for Electro-technical Standardisation
CONSULTANT	The Consortium implementing the Railway modernization project
CM	Country Manager
CO	Country Office
CoE	Council of Europe
CV	Curriculum Vitae
CWR	Continuous Welded Rail
DD	Detailed Design
DG-ELARG	EC Directorate- General for Enlargement

DG-REGIO	EC Directorate- General for Regional Policy
DMS	Decentralised Management System
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EN	European Norms
ERA	European Railway Agency
ESC	Economic and Social Cohesion
ETCS	European Train Control System
EU	European Union
EUD	EU Delegation
EUR	Euro
FIDIC	International Federation of Consulting Engineers
FR	Final Report
FS	Feasibility Study
GSM-R	Global System for Mobile communications-Railways
GTMP	General Transport Master Plan
IA	Implementing Agency
IFIs	International Financing Institutions
IIP	Infrastructure Investment Project
IPA	Instrument for Pre-accession Assistance
IR	Inception Report
IRR	Internal Rate of Return
IW	Implementation Works
JGF	Joint Grant Fund
JSC SR	Joint Stock Company Serbian Railways
JASPERS	Joint Assistance to Support Projects in European Regions
KE	Key Expert
MD	Main Design (equivalent to DD)
md	Man days
MC	Monitoring Committee
M&E	Monitoring and evaluation
MIFF	Multi-annual Indicative Financial Framework
MIPD	Multi-annual Indicative Planning Document
MoT	Ministry of Transport
MoFE	Ministry of Finance and Economy
MEDEP	Ministry of Energy, Development and Environmental Protection
MoM	Minutes of Meeting
NIPAC	National IPA Coordinator
NGO	Non-governmental Organisation
NKE	Non-Key Expert
NKSE	Non-Key Senior Expert
NKJE	Non-Key Junior Expert
NPV	Net Present Value
OCL	Overhead Contact Line
PD	Project Director
PCM	Project Cycle Management
PDF	Project Description Form
PFS	Pre-feasibility study
PGAF	Project Grant Application Form
PM	Project Manager
PTF	Project Tracking Form

PPF	Project Preparation Facility
PRAG	Practical Guide to contract Procedures for EC External Actions
PSC	Project Steering Committee
RCC	Regional Cooperation Council
RDA	Regional Development Agency
SAP	Stabilisation and Association Process
SC	Steering Committee
SEETO	South-East Europe Transport Observatory
SEIO	Serbian European Integration Office
SR	Serbian Railways
STE	Short Term Experts
TA	Technical Assistance
TD	Tender Documents
TER	Trans European Railways
TF	Task force
TL	Team Leader
TM	Task Manager (of EC)
ToR	Terms of Reference
TPPF	Transport Project Preparation Facility
TRAE	Transport sector infrastructure expert
TSI	Technical Specifications for Interoperability
TTFSE	Trade and Transport Facilitation for South East Europe
UIC	International Union of Railways
WB	World Bank
WBIF	West Balkans Investment Framework
WD	Working Day
WG	Working Group

CONTENT OF PRELIMINARY DESIGN FOR CONSTRUCTION OF A SINGLE TRACK RAILWAY BYPASS AROUND NIŠ

0 MAIN VOLUME
1.1 RAILWAY ALINGMENT AND TRACK GEOMETRY
1/1.1 Design for the railway bypass alignment and the alignment of reconstructed railway existing lines
1/1.2 Design for construction of sub-structures railway bypass and stations . water protections with drainage systems
1/1.3 Design for the permanent way for the railway bypass and stations
1/1.4 Design for reconstruction of the existing railway lines – substructure and permanent way

1.2 ARCHITECTURAL STRUCTURES
1/2.1 Design of the architectural structures in Niš Sever station
1/2.2 Design of the architectural structures in Pantelej station
1/2.3 Design of the architectural structures in Vrežina station
1/2.4 Design of the pedestrian underpass and canopy in establishment
1/2.5 Design of the pictograms in establishment
1/2.6 Design of the architectural structure in Prosek junction

2.1 STRUCTURES
2/1.1 Design of the bridges
2/1.2 Design of the underpasses
2/1.3 Design of the overpasses
2/1.4 Design of the culverts
2/1.5 Design of the retaining walls
2/1.6 Design of the noise protection walls
2/1.7 Design of the train station building in establishment – constructive part
2/1.8 Design of the pedestrian underpass, the canopy and the platform's wall in establishment – constructive part

2.2 ROADS
2/2.1 Design of access roads in stations
2/2.2 Design of Niška Banja - Prosek roads and deviation of existing road with temporary connection

3 HYDROTECHNICAL WORKS
3.1 Design of hydro technical installation in stations
3.2 Design of waterways regulation
3.3 Design of hydro technical facilities
3.4 Design of Relocation and protection of hydro technical installation

4 POWER SUPPLY FACILITIES AND INSTALATIONS
4.1 Niš Substation
4.2 Tracking sectioning cabin
4.3 Overhead contact line
4.3.1 Open line
4.3.2 Establishments

4.3.3 Niš Sever station
4.4 Design of the Transformers stations
4.5 Design of the Power supply installations and systems in establishment
4.6 Design of Relocation and protection of power lines of medium and low voltage

5.1 SIGNALLING AND INTERLOCKING FACILITIES AND DEVICES
5/1.1 Opšta sveska
5/1.2 Design for reconstruction of signalling in Trupale. Crveni Krst. Niš Ranžirna station and automatic block system Siemens SpDrS-64-JŽ
5/1.3 Design for Niš Sever station and automatic block system
5/1.4 Design for Pantelej station and automatic block system
5/1.5 Design for Vrežina station. Prosek junction and automatic block system/interstation depending

5.2 TELECOMUNICATION FACILITIES AND DEVICES
5/2.1 Design of railway tellecommunication facilities and devices
5/2.2 Design of telecommunication installation and systems in establishment

6 MECHANICAL INSTALATIONS
6.1 Design of thermotechnical installation in stations
6.2 Project of disability platform within the railway platforms
6.3 Design of relocation and protection of gas installations

7 DESIGN OF TECHNOLOGY
7.1 Functional and operational design
7.2 Design of Organization of construction works
7.3 Design of Traffic organization during the construction works

8 DESIGN OF TRAFFIC SIGNALIZATION AND EQUIPMENT
8.1 Design for access roads in establishment
8.2 Design of Niška Banja - Prosek roads and deviation of existing road with temporary connection
8.3 Design of temporary level crossing on deviation railway line Niška Banja – Dimitrovgrad at Prosek junction

9.1 DESIGN OF LANDSCAPE IN ESTABLISHMENT
9.2 UTILITY PLAN

Elaborat 1 Geodetic plan
Elaborat 2 Geotechnical conditions for construction
E2.1 Alignment
E2.2 Structures
E2.3 Laboratory test
E2.4 Geophysical survey
Elaborat 3 Expropriation
Elaborat 4 Fire protection

Study Environmental and Social Impact Assessment
Study Feasibility study

Decision on the volume and content

1 Introduction

Project title:	Modernization of Railways – Project Documentation for the Railway bypass around Nis
Contract:	CRIS No.2013/323-409
Identification no.:	131854/C/SER/RS
Country:	Republic of Serbia
Beneficiary:	Ministry of Construction, Transport and Infrastructure Department of railway and intermodal transportation Ministry of Mining and Energy Ministry of Agriculture and Environmental Protection Ministry of Finance Ministry of Economy Infrastruktura Železnice Srbije ad The City of Nis
Date of Contract signature:	28 June 2013
Total budget:	EUR 1,247,185.00
Start date:	03/09/2013
Duration:	34 months

1.1 Project Purpose

Due to inadequate maintenance and the lack of investment over the past twenty years, the condition of the railway infrastructure in the Corridor X has deteriorated to such a degree that railway is rendered decreasingly competitive compared to other means of transport, particularly with regard to passenger transport, but also regarding the goods sensitive to transport duration.

The purpose of modernization and the completion of the railway bypass around the city of Nis is to make railway transport more competitive and to equalize and improve the duration of transport by railway and road. This project shall assist in redirecting the international road traffic to railway transport with all the benefits arising thereof with regard to environmental protection.

The railway corridor X encompassing international routes E-70 and E-85, passes through Nis while connecting Paris to Istanbul and Budapest to Athens. Urban and demographic development of Nis was not accompanied by investment in road nor railway infrastructure, hence these networks are overloaded. The part of

the railway line going from Nis to the Bulgarian border is the only section of the Corridor X in Serbia which has not been electrified. The construction of the by-pass (Figure 1) shall ensure the dislocation of freight transport from the centre of the city with accompanying electrification. This solution may contribute to further development of the city of Nis and the surrounding area.

Figure 1 Bypass railway around Nis

The preliminary feasibility study with the general design for the construction of a single-track railway for the Nis bypass was completed and submitted to the State Review Commission in 2015. Based on Individual Final Reports by the expert inspection (Rapporteurs) and their Conclusions, the technical documentation „PRELIMINARY FEASIBILITY STUDY AND GENERAL DESIGN TO ANALYSE ENVIRONMENTAL IMPACT OF THE NIS RAILWAY BYPASS“ was prepared in all aspects according to the Terms of Reference and regulations in force, and is therefore technically valid and may be accepted with no objections“.

The quoted opinion together with the official approval enables the proceeding to the next stage of technical documentation preparations pursuant to the Law on Planning and Construction.

1.2 Basis for preparing the assessment study of environmental impact and social issues

In the preparation of the Assessment Study of Environmental Impact and Social Issues, the current regulations in the area, documentation for the General Design, the relevant planning documents, archive documents and field data were used.

1.3 Regulations

The Assessment Study of Environmental Impact and Social Issues should be prepared in accordance with the Law on Planning and Construction („Off. Gazette

of RS“, no. 72/09, 81/09-corr. 64/2010 decision of Constitutional Court, 24/2011,121/2012, 42/2013-decision of CC, 50/2013-decision of CC and 98/2013-decision of CC), the Law on Environmental Impact Assessment („Off. Gazette of RS“, no. 135/04 and 36/09) and all other applicable laws, rules and standards regarding environmental protection and railway and the construction design. The Law on Environmental Impact Assessment sets forth the procedure for assessing the impact of projects which may have a substantial impact on the environment, the contents of the Environmental Impact Assessment study (EIAS), the participation of stakeholders, organizations and the public, cross-border notification for projects that may have substantial impact on the environment of another country, monitoring and other issues relevant to the environmental impact assessment. The Law on Environmental Protection („Off. Gazette of RS“, no. 135/04 and 36/2009) defines the integral system for environmental protection which ensures the exercise of human rights to life and development in a healthy environment and the balance between economic growth and the environment in the country.

Other laws and bylaws with regard to environmental protection:

- Law on Nature Protection („Off. Gazette of RS “, no. 36/09,88/10,91/10 and 14/16),
- National environmental protection programme („Off. Gazette of RS “, no. 12/10),
- Law on Integrated Prevention and Pollution Control (“Off. Gazette of RS”, no. 135/04 and 25/15),
- Law on Waste Management (“Off. Gazette of RS”, no. 36/09, 88/10 and 14/16),
- Law on Waters (“Off. Gazette of RS”, no. 30/10, 93/12),
- Law on Air Protection („Off. Gazette of RS“, no. 36/09),
- Law on Agricultural Land („Off. Gazette of RS“, no. 62/06, 65/08 and 41/09, 112/15),
- Law on Environmental Noise Pollution („Off. Gazette of RS“, no. 36/09, 88/10)
- Law on Environmental Protection („Off. Gazette of RS“, no. 135/04, 36/09, 72/09, 43/11 and 14/16)
- Law on strategic assessment of environmental impact ("Off. Gazette of RS", no. 135/04 and 36/09)
- Law on Chemicals ("Off. Gazette of RS", No. 36/09, 88/10, 92/11, 93/12 and 25/15)
- Law on Biocidal Products ("Off. Gazette of RS", No. 36/09, 88/10, 92/11 and 25/15)
- Law on Protection against ionizing radiation and nuclear safety ("Off. Gazette of RS", No. 36/09 and 93/12)
- Law on Protection from ionizing radiation ("Off. Gazette of RS", no. 36/09)
- Law on packaging and packaging waste ("Off. Gazette of RS", no. 36/09)
- Law on Carriage of Dangerous Goods (“Off. Gazette of RS“, no. 88/10)
- Rules on the form of the document on the movement of waste and instructions for filling it ("Off. Gazette of RS", no. 114/13)

- Regulation on the contents of the assessment of environmental impact ("Off. Gazette of RS", no. 65/05)
- Rules on proclamation and protection of strictly protected and protected wild species of plants, animals and fungi ("Off. Gazette of RS", no. 5/10, 47/11 and 32/16)
- Rulebook on the classifying criteria for the types of habitats - vulnerable, endangered, rare and for the protection of priority habitats and measures for their preservation ("Off. Gazette of RS", no. 35/10)
- Rules on the conditions, manner and procedure of waste oils ("Off. Gazette of RS", no. 71/10)
- Regulation on establishing the list of projects with mandatory EIA and the list of projects that may be required to perform EIA, ("Off. Gazette of RS", no. 114/08),
- Regulation on eco-network, ("Off. Gazette of RS", no. 102/10),

Laws and Rules regarding railway transport:

- Law on Railways („Off. Gazette of RS, no. 45/13 and 91/15),
- Law on Railway Safety and Interoperability ("Off. Gazette of RS", no. 104/13, 66/15 and 92/15)
- Rules on technical conditions and maintenance of substructure of railways ("Official Gazette of RS", no. 39/16)
- Rules of chemical prevention of weed and shrubs on YR railways („Official Gazette of Yugoslav Railway Association", no. 8/90);
- Rules of railway superstructure maintenance („Off. Gazette of YRA", no. 3/71, 5/71, 2/75, 5/76, 8/88, 8/89, 2/90 and 8-9/91);
- Regulation on railroad crossings („Off. Gazette of SRY, no. 72/99)
- Rulebook 317 („Off. Gazette of YRA ", no.10/92)
- Regulation on the carriage of dangerous goods in road and railway transport („Off. Gazette of RS, no. 53/02)
- Directions for the reception and supply of aggregate for railway ballast construction on YR („Off. Gazette of YRA ", no. 1/02);
- Directions for actions in case of extraordinary events („Off. Gazette of YRA", no. 9/92 and 10/92);

1.4 Available technical documentation

Technical documentation for the General Design (project organization: Consortium CES COWI – NET- SUDOP; creation date: 15.12.2014) and technical documentation for this Preliminary Design (project organization: Consortium CES COWI – NET- SUDOP; creation date: in preparation), Locational conditions 7/6/2016 and conditions of collected for the General Regulation Plan have been used in drafting the Assessment Study of Environmental Impact.

1.5 Requirements and opinions from the competent institution

	Institution	Number of condition submission	Date of condition submission
1	Ministry of Defense, Department of Material Resources, Management of Infrastructure	2010-4	24.09.2015.
2	RS, Ministry of Construction, Traffic and infrastructure	350-0100636/2015-14	18.06.2015.
3	RS, Ministry of Health, Department for inspection works	530-53-1779/2015-10	19.06.2015.
4	RS, Institute for Protection of Nature of RS	03 br.0219-118/2	26.06.2015.
5	Institute for Protection of Cultural Monuments of Niš	814/2	19.06.2015.
6	PE Roads of Serbia	953-12330/15-1	03.07.2015.
7	PWE "SRBIJAVODE" - WPC "MORAVA"	07/3392/2	10.06.2015.
8	PE "Elektromreža Srbije"	0-1-2-4182/1	22.06.2015.
9	"Telenor"	2/191/15	10.07.2015.
10	PE "Jugorosgaz"	507	18.06.2015.
11	PE for water and sanitation "Naisus" Niš	15732/2	24.06.2015.
12	"Electrical distribution Niš"	10.22-641003-1231001/1-2015	10.09.2015.
13	RS, Ministry of Interior, Secretary of Interior Nis - Departemnt of Traffic Police	03/43/3/1 br. 684/15	18.06.2015.
14	RS, Ministry of Interior, Secretary of the Interior Niš, Department of Emergency Situations in Niš	07/21/1 broj 217-459/15	09.06.2015.
15	PE Heating plant of city of Niš	02-4839/2	16.06.2015.
16	Telecommunications company "Telekom Serbia" Executive Directorate of the region south	7131211495/2-2015	11.06.2015.
17	PE "Srbijagas"	06-03/11690	10. 06.2015. (3335/15)
18	Transnafta	1710	09.06.2015.
19	SMATSA	CNS.00-25/15	26.06.2015.
20	Directorate of Economy and Sustainable Development	05-659/15	06.07.2015.
21	PE "Post of Serbia" - WY post traffic "Niš"	2015-85196/2	08.07.2015.
22	Civil Aviation Directorate of the Republic of Serbia	5/3-09-0210/2015-0002	22.01.2016.
23	"Serbian Railways"a.d. (Annex 5)	13/15-924	10.06.2015.
24	Ministry of Agriculture, Trade, Forestry and Water Management, Republic Water Directorate	325-05-00451/2012-07, 325-05-00457/2012-07 i 325-05-00577/2016-07	14.05.2012. i 12.05.2016.

Those conditions are attached in Annex.

2 Details of location for execution of works

In order to get the right idea of the current condition in the wider area of the location, as well as the assessment of the prospective impact of structures to be built, it is necessary to be familiar with geological and hydrogeological characteristics of the terrain, climactic character of the area, and the current condition of ground and surface waters, air and noise levels in the observed area.

This Preliminary Design includes the construction and reconstruction of the existing single-track railway going from the station Nis marshalling yard, and the double-track railway from the station Trupale through new terminals Nis North, Pantelej and Vrezina, up to the place of joining the existing railway Nis-Dimitrovgrad in the Prosek settlement. The newly designed railway continues as a single-track one, up to the entrance into the station of Sicevo. In its first section, the line mainly follows the corridor of current railways, touches the airport area, goes through city municipalities of Crveni Krst and Pantelej, detaches after the point of the new Pantelej station and continues along the corridor of the E-80 route. In the vicinity of Prosek, it goes under the highway overpass and follows the route of the existing railway Nis-Dimitrovgrad to the point of reaching the Sicevo station.

2.1 Geographical location

The Nis valley, centrally located in the District of Nisava, stretches from:

43° 15’ and 43° 30’ of the north latitude and

21° 49’ and 22° 13’ east of Greenwich.

As a spacious and shallow depression of irregular elliptical shape with its longer axis of around 44 km and the shorter axis of around 22 km, transversely imprinted into the meridian of the South Morava swale, the Nis valley is situated in the lower Ponisavlje and the northern area of south Pomoravlje in the area of 620 km².

Nis is the largest city in the Southeast Serbia and the seat of the Nisava administrative district. It is located 237 km southeast of Belgrade on the river Nisava, not far from its confluence with Juzna Morava.

Figure 2: Location of Nis in Serbia

Figure 3: Traffic routes through Nis

Geographically, Nis is located at the crossroads of major Balkan and European traffic routes. The main route stretching from the north and passing through the Morava valley from the direction of Belgrade branches towards the south, through the Vardar valley towards Thessaloniki and Athens, and towards the east, through the Nisava valley and the river Marica towards Sofia, Istanbul and the Middle East.

2.2 Cadastral parcels and territorial coverage

The new bypass railway passes through the following cadastral municipalities and covers the total territory of around 41.81ha:

- Municipality of Crveni Krst, C.M.(cadastral municipality) Popovac, C.M. Trupale, C.M. Donji Komren and C.M. Crveni Krst – the area of 20.71Ha;

- Municipality of Pantelej, C.M. Pantelej, C.M. Donja Vrezina and C.M. Gornja Vrezina – the area of 13.85 Ha;

- Municipality of Niska Banja, C.M. Prosek-Manastir and C.M. Sicevo – the area of 7.25 Ha to be expropriated.

Figure 4: Cadastral parcels

C.M. TRUPALE :

- Part of parcel:
  7298,7439,7433,8544,5880/8,7434,7435,7436,7437,7438,7440,7462,

7463,8548

C.M. POPOVAC:

- Part of parcel:

400,399,611,395,394,393,392,391,3484,3404,3403,3402,3401,3400,3399,3396,
3395,3394,3393,3392,3391,3390,3377,3376,613,612,604,3021,3466,614/2,614
/1,617,616,615,407,405,404,398,397,396,3560,3483,3482,3478,3321,3320,331
8,3387,3385,3384,3383,3378,606,608,607,605,3561,3324,3323,3580,3465,346
4,3463,3462,3461,3458,3457,3456,3315,3314,3312,3311,3310,3309,3308,
3307,3306,3564,3566,3263,3554/1,3397,3033,3018/2,524/1,481/2,480,3590,35
88,3262,3322,3388,3583,3386,3313,3398,3586,3547,3546,3545,3544,3543/2,3
914/1,3914/2,3885,3884,3916,3915,5299,5298/1,3473,3472,3471,3470,3460,
3459,3389,402,401,403,3919,458/2,500,3562,3557

- Whole parcel:

3917,3022,1651,501,3918,3554/2

C.M. MEDOŠEVAC

- Part of parcel:

167/2,166/1,176/1,174,175/1,180/3,179/2,178/1,177/3,271/1,268/1,269/1,
270/1,258/2,257/2,256/2,255/2,254/2,253,251/2,250/2,183/2,235/2,238/2,
239/4,240/6,240/5,241/2,242/2,243/2,244/2,245/2,246/2,236/1,234/1,233/1,
232/1,221/2,220/2,219/2,108,171/1,170/1,169/1,254/1,261/1,262/1,263/1,
264/1,265/1,266/1,267/1,260/1,259/1,258/1,257/1,256/1,255/1,252/1,251/1,250
/1,249/2,249/1,248/2,248/1,245/1,244/1,243/1,242/1,241/1,240/2,240/1,239/3,
239/1,238/1,237/1,231/1,228/2,229/2,230/2,231/2,232/2,233/2,234/2,237/2,
226/2,225/2,224/2,223/2,222/2,249/4,249/3,248/3,246/1,247/2,247/1,248/4,
164/1,163,272/6,272/4,183/1,182/1,181/2,181/1,180/1,166/2,218/2,227/3

- Whole parcel:

171/2,164/2,175/2,177/1,271/2,267/2,268/2,269/2,270/2,261/2,262/2,263/2,
260/2,259/2,252/2,181/4181/3,182/2,239/2,229/1,228/1,227/1,226/1,225/1,
224/1,223/1,222/1,221/1,220/3,219/3,216/3,173/1,264/2,265/2,266/2,236/2,
272/2,173/2,175/3,176/3,177/2,178/2,179/3,180/2,172,170/2,169/2,218/3,
230/1,2251/1,

C.M. NIŠ-CRVENI KRST

- Part of parcel:

3301/2,3309/2,3310/1,1143,1144,1142/9,3311/2,1146/1,3312,3320,3323/1,
3369,3323/3,1142/4,464/2,483,472/3,485/2,2919/24,2919/18,40/2,1140/2,1141,
41/12,462/2,463/2,2919/44,1387/3,40/1,41/8,2925/8,2925/9,2924/3,1308/1,
484,43/1,41/9,41/13,2919/46,2919/53,2919/31,2919/32,2919/33,2919/51,
1386/1,1386/2,1387/2,2916/1,1308/2,1130/2,467/1,471/2,476/1,472/6,472/5,
472/4,486,494,495,992,1130/1,1129,1128/2,,1137/2,1139/3,2919/45,32/1,
2918/2,2924/1,3409,3421,,3422/1,3425/1,3425/2,3424/1,3449/1,3451/1,3452,
3460/2,3459/1,3461/2,3462/1,3470/3,3473/1,3474/1,3475/1,3475/3,3476/1,
3481,3482/1,3483/1,3484/2,3486/2,3487/1,3489,3485/1,3473/3,3423/1,40/3,
39/8,2922/55,2922/58,3285

- Whole parcel:

2922/56,1142/8,3322,3323/2,3310/3,3321,467/4,1131/3,1131/2,1131/1,2924/2,
461,1307/7,1133/4,1307/9,1307/8,1132/3,466/5,1307/6,2918/10,3311/1,

2919/41,2919/42,2919/43,2919/25,465/2,3422/2,3425/3,3424/2,3423/2,3450, 3451/2,3459/2,3462/2,3461/1,3474/2,3476/2,3482/2,3483/2,3484/1,3485/2, 3486/1,3487/2,3460/1,3470/2,3473/2,3475/2

C.M. KAMENICA

- Part of parcel:

7820/23,7816/17,7818/49,7999/32,7807/11,7807/9,7997/47,7391/21,7391/25, 7821/27,7815/5,7815/4,7807/13,7391/19,7390/8,7390/6,7807/6,7807/5,7774/2, 7390/3,7390/9,7381/1,7381/2,7380,7995/2,7382,7383,7964/10,7819/21, 7391/23

- Whole parcel:

7820/25,7820/24,7821/29,7821/28,7816/19,7816/18,7818/51,7818/50,7999/33, 7964/13,7964/12,7964/11,7964/7,8025/34,8025/33,7807/12,7807/10,7807/8, 7964/4,8025/28,7390/10,7815/6,7964/8,7807/7,7964/15,7819/23,7819/22, 7964/14,7964/6,7964/9

C.M. NIŠ-PANTELEJ

- Part of parcel:

5811,5810,5784,5783,5782,5978,5977,5967,5962,6019/1,6017,6010,6012/2, 6334/1,6001/2,6004/1,6332,6181/2,6180/2,6189/1,6189/3,6188/3,6192/3, 6139/1,6144/1,6113/1,6760/1,6728/1,6767/2,6766/2,6822/3,6816/1,6838/2, 5789,5788,5787,5786,5785,5968,5961,5836,6011/2,6011/1,6015/2,6331/1, 6177/3,6176/3,6176/2,3087,244,6187/3,6186/3,6181/3,6180/3,6127/1,6145/1, 6193/1,6192/1,6727/1,6718/1,6719/1,6110/1,6770/2,6769/3,6768/2,6840/1, 6839/1,6899/2,6817/1,6820/2,5781/1,5759/1,5814,5813,6001/1,6004/2,6003/2, 6003/1,6012/1,6033,6191/3,6191/1,6190/3,6190/1,6137/1,6194,6771/1,6769/2, 6761/1,6759/1,6764,6775,6842/2,6842/1,6839/2,5760/1,5767,5766,5765, 6179/3,6179/2,6178/1,6177/2,59/1,6899/1,6817/2,6820/3,6821/2,6822/2, 6140/1,6018/2,6018/1,5987/1,5988,6766/1,6758/1,6753/1,6717/1,6716/1, 6117/1,6118/1,6122/1,6123/1,6115/1,6119/1,6121/1,6124/1,6125/1,6126/1,42, 65/1,67/1,69/2,201/2,5737/3,203/1,204/2,1120/4,268/1,269/1,6/46,6/61,6/52, 60/1,1120/3,34,1092/1,103,284/1,283/2,283/3,6/54,6/50,6/44,18,19/1,54/1, 62/1,63,202/2,277/2,277/1,273/2,273/3,1112/3,1113/1,66/1,271/1,276/3,273/1, 39,40/1,1077/1,1121/3,1122/2,1122/1,1123/3,1355/18,1355/16,1355/15, 1355/13,1355/11,1355/9,5737/16,5737/14,5737/12,5737/4,1102/2,5738/7, 5737/5,5812,6770/1

- Whole parcel:

6333/2,6333/1,6002,6178/2,6186/2,5764,6193/2,6192/2,6140/2,6139/2,6127/2, 6137/2,6144/2,6138,6719/2,6716/2,6112/2,6122/2,6110/2,6113/2,6121/2, 6124/2,6111,6760/2,6728/2,6765/2,6758/2,6771/2,9,5763/1,5780,6190/2, 6189/2,6145/3,6145/2,6193/3,6048,6037,6191/2,6759/3,6759/2,5763/2,6096/9, 6049,6727/2,6717/2,6718/2,6125/2,6126/2,66/3,1355/12,6/53,19/2,40/2,59/2, 1120/6,1113/2,1077/2,1099/2,1100/2,5737/9,41,1121/5,1120/5,276/4,1355/14, 5737/13,1121/6,1121/4,61,60/2,1093/2,1112/4,1112/2,272/1,1355/10,5738/6, 1101/2,1093/4,203/2,6034,6157,6768/3,5762,5761,6016/1,6331/2,6112/1, 6117/2,6118/2,6123/2,6115/2,3060,6761/2,6765/1,6816/2,6016/2,6188/2,

6187/2,3377,65/2,67/2,284/2,6/62,54/2,66/2,5737/10,1092/2,272/2,6840/2

C.M. DONJA VREŽINA

- Part of parcel:

38/9,44/4,1965/28,139/5,138/3,137/3,152/3,381/8,1970/6,316/6,4/2,3/2,77/7, 79/13,136/4,383/6,383/3,340/2,327/3,307/7,1971/8,829/10,1107/4,1110/7,5/1, 37/34,36/10,79/11,1957/41,47/10,48/1,44/2,138/5,133/10,134/5,1958/12, 1958/11,382/2,355/8,326/4,1967/6,307/8,1111/8,5/2,4/3,3/3,2/5,2/4,1969/29, 37/36,36/9,1957/44,384/11,136/13,136/11,137/5,353/11,351/5,352/5,353/9, 319/3,1967/8,832/4,829/7,832/2,1111/6,1964/14,1117/1,10,74/7,75/4,76/5, 79/12,46/9,44/7,45/6,38/15,72/1,357/4,358/6,359/1,202/10,202/8,1958/16, 381/20,826/4,828/3,1971/6,318/6,316/4,315/4,313/8,313/5,312/5,307/6,1107/6, 1107/5,1109,1104,6/2,1969/30,7,833/8,326/27,326/24,335/5,1970/7,350/7, 354/4,355/10,327/4,132/8,1965/30,132/1,812/7,1964/11,833/6,833/5,356/4, 202/12,1980,335/4,216/4

- Whole parcel:

6/1,37/35,38/16,44/8,79/16,1957/43,80/6,77/6,1965/31,73/8,139/6,140/4, 384/12,383/5,132/5,384/10,381/23,202/7,358/7,359/2,357/3,339/3,328/8,328/6, 328/5,1967/9,307/4,318/8,835/5,837/8,837/7,1116/8,1116/7,36/11,47/8,78/7, 78/6,79/15,75/5,133/11,136/12,381/22,381/21,383/7,152/6,381/7,355/11,355/9, 1970/8,329/6,329/5,339/4,338/7,329/1,319/4,312/4,316/5,826/5,835/4,836/4, 1110/6,47/9,47/7,74/8,138/6,202/9,1958/17,202/4,1958/9,350/8,353/10,351/6, 352/6,353/12,354/5,337/2,336/1,1971/7,318/9,318/7,829/9,812/8,1105/12, 37/37,36/8,152/5,136/14,137/6,326/25,338/5,315/5,832/5,829/8,1115/9,1115/8, 1111/7,1117/5,1117/4,76/4,45/7,357/5,828/4,313/7,833/7,328/7,326/26,329/3, 132/9,1964/13,1964/12,356/5,335/3,1106/3

C.M. DONJI MATEJEVAC

- Part of parcel:

3809/12,3875/10,3809/14,3809/16,3809/17,3808/7,3808/8,3802/6,3801/6, 3800/5,3805/5,3805/6,3803/1,3804/1,3805/7,3806/6,3806/7,3807/6,3807/7

- Whole parcel:

3801/7,3801/8,3802/7,3802/8

C.M. BRZI BROD

- Part of parcel:

2267/7,2248/10,2250/12,2248/2,2726/2,2216/1,2215/4,2245/1,2217,2206/4, 2252,2247/1,437,1094,2207/6,2251/14,2251/12,2251/10,2251/8,2250/10, 2250/8,2206,2725/1,2705/5,2267/8

- Whole parcel:

2267/10,2245/2,2705/6,2705/4,2249/6,2248/9,2248/8,2251/18,2251/13, 2251/11,2249/4,2216/2,2186/14,2186/13,2186/12,2186/9,2186/8,2206/5, 2725/2,2267/9,2267/5,2215/6,2207/5,2207/4,2208/8,2251/7,2250/6,2185/7, 2185/6,2208/6,2208/4,2251/16,2186/10

C.M. GORNJA VREŽINA

- Part of parcel:

2517/5,2521/16,2521/14,2527/4,2522/4,2355/4,2345/5,2357/8,2342/8,2338/11, 2339/5,2340/5,2318/8,2319/5,2317/12,2317/8,2317/14,2288/11,2288/7,2289/5, 2290/5,2291/18,2291/14,2286/1,2287/6,2245/2,4578/18,4579/3,2518/13, 2518/12,2518/8,2521/12,2527/8,2527/6,2523/4,2354/1,2356/8,2346/5,2357/6, 2346/7,2350,2338/19,2338/15,4580/6,2291/10,2270/3,2278/8,2278/9,2247/1, 3055,2521/10,2520/6,2520/4,2519/6,2519/4,2518/10,2530/3,2526/3,2524/6, 2318/10,2319/7,2338/21,138,2338/13,2339/7,2340/7,2341/7,2343/7,2344/7, 2345/7,2310/2,2312/6,2312/8,2286/2,2287/4,2292/6,2293/7,2294/1,2245/4, 2243/1,3008,3007,3010,3009,3026/2,3026/1,3017/2,3021/2,3021/1,3018,3020, 3019,3022,3023,3024,3025,3059,3058,3057,3054,2528,2521/20,2521/18, 2317/10,2318/14,2318/12,4578/19,2266/2,2278/10,2278/7,2271/8,2272/3, 2271/1,2287/7,2287/5,2288/12,2288/8,2274/2,2274/1,2273/1,3015,3014, 3017/1,3012,3011,3152,3056/2,3056/1,2517/7,2516/9,2516/7,2289/6,2290/6, 2291/19,2291/15,2291/11,2292/7,2296/2,2295/3,2294/2,3032,3031,3061/4, 3061/3,3060,3062/2,3062/1,3027,2355/2,2356/9,4579/1,4585/2,2250/3,2246/3, 2250/4,2341/5,2342/6,2343/5,2344/5,2352/1,2353/1,2262/1

- Whole parcel:

2518/9,2517/6,2521/15,2521/11,2522/1,2522/5,2524/4,2356/5,2352/2,2342/7, 2343/6,2338/16,2338/12,2339/6,2319/6,2295/4,2273/8,2246/4,2246/2,2523/3, 2356/6,2357/4,2318/9,2338/20,2317/13,2317/9,2272/5,2271/7,2520/5,2519/5, 2526/2,2340/6,2341/6,2297/1,2310/1,2311/1,2244,2521/19,318/13,2273/7, 2272/6,2272/4,2516/8,2296/1,2354/2,2355/3,2245/3,2344/6,2345/6,2346/6, 2357/7,3006,2311/2,2353/2,2530/4,2523/5

C.M. MALČA

- Part of parcel:

6915,6916,6917,6938/1,6918,6914,6880/1,6633/3,6935/2,6936/7,6944,6941, 6942,6943,6336,6337,6388,6389,6799,6822,6920,6936/19,6936/16,7221/8, 6371/2,6633/2,6640,6727/2,6936/5,6939/1,6940,6227/1,6228,6229/3,6217/1, 6338,6380,6382,6383,6384,6385,6386,6387,6616/2,6372,6367/2,6612,6639/1, 6635,6636,6546/2,6546/1,6727/1,6801,6907,6908,6909,6910,6797,6823/2, 6824,6825,6811/1,6802,6818/1,6818/2,6815,6814/2,6819/1,6820/1,6926,6921, 6922,6923,6924,6925,6928,6929,6930/1,6930/2,6936/2,6936/8,6936/9, 6936/13,6879/1,6936/22,6877/26,6877/13,6877/10,6877/23,6877/18,6935/7, 6935/4,6936/15,7221/6,6221/3,6221/2,6220,6219,6218,6272,6391,6345, 6619/2,6615,6616/1,6617,6618,6610,6608,6548,6545/1,6770/1,6770/2,6770/3, 6545/2,6931,6934/1,6932/1,6364,6363/1,6369,6367/1,6368,6911,6913,6334/1, 6335,6343,6344,6346,7225,7227/1,7226,7222/6,6876/6,6637/2,6637/3,6641, 6638,6637/1,7175/1,6947/1,6948/1,6949,6950/1

- Whole parcel:

6823/1,6823/4,6877/11,6936/11,6877/14,6877/20,6877/21,6877/19,6877/27, 6876/5,6927,6633/4,6877/16,6877/15,6819/2,6633/1,6877/24,6633/5,6634, 6800,6798,6877/29,6936/21,6936/12,6936/18,6939/2,7221/7,6879/3,6390, 6876/4,6939/3,7239/1,6950/2,6948/2,6947/2,7239/2,7229,7229/2

C.M. PROSEK MANASTIR

- Part of parcel:

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- Whole parcel:

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C.M. SIĆEVO

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8209/1

2.3 Pedological, geomorphological, geological, hydrogeological and seismic features of the terrain

2.3.1 Pedological features

The pedological, i.e. the productivity layer for the territory of Nis is as follows:

• **alluvium and chernozem** are soil types with high ground waters and other corresponding edaphic factors which have the greatest potential for the growth and cultivation of crops and the greatest possibilities for growing a wide range of species. Alluvial soils do not have balanced productivity. It greatly depends on the composition of deposits, physical and chemical characteristics, hydrographic factors, etc. In the largest part of the area with much-less regular conditions, productivity has high-quality characteristics as these are mainly loose types of land, and the flat relief allows for complete application of machinery and easy irrigation.

• **vertisol** appears in the given area in the form of carbonate vertisol, normal or undergoing fortification, or eroded and redeposited. In such structural conditions,

the soil is characterised as having a medium or slightly better prospective fertility which is explained by deep and accumulative horizons and abundance in total biogenic elements.

• **brown forest soils** are soils of medium productivity abilities. Their natural fertility greatly varies depending on the content of topsoil and the degree of erosion, relief, exposition of the mechanical content, etc. On average, this type of soil is classified as having medium quality values with good possibilities for the application of agritechnical measures.

• **red soil and podsol**. Red soil is a clayey-sandy and virtually neutral soil containing great quantities of iron oxide, hence the red colour. It contains small quantities of topsoil, and is suitable for growing tobacco, wine, fruit, olives and other crops. In higher, more humid areas, red soil is degraded and it turns into podsol and brown forest soil. Pool appears at higher altitudes with high rainfall. It is possible to grow crops using agri-technical measures and abundant fertilizers. These areas are colder and moister with the characteristics typical of such conditions. The soils are highly sandy with depleted topsoil and are very rich in skeletal matter, have high permeability resulting in intense washout, with an unfavourable water regime. Productivity value of these poor quality soils is very low, and they are almost uniformly covered in forests.

• **skeletal and skeletoid soils** are areas covered in sand, gravel, stone and rock, that is, they have a geological base (70-80% of the area). The genesis of such soils can be associated with man-made impact, followed by degradation and erosion and the breakout of geological base to the surface. Regarding vegetation, xerophyte species are present on brownish soils. The fertility of these areas is inconsiderable, and they are used as pasture lands nowadays.

2.3.2 Geological features

Geological features shown in this chapter are defined based on the results of the earlier research data of the Basic Geologic Mapping. The surveyed area belongs to sheets K 34-32 Nis, K 34-33 Bela Palanka, K 34-20 Aleksinac and K 34-21 Knjazevac of the Basic Geological Mapping in the scale of 1:100 000.

Based on an earlier survey, it has been established that the terrain up to the researched depth was formed of quaternary sediments of the Pleistocene epoch and neogenic sediments of the Pliocene and Miocene age. The research area belongs to the Nis valley located on the geotectonic border of the crystalline, Rodopic mass and limestone mountains in the eastern Serbia and the joint of the great swales of the Balkan peninsula between Selicevica and Mali Jastrebac mountains and their branches (the south and west), and Svrljiske Planine and Suva Planina (the east). In the south, it starts at the narrowing at Kurvingrad and ends at the narrowing at Mezgraja in the north.

In some parts of Suva Planina, limestones and marlstone with fossils have been found, dating back these sediments to the Jurassic period and indicating a transgression of Jurassic seas up to the location where the Nis valley is situated presently.

During the Eocene, the surroundings of the Suva Planina were mainland. This was changed by the movements in the Earth crust which had probably started in the Cretaceous period, and peaked in Oligocene and Miocene. This is when the limestone masses rose, out of which Suva Planina, Selicevica and Koritnjak formed. During these movements, the area of Nis underwent more intense folding than any other region in the Balkans. The genesis of faults and great swales is also associated with this period.

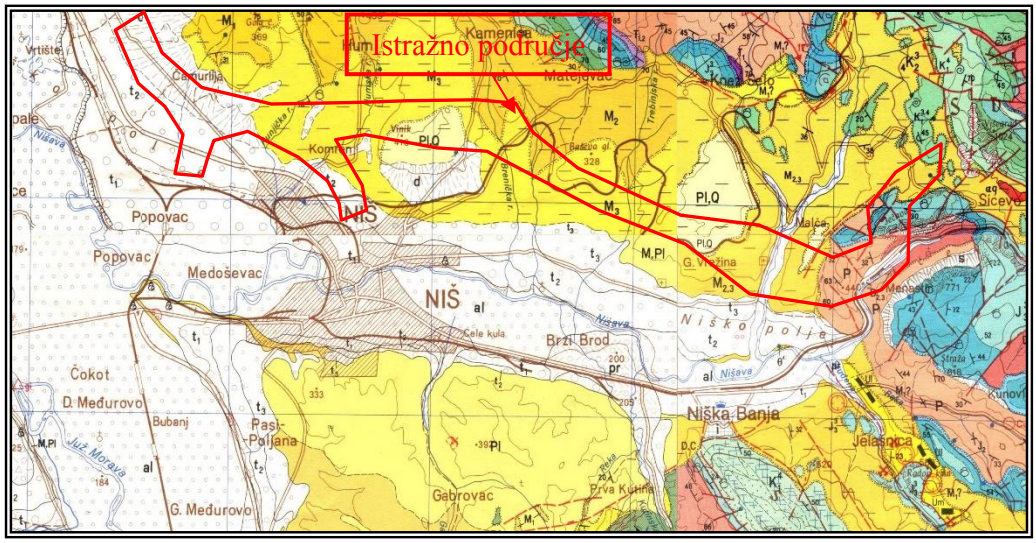

Figure 5: Excerpt from BGM

In the lacustrine development period of the Nisava valley, according to research findings, three stages or three lacustrine terraces may be distinguished.

Stages in lacustrine development of the Nisava valley

Stage one

In the oldest lacustrine stage, the area of the lake reached the height of 830 m compared to its present altitude. Only the ridges of Suva Planina and Selicevica Mountain rose above water, while Koritnjak was drowned. After a long quiet period, towards the end of this stage, a time of intense tectonic movement took place, which changed the contours of the lake bottom and caused a relatively quick drop from 830 m to 610 m.

Stage two

This lacustrine stage is characterized by the settling of movements and the drop of water level, which resulted in the increase of the mainland area. Towards the very end of this stage, large movements took place, leaving the lake at the height

of 500 m. This stage also marked the rising of the midsection between basins, drawing the contours of present-day valleys in Southeast Serbia.

Stage three

In the final lacustrine stage, a formerly big lake dissolved into four small ones which filled the Nis valley and the neighbouring valleys. The Nis Lake resembled the bay of a larger lake, which covered the areas of Leskovacko-aleksinacko Pomoravlje. Strong tectonic movements appeared at the end of this stage which belongs to late Pliocene. These tectonic movements led to changes in soil height, causing quick run-off of the lake and the formation of Pliocenic Nisava.

Nisava played a part in the formation of the modern valley relief. When it appeared as a river at the end of Pliocene, Nisava flowed at 350 to 360 m a.s.l., that is 150 to 160 m above the level of today's area of ground at the railway station Niska Banja. The traces of its oldest terrace can be seen at 450 to 460 m a.s.l.

Mesorelief and microrelief of the Nis valley were shaped by various morphological processes - terrace, thermal, karstic, clastocarstic and recent forms, and mostly by tectonic movement that lead to discordant position of layers with prevailing inclination towards southwest. This leads to the conclusion that the thrust in the area of the valley was most likely on mount Jastrebac or Selicevica. The strongest action of the thrust was in the period of Alpine orogeny when almost all earlier layers transformed, folded, rose or set against each other. It is believed that the formation of the valley area began with Baikal and Caledonian movements to continue with Hercynian and Oligomiocene movements.

The karstic relief of the Nis valley is also present in the area of the Sicevo gorge, Suva Planina and Niska Banja. Lias sandstone encompasses the limestone wall of Koritnjak at whose foot and sides Niska Banja is situated, and isolates the wall from the Suva Planina limestone massif into a separate hydrogeological unit.

The youngest sediments belong to the river Nisava alluvium and are found by the river in the lowest points of the Nis valley. These sediments are characterized by regularly arranged lithological members aligned vertically where "colourful" gravel (bed facies) lies in the slope, on top of which are various dusty and sandy depositions of floodplain facies.

2.3.3 Hydrological features

The main hydrographic feature of the analysed area is marked by two great rivers – Juzna Morava and Nisava and several smaller watercourses (Grabovacka Reka, Kutinska Reka, Jelasnicka Reka, Ostrovicka Reka, Suvodolska Reka, Malcanska Reka, Matejevacka Reka, Brenicka, etc.) with perennial and intermittent streams, and affluent groundwater with big and small springs and wells, a few of which are thermomineral healing waters.

First order streams

The Nis valley is intersected and drained by two main watercourses, Nisava and Juzna Morava, and their tributaries.

- *Južna Morava*

Figure 6: Juzna Morava

Juzna Morava rises in the Republic of Macedonia, north of its capital Skoplje. Kljucevska and Slatinska Reka rivers form the river Golema, which is known as Binacka Morava on its passing through the Macedonian-Serbian border 49 km into its course, Binacka Morava meets Presevska Moravica at Bujanovac and continues as Juzna Morava for the remaining 246 km.

The course of Juzna Morava is a composite valley. It consists of a series of gorges and valleys: Vranjska kotlina, Grdelicka klisura, Leskovacka kotlina, Pecenjevacko suzenje, Brestovacka kotlina, small narrowing Kurvingradsko suženje, Niska kotlina, Mezgrajsko suzenje, Aleksinacka kotlina and Stalacka klisura, where Juzna Morava catches up with Zapadna Morava and together they form Velika Morava.

In its entire flow through this valley it has characteristics of a lowland river with a shallow and unregulated bed and changeable water regime, conditioned by the flooding nature of its tributaries. The hydrologic regime of Juzna Morava is defined by low and flood discharges, the measured discharge at Kurvin Grad station is Qmin 3,39 m3/sec, Qsr 24,33m3/sec and Qmax 495m3/sec. Juzna Morava belongs to the II/III actual quality class for watercourses.
It intersects the entire width of the Nis valley along its western boundary. After it receives water from Nisava, Toponicka Reka and Mramorski Potok, Juzna Morava increases its discharge which is 101 m^3/s on average. In spring and late winter months, Juzna Morava has a great quantity of water, whereas in summer and early autumn months, its water quantities are small. Maximum discharge is recorded in March, while minimum discharge is in August and September.

- *Nisava*

Figure 7:Nisava in downtown Nis (by the University building) at great water levels

Figure 8: Nisava in downtown Nis (by the University building) at regular water levels

The river Nisava is the largest tributary of Juzna Morava. It is formed of Ginska Reka and Vrbnica joining at the village of Toden at 640 m a.s.l. in Bulgaria. The main source leg of Nisava is its right tributary Ginska Reka which is more abundant in water and twice the length of the river Vrbnica. Nisava enters Serbia 6 km upstream of Dimitrovgrad, and continues to flow through the composite valley consisting of a series of valleys joint by gorges Pirotska kotlina, Sopotski tesnac, Djurdjevpoljska kotlina, gorge at Sveti Otac, Belopalanacka kotlina, Sicevačka klisura) and ends in the Nis valley. From the gorge of Sicevo, Nisava enters the spacious Nis valley and winding through it as a lowland river, forms two elbow-shaped bends at Medosevac and Novo Selo. At its passage through Nis, its bed is regulated and underpinned with stones, and downstream of the city to its confluence with Juzna Morava, earth embankments were built for flood protection.

Nisava is the most water-abundant tributary of Juzna Morava. On the territory of Nis it has the highest average monthly discharges in April and March, which is attributed to snowmelt, while it is at its lowest in October and September.

Hydrological regime of Nisava is defined by the discharge of low and floodwaters which, measured at hydrometric station Bela Palanka, have the discharge of Qmin 4,48 m3/sec, Qsr 58,88m3/sec and Qmax 1905m3/sec. Nisava belongs to the III class actual quality for watercourses.

Most of Nisava's tributaries going through the Nis valley are typically lowland rivers. The area of Selicevica (southern boundary of the Nis valley) is the most intersected point by their river valleys in dry valleys. However, the riparian areas of some tributaries, although being dry valleys, endanger the riparian areas with floods. One of these is e.g. Kutinska Reka, which does not have stable banks and

therefore moves during great water levels undermining the left bank and burying the alluvial plain right thereto.

The total number of springs has not been identified. They are most numerous in the valley of Ostrovicka Reka. Studensko Vrelo is the most significant for water supply. It is formed of 12 powerful springs collected from 3 source springs and capped for the Nis water supply company.

Thermomineral springs of Niska Banja (3 springs: Glavno vrelo, Suva banja and Skolska Cesma) are particularly valuable resources.

Hydrological characteristics of the area in which the construction of the railway is planned, depend on specific elements. Firstly, these are the elements arising from geological features of the landscape. By no means less significant are geomorphological characteristics of the terrain which directly and indirectly influence the formation of certain geological features in some parts of the terrain.

Due to complex geological conditions and alternating permeable and non-permeable rocks both vertically and horizontally, the level of aquifers on the walls of the Nis valley is varied and can be broken down into three areas:

1. Aquifer area of quaternary deposits

This area of quaternary deposits includes the central part of the Nis valley up to the height marked by the lowest river terrace and is located at the depth of 7 m. In the alluvial plain of Nisava it is at lower depths of 2 m. In this area different feeding methods are distinguished for its aquifers and other aquifers, and its level is greatly influenced by the water levels of Nisava and Juzna Morava.

2. Aquifers in the area of low river terraces

The area of low river terraces encompasses the territory up to the 300 m contour line and is divided by Nisava into two sections. The northern section which makes a single zone and the southern section intersected by the valleys of rivers Jelasnicka, Kutinska and Gabrovacka Reka. The level of aquifers in this area is at the depth of 7 to 10 m, which mainly depends on the morphology of landscape.

3. Aquifers in the area of high terraces

The area of high terraces, or the aquifer area is the least prevalent in the Nis valley. It is primarily linked to its edges and it is mostly rugged. It feeds on rainfall characteristic of karstic aquifers and stretches to northern and southeastern boundaries of the Nis valley. This area loses water through the supply of many springs and drainage into the lower area.

2.3.4 Geomorphological features

The Nis valley is characterized by various geomorphological forms. This diversity is a result of a very long and eventful geological past. The relief distinguishes between tectonic and various forms of erosional relief.

2.3.5 Tectonic relief forms

The Nis valley was formed by tectonic processes, which affected its bottom and the edge, and were manifested as folding, setting, faulting and fractioning of almost every layer. Hence the valley is a separate tectonic unit lying between six mountain blocks (Selicevica, Suva planina, Svrljiske planine, Kalafat, Popova glava and Mali Jastrebac), that is, 4 morphotectonic units (Selicevica and Popova glava, Suva planina and Kalafat, Svrljiske planine, M.Jastrebac).

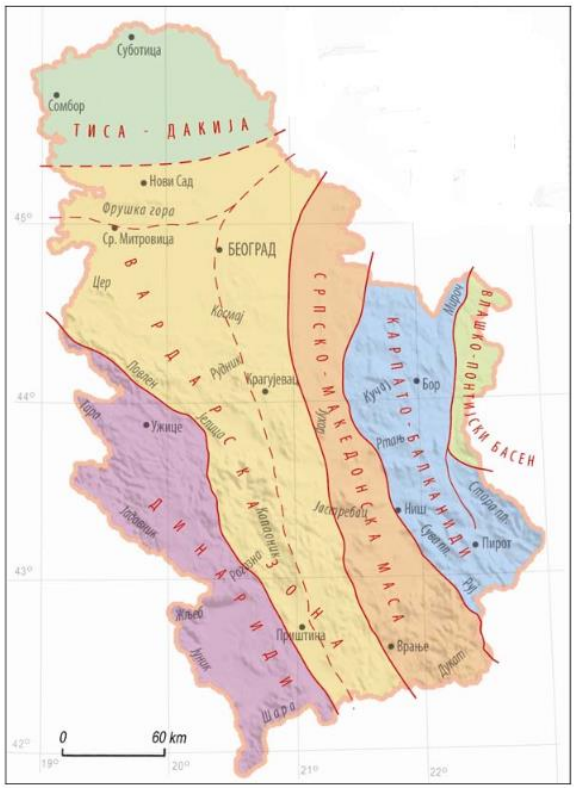

Figure 9:Tectonic relief forms

Frequent and strong folding first affected the westernmost structural unit of Mali Jastrebac. It is a low mountain, encompassed by Juzna Morava on the east, the flow of the Turija river on the north, and Klisurska Reka and Grebac pass on the west. Its highest point is Kupinjak at 946 m.

In tectonic sense, Seličevica and Popova glava belong to the Morava thrust fault (Rodopic mass) which was folded by the Caledonian and Hercynian orogeny. The highest peaks are Mala Ibrovica and Velika Tumba – 903m.

Suva planina and Kalifat are east of Morava-Zaplanje dislocation and belong to the inner limestone belt of eastern Serbia. The summit of Suva Planina is Golemi Vrh – 1,810 m. Erosion is common as the mountain is mostly deforested.

The edge of the Nis valley is formed by Svrljiske Planine, which collide with the Rodopic mass, but structurally belong to the eastern area of young mountain ranges. The highest peak is Zeleni at 1,334 m.

In the morphotectonic set of the Nis valley macro relief, the following local basins are tectonically predisposed - Jelasnica, Studena and Sveti Jovan, as well as the gorges which connect them and separate them as morphological joints:

- Sicevacka Klisura gorge, a deep breakthrough gorge of the Nisava river is 17 km long, and is located between Suva Planina in the south and Svrljiske planine in the north.
- Jelasnicka Klisura gorge, 2 km long is so narrow that its vertical cuts are only 7-8 m apart in one place.
- Prvokutinska Klisura gorge is a minor morphological unit formed on the river Kutina.
- Kravljansko-miljkovacka Klisura gorge is a part of the Toponicka Reka valley. It is prominent for its steep cuts and canyon-like appearance in some places.

2.3.6 Seismologic characteristics of the terrain

Seismicity of the terrain is a parameter which is significant for the analysis of possible negative impact on geological (natural) and technogenic (railway, buildings, facilities) environment. The term terrain seismicity in this case refers to the analysis of seismic hazard and seismic risk. Seismic hazard includes the study of kinematics and dynamics of earthquake occurrence, that is, its intensity in the terrain, while the analysis of seismic risk includes the assessment of the degree of threat to a specific structure expressed as minor or major damage.

In seismologic terms, the territory of the Nis valley, as well as the territory of Suva Planina at whose foot it is situated, is an earthquake-prone area in Serbia. This part of the Balkan peninsula is a part of a seismically very active area in the region of the Mediterranean-Trans-Asian seismic belt. In complex faulting zones under the edge of Suva Planina and the areas of Sicevacka Klisura gorge and Niska Banja, occasional neotectonic activity has been recorded. It is manifested in seismic phenomena with the effects of shocks on hydrological characteristics of ground and surface waters and morphological changes in the relief.

Day-to-day existence of the Nis valley area was occasionally disturbed by the „continuation“ of seismic activity. The activity had different intensity, happening in an almost uninterrupted sequence of years, and was particularly connected to the following two periods from the mid-seventies to the mid-nineties of the 19th century. Strong earthquakes were recorded in 1867, 1868, 1869, 1870, 1871 and 1872, as well as in 1876, 1878, 1879, 1881, 1883, 1885 and 1886. They too, like

the ones that preceded them „left“ slight or visible consequences on the geography of the Nis valley as a whole.

Table 1 Seismicity of the Nis valley

Return period (years)	Seismicity according to MCS scale
50	6°,7° and 8°
100	6°,7° and 8°
200	6°,7° and 8°
500	8° and 9°
1000	8° and 9°
10 000	8° and 9°

The researched area belongs to the complex terrains where the earthquakes of 7°, 8° and 9° MCS scale are possible, according to the seismic reionization maps. The seismic activity of these areas is conditioned by different geological, geotechnical, hydrogeological, engineering-geological and geomorphological factors. It is particularly intensified along different geotectonic units, big faults, on unstable grounds – threatened by active landslides and terrains flooded by ground and surface waters.

Seismicity of the terrain and possible seismicity increment indicate that the construction on this entire terrain calls for the compliance with the regulations of seismic construction, requiring detailed seismic studies for all buildings of investment construction.

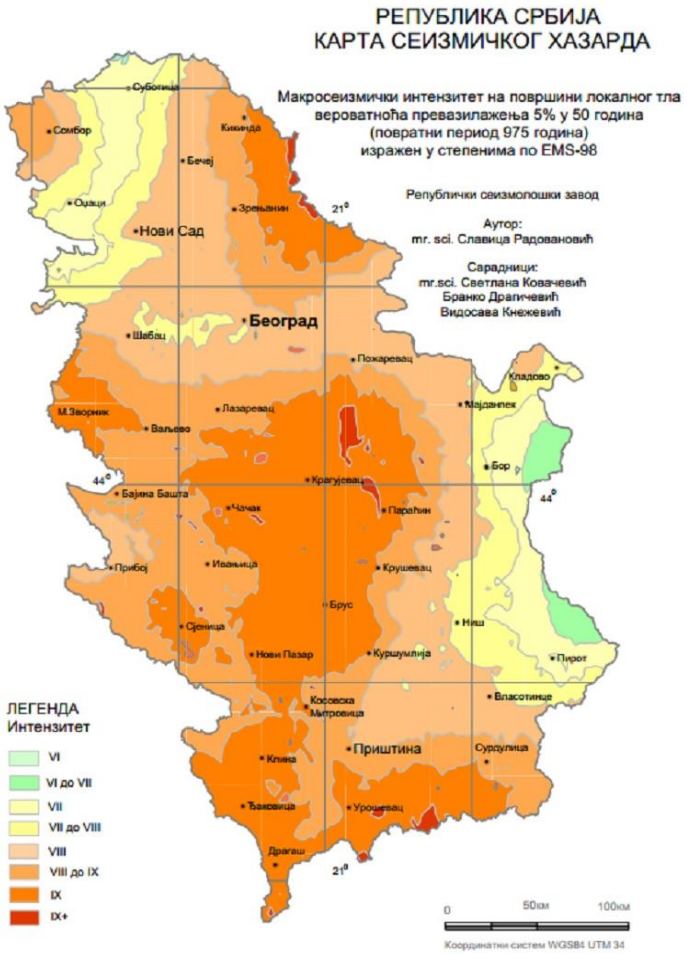

Figure 10: Seismic hazard map

2.4 Data on the water supply spring source

The part of the Carpatho-Balkan arc in eastern Serbia, together with the part of the Dacian basin is a separate hydrogeological unit with particularly complex structure.

The main hydrogeological distinguishing feature of this area comes from numerous masses of cracked and carstificated late Jurassic and early Cretaceous limestones. Rainfall infiltrates these permeable rock masses. Groundwaters are usually discharged at barriers, where inlet source springs originate.

From the perspective of groundwater utilisation, the yield of most karst source springs greatly varies, which is unfavourable.

In the basin of the Nisava river, one of the largest rock masses- the mass of Svrljiske Planine is mostly discharged through Krupacko Vrelo – Modro Oko springs. Strongly carstificated limestones of Suva Planina are characterized by

numerous large springs, such as: scattered water sources Ljubedja, Mokra, Studena, etc.

The water supply in the city of Nis is conducted using three territorially separate but interdependent water systems:

- Water system "MEDIANA" – groundwater source additionally fed with previously treated water from the Nisava river, the capacity of 100-500 l/s.

- Water system "STUDENA" – natural karstic spring and inlet pipeline with facilities, the capacity of 220-340 l/s.

- Water system "LJUBERADJA-NIS" – a series of natural karstic springs Krupac, Mokra, Divljana and Ljuberadja) and an inlet pipeline with facilities, the capacity of 800-1450 l/s.

These systems with their sources, inlet systems, distribution and supply networks, pumping stations and tanks comprise the Water Supply System of Nis (NIVOS).

It is used for water supply of around 240,000 people and a much diversified industry of Nis, with yearly and daily quantities of 37,732,608 m3 and 103,377 m3, respectively. The operation of the system is reliable and stable with the high degree of inspection regarding water quality.

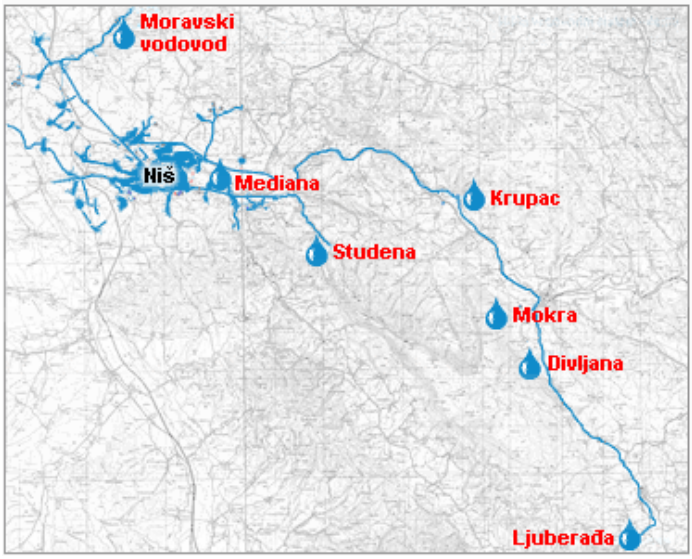

Figure 11: Sources for water supply

Limitations: Insufficient maintenance of public water supply systems and underdeveloped sewerage systems; lack of development projects regarding research and exploitation of thermomineral waters.

Potential: Abundance of surface and groundwaters, natural springs and source springs, substantial number of thermal radioactive waters and abundance of waters of karstic aquifers suitable for bottling.

2.5 Climate

Thermal characteristics of Nis and its surroundings were identified using the data from the meteorological station Tvrdjava – Nis for the period (1950-2009).

One maximum and one minimum value are prominent in the annual range of temperature. The lowest mean monthly temperature is in January (0.2°C). From then on, the temperatures increase steadily towards the summer to reach their maximum in July (22.3°C), although the mean temperature in August is similar (21.1°C). Towards the autumn, temperatures also decrease steadily towards the January minimum value.

Temperature amplitude is 22.3°C, which classifies this area as a territory with moderate continental climate.

Table 2 Climograph for Nis

Climograph for Nis (1961-1990 mean)													
Indica-tor/month	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	yr
Mean max (^{0}C)	3.8	7.1	12.3	18.0	22.9	25.9	28.0	28.5	24.8	18.9	11.7	5.4	17.3
Mean temp. (^{0}C)	-0.2	2.5	6.7	11.9	16.6	19.5	21.3	21.1	17.2	11.9	6.4	1.7	11.4
Mean min. (^{0}C)	-3.5	-1.3	1.8	6.1	10.4	13.4	14.5	14.4	11.1	6.5	2.4	-1.4	6.2
Rainfall (mm)	41.3	40.3	45.3	51.3	66.7	69.7	43.6	43.3	43.6	34.1	56.8	53.6	589.6

Table 3 Mean seasonal temperatures in Nis

Season	Winter	Spring	Summer	Autumn
Mean tem-perature	1.53°C	11.87°C	21.37°C	12.07°C

The lowest mean temperature is a positive value, which is rare in Serbia and indicates mild winters. Maximum mean monthly temperature is rather high (22.1°C), indicating a very hot summer. With the mean annual temperature of 11.74°C, Nis is one of the warmest cities in Serbia.

The summer in Nis is long and hot. It lasts for 108 days (15 days longer than the calendar summer) with the mean temperature of 21.37°C. Almost all days in July and August have a temperature above 25°C (summer days), every other day is tropical (the frequency in August is 14.9), and tropical nights (3.7 days) have also been recorded. Winters are long, but not too cold. On average they last for 99 days with the mean temperature of 1,53°C. A positive temperature in January and a high mean winter temperature indicate the general character of winters in Nis. Still, short periods with negative temperatures are highly likely.

The mean number of frost days is not high (77.2 days), and they take place from September to April. The occurrence of ice days is not rare either.

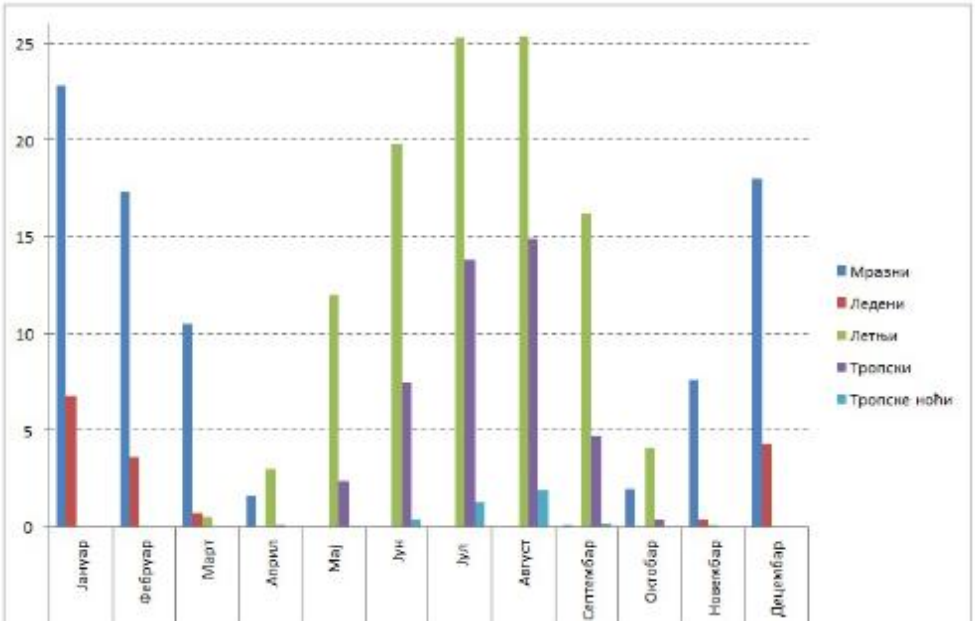

Figure 12: Frequency of frost, ice, summer and tropic days and nights in Nis for the period (1950-2009)

In the analysed area, according to the data from the Climate Atlas, the mean annual humidity is 69.6%, and 70-75% for the vegetation period. The mean annual pressure, according to the Climate Atlas of SRY is 1019-1020 mb in the entire analysed area.

Cloud coverage

Cloud coverage is the amount of clouds visible in the sky at a certain moment or period. It is expressed in fractions from 0 to 10 or as a percentage of the sky covered with clouds. It affects the temperature regime, as cloudy days are characterized by slight daily variations in temperature, whereas extreme temperatures (minimum and maximum values) occur on clear days. The mean annual cloud coverage in the analysed area is 5.5/10.

Mean annual number of clear days (with cloud coverage over 2/10) in the territory of Nis is 100 days, and the mean annual number of cloudy days with the cloud coverage above 8/10 for the entire analysed area is 120 days.

Table 4 Climate indictors

	Pressure in mb	Relative humidity in %	Rain	Snow cover ≥1 cm	Cloud coverage		Strong wind above 8 Beaufort scale
					below 2	above 8	
			Number of days				
2004	993.8	72	157	51	59	125	5
2005	993.9	73	133	63	64	113	1
2006	994.6	71	130	39	75	99	1
2007	992.8	67	131	20	86	101	3
2008	993.1	69	111	27	76	86	2
2009	991.3	74	150	28	74	117	1
2010	990.1	72	147	50	60	119	1
2011	994.4	69	114	33	110	93	1
2012	992.4	66	118	62	112	95	1
2013	991.9	68	140	14	89	95	1

Sunshine duration (insolation)

Insolation (duration of sunshine) is the duration of radiance of direct sunlight on Earth in a given place. It depends on the latitude, season, cloud coverage, terrain and air pollution. It is measured with heliograph and expressed in the number of hours of sunshine in a day, month or a year.

Insolation greatly affects the mental state of human beings, as a person's mood is completely different on a sunny day compared to that on a cloudy day. The mean relative duration of sunshine throughout the year for the entire analysed area is 55%, and 65% in the vegetation period.

Fog

Fog as an occurrence in a given area is greatly influenced by the terrain topography, hence the fog has a strongly local character.

The mean annual number of fog days in the period between 1931 and 1960 is 16, according to the data from the meteorological station in Nis.

Hail

The occurrence of hail is mainly associated with highly developed cumulonimbus clouds, the type of clouds that have the character of a natural disaster, although additional conditions are required in order for hail to occur. The mean annual number of days of hail, according to Climate Atlas of SRY, HMZS, for the period between 1931 and 1960 is 1 – 2 days in the observed area.

Wind

Winds in this area have been analysed based on the measurements at the meteorological station in Nis, namely according to their frequency in the form of a wind rose and wind speeds by wind direction. The obtained data for the relative frequency and median speeds are given in the form of the so-called "wind rose" for an average year.

The overview of major wind directions and median speeds occurrence for the meteorological station in Nis is given in percentages in the table below. For the purpose of defining the basic characteristics of the wind in the wider area of the corridor of the future railway line, the wind data from the said station were analysed for the period between 1946 and 1991. The sum value and the frequency of eight wind directions were identified. For each direction, the mean wind force was determined per Beaufort's scale.

Table 5 Overview of major wind directions and median speeds occurrence in %

Meteorological station	Wind direction	N	NE	E	SE	S	SW	W	NW	Quiet
Nis	Frequency (%)	3.9	6.1	15.	4.5	4.3	3.8	6.6	20.3	35.6
	Force (m/s)	2.1	2.7	2.3	1.6	2.2	1.7	1.5	2.9	-

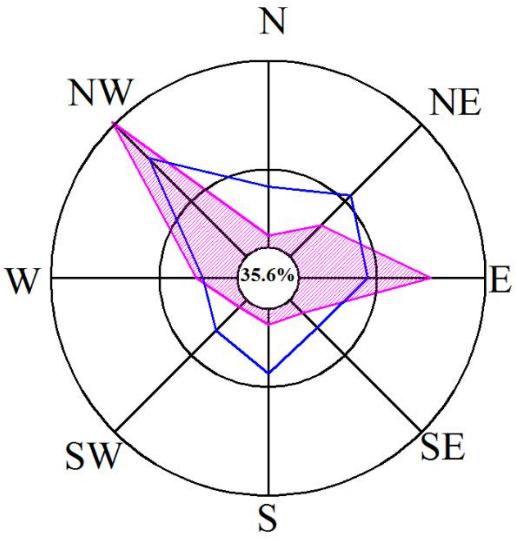

Figure 13: Wind rose for the city of Nis

2.6 Flora and fauna

Nis valley

Regarding the composition and the distribution of soil and vegetation, the Nis valley is a grain-growing and wine-growing area, with wine and fruit-growing areas dominating its peripheral parts.

In the Nis valley there are over 1,400 species of flowering plants and ferns. The most significant among these are *Lophophora cristata*, *Linaria dalmatica*, and the most prevalent ones are *Ranunculus rumelicus* and *Ranunculus serbicus*.

In addition to the willow and poplar trees, hardwood vegetation also covers the forested areas, tree nurseries and parks in the lower lands of the Nis valley. In the eastern part of the valley around the Oblacinsko Jezero lake, fast-growing poplar and black locust trees dominate, whereas the slopes of Mali Jastrebac are covered in oak, beech, pine and other forests. Near Oblacinsko Jezero, there is a fruit plantation and a nursery with the indigenous cultivar cherry. In its shallowmost part, and on the northern and western banks of Oblacinsko Jezero, cane and bulrush can be found. The foothills of the Nis valley are covered in natural forest vegetation which is the most dominant in the area of Niska Banja and Prosek. The most dominant types of trees are the hornbeam, ash tree, oak, Turkey oak, field maple and elm.

Below mountain ridges and at the peripheral top of the valley, a wild lilac can be found. In the area of approximately 14 ha around Niska Banja there is a belt of synthetic cultivars: the black locust, black pine, walnut and the ash tree.

Sicevacka klisura

In the furthermost part of the terrace, in the length of around 2.6 km, the railway enters the protected natural resource – the nature park „Sicevacka Klisura“, III degree protection (Regulation to protect nature park Sicevacka Klisura, Off. Gazette of RS, no. 16/00). The part of the route before the entrance into the Sicevacka Klisura at km 18+400 is intersected by a PBA area (PBA-Prime Butterfly Areas in Serbia), that is, a potentially chosen area for ancient butterflies in Serbia, and an internationally important plant area (IPA). Furthermore, the part of the Sicevacka Klisura where the terrace is located, from km 19+700 belongs to the Important Bird Area in Serbia, declared as such based on the criteria of the Birdlife International organization.

Figure 14: Sicevacka klisura

Due to its geomorphological characteristics and unique flora and fauna, Sicevacka Klisura has been declared a nature park and a protected area with important ecological and cultural resources. The Nature Park Sicevacka Klisura is an area rich in sites of natural beauty, and is an excellent example of occurrence and interaction between geological, geomorphological and hydrological phenomena as well as biodiversity. It is a habitat of numerous endemic, relict and rare plant and animal species.

It covers parts of the areas in Niska Banja and Bela Palanka municipalities with total territory of 77.46 km², of which 55.59 km² is located in the municipality of Nis, and 21.87 km² in that of Bela Palanka. The river Nisava divides this area into two parts – Leskov Vrh (northern) and Oblik (southern).

Sicevacka Klisura is part of the Nisava river valley which originates from intense cutting of its watercourse into the rock mass between the northern slopes of Suva Planina and southern slopes of Svrljiske Planine. It is 14 km east of Nis, between the village of Prosek (downstream) and the Dolac settlement (upstream). The gorge is 17 km long and it connects the Nis valley with the valley of Bela Palanka. It is also the shortest route connecting middle and lower Ponisavlje, and the upper and the lower part of middle Nisavlje.

The gorge is divided into two geographic units, the upper unit – the canyon Crncansko-gradistanski kanjon and the lower one – the Ostrovicka klisura gorge. The upper part is narrower resembling a canyon (from Ostrovica to Dolac) while the lower part (from Prosek to Ostrovica) has wide, mild slopes. The gorge is encompassed by Svrljiske Planine in the north and the slopes of Suva Planina in the south.

Parallel to Nisava, the railway line and the international main road were built through Sicevacka Klisura in 1886/87 and 1964 respectively. Nisava railway which goes through valley cuts of Sicevacka Klisura is part of the world railway main (London – Paris – Belgrade – Nis – Sofia – Istanbul), while the main route E-80, the eastern leg of the Corridor 10, is the part of the pan-European main route (Salzburg—Zagreb—Belgrade—Nis—Sofia—Istanbul), and presents a connection with other parts of the world through Asia Minor.

Flora

Among the relict species of tertiary European flora, the two species of Ramonda genus are reported in Sicevacka Klisura (*Ramonda serbica* and *Ramonda nathaliae*), and the sage (*Salvia officinalis*) as one of the oldest medicinal plants, these being the remnants of the subtropic European and Mediterranean flora, and likely originating from Africa. The said relict species of Sicevacka Klisura are protected by the Serbian law as a natural rarity. On the territory of Sicevacka Klisura numerous research has found important sites of thyme, summer savory, milfoil, St. John's wort, juniper and other melliferous and medicinal herbs, this being the largest and the northernmost finding site of these plants. Coronilla (*Coronilla emerus L.*), a sub Mediterranean, rarely found species in Serbia, wild lilac (*Syringa vulgaris*), rue (*Ruta graveolens*), Turkish hazel (*Corylus colurna*), wild cherry, etc. are also found there.

Figure 15: Relict species of flora in Sicevacka Klisura

Fauna

Among the wildlife living in Sicevacka Klisura, there are: rabbits (*Lepus europaeus*), foxes (*Vulpes vulpes*) and lately jackals (*Canis aureus*). A wild cat (*Felis silvestris*) is rarely seen. An otter lives in Nisava (*Lutra lutra*), although it is rare and there are fewer of them after the reduction of the fish communities to critical levels. There are also badgers (*Meles meles*), skunks (*Mustela putorius*), weasels (*Mustela nivalis*), mole rats (*Spalax leucodon*). Hermann's tortoise (*Testudo hermanni*) is a reptile worth mentioning. Among snakes there are Aesculapian snakes (*Zamenis longissimus*), horned vipers (*Vipera ammodytes*), common European adders (*Vipera berus*) and grass snakes (*Natrix natrix*) along the course of Nisava and its tributaries.

Thus far, 100 birds species have been discovered in Sicevacka Klisura, 75 of which nesting bird species. The breed that gives this area its international importance is the world's largest owl, Eurasian eagle-own (*Bubo bubo*) and another 32 rare species among which the following most significant nesting breeds: the European honey buzzard (*Pernis apivorus*); birds of prey: golden eagle (*Aquila chrysaetos*), peregrin falcon (*Falco peregrinus*), Levant sparrow hawk (*Accipiter brevipes*), short-toed snake eagle (*Circaetus gallicus*); vultures: Eurasian scops owl (*Otus scops*), black-eared wheatear (*Oenanthe hispanica*), woodchat shrike, alpine chough and rock bunting, true partridge (*Perdix perdix*), rock partridge (*Alectoris graeca*), stock dove (*Columba oenas*). The gorge is one of the last known nesting sites of the endangered lanner falcon in Serbia. The singularity of this place is a small colony of Alpine swifts (*Apus Melba*).

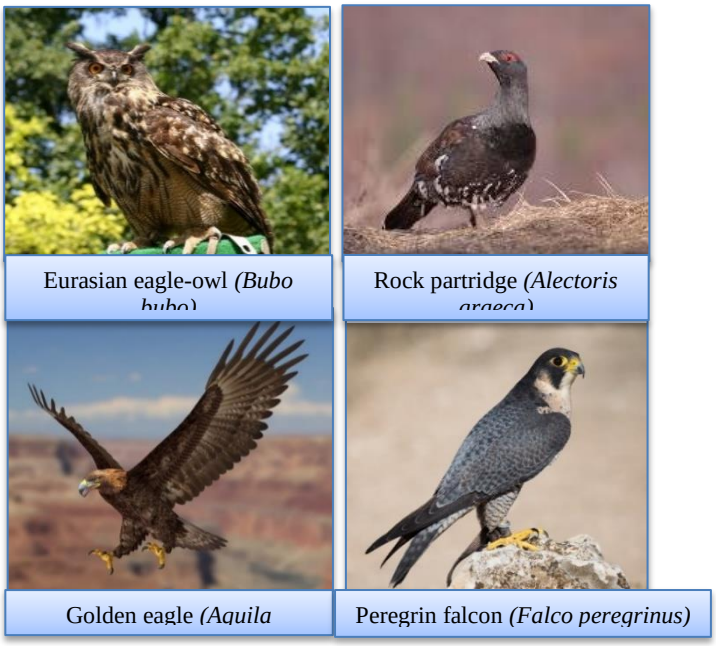

Figure 16: Examples of fauna in Sicevacka Klisura

2.7 Overview of basic terrain features

Landscape

Modernization of the part of the bypass around Nis and design of the new part of the railway section shall connect the existing international Corridor X: Salzburg-Belgrade-Thessaloniki to the current railway Nis-Dimitrovgrad (line no. 22). There are several railway routes which make the integral part of the bypass and are treated as independent routes. In that sense, the following routes or sections were singled out:

1. BR - bypass railway beginning at the marshalling yard "Niš-Ranzirna" station to the "Pantelej" station where it leaves the city area and where the section of the newly-designed railway around the road corridor X (E-80) begins all the way to the attachment to the current line no. 22 Nis - Dimitrovgrad - Tabanovce
2. Railway no. 30, "Trupale" station - "Nis Ranzirna" station which keeps a part of its route, and partly follows the new route.
3. Railway no. 3, "Trupale" station - "Crveni krst" station which for the most part goes along the new corridor.
4. Railway no. 17, "Nis Ranzirna" station - "Crveni krst" station which is to be terminated for the most part.
5. Railway no. 38, "Crveni krst" station - Zajecar, which keeps a part of its route, and partly follows the new route.

At its opening part, the bypass railway starts from the chainage point km 0+400 and goes through the village of Popovac in the length of ~100m and following a great curve, which leaves room for expanding the airport, passes through agricultural land, through the cut of up to 3m, to the chainage point km 3+550. "Niš Sever" station is planned from km 2+700 to km 3+600. Up to the point km 4+300, the route of the bypass railway is at ground level, and turns towards the underpass on Bulevar 12. Februara street, from where it follows the corridor of line no. 38 (Niš - Zaječar). From Bulevar 12. februara (~km 5+000) to km 5+972, the axis of the newly-designed route is in the embankment at the level of 1.50 to 2.50 m, extremely 4.00 m at the slope. The railway goes through the city area at km 5+465. Up to the Pantelej station at chainage ~7+000, the railway route follows the embankment through arable land. Pantelej station is partly situated in the embankment and partly in the cut.

The new railway corridor further goes through arable and green areas between the two Nis settlements slowly approaching the Corridor X of the E-80 motorway Nis-Dimitrovgrad. The terrain is gently rolling with the overall decline towards the southeast. Further on, the railway goes past the right side of the motorway where there is a settlement, that is, the city area up to the point ~ km 12+500. On this section the terrain is subhorizontal with mainly agricultural or public land (city-owned or owned by PE Roads of Serbia).

From the 12th kilometre, the railway route was designed to go past the right side of the road up to km 15+400 where it shall detach from the road corridor and go southeast, towards the river Nisava over the gently rolling terrain (arable land). From km 14+100 do km 14+900 the "Vrezina" station is planned.

At design chainage of ~ km 18+500 to km 18+700, the newly-designed route intersects the existing meander of the Nisava river and this is where the dislocation, that is the regulation of the river course will have to take place.

Finally, the newly-designed railway route goes under the overpass on the new E-80 road at chainage km 19+141 and fits onto the corridor of the old bypass railway no. 22 at chainage ~ km 19+200 from where it follows the existing corridor through Prosek to Sicevo, where the mentioned section ends at km 22+425.94, that is at km 16.668.74 of the old no. 22 line. Up to the Prosek station, the terrain is flat and the railway corridor is increasingly encompassed by the slopes of the surrounding hills. From the "Prosek" station to "Sicevo" station, the route enters Sicevacka Klisura with very steep sides and little available space for any kind of intervention concerning the adjustment of the railway axis or level. The railway goes along the corridor of the existing route Nis-Dimitrovgrad on the right side of Nisava across its alluvium.

Modernization of railways – project documentation for railway bypass around Nis should not lead to the violation of this area, but the harmonization of the railway with the surrounding natural features such as the existing tall indigenous vegetation in the form of massifs, thickets, groups or individual decorative trees.

2.8 Overview of immovable cultural heritage

According to the requirements obtained from the Institute for the Protection of Cultural Monuments in the city of Nis, no cultural heritage was identified in the observed area, however, there are several resources with monumental characteristics testifying to the city's history.

The resources with monumental characteristics on the territory of the General Regulation Plan for the bypass railway in the city of Nis are the following sites:

- Ribnik
- Kovanluk
- Ornicje

Figure 17: Location of sites on the terrace of bypass railway

2.9 Population and demographic characteristics

Impact assessment of the construction of a single-track railway for the Nis bypass analysed the data on general population characteristics and their activities and the effects they will be exposed to in the course of railway construction and utilisation.

The observed area includes the northern edge of the city of Nis. The bypass goes through the following settlements:

- Popovac, Trupale, Donji Komren, Crveni Krst in the municipality of Crveni Krst;
- Pantelej, Donja Vrezina and Gornja Vrezina in the municipality of Pantelej
- Prosek-Manastir, Sicevo in the municipality of Niska Banja.

The area of the city of Nis takes up 597 km². In addition to municipalities of Crveni Krst, Pantelej and Niska Banja, through which the bypass railway will go, there are two more municipalities: Palilula and Medijana.

Table 6 Comparative overview of population

region	1948	1953	1961	1971	1981	1991	2002	2011
District of Nisava	283,842	303,482	327,367	363,292	394,110	396,043	381,757	376,319

Table 7 Comparative overview of population in Crveni Krst

CM	1948	1953	1961	1971	1981	1991	2002	2011
Popovac	1,508	1,638	1,839	2,064	2,362	2,517	2,588	2,847
Trupale	1,667	1,819	1,901	1,963	2,131	2,223	2,109	2,127
Donji Komren	203	206	253	338	404	1,595	1,555	1,838
Crveni krst	3,499	4,186	5,823	9,192	11,638	12,993	12,992	12,516

Table 8 Comparative overview of population in Pantelej

CM	1948	1953	1961	1971	1981	1991	2002	2011
Pantelej	6,756	8,084	11,244	17,752	22,475	25,093	25,090	34,724
Donja Vrezina	552	600	818	1,355	2,270	2,696	4,088	6,758
Gornja Vrezina	1,531	1,560	1,539	1,299	1,298	1,290	1,180	1,147

Table 9Comparative overview of population in Niska Banja

CM	1948	1953	1961	1971	1981	1991	2002	2011
Manastir	122	118	101	27	6	2	2	6
Sicevo	1,361	1,368	1,389	1,268	1,093	1,012	1,007	772

According to the 2011 population census, there are 260,237 people living in Nis (the 1991 census recorded 248,086 people).

The Nis settlement is populated by 189,959 adults, and the average population age is 39,77 years (38,96 in men and 40,53 in women). There are 88,489 households, of which 120,641 flats.

This settlement is mostly populated by Serbs (according to the 2011 census).

2.10 Data on the existing and planned infrastructure facilities

Based on the collected information, the data on the existing condition of railways within the corridor having a direct impact on the corridor of the future bypass railway around Nis, the Consultant made a tour of the site. Through visual reconnaissance, the overview and detailed analysis of the existing technical documentation as per the surveyed geodetic base, the current condition of railways in the corridor of the bypass railway around Nis has been thoroughly analysed and presented with the aim to define the elements of bypass railway plan and profile, that is, the fitting thereof into existing railways.

International main railway Nis – Dimitrovgrad – state border (Dragoman) (railway no. 22)

This single-track railway was built in 1887, belongs to the D-3 category, with the bearing capacity of 22.5t/os, 7.2 ton/m, has not been electrified, and the traffic is performed using diesel traction at station spacing.

The current condition of railway no. 22 is the subject of consideration and design within the „General Design for the reconstruction and modernization of the Nis-Dimitrovgrad railway section Cele Kula-Stanicenje“, which served as documentation basis for the design.

On the subsection of railway no. 22 at km 13+000 to km 16+668 (the fitting point of the bypass into the section of reconstructed railway no.22) in accordance with the „General Design for the reconstruction and modernization of the Nis-Dimitrovgrad railway section Cele Kula-Stanicenje“:

Plan and profile elements from km 13+000 to km 16+668

On the section starting at the bridge over Nisava at km 13+000 to the entrance switch at the Sicevo station 16+668 the speed limit is 80km/h.

Table 10 Plan and profile elements from km 13+000 to km 16+668

Apex	Radius of curvature [m]	Transition curve length L1 [m]	Transition curve length L2 [m]	Note
8	500	60	60	
9	700, 310	40/60	60/100	Three-centre curve
10	300	100	100	
11	600	50	50	

Vertical alignment grade of the section is as follows: 0‰ (300m), 2.80‰ (450m), 0.70‰ (450m), 5.00‰ (450m), 1.25‰ (370m), 5.00‰ (560m), 0.00‰ (450m), -0.40‰ (300m), 0.00‰ (449m).

Currently surveyed condition of the substructure and the superstructure

The earth bed is partly located inside the embankment of variable height, and partly in the cut and fill. Roadbed does not have a blanket course, drainage was not handled properly, hence the occurrence of pockets in the surfacing, which affect railway stability and the decline of tracks. Earth and stone drainage canals are in a very bad condition.

According to the data of the Railway Maintenance Department (ZOP department) Nis, the issues regarding roadbed stability occur as a result of surfacing pockets which affect temporary or permanent decline of the track. This occurrence has been recorded on around 20% of the railway.

Figure 18 Railway no.22

The elements of the superstructure are in a very bad condition. Tracks belong to 49 E1 type, track equipment is of K type for concrete sleepers, which are of IM-2 type in the ballast made of crushed stone. IM-2 concrete sleepers were fitted into the track in 1965 and since have suffered deformation visible as surface cracks, the connection between fastenings and concrete sleepers has weakened due to rotten dowels. This issue with concrete sleepers makes track maintenance difficult for all elements. There is a long welded rail track on this railway section. In the previous period rails in outer curve arcs were replaced. The last major repair of this section took place in 1965.

Figure 19: Steel truss bridge at chainage km 13+407

Figure 20: Overpass (Route E- 80) at chainage km 13+055

According to the records of Serbian Railways, on the observed section, there is a grade crossing at km 14+735, an open railway, street width b=4m, the pavement on wooden sleepers is secured with half-barriers, a handler on the spot, train speed at road-crossing is V=80 km.

The Prosek stop at chainage km 14+744

This stop is, according to the layout plan, at the three-centre curve. The road connecting the Prosek settlement to the main road intersects the existing railway at the level of the stop area. Low prefabricated platform 20+30m high has been built outside the curve on both sides of the grade crossing.

Figure 21:The stop at Prosek

Within the General Design the reconstruction of the substructure and superstructure and railway electrification were performed. The bypass designer implemented the designed elements and complemented them with accompanying fitting works.

Railway E70/85 Belgrade – Mladenovac – Lapovo – Nis – Presevo – state border (Tabanovce) section Trupale – Nis Putnicka – Medurovo (railway no. 3)

This railway was built in 1884-1886, it belongs to D-4 category, its bearing capacity is 22.5t/os, 8 ton/m, and is electrified. It is equipped with station interlocking and telecommunication devices, with the speed limit per time table on the section Trupale – Crveni Krst of 100km/h. This route allows for the passenger transport to separate towards the station Nis Putnicka.

Plan and profile elements from km 235+300 do km 240+500

At interstation distance between Trupale – Crveni Krst stations, the smallest radius of horizontal curve is 950m.

Table 11 Plan and profile elements from km 235+300 do km 240+500

Apex	Radius of curvature [m]	Transition curve length L1 [m]	Transition curve length L2 [m]	Note
1	950	110	110	
2	1000	110	110	
3	2000	50	50	
4	1600	50	50	

Vertical alignment grade is as follows: 0.00‰ (60m), -0.47‰ (235m), 1.30‰ (330m), 3.31‰ (320m), 4.10‰ (420m), 4.93‰ (399m), 4.60‰ (396m), 0.00‰ (722m), 0.15‰ (401m), 1.70‰ (483m), 3.41‰ (449m), 0.90‰ (324m), 0.00‰ (543m), 0.00‰ (100m).

Substructure

Between the stations Trupale and Crveni Krst, the roadbed is in the embankment 2m high. Drainage canals for water running by the facilities of the substructure are in poor condition. The drainage at the station Crveni Krst is poor, while in the Trupale station drains have been built.

Superstructure

A single-track railway between the stations Trupale and Crveni Krst: track mesh was made of 49 E1 type rails with type K fastening equipment on wooden sleepers in ballast prism made of crushed stone. The last major repair of this part of the railway was in 1974, therefore all elements of the permanent way are in poor condition. In the period between 2005 and 2014, some wooden sleepers (4,000) were replaced, as well as some rails.

Structures on the railway section

On the railway section from km 235+300 to km 240+500 there are following structures:

Table 12: Structures on the railway section

Railway no.	Railway name	Chainage [km]	Type of structure	Range
3	Trupale – Nis – Medurovo	235+467	Arched culvert	L = 1.0
3	Trupale – Nis – Medurovo	235+728	Overpass (Route E-75)	
3	Trupale – Nis – Medurovo	237+519	Box culvert	L = 0.6
3	Trupale – Nis – Medurovo	238+315	Box culvert	L = 2.0
3	Trupale – Niš – Medurovo	239+903	Steel plate girder bridge	L = 5.5

Figure 22:Overpass at chainage km 235+728

Road crossings on the railway section

According to the records of Serbian Railways, there are three grade crossings on this section as follows:

- km 236+983, open railway, street width b=5.2m,
- km 238+563, open railway, street width b=4.0m,
- km 239+338, open railway, street width b=7.6m, secured with half-barriers.

Figure 23:Road crossing

Railway Trupale – Niš Ranzirna – Medjurovo - main (railway no. 30)

The railway starting from the Trupale station goes parallel with the line Belgrade – Nis – Skoplje for a short distance, and detaches in front of the building and goes towards the Nis Ranzirna station.

This is a single-tracked, electrified, D-4 category railway with the bearing capacity of 22,5t/os, 8 ton/m, aimed at redirecting the freight transport coming from the direction of Belgrade to Medjurovo and further to Skoplje using the Nis Ranzirna station.

Plan and profile elements from km 235+300 to km 237+800

The speed limit is 60 km/h.

Table 13Plan and profile elements from km 235+300 to km 237+800

Apex	Radius of curvature [m]	Transition curve length L1 [m]	Transition curve length L2 [m]	Note
33	1000	30	30	
34	2000	20	20	
35	2000	20	20	
36	600	60	60	
37	300	20	0	

Vertical alignment grades on the section are as follows: -1.61‰ (2800m), 1.31‰ (320m), 3.41‰ (643m), 3.31‰ (320m), -4.51‰ (557m), -2.29‰ (380m), -4.00‰ (320m).

Substructure

The earth bed on this section of the open railway is in the embankment of variable height, and the drainage has not been resolved in the Nis Ranzirna station up to the present day.

Superstructure

The elements of superstructure are: 49 E1 type rails, K type track equipment on wooden sleepers in the ballast made of crushed stone. All the elements of the superstructure are in a very poor general condition. The last major repair of this railway section was in 1974 and since then there have been no interventions on the elements of superstructure in terms of their replacement other than the replacement of rails in external curve arches in some places. This is a long welded rail track.

Structures on the railway section

On the railway section from km 235+300 to km 237+800 there are the following structures:

Table 14 Structures on the railway section from km 235+300 to km 237+800

Railway no.	Railway name	Chainage [km]	Type of structure	Range
30	Trupale – Nis Ranzirna –Medurovo	235+469	Arched culvert	L = 1.0
30	Trupale – Nis Ranzirna –Medurovo	235+726	Overpass (Route E-75)	

Road crossings

According to the records of Serbian Railways there is a single grade crossing on the observed section at the following point:

- km 237+018, open railway, street width b=4.0m.

Railway Crveni Krst – Nis Ranzirna – Medjurovo – main (railway no. 17)

A single-track, electrified D-4 railway, with the bearing capacity of 22.5t/os, 8 ton/m. The speed limit is 60 km/h. The chainage has been recorded from the Crveni Krst station.

Plan and profile elements from km 0+000 to km 3+299

Table 15: Plan and profile elements from km 0+000 to km 3+299

Apex	Radius of curvature [m]	Transition curve L1 [m]	Transition curve L2 [m]	Note
33	1600	60	60	
34	1500	60	60	
35	2000	60	60	
36	605	20	40	

Vertical alignment grades on the section are as follows: -0.85‰ (117m), 0.00‰ (300m), -1.00‰ (300m), -4.00‰ (920m), -0.61‰ (610m), -4.00‰ (170m), -7.91‰ (580m), -4.30‰ (160m), -10.00‰ (85m), -4.00‰ (251m).

Substructure

The earth roadbed is partly in the embankment, and in the cutting for the most part. Drainage canals are made of earth and are in poor condition.

Superstructure

The elements of superstructure are: 49 E1 type rails (type 45 in some places), K type track equipment on wooden sleepers in the ballast made of crushed stone. All the elements of the superstructure are in a very poor general condition. The last major repair of this railway section was in 1974 and since then there have been no interventions on the elements of superstructure in terms of their replacement other than the replacement of rails in external curve arches in some places. This is a long welded rail track.

Structures on the railway section

On the railway section from km 0+000 to km 3+299 there is a following structure:

Table 16: Structures on the railway section from km 0+000 to km 3+299

Railway no.	Railway name	Chainage [km]	Type of structure	Range
17	Crveni Krst – Nis Ranzirna	0+304	Concrete box culvert	L = 5.0

Road crossings

According to the records of Serbian Railways, there are two grade crossings at following points:

- km 0+868, open railway, street width b=7.6m, secured with half-barriers,
- km 1+641, open railway, street width b=4.3m.

Railway Crveni Krst–Zaječar–Prahovo Pristaniste – regional (line no. 38)

It was built in 1922 as a single-track railway on the then planned trans-Balkans main line. It is a B2 category line, with the bearing capacity of 18.0 t/os and 6.4 t/m´, with diesel traction. The station is secured mechanically, and telephone communications use overhead lines.

Plan and profile elements from km 3+453 to km 8+600

The speed limit is 60 km/h. This railway is charged to ZOP Zajecar, and the railway corridor in the section from the Crveni Krst station to the intersection with the route E-80 is in the motorway corridor in the northern part of the city.

Table 17: Plan and profile elements from km 3+453 to km 8+600

Apex	Radius of curvature [m]	Transition curve length L1 [m]	Transition curve length L2 [m]	Note
2	250, 300	40	40	Three-arch curve
3	450	40	40	
4	300	60	60	
5	500	40	40	
6	500	40	40	
7	450	40	40	
8	450	60	60	

9	500	40	40	
10	500	60	60	
11	500	60	60	

Vertical alignment grades are as follows: 7.80‰ (147m), 10.40‰ (1100m), 10.00‰ (1800m), 9.00‰ (200m), 10.00‰ (1000m), 10.30‰ (277m), 2.91‰ (328m), 11.67‰ (195m).

Substructure

The earth roadbed is partly in the embankment and is in poor condition with no blanket course.

Superstructure

The railway Crveni Krst – Knjazevac was built in 1912-1922. The rails are of the S-49/45 type with classic ties on the track. Track sleepers are made of wood and the ballast is of crushed stone. The last major repair on the section from km 3+455 to 12+079 was in 1969. The design speed on the section Crveni Krst - Niševac (km 3+455 - km 46+000) is 65km/h, whereas the timetable speed on the section Crveni Krst - Knjazevac km 3+455 - km 68+366 is 40 (30)km/h.

The general condition of the railway in this section is unsatisfactory due to the decay of track sleepers, the pollution of the ballast prism from km 3+455 to km 4+300, for example, in the distance of 100m from km 3+900 - 4+000 out of 140 sleepers, 95 are rotten, that is 68 %. In the section from km 9+800 to km 10+600, there are the most deformities due to the rotten sleepers which is particularly prominent at high temperatures.

The most important structures on the railway are two underpasses – the intersection with Nikola Tesla and 12 Februara street, and with the motorway.

The Niš Ranžirna station

The Nis Ranzirna station is located west of Nis, between the Popovac settlement and the „Konstantin Veliki“ airport. It is oriented towards the north-south, with the tracks divided into 4 groups:

- reception-dispatch
- transit
- marshalling-dispatch
- station

In addition to these groups, the Nis Ranzirna station also has a locomotive depot and a railway workshop with accompanying facilities.

The station is electrified and secured with electrical-relaying and station interlocking Siemens – el. devices.

The switches are of the 49-E1 and 45-E1 type on mixed sleepers with type K track equipment long welded in the ballast made of crushed stone. A total of 92 switches of different types were fitted. Metal parts of switches, switch elements, and all elements of the superstructure are in a very poor condition due to many years of usage and untimely replacement. In block 1 of the Nis Ranzirna station, a certain number of switches was disassembled.

Track ties at the entrance and exit necks are placed so as to enable direct entrance from each connecting railway/puller to each station track and vice versa. Photographs shown in Figures 11 and 12 were taken during the 2 onsite visits to the Nis Ranzirna station.

The last major repair of the Nis Ranzirna station was in 1974 and since only metal parts of the switches and switch elements have been replaced in some places, as well as the rails and wooden track sleepers.

Figure 24:The Nis-Ranzirna station

The Crveni Krst station

It is located in the industrial area in the city of Nis, outside the central city zone. The station is positioned situationally at grade, and alignment-wise it has a grade of 1,0-2.2 ‰. Passenger, freight and local goods transport take place here, and it serves to establish a connection with the depot and industry. The station is secured with electrical relay interlocking devices and it a part of the telecontrol system.

Figure 25 Station building Crveni Krst

Figure 26: Prefabricated platform Crveni Krst current condition

Superstructure – type 49-E1 rails, 45-E1 concrete sleepers in some places, K-type track equipment.

The Pantelej stop

It belongs to the open route of the railway no. 38 leading to Zajecar. The stop is in a clear circular curve. The low prefabricated platform is built on the inside of the curve. The railway road connecting the Pantelej settlement to the city of Nis intersects with the existing railway in the area of the stop. In the place of the road and railway intersection, there is a secure grade crossing with half-barriers and light signals.

Figure 27: The Pantelej stop

Figure 28: Road crossing at Pantelej stop

3 Project description

The following are the goals of constructing the bypass railway:

- Harmonizing the development of transport infrastructure with the city development
- Harmonizing the development of transport infrastructure with the airport development
- Dislocating the freight transport from the city centre
- Development of railway facilities without disturbing transit transport on corridor X

The lack of harmonization between the city development, the traffic and transport infrastructure leads to spatial and operational conflicts in the city of Nis.

With regard to international railway network, Nis is a point of detachment and attachment for two international main lines E-85 Budapest – Subotica – Belgrade – Nis – Skoplje - Athens and E-70 Paris – Turin – Sezana – Ljubljana – Zagreb – Belgrade - Nis – Sofia. The railways Trupale – Nis Ranzirna – Medurovo and Crveni krst – Nis Ranzirna are also main railways, whereas the Crveni Krst – Zajecar – Prahovo Pristaniste is a regional railway pursuant to the REGULATION on classification of railways Art. 6 (2) of the Law on Railways (OG of RS no. 45/13) and Art. 42 (1) of the Law on Government (OG of RS no.55/05 I 71/05 – corrig. 101/07, 65/08, 16/11, 68/12 – US I 72/12).

Table 18:Railways in Nis

Railway no.	Railway name	Length (km)	Speed (km/h)	Category	Capacity	
					ton/os	ton/m
3	Trupale – Nis – Medurovo	5.20	60-100	D-4	22.5	8.0
22	Nis – Dimitrovgrad	3.70	60-80	D-3	22.5	7.2
38	Crveni Krst – Matejevac	5.20	60	B-2	18.0	6.4
30	Trupale – Nis Ranzirna – Međurovo	2.30	60	D-4	22.5	8.0
17	C. Krst-N. Ranzirna	3.30	60	D-4	22.5	8.0

3.1 Description of preliminary works for structure execution

The team of experts at the Geomehanika company has performed geomechanical onsite and laboratory investigations to draft a Geomechanical study on geotechnical conditions of reconstruction, modernization and construction of the new section of the Nis bypass railway for the Preliminary Design – Variant 4a. The following research activities were performed:

- reconnaissance of the terrain,
- 44 trial pits of which 16 in the roadbed, and 28 on the newly-designed route right next to trial boreholes,
- 44 DCP trials in trial pits from the level of the subgrade, or formation, right under the topsoil on uncultivated ground,
- 44 trials using Light Drop Tester,
- 3 trial excavations,
- 53 trial boreholes with total depth of 396.70 m,
- 45 trials of standard penetration in boreholes,
- 17 static penetrations for the reconstruction of existing structures along the railway route which shall be used for the preparation of longitudinal and cross sections of the route.
- taking of disturbed and undisturbed samples of soil and identifying the level of groundwater.
- geoelectric trials at 38 points.

The works were executed between 3 February and 12 June 2015.

3.1.1 Engineering-geological and physical-mechanical characteristics of the materials used in railway base and construction

The analysis and synthesis of all the data obtained from the field survey of the terrain and laboratory trials provided the insight into geological composition, engineering-geological and hydrological characteristics of the surveyed terrain and materials that make up the railway structure, and as an end result, a geotechnical base was obtained for further design process. The following were the subject of the survey:

- railway superstructure
- railway substructure
- the base, natural uncultivated soil.

The railway superstructure includes the tracks (track equipment) and ballast.

Crushed stone ballast - GP-GM-G layer no 1. Surfacing the track in railway superstructure was performed using gravel grits. The crushed stone is of limestone origin, contaminated with small fractions in places, often mixed with the blanket (protective layer) or black slag in the floor segment after sifting.

It is of variable thickness, ranging from 0.56 m to 1.10 m in areas of superstructure enhancement, measured from the upper edge of the rails at the boundaries of the embankment. On some parts of the route, where bags of crushed stone and injection-moulded sleepers are present, this thickness in the central part of the embankment – the railway axis may be greater, and the said crushed stone is oftentimes contaminated with great quantities of fine-grain fraction.

Since it is contaminated and does not meet the requirements (mineral composition) nor the latest standards regarding its placement in the superstructure, the crushed stone must be removed during the planned railway reconstruction on parts of the route where the routes and vertical alignments of the existing and the newly designed railway meet.

The railway substructure comprises the protective course (blanket) and formation of the soil – embankment.

The protective blanket course - SP-SC-SM, course no. 2. The protective blanket course has been made using sand for the floor and gravel for the roof. On the discussed sections, the existing railways usually lack this course or their preliminary structure or the composition have been altered during railway repair (by sifting) hence the double-layered blanket course has been reported in a single trial pit in the designed thickness of 40 cm (the usual thickness being 30 cm). In other trial pits it is present in the form of small intercalations mostly made of gravel or sandy gravel. The layer thickness ranges from 10-25 cm and is oftentimes non-existent. Locally, it has been mixed with crushed stone or contaminated by organic matter, small-grain fraction and hydrocarbon. On parts of the route where crushed stone is completely mixed with the blanket (as a result of "sifting" on the railway), the water-permeability of this course is slow, therefore the drainage of soakaway water from the structure is not performed in a regular way even in places where operating canals exist, resulting in the collection of water in the roadbed (particularly in the area of Prosek). Due to material impurity, the sandy-gravel mixture is not an acceptable material to be newly placed into the blanket course on the new route even after separation of fractions.

Embankment – SM, SP, ML-CL. The railway embankment is mostly made using locally found materials, hence it follows the lithology of the very base, that is, the surrounding foundation soil.

From the beginning of the said course, "Trupale" and marshalling yards "Niš" stations through the "Crveni krst" station all the way to km~7+500 on the bypass, i.e. the old chainage point km 6+400 on railway no. 38, the embankment is made of local

materials which are genetically associated with the first river terrace. These are particulates with variable content of sandy and clayey fractions (CL). Laboratory testing has determined that the placed materials have solid geomechanical characteristics and meet the prescribed standards for embankment building materials. The material may be reused for embankment construction after its demolition, provided the geotechnical supervisors have determined the quality of materials on the spot during the ongoing check-up tests in the railway construction phase.

From the chainage point km ~5+500 of the bypass railway to km 7+500 in the length of 2.15 km, the roadbed, i.e. the embankment is made of particulate and sandy particulate matter (CL-SM) of the middle river terrace t_2. On this part of the route, there is a visible variation of onsite and laboratory test results caused by variability of facies. For the most part of this section, the existing route deviates from the newly-designed route, therefore the existing railway is to be removed. The material from this section can selectively be separated and placed into the new embankment after check-up tests and approvals from geotechnical supervisors.

From the chainage point km 7+500 to km 9+150 of the bypass railway where the line for Zajecar detaches, the embankment is made of mostly Miocene and diluvial sediments of various composition. The most part of the embankment of this section is made of sandy and sandy-particulate matter (CL, CM and ML). Due to the variability of facies and the presence of diluvial sediments in the upper part of the ground, anisotropy of embankment characteristics occurs. As there is no regularity in the variation of geomechanical indicators of soil along the railway route, it is impossible to identify quasi-homogenous areas for embankment re-ionization. Generally speaking, it can be concluded that the embankment matter meets the conditions and is suitable for placement in the embankment based on its basic characteristics given in the applicable technical specifications. After removal, it can be used only after check-up tests.

After its attachment to the corridor of railway no. 22, the decayed red Permian sandstones are found in the roadbed in different stages of decay (from clay to stone debris). The most part of the embankment on this section was made of sandy and sandy-gravel material(CL, ML and GW).

As the rocks in the surface are weathered to different degrees, the material in the roadbed is characterised by great variation of geomechanical characteristics. Generally, it can be said that the materials composing the embankment meet all the requirements and are suitable for placement into the embankment based on their characteristics, however, the current condition does not meet the conditions given in applicable technical specifications.

Roadbed includes the natural soil bearing the railway superstructure and substructure. The bed of anthropogenic sediments is made of alluvial sediments (al), river terrace sediments (t_1-t_3), early Miocene (M_3) and in small part of diluvium (d). Re-

gardless of the origin, the present material varies only slightly in terms of geomechanic characteristics with the exception of alluvium sediments and river terrace sediments in which there are gravels or the grits of solid rock mass.

Early Miocene sediments (M_3) – these sediments have been discovered in the central part of the terrace. They occur as particulate sandy sediments with intercalations of gravel up to several meters in depth, mainly in brown colour. They contain a large quantity of extracted calcium carbonate in the form of concretions, powder or venations in the cracks. They were discovered at the bypass railway chainage point from km 7+500 to km 10+800 and have favourable geomechanic characteristics.

River terraces (t_1-t_3) – these are the most dominant sediments in the observed area. They occur in morphologically lower parts of the wider investigation area, more precisely, in the immediate vicinity of Nisava and the edges of the Nis basin. In roof areas, they occur as particulate and particulate sediments mostly in brown or brown-yellow colour, while in the floor area pebbled sands are present. It is very difficult to identify the line between the sediments belonging to river terraces of various ages, as they are very similar in terms of composing matter. Variability of facies is also visible, both horizontally and vertically, although sediments in the vertical direction range from small ones in roof areas to large ones in the floor area of the package. They generally have good geomechanic characteristics.

Diluvial sediments (d) – have been discovered on the part of the terrace from km 8+400 to km 10+150 on the bypass railway, although the railway departs from these sediments with the dislocation of railway axis compared to the earlier condition, hence they are found only in the trial borehole OP/B-19. They occur as mostly dark to reddish particulate matter with brown particulate of loess in roof areas, whereas in floor areas the particulate is greyish-yellow and greyish-green. They have no visible stratification, but have a massive structure, are abundant in $CaCO_3$ particularly in the reddish particulate, where the areas of extracted calcium carbonate are present in the form of concretions and powder along cracks and caverns. The material is generally medium-compacted to well-compacted.

Alluvial sediments (a) – these sediments are genetically associated with alluvial processes of the river Nisava and its tributaries. In the boreholes there is a regular positional ratio of pebbled sandy and alevrit particles. The deeper and the older horizons were made of coarse-grained gravel of the bed facies onto which there are subsands and subclays of the inundation facies. These are mainly gravels of carbonate composition and pebbles of Permian sandstone, the grains are well-rounded and may be over 10 cm in size.

The content of sandy fraction may vary greatly from GS to GP. Inundation facies is made of brown to dark-red subclay depending on the composition of local soil. Sediments in the bed facies are of good geomechanical characteristics with variable quality of inundation sediments.

3.1.2 Newly designed railway and geotechnic recommendations

For the purpose of designing the reconstruction and extension of the aforementioned railway line, it is necessary to comply with the updated Guidelines 338 for controlling the compactness of the railway substructure as issued by the „Association of Yugoslav Railways“ and The Rules on technical conditions and maintenance of substructure of railways ("Off. Gazette of RS" no. 39/16 from 23.04.2016. God.)

Technical specifications for total or partial demolition of the existing railway and subsoil replacement

The newly-designed railway line coincides with the old line only in places of fitting into stations, partly in the route of railway no. 3 from the newly-designed station "Nis Sever" to the "Crveni Krst" station, in the area of the "Pantelej" station and after the fitting onto the existing railway no. 22 before Prosek to Sicevo. However, apart from the places of fitting into existing railways, the old and the new railway do not have many elements in common. This means that the most part of the existing railway structure will be terminated and removed – demolished, except for the fittings into the stations and the part of railway lines no. 3 and no. 22. The parts of the railway structure to be removed-demolished are the ballast made of crushed stone fraction of 50-60 m, the protective layer of formation (if applicable) and parts of the embankment.

The removed stone grits may, after check-ups, be fitted as a replacement layer instead of Iberlauf stone with the selection of the appropriate geogrid with smaller eyelet diameter in places where it is necessary to stop the capillary rise of water or in case of weak soil. The protective layer is mostly made of sand and gravel, it is contaminated and it is not to be placed again. However, if during the excavation it is proved clean, it can be placed as a replacement material after checking its quality. The matter removed from the surface layer of the slopes of the existing embankments may only be fitted as a slope lining or for landscaping purposes, provided this is a particulate ranging to the sandy particulate rich in organic matter. Otherwise, the removed material is unsuitable for placement and must be transported to the special landfill.

The material removed from the body of the embankment may be placed into the new embankment after quality check-ups, and the placement must be done in optimum wet conditions.

The designer shall give the estimate of the demolition degree for the existing railway after reviewing urban plans for the city of Nis and identifying the final morphology of the railway corridor and the needs for construction materials for the construction stage of the new railway.

The following are the places where the existing vertical alignment is kept and where the fitting onto the old railway is performed or the embankment is extended:

- from km 235+320 to km 235+900 of railway no. 3 (km 236+450 railway no. 30),
- start of intervention – entrance into the "Nis" marshalling yard km 0+000 BR – bypass railway (3+254.07 railway no.17),
- from km 236+011.48 to km 239+450 railway no.3 (or km 3+874.09 BR),
- from km 3+300 to km 4+900 railway no.38 (or km 5+100 do 6+000 BR),
- from km 8+395 to km 8+660 railway no. 38 (branching to Zajecar) and
- from km 14+017.02 to km 16+668.74 railway no. 22.

At the exit of the "Trupale" station to km 235+900 where the railway no. 3 detaches eastwards, and the no. 30 line continues along the existing corridor towards the "Nis" marshalling yard with slight deviation of the vertical alignment in horizontal direction, it is possible to keep the part of the existing railway structure which is in good condition, particularly the embankment which only needs to be compacted on the surface to required compactness. At the entrance into the "Nis Ranzirna" station, the greatest challenge is posed by high levels of groundwater. Drainage canals should be constructed to permanently decrease the level of groundwater. As Nis Ranzirna station is in a hypsometrically lower part of the terrain, the worst-case scenario for foundation, i.e. the saturated area should be allowed for. It is necessary to provide some type of mechanical stabilization to that end. The proposal for soil enhancement is the placement of blankets made of iberlauf or broken stone fraction of 60-100 mm. The blanket should be placed in layers of minimum 25 cm thickness onto a previously compacted subsoil until the compression index of 25 MPa has been achieved.

The subsoil should be executed under the slope of 2-4 % for more convenient drainage of rainwater. If groundwater is high, it is necessary to lower it to the level of -50 cm from the level of the subgrade and provide the optimum material wetness. Place the geotextile and geogrid with the eyelet diameter of max 50 mm onto the compacted subsoil, which shall prevent the imprinting of the Iberlauf grains or broken stone into the soil due to the action of the train dynamic load.

After the placement and blanket compaction, place another layer of geogrid and geotextile to prevent the washing off of small fraction from the transition and protective layer into the blanket. The blanket may be replaced by extending the transition layer, however in order to stop the capillary rise more effectively, the use of larger fraction is advised as well as the compliance with filtering rules during placement.

During designing, make sure the drainage canals are placed lower than the blanket level to ensure the dewatering of the blanket and the collection of groundwater and the decrease of its level (Figure 29).

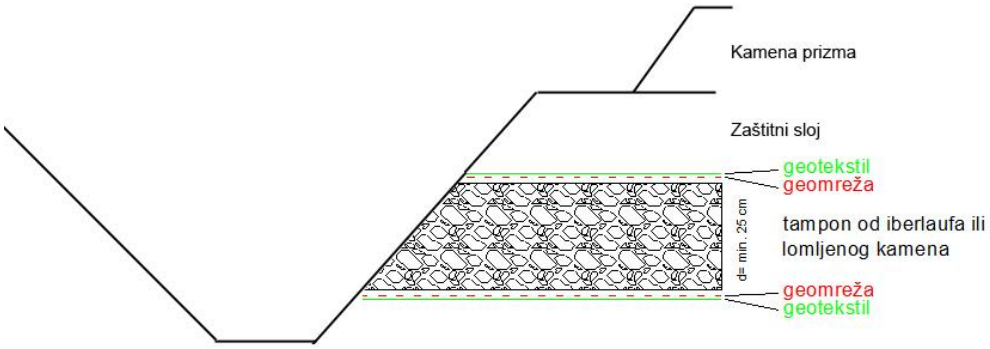

Figure 29: The model of soil improvement and stoppage of capillary water

This model can be used in all the places where it is necessary to improve the bearing capacity of subsoil and stop capillary rise of water.

In the remaining 4 positions mentioned in the text, the substructure, that is, the embankment is in good condition and unless the vertical alignment does not require significant construction works, the embankment can be retained. The superstructure, built of contaminated grit and the protective layer made of gravel and sand, must be completely removed and replaced with the new one. Before placing the stone ballast, it is necessary to bring the embankment formation into the condition prescribed in Guidelines 338 and The Rules on technical conditions and maintenance of substructure of railways ("Off. Gazette of RS" no. 39/16 from 23.04.2016. God.).

The stone ballast is in good general condition, it is mostly contaminated, especially at the floor level, and as its mineral composition does not comply with the regulations, it shall be removed. The removed stone debris may be used for various fillings, reinforcements or mechanical soil stabilization, if necessary. If there is a minor deviation of vertical alignment horizontally, the embankment should be expanded. After topsoiling in this expansion zone, the planning and compaction of horizontal embankments surfaces take places, followed by the placement of new layers. With higher embankments, it is necessary to cut the embankment slopes with the minimum berm width of 1.50 m and the step grade of 2:1. The step height should not be over 50 cm (optimum 30 cm), and compaction working space must be at least 2.00 m (1.50 m berm + 0.50 m), Figure 30. In case of risk of permanent or temporary extreme rise of ground and surface waters, it is necessary to allow for a layer to stop capillary rise of water that will prevent excess embankment wetness.

Total demolition due to the low embankment height shall take place in the lower embankment (< od 1.00 m) or in places where the railway is at the level of the ground. After removing the ballast made of stone debris and the protective layer, the uncultivated land shall be entered or the remaining embankment shall be removed due to technical and technological specifications for execution. The final excavation

level in such cases will be defined in the construction design based on the adopted measurements for the railway structure (superstructure and substructure) which will be 80 cm minimum.

If the railway route goes through weak soil or if the groundwater is close to surface like in the section before Prosek from km 14+000 to km 14+500 (km ~ 19+500 - 20+200 BR), it is necessary to replace the subsoil. Due to the dynamic effect of railway transport, the surface layers of the soil have been completely damaged. It is necessary to demolish the embankment or the railway structure completely regardless of its height. After demolition, it is necessary to replace the poor bearing material and stabilize the subsoil, so as to continue with embankment construction. The same technical specifications apply as those in the intervention in the Nis marshalling yard (Figure 29).

Replacement layer should be placed in two layers with the addition of geogrid and geotextile. If the hydrogeological conditions permit so, after the excavation to the replacement level (min 30 cm), compact the uncultivated soil by rolling until reaching the compaction index of 25 MPa. If there is a problem regarding groundwater, which must be at least 50 cm below excavation level, lower the level of water by section through construction of wells, wellpoint spears or collection canals. Before placing the first replacement layer made of Iberlauf or broken stone aggregate fraction of 60-100 mm in depth of 30 cm (min 25 cm), place the geogrid with appropriate eyelet diameter compatible with the replacement layer fraction and the geotextile layer to prevent precipitation of small fraction particles in the blanket.

Geogrid is necessary to improve the bearing capacity of the subsoil and prevent the imprint of the aggregate material into soft soil due to dynamic and static load. Compact Iberlauf or stone aggregate by rolling until complete incarceration, and then place another layer of stone aggregate fraction of 31.50-63.00 mm in minimum depth of 30 cm. Compaction may be done using vibrating devices until reaching the compaction index of Mv=75 MPa. When executing the second replacement layer, the top (end) level of the replacement material must be 30 cm from the soil surface at least, so as to prevent capillary rise of surface water which may laterally enter the railway embankment.

As the replacement layer finish is made using the 31.50-63.00 mm fraction, prior to the placement of the initial embankment layer, it is necessary to place geotextile to prevent the washing off of the small fraction from the embankment layer and colmatation in the stone aggregate which in time may lead to complete filling of the cavities and capillary rise of water. Geotextile between the last embankment layer and the protective layer is desirable, though not mandatory.

The replacement layer may be in smaller size if the subsoil is not of particularly poor geomechanic characteristics, which must be proved on a trial section. The contractor is advised to have a trial section for each section on which the replacement of subsoil is planned, in the presence of geotechnic supervisors and establish on the spot the

optimum thickness for the replacement layer particularly taking into account a great dynamic load of the moving train and the embankment height.

On the section from ~ km 3+900 to 4+400 and km 5+100 to 6+000 on the BR, the fitting will be performed, that is, the embankment of the existing railway will be expanded. In positions where the embankment is already formed, the expansion of the embankment and the formation shall be executed by cutting the steps into the old slope of the embankment. Slopes are cut using appropriate machines, and manual excavation is allowed when it is impossible to do it mechanically. Terraced placement of new embankment layers onto the existing slope is done at all grades of over 20^0.

The step width may vary from 2.0 – 5.0 m with 4% grade going down the slope (towards the embankment foot), unless otherwise set by the designer. The slope of the step cut should be 2:1 according to the representation of a standard slope cutting (Figure 30) or the representation of the whole embankment (Figure 31).

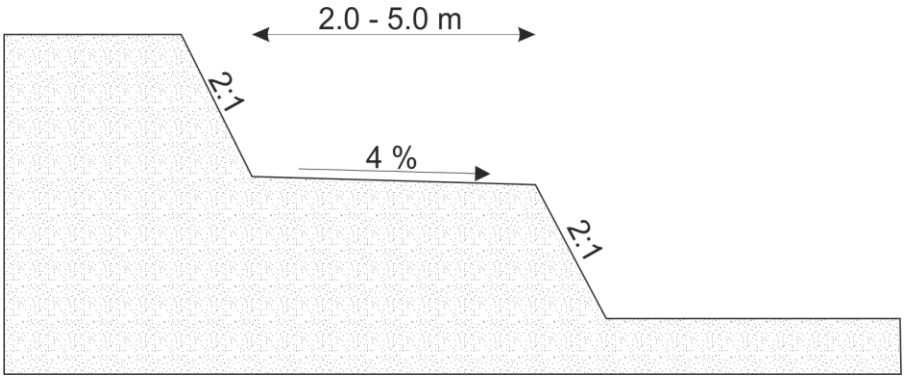

Figure 30: Cutting steps into the embankment for expansion purposes

When the terrain has a grade of over 30°, cutting of steps should be made without any interspace, and when the grade is between 20° and 30°, allow for an interspace of 1.50 m (Figure 31).

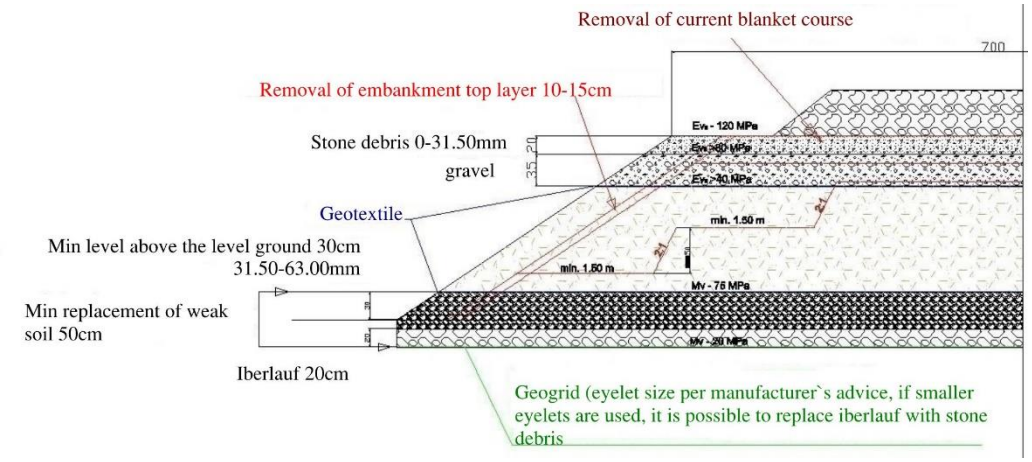

Figure 31: Embankment model with mechanical stabilization

Railway sections to be completely demolished or terminated:

1. from km 235+900 to km 238+700 railway no. 3,
2. from km 236+450 to km 238+550 railway no. 30,
3. from km 1+220 to km 3+240 railway no. 17,
4. from km 4+900 to km 8+395 railway no. 38
5. complete railway no. 22 section from the Crveni Krst to the intervention ending point at km 14+017.02.

Technical specifications for the new railway construction

In consultation with the construction designer in charge, the updated Guidelines 338 and The Rules on technical conditions and maintenance of substructure of railways ("Off. Gazette of RS" no. 39/16 from 23.04.2016. God.) were used as the applicable criteria for structure measurements in checking the compaction of the railway substructure using the dynamic method and the light drop weight on the Yugoslav railway network.

The said criteria requires the following:

Table 19: Technical specifications for construction

Railway type	Railway formation (top of protective layer)				Soil formation (top of roadbed's transition layer)			
	Dpr	Ev_2 (N/mm^2)	U	Evd (N/mm^2)	Dpr	Ev_2 (N/mm^2)	Soil group	Evd (N/mm^2)
Tracks belonging to main railways	1.03	120	>15	50	1.0	≥80	GU, GP, GW, GF, SP, SW	≥40
							Other soil types	≥35

where: Dpr –degree of compaction,
U – unevenness,
Evd - dynamic deformation modulus
Ev_2 - static deformation modulus

The specified values may be achieved in hydrologically favourable conditions for the execution of earthworks. As the materials from the A-7-6 and A-6 groups are also used, which classify as clays of low plasticity according to USCS, they are highly sensitive to moisture and if the works were to be executed under bad hydrological conditions, substantially lower CBR-a and Ev_2 would be obtained. The expected compaction values in the existing soil formation are far lower than those required for this railway rank.

In order to comply with the set criteria, it is necessary to place a protective layer (or protective + transition layer) with 70 cm of sand, or 50-60 cm if combined with fine gravel, or allow for limestone stabilization to achieve the required compaction on the railway formation (blanket) of $Ev_2 = 120$ N/mm^2 and Evd$\geq$ 50 N/mm^2, on part of the section with CBR $\leq$ 6.5 % on particulate-clayey matter in the formation.

General geotechnical recommendations for subsoil treatment

Before starting embankment works on the planned sections and parts of the route that will be executed as small cuts or cuts and fills, it is necessary to remove the topsoil. The excavated topsoil should be deposited on temporary stockpiles to be subsequently used for covering sloped surfaces.

After removing the topsoil, it is necessary to prepare the subsoil for roadbed construction. Based on laboratory testing of samples from different environments, the conditions for subsoil compaction were obtained. The values of Californian bearing ratio, maximum bulk density and optimal moisture per Proctor were summarized in the table below:

Table 20:Max bulk density and optimal moisture content per Proctor

lit.unit	CBR (%)	γ_d max (kN/m^3)	w_{opt} (%)
M_3	3.10-4.60	15.94-16.35	19.64-25.87
t_1-t_3	3.00-4.80	14.99-16.93	18.69-24.00
d	4.40	16.18	20.20
al	3.80-23.90	16.50-19.67	11.00-19.60

The following are the required values for assessing the quality of subsoil treatment, i.e. the compaction:

- for embankment height to 2 m and subsoil of cohesive material, the required compaction is $D_{pr} \geq 97\%$;
- for embankment height over 2 m and subsoil of cohesive material, the required compaction is $D_{pr} \geq 95\%$ and
- for cuts the required compaction is (top 50 cm of soil) $D_{pr} = 100$ %.

During heavy and prolonged rainfall, moisture of materials to be placed in embankments poses a problem, as in the case of soil preparation in cuts since it is difficult to lower the moisture and achieve optimal compaction, therefore, the construction must take place in optimal weather (no frosts or rainfall). In the course of subsoil treatment, make sure drainage is possible during construction activities.

Geotechnical investigation works discovered that in the area of embankment construction on the section from 16+000 to km 16+500, the soil surface is made of strong layers of topsoiled particulate with poor geomechanic characteristics. Here the topsoil and the embankment have considerable thickness and it is necessary to remove the surface matter over 1.00 m thick. The final excavation thickness shall be determined by geotechnical supervisors on the spot.

General geotechnical recommendations for embankment construction

In the conducted analysis of construction conditions for the planned railway route, it has been agreed to use the materials from cuts and local borrow pits for embankment construction.

The embankment groundwork must ensure the drainage of surface waters. In case of high water levels and if embankment poses a barrier to natural run-off, the contact area of the soil and the embankment must have a blanket drainage layer.

As the given section is located near the river Nisava, it is possible to plan the construction of the embankment using cohesionless materials from the alluvium, but it is necessary to obtain consent from PE Vode Srbije based on the required quantities and capacities of the Nisava river bed and the surrounding rivers. In the lack of new regulations for railway design and construction in Serbia, the requirements for material placement into embankments have been taken from road construction regulations:

- Material should be of such a grade so that the unevenness ratio is $U=d_{60}/d_{10}$>od 9. The use of material with $U \leq 9$ (e.g. uniformly graded sand) is another option, only with the use of special placement technologies (e.g. dredging)
- Embankment materials shall not contain over 6 % organic admixture. If the content of organic mixture is 6-10 %, its suitability shall be proved using detailed laboratory tests. This condition applies to evenly distributed and dissolved organic matter. Organic matter in chunks (wood, etc.) should be removed from the embankment material.
- Optimal water content must be under $W_{opt} \leq 25\%$,
- Material moisture must be close to optimal value ($\pm$ 2%),
- Dry bulk density of the material (according to Proctor) may not be less than $\gamma_d = 1.50$ t/m^3, for embankments up to 3.00 m, and for embankments over 3.0 m $\gamma_d = 1{,}55$ t/m^3,
- The liquid limit – of the material may not be above $W_l \leq 65$ %.
- The plasticity index of the material may not be above $I_p \leq 30$.
- The swelling of material after 4 days underwater may not be above 4%.
- Proctor value $Pb = \frac{1}{\gamma_d} - \frac{1}{\rho}$ must be Pb=0 to 0.20.

Hauling and filling of the material is carried out after subsoil treatment and preparation. On the given sections, the layers are placed and spread horizontally in longitudinal direction or near the longitudinal grade, and along the defined grade in cross-sectional direction (single-sided 4 % or double-sided 2.50 %). The cohesive materials should be placed immediately after hauling. The embankment is placed in layers of roughly 30-50 cm, and the actual greatest thickness of the embankment slope is established on a trial section unless the thickness of layers in which the material may be regularly compacted with compaction devices was tested in practice.

Table 21: Requirements regarding compaction and bearing capacity of the embankment, plug and subgrade

Description of works	Required compaction (%)		Required load bearing capacity Ev_2
	SPP	MPP	MN/mm^2
*Embankments and plugs over 2m below subgrade made of:			
-cohesive earth material	95	-	-
-enhanced cohesive material	95	-	-
-consolidated and stabilized material and fly ash	95	-	-
-cohesionless material	-	95	-
*Embankments and plugs over 2m below subgrade to the formation under subgrade made of:			
-cohesive earth material	98	-	15
-enhanced cohesive material	98	-	20
- consolidated and stabilized material and fly ash	98	-	30
-cohesionless material	-	98	60
*Embankments and plugs at subgrade level made of:			
-cohesive earth material	100	-	20
-enhanced cohesive material	100	-	25
- consolidated and stabilized material and fly ash	100	-	40
-cohesionless material	-	100	80

SPP – standard Proctor procedure
MPP – modified Proctor procedure
Ev2 – deformation modulus

Material is compacted using the selected machinery starting from the edges towards the centre of the embankment or against the structures. Cohesive materials must have the moisture content close to optimal value according to Proctor, therefore in bad weather conditions works cannot be executed. The filling of the new layer may begin

once the required compaction of the previous layer is proved. Filling and plugging works should be stopped whenever it is impossible to achieve the required results (due to rain, high surface waters or other weather related disasters). The filling material may not be placed onto a frozen base. In addition, snow, ice or frozen earth material should not be placed into embankment.

The assessment criteria for placing cohesive material in embankments are given below:

- For embankments up to 2 m, the required compaction is Dpr ≥ 98% and required minimum deformation modulus is Ev2 ≥20 MPa, that is Evd ≥20 MPa.
- For embankments over 2 m, the required compaction is Dpr ≥ 95% and deformation modulus of Ev2 ≤ 20 MPa, that is Evd ≤ 15 MPa.

According to the adopted criteria for the bearing capacity and railway rank, the top layers of the earth formation require the placement of 25 cm thick high-quality mineral mixture with compaction of $D_{pr} \geq 97\%$ with the required deformation modulus being E_{v2}=80 MN/m^2 and dynamic deformation modulus of E_{vd} =35 MN/m^2 for cohesive soils and E_{vd} =40 MN/m^2 for cohesionless ones. If the required values cannot be achieved, it is necessary to use geosynthetic materials, replace the material and perform the chemical stabilization of soil.

Drainage around the embankment shall be defined in the hydrotechnical study and construction of culverts through roadbed.

On the given section, at the following chainage points:

1. km 3+900 - 5+200;
2. km 6+400 - 7+800;
3. km 9+250 - 9+450;
4. km 9+800 - 10+180;
5. km 11+450 - 11+730;
6. km 15+600 - 16+200;
7. km 17+400 - 17+880;
8. km 18+250 - 18+650,

embankments of 2-9 m in height are planned and they shall be replaced by structures in some positions. With such high embankments, there is a higher degree of settlement which may lead to delevelling in the area of the gravel wedge, that is in the place where the structure touches on the embankment. To reduce or remove such occurrences, in extremely high embankments, the range of structure is either expanded as on the section from km 4+300 to 4+900 where the construction of a viaduct is advised, or the subsoil is stabilized by combining the blanket made of rock and synthetic materials such as geogrid or geotextile, whereby due to a better distribution of the embankment stress on the soil, the degree of subsoil settlement is reduced.

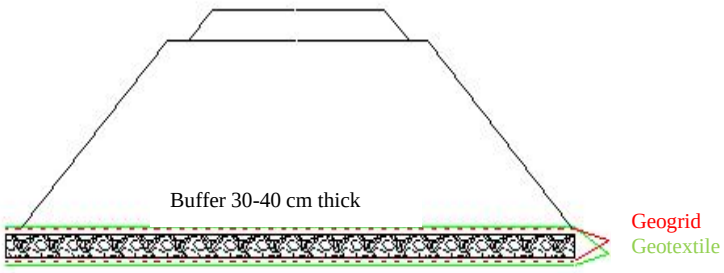

Figure 32: Model of high embankment with mechanical stabilization

Stability of embankment slopes

The morphological features of the terrain and technical regulations have made the embankment a dominant cross section of the given railway.

For this stage of the design, the calculations analysed the embankments 7.00 m high made using the particulate and particulate sandy material 17.00 m wide in the formation and slope grade of 1:1.5 with the train load and synthetic materials in the area of subsoil, that is the embankment subgrade for better redistribution of stress and lower degree of settlement.

When the material strength indicators are identified with great reliability, the acceptable safety factor may be 1.30, hence the calculations returned stable slopes with 1:1.50 grade and a safety factor of Fs=1.33-1.34 for the embankment made of particulate matter, Fs= 1.43-1.47 for gravelled embankment and Fs=1.47-1.53 for the combined one made of gravel and particulate. It can be concluded from these calculations that the local materials are suitable for the construction of high embankments up to 7.00 m using all combinations of materials.

Next, the deep cut in the area of the future "Pantelej" station was analysed for its stability, where, due to the lowering of the railway vertical alignment, the deep cut will be formed, which shall have a depth of 6.00 m together with the drainage canal. The calculations show that the deep cut in natural particulate matter in the area of the "Pantelej" station is stable at the grade of 1:1.50 with minimum safety factor of Fs= 1.53-1.60. Further analysis of economic indicators will enable the adoption of the final design for the cut execution, that is, whether the supporting structure which is safer in terms of excavation stability and the entire slope and which requires lesser degree of expropriation is to be executed or the cut with slopes shall be designed, which although cheaper to execute, demands a wider area for expropriation.

In the course of the Nis bypass design, the problem areas along the route of the future railway were identified as it goes immediately past the river Nisava, where the future railway forms a deep cut, a very high cut and fill or the embankment which encroaches on the river bed. Stability analysis has shown that the sloped surfaces are unstable, i.e. that the safety factor ranges between 1.00-1.20. With the lowering of groundwater (which was not surely identified), the safety factor increases to the acceptable 1.32, with the depth of the supporting structure being around 8 (m) (piles are advisable).

On the cut and fill of up to 14 m deep and slope of 1:1.5 which is unstable with the minimum safety factor of Fs= 1.08-1.13, various stability measures were purposed such as construction of berms, retaining structures, or stabilization using stays combined with steel grids.

Among the analysed stabilization variations, the one including a retaining wall and stays would increase the stability of Fs>1.30.

General geotechnical recommendations for cut construction

The greatest cut on the given route due to the correction of levelling for the new railway, is planned in the area of the current "Pantelej" station. The lowering of the railway vertical alignment leads to entering a cut of up to 3 m deep, and the excavation is to be conducted on sediments of the second river terrace and Miocene sediments characterized by extreme variability of facies. The longitudinal section is dominated by particulate-clayey-sandy matter with the occurrence of layers and intercalations of gravel and pure sand depending on the depth. They should satisfy the maximum compaction and bearing requirements per Proctor for the formation position (CBR_{max} and the corresponding E_{v2} and Evd values, similar to top embankment layers) and since the corridor marked by the city area of Nis is narrow (surrounded by residential houses), it is not possible to build a typical cut with slopes, hence some kind of structure such as retaining walls or the open tunnel should be planned. This will protect the neighbouring structures from secondary settlement or land sliding, and block the access to the railway for humans and animals.

General geotechnical recommendations for cut and fill construction

This project includes planned works for securing the right bank of the Nisava river on the sag curve in the immediate vicinity of the designed railway route in the length of 150 at chainage km 18+430 do 18+840. The technical design includes the structures and the works to primarily stabilize the right bank of the Nisava river, that is, to protect the bank from prospective progressive erosion caused by the flow in the river bed. On the other hand, the planned structures should also serve as an embankment for the designed railway and protect it against negative impact of flood discharge of the Nisava river. On the left side, it is necessary to soften the slopes and perform the obligatory further analysis of the slope stability in the next phase of project documentation drafting.

As there is a very highly placed cut and fill on the one side and an embankment on the other side, towards the Nisava, the construction of a retaining structure is advised towards the right bank of the Nisava, whose foot area is to be protected by a big stone mound or a gabion to prevent the washing off and the erosion of the material at the base of the retaining structure.

In the upper part, considering a highly placed cut and in order to lower the slope radius of 1:1.5, a retaining structure 2-3 m high is advised and the further execution of the slope at the grade of 1:1.5 to the height of its intersection with natural terrain. The exact grade and the height of the designed slope shall be given after the stability analysis by characteristic profiles.

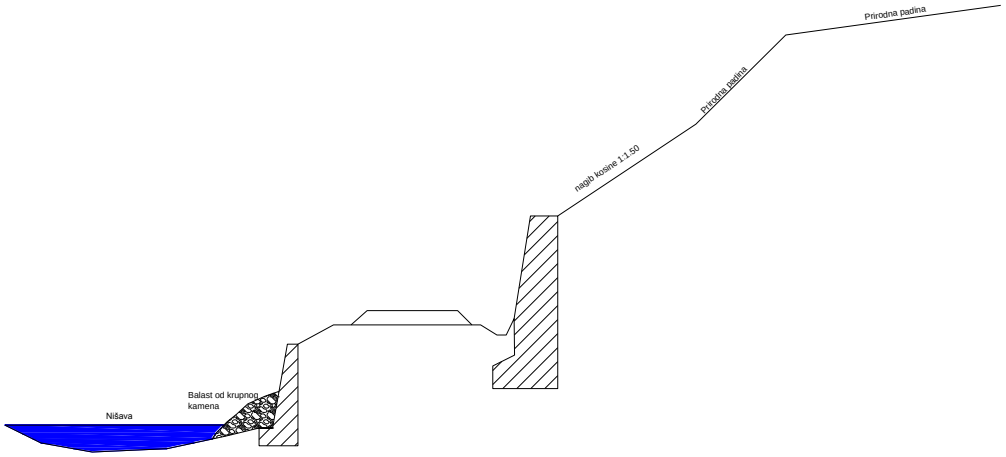

Figure 33: Proposal to stabilize a notch in the Nisava area

General geotechnical recommendations for the construction of sub-structure and superstructure

Standard cross sections of the main railway and the cut define the basic characteristics of the railway and its geometry.

A concrete sleeper width is 2.60 m, crushed stone prism is 3.40 m in the upper, and 5.00m in the lower part (at contact with the blanket – protective course) 0.30 m thick. The blanket course made of gravel (protective layer) is planned under the crushed stone – 6.60 m wide in the upper part and 7.50 m in the lower part (at contact point with top course of the earth formation) and 0.30 m thick. The crushed stone ballast will be made using the standard igneous aggregate conforming to the JUS B.B8.001: JUS B.B8.044: JUS B.B8.013. quality standards.

The construction of a gravelled course – blanket of gravelled sand is defined in Rulebooks 315 and 317, whereas regarding the compaction checks it adheres to Guidelines 338 of the Yugoslav Railway Association and The Rules on technical conditions and maintenance of substructure of railways ("Off. Gazette of RS" no. 39/16 from 23.04.2016. God.)

The materials for this purpose cannot be found in areas of working excavations, nor in the immediate vicinity. Therefore the required quantities of gravel are to be supplied from the nearest economically justified borrow pits of the Nisava or other locations.

The protective layer material – blanket of gravelled sand must be adjusted to the filter rule, and it must meet the following requirements:

- water permeability ratio shall be k ≤ 10-6 - 10-4 cm/s
- degree of unevenness shall be U ≤ 7, due to compaction requirements and the required bearing capacity
- it shall have a required compaction (Ev2 ≥ 80 MN/m^2 and Evd ≥ 40 MN/m^2)
- it shall not contain organic matter
- it shall be frost-resistant (with the degree of unevenness of U = 15, it shall not contain more than 3% of fraction smaller than 0.02mm).

These requirements shall be checked against the certificates obtained from the planned deposit sites and during testing of trial samples from the stockpiles before placement.

Drainage and dewatering of surface and groundwaters in the railway area

Drainage and dewatering of surface and groundwater from the railway area and the roadbed shall be solved within the construction design, by planning and designing: a formation grade, drains and drainage canals and culverts in the railway area.

Topsoil padding and landscaping of sloped surfaces

Geotechnical recommendations for the construction of the railway route include topsoil padding of all slopes of embankment and cuts, in the layer ~20 cm thick and grassing thereof. The topsoil removed from the area (around 30- 50 cm) can be used for the construction of the embankment and cuts.

Material disposal sites

There is no excess material on the given section. Small quantities of poor quality material (which would not be placed into embankments) may be spread in the foot of the added embankments in the expropriation zone which would additionally secure the embankment.

It is necessary to make temporary stockpiles for topsoil disposal to be later used for embankment slopes coverage. Flatter areas should be found for such piles and arable agricultural land avoided.

Usability of local material for embankment construction

Laboratory testing of samples taken from trial holes in the immediate vicinity of the railway route established the geomechanical characteristics of local materials.

The wider investigation area is made of terraced sediments (t_1-t_3) in the form of particulate and sands, Miocene sediments (M_3) with the predominance of particulate and sands in top areas, but there are also sandy gravels, alluvial sediments (a) – occurring in floodplain facies (particulate and sandy particulate) and bed facies (sands and gravels). All the locally found materials can be placed into the railway embankment after topsoil removal in the average thickness of 15-20 cm as well as the materials from existing borrow pits which meet the set requirements.

For the purpose of the Main Design, it is necessary to determine the exact required quantities, the types of materials and micro locations of prospective borrow pits which may be expropriated and are located near the route in accordance with the allowed and optimal transport distance.

It is also necessary to complete a detailed engineering and geological survey of the prospective borrow pits for materials and all the accompanying laboratory testing and draft the Design regarding the construction of material borrow pits based on these.

3.2 Project description

Figure 34: Bypass railway around Nis

Based on available documents, the collected data from field visits, consideration of the current railway condition and the tasks to be completed in order to modernize

and construct a single-track bypass railway with the starting point at Nis Ranzirna station at PS 3 exit switch and end point PS 1 entrance switch in the Sicevo station (the data on the PS1 location for the entrance switch in the Sicevo station has been taken from the Main Design for the reconstruction and modernization of the Nis-Dimitrovgrad railway section Cele Kula – Stanicenje), the following limits have been set for the elements in the design proposal for the required speed of v=160km/h:

- Minimum radii Rmin = 1500 m
- Minimum transition curve Lmin = 140 m
- Maximum grade of vertical alignment on the open railway imax = 12,5 ‰.
- Maximum grade of vertical alignment in new stations imax = 1 ‰.
- The change of grade in the vertical alignment at adjacent grades gap $\Delta i \geq 1‰$
- Rounded radius for vertical curvature is Rv nor $\geq 0.4\ v^2$
- Rv – allowed limit $\geq 0.25v^2$
- Track spacing:
  - open railway min 4.20m
  - track spacing min. 4.75m
- The designed railway elements are intended for the axle load of 225kN and weight of 80kN/axle.

Transition curves and elevation ramps

For speeds up to 160 km/h a cubic parabola with straight-lined transition elevation ramp is used as a transition curve, with the mandatory rounded vertical breaks at the entrance and the end of the transition elevation ramp.

The length of the transition curve and elevation ramp for new and reconstructed railways for speeds up to V = 160 km/h is set according to the Rulebook.

The rectilinear transition ramp is executed in the area of the transition curve and matches its length. The crossing from the track part with no elevation to the track with elevation, is done gradually using a transition ramp. The transition ramp is executed using a uniform grade (rectilinear ramp).

On the bypass railway, a railway clearance UIC-C has been provided, according to the UIC announcement 506 as shown in Figure 34.

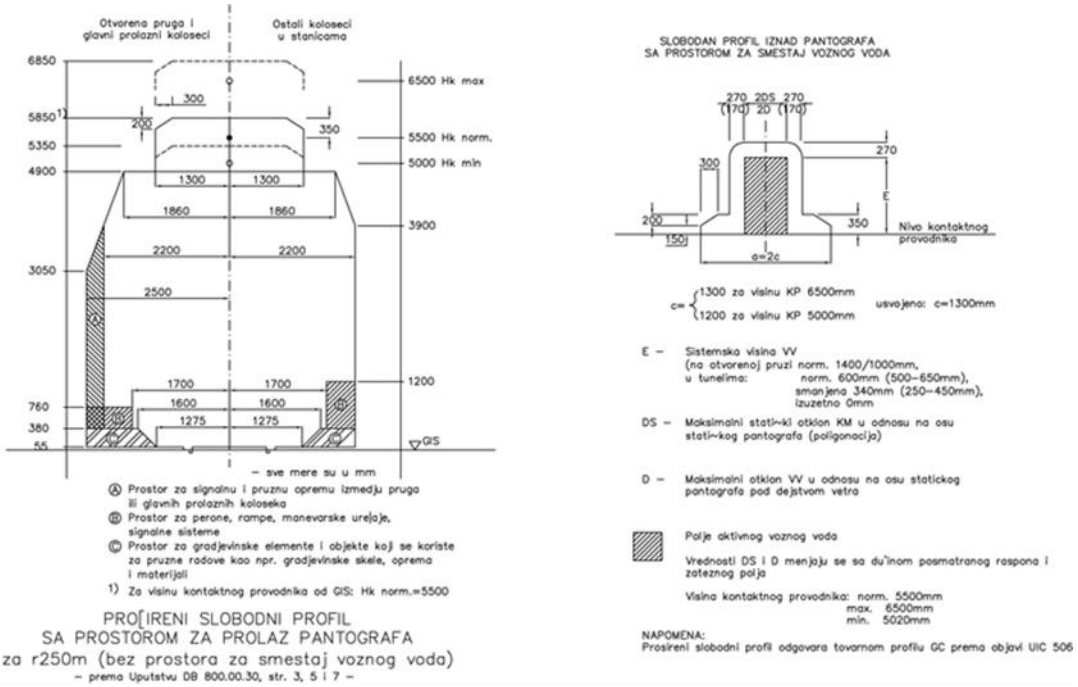

Figure 35: Railway clearance

Railway dewatering

The collection and evacuation of waste water in the city of Nis is carried out through a mixed sewer system, general and separate type. General type of sewer covers most of the territory of the city. It consists of two sub-systems, which operate independently of each other. They are built on the left and the right bank of the Nišava. Waste water from urban sewage is discharged into the Nisava without treatment because Niš does not possess plant for waste water treatment.

The concept of track drainage belt is based on the acceptance of surface water and water from the drainage system of open channels. Recipients of track channels are open streams and canals, as well as storm sewer collectors (existing and planned).

On the route of the projected railway line has a total of 25 outlets drainage network. At a location where there is no canal network nor the planned sewer lines, pumping stations is planned. Drainage of railway is planned drainage system between the track drainage pipes. Manholes are spaced at a distance of 50m.

At the locations of the planned station there built water and sewage infrastructure. In ground floor of the station buildings were designed by one kitchen and a toilet. These needs include the following plumbing and sewage:

- Hot water

- Fire Water

- Sewage.

It is envisaged that all sanitary fecal waste water from the station buildings take in future city fecal sewage network.

If the station would builded before the construction of fecal sewage network for the collection of sanitary-faecal waste water from the stations, predict watertight septic tanks of appropriate volume, or provide other technical solutions that prevent soil and water pollution due to their uncontrolled releases.

Sewage sources all the waste water from the sanitation, the system of horizontal and vertical divorce discharged into the sewer manhole newly designed from precast concrete rings. Manhole was set up outside the building and is located in a green area, on land parcel railway station. Over the projected manhole will be a link to the planned sewerage system. Emptying designed manholes will be done by a public utility company with which the competent institution will make a contract, until the construction urban sewage system.

Drainage of storm water from the roof and canopies on platforms running through downpipes. Solution drainage of rainwater from downpipes, from the plateau around the station buildings, platforms and subways carried out the design of storm sewers. Collecting water from the plateau around the station buildings, as well as with the plateau of the platform is done through gutters and mounting channel with line bars. Drainage of storm water from the underpass is done through regular channels with the mounting bars. The collected water from the gutters using drains flows into storm sewers manhole. Water from the gutters, gullies and channels fabricated from the mouth of a sewer system associated manholes, in the grounds of the projected railway station. In the area of railway stations there is no built installing storm sewers. Designed manholes on the access roads, which will be linked to the planned city sewer.

Until the construction of the city's atmospheric sewage network, storm water drain from station in the existing channels for the collection of rainwater.

In order to supply railway stations are designed for the installation of sanitary and fire water in the building of the station building. Since it is not built water infrastructure to railway stations, it was designed connection, but only gauging shaft within the parcel railway station. In addition to other forms of protection against fire in the house is designed and hydrant installations. With regard to the use of the facility, hydrant network is designed for one simultaneous fire capacity 5l / s.

3.2.1 Description of designed (reconstructed) railway routes

The route of a single-track bypass railway in the length of 22.4 km with the starting point in Nis Ranzirna, that is, the design chainage of the bypass railway km 0+000, equalized with the railway no. 30 chainage of km 237+ 836.

The modification of the existing railway route 17 so as to meet the visibility requirements for the Airport Constantine the Great runway led to the reconstruction of the entrance neck of the Nis Ranzirna station from the direction of Trupale and Crveni Krst.

The route of the bypass railway from the track no. 9 from PS – OP3, its left curve R 300 with transition curves (station area) goes through the outskirts of the Popovac settlement to continue after the designed exit switches OP1 and OP2 through its right curve R300 with transition curves along the route to the designed station Nis Sever.

The exit from the reconstructed exit neck of the Nis Ranzirna station is at km 0+797 of the bypass railway. On this section, the bypass railway is mostly in the cut which suits the demands of the Airport to have a better visibility in the area of its runway.

The Niš Sever station

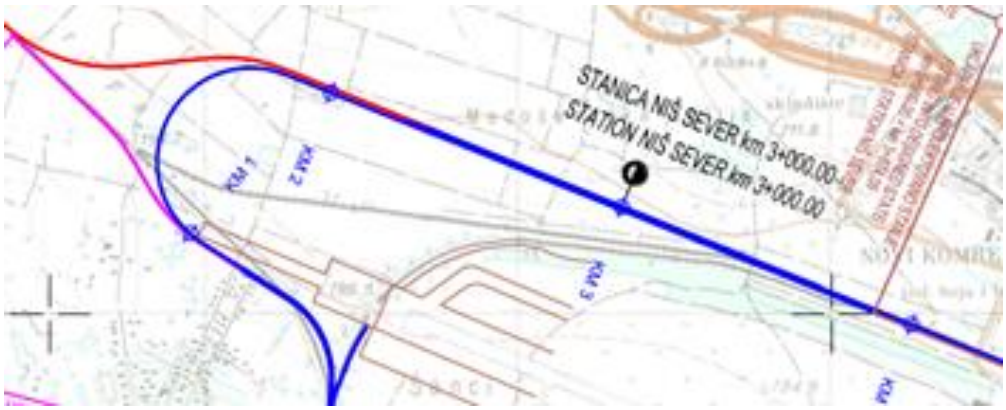

Figure 36: Nš Sever station

The Nis Sever station km 3+000 is located in the north of the city. The designed station is placed horizontally and at grade throughout. The total station length is 1,542 m as measured from the PS entrance and exit switches. In transportation sense, it is an intermediary station and the meeting place of 3 railways, where the lines Belgrade, Skoplje and Dimitrovgrad detach and intersect.

For the completion of all technological tasks, in the final design for the area of the double-track bypass railway, the Nis Sever station was designed as having 7 tracks and 2 platforms.

Table 22 Purpose and usable length of tracks in the Nis-Sever station

Track no.	Track purpose	Usable construction length (m)
1	Incoming-outgoing track	750
2	Main through track for the line (Dimitrovgrad) – Pantelej – Trupale – (Belgrade). Railway no. 3 is introduced onto this track from the direction of Trupale.	750
3	Main track for Niš Sever – Pantelej – (Dimitrovgrad). Future second track of the railway no. 3, i.e. the main through track for the line (Belgrade) – Trupale – Niš Sever – Pantelej – (Dimitrovgrad)	923
4	Main track for the line Crveni Krst – Niš Sever Railway no. 3 is introduced onto this track from the direction of Crveni Krst.	923
5	Incoming-outgoing track from the direction of Crveni Krst	750
6	Incoming-outgoing track	569
7	Handling track	569

In the extended handling track a stub track has been designed for the purpose of manoeuvring in the station.

Two platforms are planned for passenger entrance and exit which are interconnected with an underpass.

- Platform 1 next to the first incoming-outgoing track, 220 m long, 55 cm high above TER (top edge of the rail)TER, and 4 m wide;
- Platform 2 between tracks 4 and 5, 247 m long, 55 cm high above TER, and 6,1 m wide.

Phase one of the Nis Sever station construction includes the construction of 4 tracks, a station building, a plateau, an access road and a parking lot, an underpass and platform no. 2. The new station building shall store interlocking devices, telecommunication equipment and power supply devices. The tracks with switch installations to be built in this phase are as follows:

- Track no. 2 for the line (Belgrade) - Trupale – Niš Sever (the main future trough track for Niš Sever – Trupale – Belgrade * regular)- Kd= 868 m;
- Track no. 3 for the line (Dimitrovgrad) – Pantelej – Niš Sever (the main future through track for (Belgrade) - Trupale – Pantelej – (Dimitrovgrad) Kd= 923 m;
- Track no. 4 for the line Crveni Krst – Niš Sever Kd= 923 m;
- Track no. 5 - incoming track from the direction of Crveni Krst Kd= 868 m
- Stub tracks in the length of 100m (two at the entrance in the station Niš Sever from the direction of Trupale) and one at the exit at Pantelej.

From the exit point from the Nis Sever station, the route of the bypass railway has been designed along the left curve R 500 with transition curves, and shortly afterwards, it follows the right curve R 300 with transition curves in the direction of the Pantelej settlement. From km 5+270 to km 6+898 (entrance to the Pantelej station), the bypass railway is mostly in the embankment with layout plan elements designed for the speed of v=120km/h where the normal radius of the horizontal curve is R 1000 with transition curves.

The open route in the observed part is in the embankment. The bypass railway has been designed within the corridor with a reconstructed single-track regional railway no. 38 Crveni Krst – Zajecar.

The Pantelej station

Figure 37: The Pantelej station

The Pantelej station at km 7+450 is located in accordance with spatial possibilities and maximum compliance with the existing infrastructure and minimum requirements for their removal in order to adhere to the functional and technological requirements of station operation.

Terrain configuration and interoperability requirements with technological operation requirements in the station served as inputs for defining the station length of 1,855m. In traffic terms, this is an intermediary station and regulates the movement of trains on lines Niš – Dimitrovgrad – state border and (Niš) – Crveni Krst – Zaječar – Prahovo Pristanište, and on the bypass railway. In the Pantelej station the lines for Dimitrovgrad and Zajecar depart, and it is open for operation in passenger suburban, local and city traffic.

For the completion of all technological tasks in the Pantelej station, in the final design of the Pantelej station 5 tracks and 2 platforms were designed.

Table 23: Purpose and usable length of tracks in the Pantelej station

Track no.	Track purpose	Usable construc-tion length (m)
1	Main incoming-outgoing track from the direction of Crveni Krst	1,165
2	Main through track for the line Niš Sever – Vrezina – (Dimitrovgrad)	1,192
3	Main through track for the line (Dimitrovgrad) – Vrezina – Niš Sever	1,278
4	Main incoming track from the direction of Zaječar	1,144
5	Incoming-outgoing track	1,144

The station has been designed in the curve R=2000m. The part of the station plateau is placed in the embankment with the average height of 3.5m, and its other part is in the cut with average height of 3.5m.
Two platforms are planned for passenger entrance and exit which are interconnected with an underpass.

- Platform 1 next to the first incoming-outgoing track, 220 m long, 55 cm high above GIŠ-a, and 4 m wide;
- Platform 2 between tracks 4 and 5, 150 m long, 55 cm high above TER, 6,1 m. 3.5m wide.

Phase one of the Pantelej station construction includes the construction of 4 tracks, a station building, a plateau, an access road and a parking lot, an underpass and both platforms. The new station building due to the land features has been designed as a two-storey building and hence the ground floor shall store interlocking devices, telecommunication equipment, power supply devices and a ticket office, whereas the first floor at platform level is reserved for the technical department.

The tracks with switch installations to be built in this phase are as follows:

- Track no. 1 incoming-outgoing from the direction of Crveni Krst, Kd=1165 m;
- Track no. 2 – main track from the direction of Niš Sever, Kd= 1192 m;
- Track no. 3 – main track from the direction of - (Dimitrovgrad), Kd= 1278 m;
- Track no. 4 incoming-outgoing from the direction of Zaječar Kd=1252 m.

Levelling wise, due to the configuration of the terrain, the entrance/exit neck of the Pantelej station have been designed with the grade of 10‰, with the station grade of 1‰. On the part exiting the station, the railway is in the city area inside the cut, hence the designed retaining walls conform in all things to graphic documents and costing (separate volume).

The bypass railway route from the exit from the Pantelej station km 8+753 to km 18+331 (near the Prosek turnout point) has been designed with the plan elements intended for the speed of v=160km/h. The designed curves radii is R 2000 with transition curves.

The Vrezina station

Figure 38: The Vrezina station

The Vrezina station has been designed in km 14+600 so as to be open for operation in passenger suburban, local and city traffic, but not for operation in freight transport. The station length in the final phase is 1.319 m.

For the completion of all technological tasks in the Vrezina station, in the final design for the Pantelej station 4 tracks and 2 platforms were designed as shown in the table below.

Table 24: Purpose and usable track length in the Vrezina station

Track no.	Track purpose	Usable construction length (m)
1	Incoming-outgoing track	750
2	Main through track for the line Pantelej – Vrezina (Dimitrovgrad) – Vrezina – Niš Sever	750
3	Main through track for the line (Dimitrovgrad) – Sićevo – Pantelej	750
4	Incoming-outgoing track	750

Two platforms have been planned for passenger entrance and exit interconnected with an underpass.

- Platform 1 next to the first incoming-outgoing track, 220 m long, 55 cm high above TER, 3 m wide;
- Platform 2 next to the fourth incoming-outgoing track, 220 m long, 55 cm high above TER, 3 m wide.

Phase one of the Vrezina station construction includes the construction of 2 tracks, a two-storey station building with rooms conforming to technical requirements, a plateau, an access road and a parking lot, and underpass and platform no. 1. The constructed tracks shall be assigned the function of a junction to Vrezina station in phase 1.

The tracks with the accompanying switch installations for this construction phase are as follows:

- Track no. 1 incoming outgoing track Kd=750m;
- Track no. 2 main trough track Kd=750m.

The route of the bypass railway from the exit point from the Vrezina station to the Prosek turnout point past the Nisava was designed to avoid guiding the route through the hill. For the given subsection the approved technical design includes retaining walls (the length of 200m) as to provide protection from the Nisava on one side, and for cutting into the hill on the other side. Simultaneously, on this subsection the designed plan elements correspond to the speed of v=120km/h as the joining point into railway no. 22 is close.

Prosek turnout point

The turnout point is a temporary solution until the construction and modernization of railway no. 22 is complete, and it has been designed at km 19+304 of the bypass railway. In this new structure on the left of the railway, the interlocking devices, telecommunication and power supply systems shall be stored, and the building temporarily accessed from the state road which conforms fully to the Technical requirements of the PE Roads of Serbia.

At km 20 +000 the bypass railway joins the route of the reconstructed railway no. 22 (km 14+258) pursuant to the Main Design for the electrification of the Nis – Dimitrovgrad railway. The route of the bypass railway to the Sicevo station (PS of the entrance switch) is guided along the route of the reconstructed railway no. 22 with the note that the existing road crossing in Prosek is terminated pursuant to the Law on railway safety and interoperability. To ensure communication, an access road

starting from the lower side of the bypass railway has been designed from the newly-designed rotary intersection JUG.

Designed structures on the bypass railway route

- **Retaining walls**

The adherence to spatial limitations, rules of the trade and accommodation to the current condition, and above all, the preservation of residential buildings on some subsections, conditioned the design of the retaining walls at the following chainage points on the bypass railway:

- Km 4+230 to km 4+400 (on the part of the bypass railway cant with railway lines 3 and 17)
- Km 8+340 to km 8+600 left and km 8+300 to km 8+630 right in the area of the high cut in the Pantelej settlement From km 8+910 to km 9+270 (on the part of the bypass railway cant with railway 38)
- Km 12 +960 to km 13+030 the area of protection at the Nisava river

- **Structures**

Table 25: List of structures on the single-track bypass railway route

No.	Planned structure	Railway	Chainage	Intersection with roads
1	culvert	30	0+307.16	agricultural
2	culvert	3	0+472.76	agricultural
3	culvert	bypass	2+435.00	hydrotechnic
4	underpass	bypass	2+575.05	access
5	underpass	17/3	3+867.71	access
6	underpass	bypass	4+659.49	collecting
7	bridge	bypass	4+831.60	watercourse crossing
8	bridge	bypass	4+831.60	NIS track
9	underpass	bypass	4+996.54	Boulevard- primary
10	underpass	bypass	5+991.83	Bulevar- primary
11	underpass	bypass	6+592.85	collecting
12	underpass	bypass	7+658.22	Boulevard- primary

13	underpass	bypass	8+584.22	collecting
14	underpass	bypass	10+379.07	Boulevard- primary
15	bridge	bypass	11+588.78	collecting
16	bridge	bypass	11+588.78	watercourse crossing
17	underpass	bypass	13+104.92	collecting
18	bridge	bypass	13+161.67	watercourse crossing
19	culvert	bypass	15+205.27	hydrotechnic
20	overpass	bypass	15+242.00	collecting
21	underpass	bypass	16+293.16	collecting
23	underpass	bypass	17+672.28	Boulevard - primary
24	bridge	bypass	17+742.22	watercourse crossing
25	underpass	bypass	19+477.03	collecting
26	culvert	bypass	19+548.75	hydrotechnic

Reconstruction of railway no. 3

The subsection of the railway line E70/85 Beograd-Mladenovac-Lapovo-Niš—Preševo – state border (Tabanovce) section Trupale – Niš Putnička - Međurovo – main *(railway no.3)* in the corridor of the railway bypass around Nis must be reconstructed in the length of nearly 4 km.

The designed chainage for the railway reconstruction 3 km 0+000 corresponds to the chainage of the current railway of 3 km 235+861.57. Completion of the reconstruction and fitting into the current condition of the reconstructed railway 3 is at km 3+958.92 = km 239+857.20 (chainage of the current railway no. 3).

Design elements for the reconstructed railway no. 3 correspond to design speed of v=100km/h

Reconstruction of railway no. 30

The subsection of the railway Trupale – Niš Ranžirna – Medjurovo - main (railway no. 30) in the corridor of the railway bypass around Nis must be reconstructed in the length of nearly 1,8 km.

The design chainage for the railway reconstruction 30 km 0+000 corresponds to the chainage of the current railway 30 km 236+011.48. Completion of the reconstruction and fitting into the current condition of the reconstructed railway no. 30 is at km 1+847.37 = km 237+836.01 (chainage of the current railway no. 30).

Reconstruction of railway no. 17

The subsection of the railway Crveni Krst – Niš Ranžirna – Medjurovo – main (railway no. 17) in the corridor of the railway bypass around Nis must be reconstructed in the length of 2.9 km, or, more precisely, the railway no. 17 from Niš Ranžirna station (km 3+232=PS 3) to Niš Sever station has been overtaken by the bypass route. This means that the railway no. 17 shall be completely dismantled in the length of 1.7km.

The reconstruction of line 17 starts from km 1+525 (the current chainage of the line 17 going backwards as the line 17 chainage has been guided from the Crveni Krst station to Niš Ranžirna) = km 0+000 of design chainage in the Niš Sever station = km 3+879.09. of the bypass line to the point of joining the current condition of the line no. 17 at km 0+350.37 (current chainage of line 17) = km 0+879.64 of design chainage.

Reconstruction of railway no. 38

The subsection of the railway Crveni Krst–Zaječar–Prahovo Pristanište – regional (railway no. 38) in the corridor of the railway bypass around Nis must be reconstructed in the length of nearly 4.5 km.

The design chainage for the beginning of line 38 reconstruction km 0+000 corresponds to the chainage of the current railway no. 38 km 4+146.92. Completion of the reconstruction and fitting into the current condition of the reconstructed railway no. 38 is at km 4+460.78 = km 8+655.25 (chainage of the current no. 38 line).

Reconstruction of railway no. 22

The subsection of the railway Niš – Dimitrovgrad – state border (Dragoman) (line no. 22) international main line must be reconstructed in the length of 0.5 km in the part of the Prosek turnout point.

The design chainage for the beginning of line 22 reconstruction km 0+000 corresponds to the chainage of the current railway no. 22 km 13+085 from the Main Design as drafted by the Transport Institute CIP. Completion of the reconstruction of railway 22 and fitting into the bypass line (in the part at the Prosek turnout point) is at km 19+288 of the bypass line = km 0+467.19 (design chainage).

Finally, the bypass line at the point of km 20 + 000 = km 14+258.62 (chainage of railway no. 22) is guided to the route of line 22 according to the Main Design as drafted by the Transport Institute CIP to the point of fitting into the Sicevo station. The end chainage of the bypass line km 22+ 425.94 = km 16+668.74 of the railway no. 22 at design chainage of the entrance switch into the Sicevo station.

3.2.2 Noise barrier walls

Noise protection walls are provided on the left or right side, as observed in the chainage growth direction, at the total length of 1.120 m. The walls are situational and levelled as defined by this Design.

Table 26:Noise barrier walls

Wall No.	Chainage at the beginning of the wall	Chainage at the end of the wall	Side	Wall length [m]	Wall height [m]
Wall 1	5+193.86	5+484.51	Left	292	4.00
Wall 2	5+140.62	5+304.22	Left	292	3.50
Wall 3	8+840.65	9+136.71	Right	260	3.00
Wall 4	11+246.3	11+618.3	Left	60	3.50

In the further stage of development of the project documentation, in preparation of the final design, it is necessary to analyse the soundness of structures to be protected and re-examine the necessity for protection measures.

If during operation indicate impacts on facilities that exceed the limit values, it is necessary to consider the implementation of measures in the facilities.

Since the railroad is designed for speeds of 160 km / h in the next phase of preparation of project documentation is necessary to consider the setting of the walls at a distance of 3.30m from the axis of streaks.

All walls have the same structural characteristics:

- Grounding of pillars is done on the bored piles with a diameter of Ø70cm and are fastened with steel anchors.
- Pillars are made of HEA180 steel profiles. Ranges between the pillars are 4.0m.
- Precast reinforced concrete sheet piles, made from MB 30 type of concrete and steel fabric reinforcement MAG 500/560 and RA400/500. Length of the sheet piles are 3.96m.
- Absorption panels are formed from prefabricated absorption sheet piles, and based on the length are 4.0m. Sheet piles (panels) are made of perforated aluminium casing whose interior is filled with absorbent material (glass wool in the polyester layer). Absorption characteristics of the panels correspond to category A3 of the European standard EN 1793-1 categorization.
- All seals are made of rubber gaskets resistant to UV rays. All concrete elements should be resistant to salt and cold (OMO 100, OSMO 25). The waterproofing coating should protect all elements in the ground.
- All situational, levelling elements and structural details are shown in the drawings.

1.1.1 Maintenance

Noise protection walls are designed to require minimum maintenance, except regular cleaning. Concrete elements do not require maintenance during the design period. Damage during construction of the walls must be avoided since it shall significantly reduce the “lifespan” of the walls.

Surfaces of the walls and their joints must not contain dirt, moisture and other which can cause rust. Although there is no specific requirement in terms of longevity of the wall elements, the manufacturer of these elements should guarantee a minimum of

10 years in terms of durability in terms of resistance of paint, stone hits, resistance to corrosion and aging, fire, etc.

1.1.2 Acoustic Analysis

Software package CadnaA was used for determining the noise level caused by the traffic on the railway bypass around Nis. Dutch national method for the assessment of noise indicators of rail transport SRM II - 1996[1], as recommended by the Directive 2002/49/EC was used for the analysis. Use of the Dutch national method is defined by the Regulation on noise indicators, limit values, methods for assessing noise indicators, disturbing and harmful effects of noise in the environment (Official Gazette of RS No. 75/2010).

Acoustic model was formed for the purposes of acoustic f, which included a 3D model of the terrain, technical and technological characteristics of the railway and rolling stock, volume of railway traffic, and the distribution and use of the structures. Analysed railway is divided into sections with different characteristics (number of trains, type of railway, speed limits, etc.).

On the following pictures is shown the 3D model of the terrain and railway formed for the purpose of acoustic analysis, as well as the model with objects of different purposes, which are in the zone of 200m from the railway.

[1]Published in the "Rekenen Meetvoorschrift Railverkerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer", November 20, 1996)

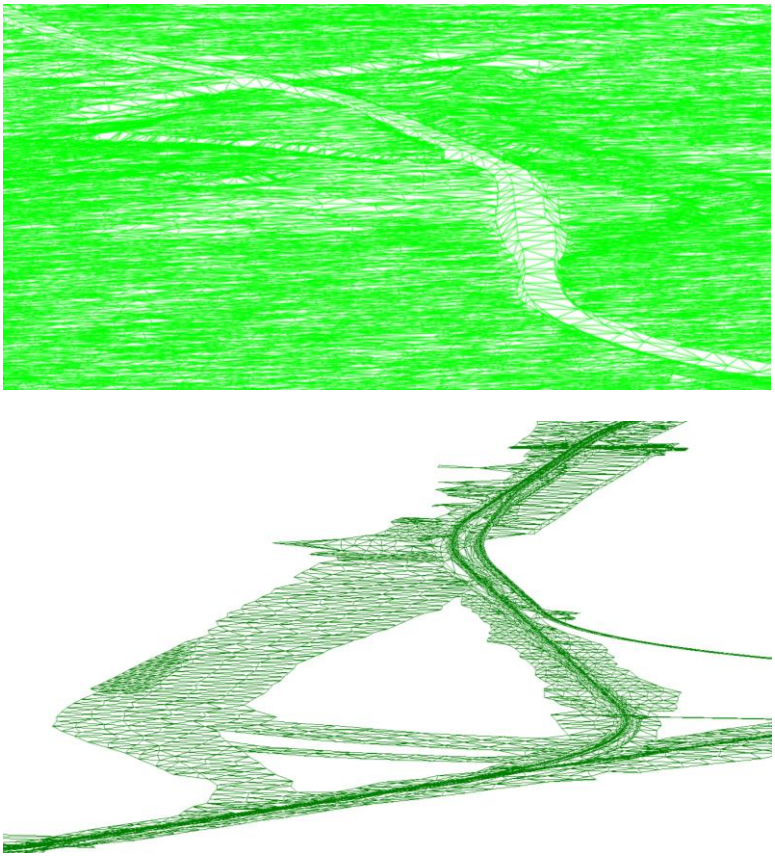

Figure 39: 3D model of the terrain and railway

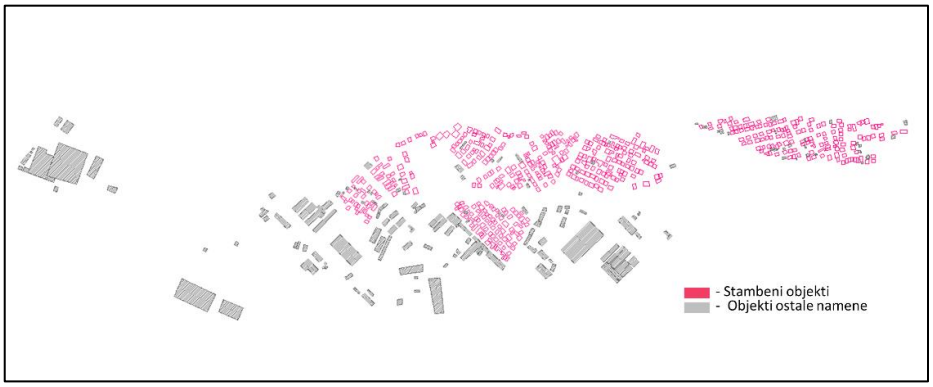

Figure 40: Facilities in railway zone

The input parameters for modeling the noise data from parts of the preliminary design, project technology traffic and feasibility studies.

The figure below shows the planned timetables taken from Volume 7.1 Traffic-technological design.

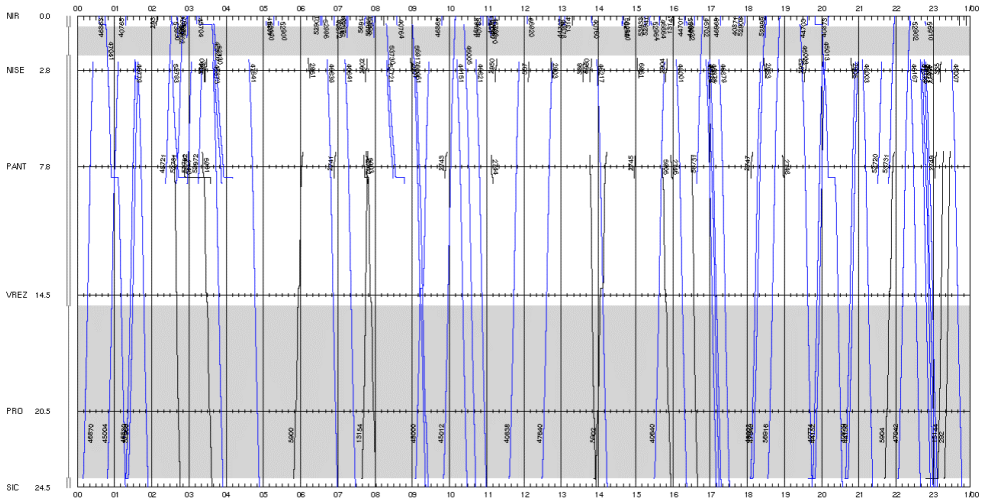

Figure 41: Graph of the timetable for the new design (taken from volumes 7.1, contribution 15)

The following table shows the number of trains per sections and the periods of day used in the analysis.

Table 27:The number of trains per sections and the periods of day

Section	Passenger trains			Freight trains		
	22-06	06-18	18-22	22-06	06-18	18-22
Trupale – Niš Sever	11	13	6	9	8	2
Niš Sever – Crveni Krst	12	15	7	7	6	2
Niš Sever – Pantelej	0	0	0	15	12	3
Crveni Krst – Pantelej	8	11	5	3	2	0
Pantelej – Matejevac	3	5	2	4	2	1
Pantelej – Prosek	6	8	2	12	10	2

The following table shows the speed of trains per sections for passenger and freight trains used in the analysis.

Table 28:The speed of trains per sections for passenger and freight trains

Section	Passenger trains [km/h]		Freight trains [km/h]	
Rang	Passenger	High speed	Inter-city	Regional
Trupale – Niš Sever	70	70	70	70
Niš Sever – Crveni Krst	100(*40)	120(*40)	80(*40)	100(*40)
Niš Sever – Pantelej	100	120	80	100
Crveni Krst – Pantelej	100	120	80	100
Pantelej – Matejevac	50(*40)	50(*40)	50(*40)	50(*40)
Pantelej – Prosek	120	160	80	100

* train speed in station

Existing rolling stock and those planned for purchase by SR are taken into account when selecting the types of trains, which will operate on this railway.

3.2.3 Electric power systems and devices

OCL power supply

The power supply for the OCL of the Nis bypass railway is to be provided from the existing traction substation (TS) Nis. Based on preliminary electric power calculations, it is necessary to increase the TS power, and considering the age of the current TS Nis, the complete plant overhaul is to take place.

For the purpose of fitting the OCL of the newly-designed Nis bypass line into the current system for power supply and sectioning, a new sectioning plant (PS) Pantelej has been planned. The electrification of this section shall be completed in the Vrezina station where the PS/PSN Vrezina shall be built.

Overhead contact line

The OCL on the newly designed Nis bypass is supposed to have a compensated catenary made of a conductor wire and the supporting wire. This catenary has a "Y" wire, which is suitable for speeds up to 160km/h. The conductor wire is a copper wire with a cross-section of 100mm^2 and the supporting wire is made of bronze Bz II-65mm^2. The normal height of the conductor wire above GIŠ is 5,500mm, minimum height is 5,200 mm, maximum height is 6,500 mm, and above road crossings it is in the range of ≥ 5500mm.

The OCL supporting structures are planned in two forms: cantilever beams made of steel (U) sections and meshed steel portal structures.

As a return current conductor a single or both rails of each track are used in stations and both rails on an open railway. The continuity of the OCL return line is ensured through mutual power supply of the adjacent non-welded rail strings using rail breakout. To decrease voltage drops and potential equalizing in the return line, interrail and intertrack bonds are inserted between non-insulated rails.

The earthing of OCL supporting structures is planned as a connection to the nearer non-insulated rail.

For OCL longitudinal power supply and sectioning, motor-operated disconnectors are to be used, and for the purpose of transversal sectioning in stations, manual disconnectors are provided for.

Remote control

The fitting of the new equipment for remote operation of the newly-designed traction power plants in CDU Nis and in the plants have been planned, as well as the replacement of currently used devices. It is necessary to provide sufficient capacity of transmission lines and compatible transmission equipment.

Electric power supply for railway stations

In each designed railway station Niš Sever, Pantelej and Vrezina, it is planned to build a 10/0,4kV substation with the appropriate power and 10kV connecting lines. This substation shall provide the power for interlocking and telecommunication devices, external lighting and consumers in the station building. The power supply for switch heaters and back-up supply for interlocking and telecommunication devices shall come from new 25/0.23kV pole-mounted substations with the corresponding power, which are connected to the OCL catenary.

It is planned to dislocate and protect all the overhead and underground power lines which are in collision with the newly-designed route of the Nis railway bypass.

3.2.4 Station interlocking systems and devices

The preliminary design deals with the methods of securing the new and reconstructing the security of current railway stations and inter-station distances in the area of the Nis bypass, in compliance with the CENELEC EN 50126, EN 50128 and EN 50129 standards for the operation in the 25kV, 50 Hz electric traction system. Technical design provides for the equipment of new stations with interlocking devices with the electronic signal box and interstation distances with secured devices of the centralized automatic line block, that is, the interstation dependence, reconstruction of the current interlocking devices, and the fitting of ETCS level 1 devices, is as follows:

- In the new stations Niš Sever, Pantelej and Vrezina it is planned to fit centralized station interlocking devices with electronic signal boxes
- As the Prosek turnout point has not been occupied, the design provides that the train dispatcher in the Vrezina station shall manage the interlocking devices and switches of the turnout point (itineraries). For connecting the interlocking devices in the Vrezina station with the remote safety control of external elements on the Prosek turnout point, a 2-fibre optic cable along the rail shall be used for interlocking devices
- The security of the interstation distances between Trupale-Niš Sever, Niš Ranžirna-Niš Sever and Niš Sever-Pantelej shall be conducted within the central automatic line block system

- The security of the interstation distances between Niš Sever-Crveni Krst and Crveni Krst-Pantelej shall be conducted within the interstation dependence system
- The interlocking devices on the bypass railway shall be included into the existing traffic telecontrol system headquartered in Nis
- The installation of the level 1 European train control system (ETCS).

The design provides for the equipment of the Niš Sever, Pantelej and Vrezina stations with new interlocking devices with electronic signal boxes and central placement of switches and automatic routing of itineraries through the station area and the elements of the level 1 ETCS system.

The Niš Sever station shall be equipped with major light railroad signals for incoming and outgoing trains in the direction of Trupale, Niš Ranžirna, Crveni Krst and Pantelej stations. Section control in the station area and interstation distances shall be conducted using electronic axle counters with an arrangement that fully ensures the control of all elements participating in the assigned itinerary.

The Pantelej station shall be equipped with major light railroad signals for incoming and outgoing trains in the direction of Niš Sever, Crveni Krst and Vrezina. The interstation distances Niš Sever-Pantelej and Pantelej-Vrezina shall be equipped with devices of the central automatic line block for conducting traffic in interstation distances by installing the necessary external equipment. The interstation distance Crveni Krst-Pantelej shall be equipped with devices of the interstation dependence system, whereas on the interstation distance Pantelej-Matejevac, traffic shall take place at the station spacing (until the Matejevac station is secured with fully centralized interlocking devices). Section control in the station area and secured interstation distances shall be conducted using electronic axle counters with an arrangement that fully ensures the control of all elements participating in the assigned itinerary.

The design provides for the equipment of the Vrezina station with a new interlocking device with electronic signal boxes and central placement of switches and automatic routing of itineraries through the station area which will also manage the remote control of the elements in the Prosek turnout point.

The fitting of the level 1 ETCS system elements is also planned along the bypass railway.

The Vrezina station and the Prosek turnout point shall be equipped with major light railroad signals for incoming and outgoing trains in the direction of Pantelej, Niska Banja and Sićevo. Interstation distances Pantelej-Vrezina and Vrezina-Prosek shall be equipped with devices of the central automatic line block for conducting traffic in interstation distances by installing the necessary external equipment. On the interstation distance Niska Banja-Prosek and Prosek-Sićevo the traffic shall take place at the station spacing (until the Niska Banja and Sićevo stations are secured with fully

centralized interlocking devices). Section control in the station area and on secured interstation distances shall be conducted using electronic axle counters with an arrangement that fully ensures the control of all elements participating in the assigned itinerary.

The new interstation distance Trupale-Niš Sever shall be equipped with the central automatic line block devices with section control using the axle counter. One block (cable cabinet CC-BT1) shall be installed at km.236+411 on railway no.3, that is, there will be two spatial sections OpT1 and OpT2. Instead of the current railhead and impedance bond at signal Tu91, a STT0 axle counter shall be installed for controlling the OpT1 spatial section. In order to control the OpT1 and OpT2 spatial sections in the Trupale station, an internal device shall be installed for controlling the occupancy of OpT1 and OpT2 spatial sections. A three step motor relay shall be installed to control the section towards the Nis Sever station as another internal device, and the current control benchboard shall be rearranged in accordance with the arrangement of new block points on the Trupale-Niš Sever interstation distance.

In order to achieve communication between electronic signal box devices in the Nis Sever station and the SpDrS-64 JŽ device in the Trupale station, a dislocated controller of external elements (FEC) shall be installed in the Trupale station with the central computer unit having a „2 out of 3“ configuration, with I/O modules towards relay interface. Two relay interface units shall also be installed in the Trupale station.

The new interstation distance Niš Ranžirna-Niš Sever shall be equipped with the central automatic line block devices with section control using the axle counter. One block (cable cabinet CC-BA1) shall be installed at km.1+528 on the bypass railway. In order to control the OpA1 and OpA2 spatial sections in the Nis Ranzirna station, an internal device shall be installed for controlling the occupancy of OpA1 and OpA2 spatial sections.

Based on the new condition of the tracks of the Nis Ranzirna station and new interstation distances, the design provides for the following in the Nis Ranzirna station:

- disassembly, repair and reassembly on the new location of entrance signal from the side of Trupale (Vu92),
- installation of the new entrance signal from the side of Nis Sever (Au91), and presignalling repeater (PPAu91) as the entrance signal does not have the required visibility distance
- disassembly of the electronic signal boxes for 6 switches (no. 2, 3, 4, 7, L1, L2) and reassembly of the 4 signalling boxes for switches on new locations (no. 3, 4, 4a and 7) according to the new condition of the tracks in the station
- disassembly of manoeuvre signals MV1, MV2, MV3, MV4 and MV6, their repair and reassembly on new locations

- supply and installation of new electric signal boxes for new switches OP1 and OP2
- installation of appropriate elements for the station section control per new condition of the tracks in the station (railheads, insulated joints)
- placing a part of the new cable network for new security elements
- rearrangement of the current control benchboard
- installation of new relay groups, disassembling a part of current relay groups and additional wiring of the relay device per new diagram for relay group connection
- installation of a dislocated controller of external elements (FEC) with the central computer unit having a „2 out of 3“ configuration, with I/O modules towards relay interface used to communicate with the electronic signal box in the Nis Sever station
- installation of the adjustable interface for interdependent station line block of the electronic signal box in the Nis Sever station and station line block using SpDrS-64-JŽ technology with a controller (FEC)
- installation of the adjustable interface for reception of data regarding the condition of the block signal from electronic block device in the Nis Sever station and transmission of controls for such signals using a controller (FEC)

In the Traffic Telecontrol Centre the panel and the internal central unit need to be repaired as a result of the new condition of tracks in the Nis railway hub and the bypass railway.

3.2.5 Telecommunication systems and devices

According to the railway bypass construction design, the electrification shall be conducted using the 25 kV/50 Hz system, hence the network of railway and local cables needs to be constructed.

With regard to the data transmission requirements and the current condition of technical support, it is necessary to have optic cables in addition to copper railway cables. Optic cables without metal elements and single-mode fibres shall be fitted.

Local cable networks shall include all the participants in station areas into the railway telecommunication system.

Dispatch systems and railway telephony shall provide connections for traffic regulation and service links.

A radio-dispatch system is designed pursuant to the legal obligation stipulating that all railways with speeds over 100km/h must have a radio-dispatch system.

GSM-R network on the bypass railway is designed based on the requirements set forth in the Terms of Reference.

The new terminals Niš Sever, Pantelej, Vrezina and Prosek are planned to have the following telecommunication systems installed:

- Passenger information system (visual information system, clock system and sound system)
- Station safety system (video surveillance and fire alarm system)
- Local computer network for telecommunication data transmission using the principle of structural cabling with category 6a copper cables with the installation of the necessary active and passive equipment

The computer network in new terminals shall be a part of the structural cabling network. The future computer network between stations shall be established using an optic cable laid along the railway. In each station, four optic fibres shall be laid for telecommunication systems. Optic cables in terminals end in optic termination boxes.

The central device of the clock system shall be the master clock placed in Nis. The information about the exact time shall be „drawn" from the computer network using the NT/AFNOR interface.

According to the expected needs in the stations Niš Sever, Pantelej and Vrezina, the (departure and arrivals) information displays are to be installed.

All the information displays are based on the TFT technology and shall be connected into a single system using the common computer network. For displaying the data on the platform displays, a database with information on train movement shall be used, based on the timetable and database updates (made manually or using the information collected from the remote control centre). The text on the displays in terminals shall be generated from the database located in Nis. On each railway stop platform two-sided platform displays shall be placed.

The designed sound system is intended for the transmission of spoken information about train arrivals and departures. The sound system for the platform shall use sound horns placed on lighting poles or canopies at about 4 m or on the building facade. Horns and externally mounted projectors are flame-proof. Generating messages (made using the VIS), forwarding spoken announcements through the call station in stations Niš Sever, Pantelej and Vrezina and direct forwarding of spoken messages through call microphone station in Nis, the visual information system and the video surveillance system shall be possible after establishing the centre and its

connection to the computer network on the railway section Nis-Dimitrovgrad. There is also an option of local operation, which means each station can announce spoken messages itself.

The video surveillance system in the terminal is there to protect the telecommunication equipment for passenger information, which is placed outside the building, and to track the movement of passengers along platforms. The entire system is based on IP technology and devices. Outdoor cameras are fixed Day/Night cameras mounted on the lighting poles or canopies placed at around 4 m from the ground level. Cameras are installed as part of the common communication U/FTP networks and cat 6a cables.

The central device of the automatic fire alarm system is a fire alarm central unit with a single addressable loop which connects detectors and modules inside the building. The central unit is connected to the telephone machine for remote alarm and error signalling. The central unit is in the train dispatcher's room.

3.2.6 Organization of works and execution technology

The execution of works given in this Preliminary Design shall take place in 5 phases as outlined in the Design on organization and technology of works.

Phase 1 is the most comprehensive one and includes all the works that can be executed without affecting the operation of rail traffic within the Nis railway hub.

Phase 1 includes:

- SUBSECTION 1 – Reconstruction of railway no. 3, Trupale - Niš Sever (km 0+200 - km1+500), L=1300m
- SUBSECTION 2 – Bypass railway, Niš Ranžirna - Niš Sever (km 1+300 - km2+400), L=1100m
- SUBSECTION 3 - Bypass railway, in st. Niš Sever (km2+400-km3+500), L=1100m, tracks which are not part of railways no. 3 and 17
- SUBSECTION 4 - Bypass railway km4+450-km5+000, L=550m
- SUBSECTION 5 - Bypass railway km6+700-km7+400, L=700m
- SUBSECTION 6 - Bypass railway km8+650-km9+400, L=750m and part of railway no. 38 in the length of 700m
- SUBSECTION 7 - Bypass railway km9+400 - km19+100, with Vrezina station
- SUBSECTION 8 – PROSEK

On subsections 1 to 6 the works on the railway substructure and superstructure shall be executed alternately (section by section), whereas multiple simultaneous targeted locations (parallel execution) are planned for larger concrete works (bridges, overpasses, retaining walls) which require longer construction time in technological terms as this time is thus shortened.

Phase 1 allows for the works to be executed in such a way so as to keep the road and rail traffic in operation as long as possible (railways no. 3, 17, 30, 38 and 22).

Subsections 7 and 8 are to be executed alternately with parallel work execution on sections 1-6.

Phases 2 to 5 require the termination of traffic on particular railway lines for the execution of works.

Phase 2 provides for the works on Subsection 9, Niš Sever – fitting towards the Crveni Krst station:

- Works on Niš Sever station completion (km3+500-km3+870)
- Works on railway bypass construction (km 3+870-km 4+450)
- Reconstruction of railway no. 3 in the length of about 850m
- Reconstruction of railway no. 17 in the length of about 580m
- Fitting into the current condition of the railway no. 3 from Crveni Krst to Trupale
- Fitting into the current condition of the railway no. 17 to Crveni Krst

In the course of work execution within Phase 2, the rail traffic from railway no. 3 shall be redirected to railway 30 and terminated on railway 17.

Phase 3 provides for works on Subsection 10, stations Niš Ranžirna and Niš Sever:

- the Niš Sever station
- the Niš Ranžirna station
- Reconstruction of railway no. 30
- Reconstruction of bypass railway from km 0+000 to km 1+300

In the course of work execution within Phase 3, the rail traffic from railway no. 30 shall be redirected to the reconstructed railway 3.

Phase 4 provides for works on Subsection 11, part of railway Crveni krst - Pantelej and part of the station Pantelej:

- Part of bypass railway and railway no. 38 from km 5+000 to km 6+700
- Part of bypass railway and railway no. 38 from km 7+400 to km 8+650
- Pantelej station.

In the course of work execution within Phase 4 traffic shall be terminated on railway no. 38

Phase 5 provides for works on Subsection 12, bypass railway from Km 19+100 to km 19+450:

- Prosek turnout
- Road L=200
- Temporary road crossing

- Fitting of bypass railway into railway no. 22 at km 20+000

In Phase 5, traffic will be terminated on the railway no. 22.

On open railway sections, depending on the scheduled works (substructure and superstructure), the works shall be executed using conventional construction machinery.

Selection of locations for material stockpiling

Rails are stored in the intertrack space for subsequent haulage in the way which does not interfere with the works and traffic in stations where piles of material to be placed have been formed.

Crushed stone aggregate is stored in a pyramidal shape with a slope gradient of 1:1.5 and is loaded into Fad trains using loaders. Once the stockpiling space is emptied, the pile may be replenished.

In phase 1, traffic shall be in operation on all lines, therefore it is most convenient to deliver the material to the location of its placement by rail.

In the Niš-Ranžirna station, there is a loading/unloading ramp and a track making this station suitable for the storage of bulk materials.

The plateau intended for the construction of the Nis-Sever station and in the Pantelej station, piles of gravel and crushed stone aggregate may be formed, as well as piles of new sleepers and dismantled (“old”) sleepers and rails.

The material from the cut obtained during the construction of the Nis Sever station is suitable for embankment construction in the Pantelej station and may be transported by rail.

A temporary pile of earth may be formed in the Niš Sever station at km 3+000 (chainage of bypass line) on the south side. In the Pantelej station, a temporary stock pile can be placed at km 6+800.

In phase 2, the stockpile may be placed between the bypass rail and lines 3 and 17 at km 4+550 (chainage of bypass line).

In phase 3, the stockpile can be formed at the exit from the Niš Ranžirna station, outside the Popovac settlement, at km 1+000 (chainage of bypass line) and km 236+800 (chainage of current line 30).

In phase 4, the material from the cut goes into the embankment together with the material stockpiled in the Pantelej station and the material from the excavation in the Nis Sever station.

All the mentioned stockpiles of materials for the substructure and the superstructure and a construction site shall be temporary.

Material stockpiles, as they are located near construction sites, or the terminals within Railways of Serbia, shall be under constant surveillance.

On completing the works on the entire "structure" and removing temporary stockpiles and a temporary construction site, the affected areas must undergo planning and landscaping.

The selection of the location for stockpiling all materials depends on: general distribution of works (phases, sections, subsections), the approved direction of works advancement, the intended technology for the execution of some works, the possibility of using vacant stockpiling areas on the railway land, the possibility to temporary use particular station tracks for material handling (unloading, loading, storage), time during which the material must be piled on the construction site (all of it before the commencement of works, or successive delivery or shipment per advancement of works), etc. The exact location of stockpiles, types, quantities and the period of material stockpiling shall be defined through Execution design for construction organization and technology.

Supply of resources

For the Investor, it is important to ship the materials to the construction site by rail to the extent possible in order to reduce construction costs. It has been generally agreed to purchase all the necessary resources in Serbia from local manufacturers provided they meet the requirements regarding quality, quantities and deadlines for delivery.

Substructure materials

Among the materials for the construction of the embankment substructure, the material **(cohesive material)** and **blanket construction material (granulated gravel)** is needed. They must conform to the requirements set forth in the construction design and Technical Specifications in all things.

Regarding **blanket construction material**, such material is available from several locations (gravel pits along the Velika Morava river, gravel pits along the Nišava river). These locations, i.e. gravel pits meet the requirements with regard to quality and necessary quantities.

Crushed stone aggregate 0/31.5 can be obtained from quarries around Niš.

PVC drainage pipes Ø150 for constructing drainage systems in the stations and on the open railway, which are used for draining stations, the railway and road crossings, are of appropriate length and quality, can be purchased from local manufacturers (Aranđelovac, Belgrade, Niš, etc.).

Prefabricated concrete pipes Ø1000 and prefabricated conical ends for the inspection chamber, other concrete pipes used for sanitary and storm sewer, and drain pipes, may also be purchased from local manufacturers of concrete products (Stalać, Lapovo, Čačak, Niš). This is also the case with metal lids with a frame for inspection chambers.

Superstructure materials

The design calls for the use of 49E1 type rails. This rail type is not manufactured in Serbia or its immediate vicinity. Well-known European manufacturers – suppliers of standard rail types are Austria, the Czech Republic and Poland.

Concrete sleepers. TOR calls for the use of concrete and wooden sleepers. In Serbia, concrete sleepers are manufactured by factories in Stalać and Svrljig, and Vinkovci in its immediate neighbourhood. Wooden sleepers are produced in Ćićevac.

Elastic fastening equipment for concrete sleepers is planned in the TOR for the entire section. The exact type of fastening equipment and the manufacturer or supplier thereof shall be identified after the bidding procedure for the most favourable supplier.

Switches. This is the purchase of complete switches on concrete sleepers with elastic fastening equipment. The prospective (a long time) railroad switch manufacturer is in Nis, but the final choice is conditioned by the possibility to deliver the entire switch on concrete sleepers with elastic fastening equipment.

The design calls for the use of **igneous aggregate rock** on the entire railway section. At the moment, prospective suppliers that have plants for producing required fractions of igneous crushed stone for placement in the railway ballast are located in: Ledinci, Ljubovija, Raška, Dimitrovgrad, and quarries on mount Divčibare and Rudnik. Where the Contractor will decide to get his supplies from shall depend on cost-effectiveness.

The manufacturers of igneous aggregate rock that do not have an immediate rail connection, require truck haulage from the place of manufacture to the nearest railway station where the material shall be reloaded or temporarily piled and loaded onto special FAD trains. Transporting aggregate by rail from the locations of considerably remote suppliers (Ledinci, Ljubovija, Raška, Divčibare, etc.), can be complicated and difficult as the locomotive traction type needs to be changed along the way, which results in a long delivery period from the manufacturer to the placement site.

AT welds. All the material required for aluminothermic welding of the 49E1 type rails and switches, may be purchased from qualified local suppliers (Smederevo, Šabac) and numerous European manufacturers.

Railway equipment. Kilometre, hectometre and curve sign boards, railway grade signs, etc. can be made at the construction site by the Contractor, or purchased from other suppliers pursuant to railway standards.

Operational power supply

Diesel. The most significant fuel source necessary for the operation of the railway and construction machinery – diesel, can be purchased in sufficient quantities in Nis and settlements along and near the design railway route.

Electricity. Connecting to the electric power grid, mostly for the purpose of power supply for buildings and lighting provision on the temporary construction site or the stockpiles, is possible in both current railway stations and along the route of the newly-designed railway as the route goes through the urban and populated part of the city of Nis after prior checks and the consent from the railway and the competent electric power distribution organization.

Short-list proposal of construction works machinery

1. For substructure works

Position: Roadbed construction

- Loader
- Truck
- Bulldozer
- Road grader
- Tank truck
- Sheepsfoot roller
- Vibrating roller

Position: Machine-operated excavation in roadbed

- Excavator
- Bulldozer

Position: Planning and rolling of subsoil

- Sheepsfoot roller
- Tank truck

2. Short-list proposal of superstructure machinery

Position: track placement

- Crane for track replacement
- Universal two-way excavator
- Locomotive
- Flatbed wagon
- Winding machine

Position: Placement of railroad switches

- Universal two-way excavator
- Locomotive
- Flatbed wagon
- Winding machine

Position: Aggregate unloading and placement

- Locomotive
- Hopper dozator
- Wagon dumper
- Plow

Temporary construction site

The final arrangement of the construction site components, both residential and industrial, as well as the arrangement of buildings will be set by the Contractor, and it is advised for these to be in the area of the Nis-Sever and Vrezina stations.

The station area in which the blanket material, aggregate, and superstructure materials are to be stockpiled belong to the railway company, therefore the lease or expropriation of these areas is not necessary.

According to local laws and regulations, the Contractor shall, before the commencement of works, draft the "Study of construction site planning" and have it approved and accepted by the relevant authorities and the Railway company. This study shall detail the conditions of construction and the planning of the temporary construction.

Railway machinery and the work train shall be located at end tracks in the Niš Ranžirna, Crveni krst, Trupale, or Prosek stations, according to the phase of execution in progress.

Conventional construction machines shall be kept in the immediate vicinity of the current place of work or on the temporary construction sites in stations, from where it is convenient to arrive to the place of work.

For installing the concrete mixing plant on the construction site, the minimum required flat area should be 30x30m. If there is insufficient free space in the area of temporary construction sites for doing so, the Contractor must haul fresh concrete to the site.

Due to the linear nature of the structure, "movable service workshops", i.e. road vehicles shall be used for the maintenance of machinery. For major faults, the repairs shall be made in the Contractor's specialized workshops.

Portable laboratories shall be used primarily for checking the quality of executed works (compaction and deformation modulus for the subgrade and top course of the railway formation, an ultrasound for AT welds) and temporary quality checks performed of supplied materials (grain composition of the blanket course material and aggregate).

Temporary settlements

For the construction site staff, depending on the demands, manner and the habits of each Contractor, the necessary accommodation space is provided for housing and catering day-to-day needs of employees and managers.

The most convenient place for accommodation as provided by the Contractor in the form of containers is in the Nis Sever station, which has all the facilities for day-to-day human life (shopping, healthcare, entertainment, culture) allowing the employees to be near the place of work execution in both phases.

There is also a possibility of putting up workers and managers in hotels, hostels or private apartments in Nis.

3.3 Types and quantities of necessary construction resources

3.3.1 Types of necessary materials

For the reconstruction and construction of the railway and accompanying structures the following materials are required:

- natural gravel,
- gravel and sand material,
- stone of various particle size,
- sand,
- earth,
- steel for rails, poles for noise barrier walls and the reinforcement;
- concrete for sleepers and other concrete structures (and concrete admixtures);
- iron for fastenings,
- cement,
- bituminous aggregate, asphalt concrete for the pavement structure on driveways to road crossings and station buildings
- electric power necessary for the construction and electrification of the railway line;
- diesel for machinery operation;
- water and other ancillary materials (not placed into the structure).

3.3.2 Quantities of necessary materials

According to the Preliminary Design data the following quantities of material shall be used for the superstructure:

Quantity of materials for railway superstructure

- steel for different rail types: 4,545 tons;
- concrete sleepers: 59,692 pcs;
- wooden sleepers: 3,240 pcs;
- igneous aggregate: 74,446 m3;
- steel for switches and intersections: 714 tons;
- track fastening equipment: 52,932 sets;

Quantity of materials for railway substructure

- excavation of material: 544,572 m3;
- material for roadbed embankment: 348,437 m3;
- material for transition layer (145,591 m3) and blanket layer (73,588 m3);
- geogrid: 13,354 m2;
- material enhancing bearing capacity: 2,826 m3;

Quantity of materials for railway dewatering

- inspection chambers: 224 pcs;
- drain pipes: 8,724 m';
- concrete elements for canal lining: 27,130 m^2

Quantity of material for building construction in terminals

- concrete for buildings: 573.38 m^3;
- reinforcement: 43,602.00 kg;
- blanket course gravel: 109.82 m^3
- hollow clay block laying d=20cm: 220.13 m^3
- full brick laying d=12cm: 76.02 m^2
- facing brick laying d=12cm: 913.72 m^2
- wall plastering: 1,861.13 m^2
- base cement screed: 813.53 m^2
- waterproofing : 1,635.28 m^2
- thermal insulation: 2,018.29 m^2
- façade thermal insulation: 1,109.87 m^2
- ceramic tile laying : 800.35 m^2
- laying ceramic skirting : 569.43 m^1
- structure carpentry : 558.77 m^2

- board laying carpentry: 609.08 m^2
- sheet-metal works roofing: 771.56 m^2
- sheet-metal works gutters : 109.96 m^1
- sheet-metal works - hemming: 170.86 m^2
- painting: 3,100.4 m^2
- façade works - bavalite: 288.7 m^2
- elevated antistatic floor: 150.83 m^2
- metalwork:142.47 m^2
- façade aluminium joinery: 429.4 m^2

Quantity of materials for platforms with canopies

- concrete for platform and retaining walls: 521.82 m^3;
- reinforcement for platform and retaining walls: 46,738.00 kg;
- boards for platform pavement: 4,678.85 m^2
- steel for canopies: 52,074 kg;
- reinforcement for canopies: 1,793.00 kg;

Quantity of materials for underpasses construction in stations

- gravel for the blanket course and gravel wedges : 183.45 m^3;
- non-reinforced concrete: 276.2 m^3;
- concrete for bottom slabs for the underpass, walls and top slabs: 1,152.21 m^3;
- imprinted concrete finish for floors and walls: 952.20 m^2
- reinforcement : 208,903.00 kg;
- waterproofing: 2,724.09 m^2
- painting : 813.58 m^2
- façade works – imprinted concrete : 223.61 m^2
- façade works – cleave bricks d=3 cm: 158.91 m^2
- cover slabs – imprinted concrete: 216.42 m^1
- handrail placement on underpass staircase 150.36 m^1
- steel for underpass canopies: 6,099.00 kg;

Quantity of materials for hydrotechnical works

- sandy gravel: 83.10 m^3;
- crushed stone : 0.80 m^3;
- concrete and reinforced concrete: 50.93 m^3;

Quantity of materials for deviation and access roads

- ***superstructure***
  - Asphalt: 9650 m^2;

- BNS: 9650 m^2;

- ***substructure***

  - excavation of material : 780 m^3;
  - excavation of material (earth) for embankment: 26,210 m^3;
  - material for embankment construction: 26,990m^3;
  - stone material of different grain size: 5,038 m^3

Quantity of materials for noise barrier construction

- stone aggregate for noise barrier construction: 84.8 m3;
- concrete for construction of 517 pcs of prefabricated concrete foundations: 596.89 m3;
- concrete for construction of 509 prefabricated AB planks: 110.86 m3;
- steel for construction of prefabricated steel poles: 85,576 kg;
- absorptive planks 3,609 pcs.

These quantities shall be increased if it proves necessary that the number of locations with noise barriers should be higher (than 11 locations provided for in the Preliminary Design).

Quantity of materials for the construction of bridges, underpasses and overpasses

- Concrete and reinforced concrete: 16,288.79m^3
- Reinforcement: 1,385,816.00 kg
- Prestressing tendons: 4,074.24kg
- Barriers (pedestrian, wire, safety): 3,109.40m'
- Waterproofing: 18,154.33m^2
- Hydrophobic coating: 16,832.34 m^2

Quantity of materials for culverts

- Gravel: 1,237.26m^3
- Concrete and reinforced concrete: 638.08m^3
- Reinforcement: 33,093.46kg
- Waterproofing: 1,033.87m^2

Quantity of materials for retaining walls

- Concrete and reinforced concrete: 13,088.37m^3
- Reinforcement: 887,0570.88kg
- Micropiles (concrete and steel): 553,234.49m'

Quantity of materials for watercourse regulation

According to the Preliminary Design the following quantities of materials are necessary for watercourse regulation:

- excavation of earth: 6,200 m^3;
- sandy gravel material: 780 m^3;
- crushed stone: 1,200 m^3;
- concrete and reinforced concrete: 1,560 m^3;

Quantity of fuel for material, equipment and waste transport

The consumption of fuel for these purposes shall depend on the remoteness of companies – suppliers and the type of transport. If road transport is used, then the 5 ton truck (empty or full) needs 250 l of fuel for the haulage of e.g. 25,000 m^3 to a temporary stockpile within 100 km or from a borrow pit to the place of railway construction.

Necessary water quantities on the construction site

The consumption of water in the construction process (other than the employees' needs) boils down to water consumption for concrete production and curing. As the production of 1 m^3 of concrete requires 150l/m^3 of water, and the total required concrete is 37,572 m^3, this calls for 5,635,800 l of water. Let us assume that concrete curing requires three times as much. Since water is necessary for other construction activities, this quantity has been increased by 40%.

5.635.800 X 3 X 1.4 = 23.670.360 l of water.

3.4 Emission types and quantities

Types and quantities of waste in the construction phase

Types of waste

Reconstruction and modernization of railway implies the generation of considerable quantities of different types of waste, such as:

- contaminated ballast material (aggregate);
- excavated earth material;
- timber (sleepers, poles, pieces of demolished buildings, etc.);
- metal waste (rails, splinters, pieces of fittings, pipes, etc.);

- rubble (pieces of construction material);
- used and spilt hazardous substances (oils, liquid fuels, etc.);
- packaging (plastic, wooden pallets, glass, foil, cardboard, paper, wood chips);
- battery acid;
- coolants;
- various plastic materials (waste from equipment);
- waste vegetation (felled tree, shrubbery, etc.);
- waste gases generated in the course of operation of construction machinery;
- wastewater (oiled rainwater from access roads, locations for fuel and oil decanting, locations for rolling stock and machinery repair and oiling, platforms, parking lots and other areas in the railway belt or the station compound);
- faecal and sanitary wastewater from temporary dwellings (containers and trailers for employee accommodation and communal kitchens, pit toilets, cafeterias, etc.)
- industrial wastewater from the welding ground within the station compound and the station belt, the washing ground for rolling stock, spots for equipment assembly, spots for construction material mixing, wastewater from washing out and testing waterproofing, etc.;
- material spilt in the course of construction;
- waste generated in the course of material stockpiling;

Quantity of materials as a result of demolition

The first thing to do is to clear out the surrounding area from shrubs, bushes and trees and haul them out of the construction work zone. Tree branches should be cut, trunks and massive branches cut in length suitable for hauling, roots and stumps dug out and the braches, trunks and stumps hauled within 5 km of the construction work zone.

Topsoiling usually accompanies the removal of the existing crushed stone. It is done using the grader scoop if topsoiling is carried out from the top or using an excavator (for embankments lower than 2m).

The removed crushed stone is hauled to the landfill. The location of this landfill is provided in the Main Design. If based on the nature of waste, it is determined that

some parts of the crushed stone classify as dangerous (contaminated with oils, fats, herbicide, heavy metals), allow for their further disposal.

Dismantling the existing track includes the dismantling of the track and counter rails on road crossings with their loading, hauling of up to 10 km, unloading, dismantling and piling according to the type and degree of usability.

Dismantling of the existing switches includes the dismantling of switches, loading of entire material (metal parts, switch parts), hauling up to 1 km (within the construction site), unloading and their storage.

In stations there are some buildings made of solid materials planned to be demolished (deserted houses, huts, guard shacks, bunkers, etc.). The existing platform in all stations shall be demolished before the removal of the current track. In construction of culverts and retaining walls, the existing building is to be demolished first.

All the construction waste shall be deposited on the location set forth in the Main Design and be classified according to the degree of usability, as they might be fitted on other locations in the future. The landfill for construction waste must be within the cadastral parcel owned by the Main Contractor.

Emissions of pollutants

Transport of material and equipment in the construction area and other remote locations (landfills, borrow pits, equipment manufacturing plants) contribute to the emission of dust and fumes.

The operation of construction machinery also contributes to such emissions. The emission of pollutants that have a longer retention time in the atmosphere, are products of fossil fuel combustion in motor vehicle aggregates. Although vehicles expel around 200 different substances through exhaust fumes, only the ones legally sanctioned and whose content in the environment is monitored, are analysed.

Regarding construction machinery and equipment, four-stroke and two-stroke internal combustion engines are used. On the construction site unpaved roads that are a source of dust and suspended particle emission, there are no emissions typical of pavement wear (hydrocarbons, metals, etc.). According to EMEP/CORINAIR-1997 methodology the following are the most significant factors affecting the air pollutant emission:

- vehicle/machinery engine type;
- engine power;
- fuel consumption per power unit;
- capacity of vehicles/machinery;

- age of engine.

Table 29: Specific emissions for construction equipment and machinery [g/kg of fuel]

Type of engine	Working environ-ment	NOx	NM-VOC	CH_4	CO	NH_3	N_2O	PM_{10}	$PM_{2,5}$
Diesel	Land	48.8	7.08	0.17	15.8	0.007	1.30	2.29	2.15
	Water	42.5	4.72	0.18	10.9	0.007	1.29	4.12	3.87
Petrol (two-stroke)	Land	2.10	602	6.00	1103	0.004	0.02	-	-
	Water	2.67	505	5.06	892	0.004	0.02	-	-
Petrol (four-stroke)	Earth	9.61	43.4	2.17	1193	0.005	0.08	-	-
	Water	9.70	34.4	1.72	1022	0.005	0.08	-	-

Emissions as a result of traffic on the motorway and state roads on the given section depend on several factors, majority of which cannot be identified at this level of analysis, these being: the age of the road, the condition of individual engines and evaporating emissions, vehicles with different engine types and fuel consumption, etc. However, the most significant factor for defining the emissions made by air polluters is the vehicle travelling speed, i.e. road conditions and road structure, and the share of different type of vehicles. The emissions of pollutants from road traffic were given in *Table 30* by fuel type using the COPERT 4 methodology:

Table 30: Specific emissions for vehicles in road traffic [g/kg of fuel]

Category	Fuel	CO	NOx	NM-VOC	CH_4	PM_{10}	CO_2
PA	petrol	221.70	28.39	34.41	1.99	0.00	2720
	diesel	12.66	11.68	3.73	0.12	4.95	3090
LTV	petrol	305.63	26.58	32.61	1.51	0.00	2590
	diesel	15.94	20.06	1.08	0.08	4.67	3090
TTV	diesel	11.54	38.34	6.05	0.34	2.64	3090
BUS	diesel	10.61	42.02	5.75	0.44	2.24	3090

Diesel engines expel numerous hydrocarbons and their products such as cancerogenic aromatic polycyclic hydrocarbons through exhaust fumes.

Exhaust fumes also contain lead and halogenic compounds (50% Pb, 15% Br and 10% Cl) as well as 1-6% Fe, 1-2% Sn and around 9% C.

Fuel consumption depends on the speed of vehicle movement and engine type (PREECE, ECE, EURO), volume and the engine operating mode (temperature), evaporative emissions and working environment temperature. The content of sulphur in fuel depends on the added agents and fuel manufacturing technologies, although its considerable reduction is to be expected in the future. Hence the emissions of SO_2 as a considerable pollutant would decrease (from current content of 500 mg/kg to just 30 mg/kg)

Noise emission

In the construction phase, the noise from construction equipment and machinery will be generated. Table 31 shows the expected noise levels.

Table 31: Noise levels generated by the use of construction machinery

Source of noise	Noise at 16 m from the source dB(A)	Noise at 16 m from the source dB (calculated) in dB(A)
Compressor	87	111
Roadheader	81	105
Truck – Concrete mixer	85	109
Concrete pump	70	94
Concrete vibrator	77	101
Cranes - mobile	81	105
Dampers	83	107
Generator	Not taken into consideration	75
Hammer pounding	86	110

Pneumatic hammer	88	112
Pile driver	100	124
Circular saw	80	104

Source: www.gvrd.bc.ca/education/pdf04/ColumbiaWorkshop1-ConstructionNoise.pdf

For some construction machines (gauge (rollers), loaders, concrete mixers, cranes, vibrators, motor saws) the prescribed limit is 75 *dB(A)*.

Emissions from project operations

In the course of regular railway traffic on the Nis bypass the following emissions will occur:

- noise and vibration,
- non-ionizing radiation;
- municipal solid waste and municipal waste water from exploitation of station buildings;
- dangerous substances used for weeding the railway;
- light energy;

Emissions of noise and vibration

Intensified traffic shall contribute to the noise and vibration levels through:

- greater traffic volume (more frequent trains);
- altered network structure,
- higher speeds of rolling stock,
- stricter network maintenance (e.g. frequent rail drilling);
- intensified network utilisation;
- heavier trains;
- new buildings;
- new signalling system.

As the current passenger train speeds range from 20 km/h (noise levels per 25 m – 55dB(A) by day and 53.7dB(A) by night) to 100km/h (noise levels – 68.5 dB(A) by day and 68.2 dB(A) by night) on particular railway sections, it is clear that the increase of train speed to max 160 km/h will considerably contribute to the increase of noise and vibration levels in the course of new railway utilisation, which is an important negative impact.

Intensified traffic, heavier trains and greater train speeds shall contribute to the increase of vibration levels in the railway belt.

On the other hand, the placement of appropriate rail fastening equipment shall contribute to the mitigation of the said vibration impact on residential buildings within 25m of the railway.

Emissions of non-ionizing radiation

The OCL electric field power on a single-track railway at a 2m distance (minimum distance in which the maintenance staff body parts can be found during OCL maintenance) is : E_{2m} = 3,43 kV/m< 5 kV/m which is less than the recommended minimum value for people in 24 hours a day.

Magnetic induction value is 0.07 mT < 0.5 mT, which means that this value in points available to staff and passengers is below the allowed limit.

Emissions of waste matter

In the course of day-to-day railway utilisation, greater quantities of waste matter are to be expected due to:

- greater passenger flow in stations (affects the increase of garbage, sanitary and faecal waste waters in the station and trains);
- utilisation of new buildings wherein the waste is generated.

It has been estimated that:

- the increased number of passengers impacts the generation of the following additional quantities of municipal solid waste: no. of passengers X 0.4 kg;
- the increased freight impacts the generation of the following additional quantities of municipal solid waste: freight (t) X 0.025 (2.5%).

Emissions resulting from chemical treatment of vegetation on the railway route

According to data obtained from PE „Railways of Serbia“ chemical treatment is carried out using three types of herbicide solutions (in optimal water quantities) -Grifol and Atrazin; Herbisan and Herbisan and Titan.

The procedure shall be conducted using the overhauled chemical train equipped with modern sprinkling system. The best treatment results are obtained at chemical train speeds of 30 km/h and 40 km/h.

These herbicides pollute the crushed stone on the railway route.

3.5 Technologies of waste treatment

The objectives of proper waste management are as follows:

- Prevention and reduction of waste generation
- Reuse of materials and instruments
- Recycling and regeneration of materials and instruments
- Material processing to obtain energy
- Safe and sanitary disposal of waste

The implementation of this project will yield a greater quantity of construction waste, namely: sleepers, fastening equipment, rails and switch installations steel parts, prefabricated type platform elements, and OCL poles. According to the needs of PE „Railways of Serbia“, a part of this waste is to be recovered, after which it shall be placed in tracks of lower rank (other than prefabricated type platform elements which do not need to be recovered before being fitted on other locations), which is an optimal way to solve the problem of solid waste.

Recycling construction waste obtained in the course of reconstruction and modernization of railway includes the removal of materials from the existing railway, its collection and treatment with possible addition of new materials for the purpose of reinstallment. To that end, temporary landfills for construction waste should be created in construction work areas, which will be closed and restored after the completion of works. The locations for such temporary landfills will be set forth in the Main Design.

In railway reconstruction and modernization projects, special attention should be paid to the treatment of replaced crushed stone. The replaced ballast material shall be removed from the construction site and disposed of in locations of proper capacity which enable the protection of surrounding areas before it is reused or hauled.

Among other things, it is necessary to determine whether weed protection in the ballast material was conducted using herbicide. If so, the locations for disposal must be additionally protected from the penetration of such ingredients into soil and water, and such ballast material should be cleaned before its reuse. If the Beneficiary has already treated the ballast with herbicide used in fruit cultivation and agriculture in diluted form, additional safety measures are not necessary.

The replaced wooden sleepers may be full of heavy, creosote oils (creosote was used as a wood preservative for decades to maintain its required age, and it contains toxic chemical compounds including polycyclic aromatic hydrocarbons (PAH). Some of

these are hazardous to human health as cancerogenic (creosote is classified as potentially carcinogenic), and therefore must be disposed of on special locations confirmed by the Beneficiary before being reused on secondary railways or hauled to the location of incineration, which is to be performed using a strictly controlled procedure.

Only heavily corroded fastening equipment and rails may have negative effects on the environment. There are two options: to explore the ways for their reuse on lower ranked railways or haul them to the nearest plant for steel treatment and its transformation into scrap iron.

4 Overview of the Main Alternatives Considered by the Main Contractor

4.1 Analysis of Alternative Solutions

Five potential alternative solutions were considered within the Final Design during the previous phase of design. The proposed "Variant 4a optimized" was adopted at the session of the Audit Commission for the Professional Control of Technical Documentation of the Ministry of Construction, Transport and Infrastructure of the Republic of Serbia, held on 10 December 2015.

Having in mind the Measure defined within the RRK Report, for the next phase of drafting the technical documentation, the Preliminary Design, to implement a comparison of alternatives and a selection of the optimum route alternative by using multi-criteria evaluation of the considered alternative solutions, the decision was made for the Preliminary Design to implement evaluations for the two realistic alternative solutions for the route, as considered in the Final Design, namely "Variant 1" and "Variant 4a optimized".

The Final Design proposed four alternative solutions for the bypass railway route.

The position of the ***bypass railway*** route was determined by the Detailed Regulation Plan of the Nis-Dimitrovgrad railway, section Crveni Krst – Prosek, within the corridor of highway E-80 in Nis (adopted in 2009). Alternative solutions differ in the part not encompassed by the DRP, namely: section from the Nis Marshalling Yard and the Trupale station, to the new station Nis Sever and the sections from Prosek to the entrance to the Sicevo station.

Image 42: Variants 1 and 4a

4.2 Method, Goals, Criteria and Indicators for Evaluation

Multi-Criteria Compromise Ranking was applied (VIKOR method).

The main characteristic of the VIKOR method is the multi-criteria ranking of alternative solutions for the given values of criterion functions.

The first and key step in the process of evaluating alternative solutions is defining the goals, criteria and indicators, and their relative weights.

The following goals have been adopted for this survey:

1. **Minimum costs of construction**
2. **Minimum costs of maintenance**
3. **Minimum spatial impact**
4. **Minimum environmental impact**

The selection of criteria and their partial share (relative weight) in the evaluation was performed based on domestic and foreign experiences in implementing similar surveys of design documentation and the specific nature of the survey area, as well as surveys establishing the matrix of weights, i.e. the importance of each goal, criterion and indicator, respecting overall knowledge and specific details of the local conditions to the degree that they could have been known during this phase of the survey.

Of particular note is that elements that are the same, or approximately the same for the considered alternative solutions have not been included in the evaluation, i.e. alternative solutions are compered based on their differences.

4.2.1 Minimum Costs of Construction

Based on the evidence sheet, the amount of technical documentation and the realistic prices of items, an assessment was completed for the investment value of the works for the construction of the single-track railway bypass around Nis.

The evaluation of the investment value was completed based on the alternative solutions considered, as well as data from the technical documentation of similar facilities, data processed at the bureau, situation plans and data processed on computer, as well as average prices for this type of work, as per the provided descriptions of items.

4.2.2 Minimum Costs of Maintenance

The costs of maintenance encompass the costs of regular and extraordinary maintenance of the bottom and top layer. The projections of these costs may use estimated values, based on indicators for the amounts of such costs on our railways or on railways in the region, and/or Europe.

The evaluation of the considered alternative solutions adopted the costs to be determined relative to the length of sections of open railway outside bridges, underpasses and tunnels, with the established unit price of annual costs per km to the amount of 20 000.00 €/km ann, as well as the length of sections on bridges, underpasses and tunnels, with the established unit price of annual costs per km to the amount of 8 000,00 €/km ann.

Total annual costs of maintenance:

Table 32:Costs of maintenance for alternative solutions

		Variant 1		**Variant 4a**	
		km	€/year	km	€/year
Railway length		21.79		21.86	
Open railway length	20,000	20.77689	415,537.8	21.41129	428,225.8
Structure length	8,000	1.01311	8,104.88	0.44871	3,589.68
Total			**423,642.68**		**431,815.48**

4.2.3 Minimum Spatial Impact

Minimum spatial impact is expressed through the criterion of consequences for spatial units, collision with the existing and/or planned use of surface areas and collision with technical infrastructure.
The consequences for spatial units are defined by indicators of the length of route through residential and commercial zones, as well as length of route through protected zones.
Collision with the existing and/or planned use of areas is defined by the length of route through residential and commercial zones.
Collision with technical infrastructure is defined by the length of route in collision.
The lengths for the above indicators are determined from the map of planned use of surface areas.

4.2.4 Minimum Environmental Impact

Minimum of environmental impact is expressed through the criteria: noise, vibration, flora and fauna, and occupation of surface. Indicators were determined as per the prepared technical documentation and in accordance with the valid planning documentation.
Indicators for the impact of noise and vibration were defined to be lengths of the route through residential areas and lengths of the route through commercial zones.
The indicator of impact on flora and fauna was determined only on sections of the route not in tunnels, on bridges and underpasses, through forests and protective greenery, i.e. along the length of open railway and stations, without buildings.
Indicators of occupation of surface areas have been determined to be lengths of route through residential zones and lengths of route through protective greenery.

Goal/group of criteria		criteria			indicators						
name	func-tion	name		func-tion	name	unit	function	Wi	V1	V4a	ω
Min construction costs	min	investment		min	Investmenet costs	€	min	0.85	128,935,663.53	72,749,226.90	0.35
					expropriation area	ha	min	0.15	26.65	40.00	
Min maintenance costs	min	Railway maintenance costs (perm.way & substructure)		min	Open rail and station maint. costs (no struc-tures)	€/yr	min	0.5	415,537.80	428,225.80	0.25
					Railway and station maint. costs (bridges, underpasses and tunnels)	€/yr	min	0.5	8,104.88	3,589.68	
Min spatial impact	min	Impact on spatial units	0.45	min	Section length through resi-dent. and busi-ness areas	m’	min	0.6	8,196	8,975	0.23
					Sect.length through pro-tected areas	m’	min	0.4	2,600	2,600	
		Collision with cur-rent or planned pur-pose of the area	0.35	min	Section l. through resi-dent. areas	m’	min	0.75	1,825	2,200	
					Section l. through bus. ar-eas	m’	min	0.25	6,371	6,775	
		Collision with tech.infrastructure	0.2	min	Section l. in col-lision with col-lect. main	m’	min	0.6	1,225	850	
					Sec.l. in colli-sion with gas pipeline	m’	min	0.4	121.98	135.14	
		noise	0.3	min	Sec.l. through res.areas	m’	min	0.6	1,825	2,200	
					Sec.l. through bus. areas	m’	min	0.4	6,371	6,775	
					Sec.l. through res.areas	m’	min	0.6	1,825	2,200	

Goal/group of criteria		criteria			indicators						
name	func-tion	name		func-tion	name	unit	function	Wi	V1	V4a	ω
Min environmental impact	min	vibration	0.25	min	Sec.l. through bus. areas	m’	min	0.4	6,371	6,775	0.17
		flora and fauna	0.15	min	Sec.l (no struc-tures) through forests and pro-tect. greenery	m’	min	1	8,247.89	8,861.29	
		area coverage	0.3	min	Sec.l. through res.areas	m’	min	0.4	1,825	2,200	
					Sec.l through forests and pro-tect. greenery	m’	min	0.6	9,261	9,110	

Table 33:Matrix of criteria

4.3 Conclusion

The results of evaluation using the "VIKOR" method based on the presented criteria indicate that route variant no. 4a, without tunnels, holds a stable first place and advantage compared to route variant no. 1, with a tunnel, and therefore leads to the conclusion that the optimized variant 4a for the construction of the bypass railway around Nis represents the optimum solution.

5 Overview of the State of the Environment on Site and in the Immediate Vicinity

This chapter describes environmental factors that may be exposed to considerable risk of pollution – degradation due to the construction and utilisation of the railway bypass around Nis.

5.1 Population

The survey area is part of the Nisavski county. The bypass railway in question passes through the municipalities Crveni Krst, Pantelej and Niska Banja.

The impact assessment for the single-track bypass railway processed data related to the basic characteristics of the population and their activities, as well as parts of the settlements exposed to impact (positive and negative) due to the construction and utilisation of the railway.

For decades the village has had an isolated and extensive development function, without a clear vision and orientation, leading to its social-economic and territorial marginalization. More favourable living conditions in cities led to the decline of the rural population, aging and demographic deterioration of settlements. The construction stock has poor productivity, lacking infrastructure, with buildings of significant age tending to deteriorate, particularly those built from traditional materials – earth and wood. These new buildings are precisely the representatives of autochthonous rural architecture, some of them under protection, but not revitalized. Some villages show extremely negative demographic growth (Manastir, Koritnik), but have the potential to be revitalized as tourist and weekend settlements.

Considering agricultural production as the primary activity of the rural population, villages have an unbreakable bond with their environment. Private farms encompass approximately 85% of agricultural land. The structure of properties is fragmented, with an average size of 3ha, and/or 2ha of arable land per household. Basic needs are met by engaging in non-specialized production without a clear business or market orientation.

The ownership structure is dominated by private property, comprising 98.1% of the territory. The use structure is dominated by agricultural land at 58.97%, followed by forests and forest land at 23.67%, and construction land with 13.42%.

The uncontrolled spread of urban construction land to areas of agricultural land with high valuation classes is notable, along with the unplanned cutting and clearing of forests and exposure of land to erosion processes, as well as concentration of industrial capacities in Nis.

Municipality of Crveni krst

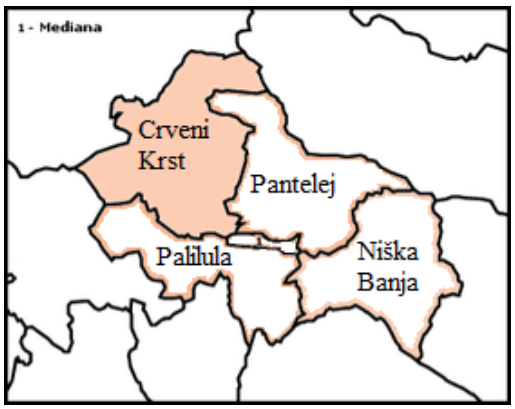

Image 43:Municipality of Crveni Krst

Encompassing nearly a third of the surface area of the City of Nis, UM Crveni Krst encompasses the majority of Nis villages (23), but also the lowest number (around 15%) of the city population. The territory of the municipality encompasses the entire north-western industrial zone of Nis with numerous commercial entities of various profiles.

The city area leans against a village with a large field area, a large transport junction and industrial zone.

Population: the city part of municipality has 8 882 citizens, mostly in family houses. Nearly one third of the number are members of the Roma national community located mostly in MK 12. februar. The remaining 24 530 citizens live in the 23 villages.

Economy: Large business entities operate within the territory of the municipality, such as the Nis tobacco factory, part of the Mechanical Industry of Nis, the "Jastrebac" pump factory, the wholesalers "Tempo", Impeks promet, "Miloscic" Resor, Balkan, Belvit, Pakom…

Among the 845 companies and institutions, 114 are in the field of industry and mining, 19 in construction, 345 in trade, 37 in crafts and personal services…

Corridor 10 and the railway line towards Belgrade and Zajecar pass through the municipality, and the "Konstantin Veliki" airport is located therein.

Municipality of Pantelej

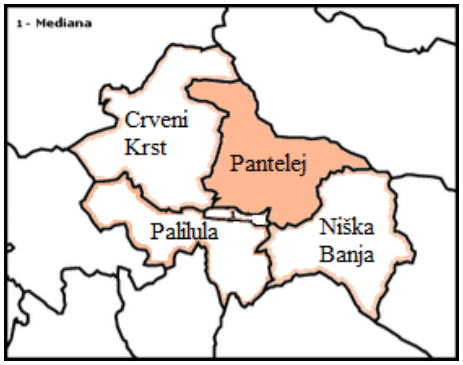

Image 44: Municipality of Pantelej

The territory of the municipality contains 4 city settlements and 12 villages.

UM Pantelej is mainly a rural municipality, containing settlements where agriculture represents the traditionally best represented branch of the economy, as well as the key development potential within the programme assistance for the dominant business activity.

The characteristics of the municipality of Pantelej include significant migrations from surrounding settlements to the city, leaving only elderly households in villages.

According to the 2002 Census, the municipality of Pantelej had 3.5% citizens with no education, and 7.0% highly educated citizens.

A large percentage of unemployed population is notable. Among those employed, the majority work in business, processing industries, and wholesale and retail.

Municipality of Niska Banja

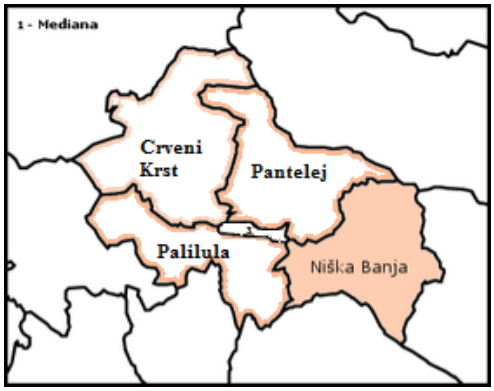

Image 45: Municipality of Niska Banja

The main economic activity in UM Niska Banja is tourism based on the natural curative properties of geothermal waters, curative mud and inhaling gas. Rural settlements around Niska Banja, with their agricultural resources, farming, vineyard and cattle production, are aimed at developing the basic activities – healthcare tourism. Rural settlements themselves contribute to the development of the main economic activity through developing rural tourism. The "Nisal" aluminium industry is also contributing to the improved standard of the population, along with small and medium-sized enterprises in the field of production, trade and services.

The majority of buildings within the territory of the urban municipality of Niska Banja are intended for individual housing. There is no industrial zone in the classic sense within the territory of CM Niska Banja. Commercial facilities are located within the residential zone.

5.2 Fauna and flora

Within the matrix of criteria along the railway – environment relation, an important place is held by the impact of the railway on the existence, diversity and number of plant and animal special present. All living activities unfold in the ecosystem, representing the cultural and functional unity of living and non-living components in space and time. The construction of the railway leads to changes in the biotope causing, as a rule, negative impact on the very sensitive complex of relations between plant and animal species and their interaction with the surrounding non-living nature.

The survey area is characterized by shifts of terrain between urban areas and surfaces under annual and perennial crops. Forests of forest oak, willows, poplars and other hydrophilic species from the lower strata of trees are present along waterways and have been significantly cleared to obtain arable land. Lands under forests are very rich in fauna, primarily earthworms, insect larvae, centipedes, moles and mice. Voids on the vegetation map without such communities are the results of intensive long-term anthropozoogenous impact, leading not only to the degradation of types of forests across large surfaces, but to the total destruction and replacement by low budding forests, meadows, pastures, cultured fields and clearings. The newly designed bypass railway passes through the Sicevacka Gorge along its final segment, to a length of around 3km. The forest vegetation of the nature park Sicevacka Klisura is characterized by an abundance of species, including those of special interest, tertiary endemorelicts and relicts, as well as numerous species of sub-Mediterranean floral elements: Corylus colurna, Juglans regia, Syringa vulgaris, Prunus, Mahaleb, Prunus padus, Quercus pubescens, Quercus cerris, Querus farnetto, Carpinus orietalis, Fraxinus ornus, Ostrya carpinifolia, Acer monspessulanum,Tilia tomentosa, Sorbus aria, Rhamhus tinctoria, Cononeaster tomentosa, Cotinus coggygria, Evonimus verrucosus, Vitis silvestris, Salvia officinalis, Ramondia serbica, etc. Sicevacka Gorge is the habitat of rare bird species, including the bald eagle, protected by the Bonn Convention, as well as peregrine falcon, griffon vulture, Egyptian vulture and numerous migratory birds. Regarding wild game, this area has populations of roe-deer, wild boar, rabbit, rock partridge and others, as well as predators: wolf, fox, marten, badger and wildcat.

Part of the space is taken up by cultural and agroecosystems, primarily created on account of natural ecosystems. Two basic species can be noted within cultural ecosystems: grain and vegetable cultures, and orchard and vineyard cultures. Within the river zone there are alternating flatland meadows, representing herbaceous ecosystems, and tilled surfaces. Meadow communities in the alluvial area are represented by species characterizing areas with high levels of ground water. Since the meadows are predominantly degraded, various weed species are significantly represented. Aquatic ecosystems within the borders of the analysed area are comprised primarily by the Nisava river ecosystems. These ecosystems have been degraded to a large extent by the pollution present in the water. Nisava contains representatives of ichtiofauna characteristic for flowing waters in our region. The associations of sports fishermen from Nis provided information that this river is currently inhabited by carp, crucian carp, Prussian carp, chub, common roach (yellow-eyed), common nase, common barbel, Mediterranean barbel, Kessler's gudgeon, gudgeon, vimba bream, sunbleak (belica), schneider (riffle minnow), European bitterling, tench (abandoned parts of the bed), spined loach, catfish, pumpkinseed (pond perch), perch and pike. Nisava was mostly seeded with mixed white fish, Prussian carp, common carp.

5.3 Soil, Water and Air

No measurements have been implemented specifically for this study. The department for environmental protection operating within the Administration for Economy, Sustainable Development and Environmental Protection in the City of Nis monitors data on the quality of water, air, soil, measurements of the level of communal noise and radioactivity in the environment. This data is public and can be found at http://www.privredanis.freeiz.com/ZivotnaSredina.htm.

Soil

Samples of non-agricultural soil have been taken from locations defined by the "Programme of systematic monitoring of the quality of soil within the territory of the City of Nis for 2015", including land near the locations: on the left and right banks of the river Nisava, around healthcare facilities, near petrol pumps, from recreational, park surfaces and children's' playgrounds, near PE Thermal Plants, near the busiest transport lanes, etc.

The following conclusions can be drawn based on the testing of samples of non-agricultural soil taken from locations across the five city municipalities within the territory of the City of Nis, regarding the quality of soil for 2015:

- Regarding the total nitrogen (TN) content of the tested soil, it mostly belongs to the class of soil with medium provision of nitrogen. The total nitrogen content in 38 of 70 samples is in the range of 0.10 to 0.20 %, in 27 samples nitrogen is below 0.10 %, and in only 5 samples is it above 0.20%.

- Regarding phosphorus content, the tested soil mostly belongs to the class of soil with high content, i.e. in 55 of 70 samples phosphorus content is in the range of 25 to 50 mg/100g. One sample has very low phosphorus content (below 5 mg/100g), while in 14 samples phosphorus content is very high (above 50 mg/100g). There are no samples with low (5 ÷ 10 mg/100g) and medium (10 ÷ 25 mg/100g) phosphorus content.

- Organic carbon content ranges from 1 to 6 %, i.e. the lowest obtained value is 1.15 %, while the highest value is 5.84.

- The analysis of heavy metal content shows increased concentration, i.e. exceeded corrected limits of cobalt (40 samples), cadmium (37 samples), copper (37 samples), nickel (26 samples), zinc (17 samples), arsenic (5 samples) and lead (2 samples). In all cases the concentrations found are slightly above the corrected limits, and far below remediation values, except for one sample (no. 2303/15-240-9) where the value of arsenic (As) concentration is above remediation values.

- Testing organic contaminants – polychlorinated biphenyls (PCB) in soil samples found their concentrations below quantitation values, i.e. below the limits.

- Testing organic contaminants – polycyclic aromatic carbohydrates (PAH) in soil samples found their concentrations also below the quantitation levels, i.e. below the limits.

- Testing organic contaminants – pesticides in soil samples found their concentration to be significantly below values that may indicate significant contamination.

State of waters

The following may be concluded based on insight into the results of testing the quality of surface waters of the rivers Nisava, Kutinska, Toponicka and South Morava during the last quarter of 2015:

- Along most of the measurement points of the river Nisava the values of the tested physical-chemical parameters corresponded to status I-III class (excellent to moderate ecological status). Based on the results of bacteriological testing, Nisava was outside the status of I-III class along all measurement points.

- The values of the tested physical-chemical parameters at both measurement points on Kutinska River were within the status of I-III class (excellent to moderate ecological status). Based on the results of bacteriological testing, Kutinska was outside the status of I-III class at both measurement points.

Air

In accordance with the Law on Air Protection, the competence over the State Network for Monitoring the Quality of Air at the level of the Republic of Serbia is held by the Environmental Protection Agency. Operative monitoring is implemented across 40 automated stations for monitoring air quality, AMSKV.

Fulfilling the obligations of informing the public on the quality of air, the Environmental Protection Agency is presenting the results of automatic air quality monitoring in real time. Preliminary, unverified values of air quality parameters are presented. Verified values and the assessment of air quality in agglomerations and zones are provided in the Annual Report on the State of Air Quality in the Republic of Serbia.

The collection and processing of data on emissions of polluting substances in the air in the Republic of Serbia is implemented based on the Rulebook on the methodology for preparing the National and Local Register of Pollution Sources, as well as the methodology for the types, methods and deadlines for collecting data ("Official Gazette of RS", no. 91/2010, 10/2013), and based on the Decree on the limits of emissions of polluting substances in the air ("Official Gazette of RS", no. 71/2010). The Environmental Protection Agency, in accordance with legal provisions, is keeping a National Register of Pollution Sources, while keeping local registers is under the competence of the local self-government. A more detailed overview of air emissions is provided in the Report on the State of the Environment in the Republic of Serbia at the annual level. The data is public, and accessible at:

http://www.sepa.gov.rs/index.php?menu=300&id=20028&akcija=showAll

There are two automated stations for monitoring air quality in Nis, namely:

1. At the corner of dr Zorana Đinđića boulevard and Zetska (IZJZ)
2. At the corner of Branka Krsmanovića and Pariske komune (PS Sveti Sava)

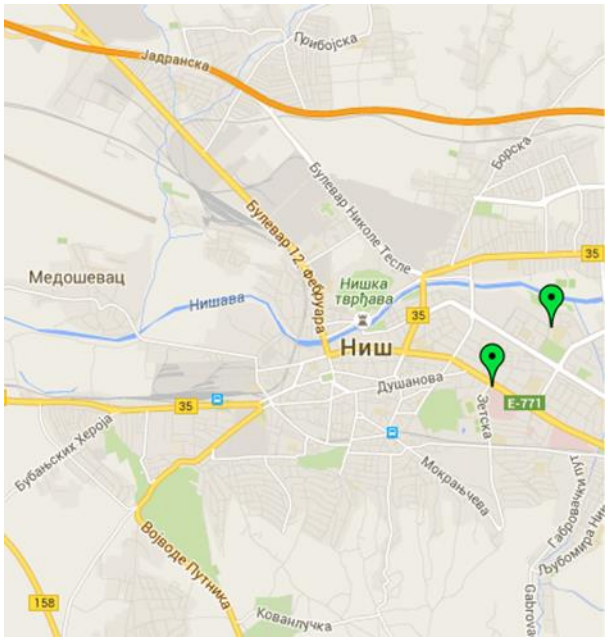

Image 46: Disposition of automated air quality monitoring stations in Nis

Table 34. Criteria for determining air quality

Averaging period	pollutant	GV, µ/m^3	TV, µ/m^3	EXCELLENT	GOOD	ACCEPTABLE	POLLUTED	VERY POLLUTED
24 H	SO2	125		0.0-50.0	50.1-75.0	75.1-125.0	125.1-187.5	>187.5
	NO2	85	125	0.0-042.5	42.6-60.0	60.1-85.0	85.1-125.0	>125.0
	PM10	50	75	0.0-25.0	25.1-35.0	35.1-50.0	50.1-75.0	>75.0
	CO	5,000	10,000	0.0-2,500	2,501-3,500	3,501-5,000	5,001-10,000	>10,000
	03-8h max	120		0.0-60.0	60.1-85.0	85.1-120.0	120.1-180.0	>180.0
	Soot	50		0.0-25.0	25.1-35.0	35.1-50.0	50.1-75.0	>75.0
Calendar year	SO2	50		0.0-30.0	30.1-40.0	40.1-50.0	50.1-75.0	>75.0
	NO2	40	60	0.0-26.0	26.1-32.0	32.1-40.0	40.1-60.0	>60.0
	PM10	40	48	0.0-20.0	20.1-28.0	28.1-40.0	40.1-48.0	>48.0
	CO	3,000		0.0-1,500	1,501-2,100	2,101-3,000	3,001-4,500	>4,500
	Soot	50		0.0-25.0	25.1-35.0	35.1-50.0	50.1-75.0	>75.1

Noise

The Faculty for Protection at Work in Nis, Centre for Technical Testing, Laboratory for Noise and Vibrations, is implementing environmental noise measurements within the territory of the City of Nis. Measurements are undertaken across several points, with the points relevant for the bypass railway marked as 20 and 29.

Disposition of measurement points for measuring noise levels:

Image 47: Disposition of measurement points for assessing noise levels

The assessment of the values of the relevant noise levels was implemented by comparing the values of relevant noise levels with the limits for open spaces defined in Table 1 of the Decree on noise indicators, limits, methods for assessing noise indicators, disturbance and harmful effects of noise in the environment ("Official Gazette of R. Serbia", no. 75/2010), based on acoustic zoning of the territory of the City of Nis.

The assessment of the relevant values of noise levels is in regards to the marked measuring points and measurement intervals.

Table 35. Assessment of relevant values of noise levels

Measurement interval	9:00-12:00	13:00-16:00	18:00-20:00	22:00-01:00	02:00-05:00
7.3 (20) Bul. Nikole Tesle – residential area "Stevan Sindjelic"	Acoustic zone 5				
Relevant values of noise levels	66.5	65.4	65.5	58.4	61.3
Extended measurement uncertainty	2.73	2.75	3.07	4.56	4.35
Limit values of noise levels	65	65	65	55	55
Exceeded levels (dB)	1.6	0.4	0.5	0.5	5.3
Relevant values of noise levels exceed the noise level limits	YES[2)]	YES[2)]	YES[2)]	YES[2)]	YES[1)]
10.3 (29) Somborska street – block of flats	Acoustic zone 5				
Relevant values of noise levels	64.6	64.2	62.5	59.8	55.7
Extended measurement uncertainty	3.09	3.06	3.34	4.69	3.19
Limit values of noise levels	65	65	65	55	55
Exceeded levels (dB)	-	-	-	4.8	0.7
Relevant values of noise levels exceed the noise level limits	NO[3)]	NO[3)]	NO[3)]	YES[1)]	YES[2)]

[1)] Assessment of noise level provided with a confidence level of 95% for the calculated extended measurement uncertainty.
[2)] Assessment of noise level not provided with a confidence level of 95% for the calculated extended measurement uncertainty, meaning there is a possibility the relevant noise level does not exceed the limit for noise indicators.
[3)] Assessment of noise level not provided with a confidence level of 95% for the calculated extended measurement uncertainty, meaning there is a possibility the relevant noise level exceeds the limit for noise indicators.

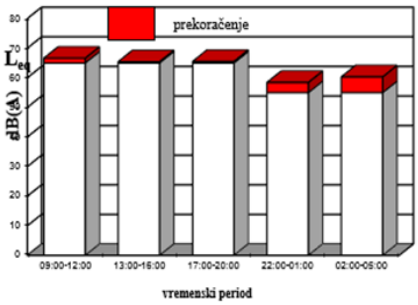

Image 48: Breach of limit – measurement point 7.3

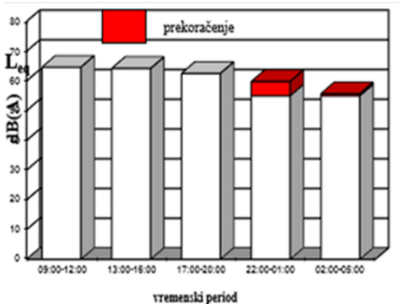

Image 49:Breach of limit – measurement point 10.3

Insight into the results of the measurement of noise levels within the territory of Nis indicates the conclusion that increased values have been measured in the city core, while at other points they are at the upper limit, or slightly above. The measured noise originates from road transport.

5.4 Immovable cultural heritage

Immovable cultural heritage is protected integrally with the space it occupies. In areas where such goods are fully integrated into the natural environment, they are protected along with the preserved environment.

According to the conditions received from the Institute for the Protection of Cultural Monuments of the City of Nis, there are no established cultural monuments within the subject matter area, but there are several items with monument properties witnessing the history of the City of Nis.

The items with monument properties within the territory of the General Regulation Plan of the railway bypass within the area of the city of Nis are:

- The Ribnik site,
- The Kovanluk site,
- The Orničje site.

Image 50:Sites along the railway route

5.5 Landscape

Landscape represents the specific nature of the ecological value of the environment and harmonization of natural and man-made components. Violations and changes to natural environments are caused by the construction and utilisation of the line facility. Therefore the landscape characteristics encompassing the corridor under analysis represent an important element for the analysis of the overall relationship along the lines of railway – environment, bearing always in mind that a subjective assessment of the value of landscape depends equally on its characteristics, as well as the characteristics of the observer.

Dividing the landscape into two basic categories involving the following characteristics was proven to be beneficial in order to quantify certain issues regarding this phenomenon:

- Physical, i.e. material, and
- Affective, i.e. psychological.

The category of material landscape characteristics involves physical characteristics that may be natural or man-made. Natural physical landscape characteristics are primarily: terrain morphology, vegetation, water surfaces and sky, while man-made ones are: built-up nature of the space and tilling of surface areas.

The psychological-affective characteristics include: liveliness, unity, coherence, harmony, intactness, etc. Terrain morphology represents the most impressive element of landscape, therefore it is understandable that impact regarding changes to terrain morphology due to the construction of the railway is considered to be the most significant. Valuation of vegetation as a material landscape category involves its visual and biological quality. Visual impressions, considering the diversity of plant species in the area, reaches its full impact during the vegetative period.

The given railway bypass passes through residential zones in the settlements Novi Komren, Pantelej, Donja and Gornja Vrezina and Prosek. The remainder is unused construction land, commercial, industrial and working zones, and zones with unused buildings.

The built-up nature of the corridor as an element of the existing landscape involves all existing artificial buildings in the corridor. Settlements found in the analysed corridor developed spontaneously, without planned direction in the development concept. Visual characteristics of settlements found in this sector, regarding qualities that may be of significance from an environmental standpoint, are not significant.

Part of the surveyed area belongs to cultivated – agricultural surfaces, valued as a significantly less attractive space compared to natural space. However, these areas also have a lively nature and beauty, the harmony of colours of the tame and fertile area, thus contributing to the quality of the landscape depending on the season.

5.6 Mutual relations of the above factors

The mutual relations of environmental factors along the given sections can be commented on at the level of data available on this area. Insight into the provided results on the quality of waters and soil indicates the need for comments elaborating the existing (zero) state. Primarily, despite the undisputed quality and potential of the given area (landscape and natural), its "burden" of various degrees of construction must be kept in mind. The analysis of data on water quality for the Nisava River can show that the concentrations of pollutants in waterways exceed the maximum permitted concentrations for II category waterways, i.e. the quality of waters has deteriorated significantly, both microbiologically, as well as in the physical-chemical sense. These results of analyses of the existing state of water quality in the Nisava River indicate nothing has been done to create plants for the treatment of industrial and communal waste water in the upstream section of the basin, and this situation is partly the consequence of the intensive use of artificial fertilizers in agricultural production.

The construction of the bypass railway is not expected to decrease the domains of the current state of the environment within the impact zone. All expected impact needs to be quantified in order to make a conclusion on its significance, along with proposals for relevant protection measures.

6 Description of potential significant environmental impact

This chapter presents the significant environmental impact to be caused by the construction, utilisation and maintenance of the bypass railway around the city of Nis. A qualitative and quantitative overview of potential changes to the environment is provided for regular utilisation conditions, as well as cases of accidents. A categorization of changes has been implemented as per their permanence.

Regarding the impact of the construction of the railway bypass on the environment, two key phases stand out:

- Construction phase, and
- Utilisation phase.

6.1 Expected environmental impact during the execution of works

This impact occurs during the process of production of materials, implementation of construction works, and temporary disposal of waste.

Environmental impact may be the consequence of creating, producing and transporting the required materials and equipment. In most cases such impact mostly follows industrial production (emission of gasses, noise, energy and natural resource use, creation of hazardous solid and liquid waste), occurring in existing plants that may be at significant distances from the railway network and implementing a wide spectrum of other activities.

The majority of negative impact, including emissions of pollutants into the air, surface waters and soil, changes to the noise level and generation of various construction waste, will arise during the implementation of works on reconstructing and modernizing the railway. These effects, unlike the effects of railway transport after project implementation, have an environmental impact limited in time. Thus, for example, the operation of heavy machinery (drills, impact hammers, etc.) required to build a railway can cause significant negative environmental impact, unless mitigation measures are given adequate attention. Likewise, the emission of noise from the construction site created by the operation of machinery may create negative effects not only for the workers, but also the population and settlements near the railway. At the same time, the laying of a new track surface can cause significant dust emissions. However, the application of positive construction practice (spraying with water, limited work times, etc.) can significantly mitigate both effects (dust and noise).

Table 36. Impact of construction and other works

Activity	Potential impact	Location
Preliminary works: •waste removal, •demolition and removal of artificial structures : - support walls, - existing station platforms, - demolition of buildings in the belt encompassed by works •works on cultural monument locations	• Emission of dust, • Emission of noise, • Soil pollution, • Solid waste creation, • Impact on vegetation, flora and fauna, • Potential damage to cultural monuments and decrease of the value of cultural heritage	• Railway stations • Open railway
Temporary approaches, transport outside the construction site	• Emission of dust, • Emission of noise , • Pedestrian risk, • Traffic jams, • Undesirable habitat impact.	• Railway stations • Open railway • Road crossings
Movement of polluted and other soil, expansions of the railway bed (various digs)	• Emission of dust, • Ground water pollution, • Safety risk (potential accidents), • Health risk, • Impact on plant and animal life, • Production of solid waste.	• Railway stations • Open railway • Road crossings
a) Clearing vegetation during preparation of terrain at railway stop **a1) clearing the surface from small vegetation,** **a2) cutting thicker trees.**	1) Impact on vegetation: a1) cutting copses, digging up roots, clearing vegetation parts, cutting of branches and cutting trees up to 10 cm thickness a2) cutting of trees,	a1) and a2) Railway stations b1) and b2) Open railway

b) Clearing vegetation along the railway: **b1) clearing the surface from small vegetation,** **b2) cutting thicker trees.**	b) cutting of trees, diameter 10 - 20 cm b2) Impact on fauna.	
Operation of construction machinery (and leakage of fuel and oil)	• Emission of exhaust gases, • Emission of dust, • Emission of noise, • Vibration, • Soil and ground water pollution, • Unfavourable impact on plant and animal life, • Use of fuel for engine operation	Railway stations and railway belt
Drainage	• Surface water pollution, • Impact on vegetation, flora and fauna.	Railway stations and railway belt
Track reconstruction: **Digging up old track materials, replacement and compacting of the surface, replacement of sleepers, replacement of rails, sanding of rails, setting points** **Welding (rails, track bonds, points)**	• Emission of dust, • Emission of noise, • Vibration	Railway stations and railway belt
Ancillary work on the construction site	Production of solid and liquid waste	Railway stations and railway belt
Execution of construction works: 1. Reconstruction of the ballast prism,	**Consumption of natural resources:** 1. Use of gravel – cca. 100 m^3 for 1km of railway,	1.Railway tracks on railway stations and railway belt on open railway,

2. Production of dikes (layers to interrupt capillary climbing and the tampon layer), 3. Producing dikes from coherent material (in layers d = 30 cm), 4. Filling the drainage ditch (producing the filtering filler), 5. Producing the lower bearing layer, 6. Producing the upper bituminized bearing layer of the railway structure BNS, 7. Producing the wear layer of the railway construction (AB 11)	2. Use of gravel-sand material from the selected borrow pit 3. Use of coherent material 4. Use of sandy gravel or crushed rock detritus (granulation 1 - 6 cm) 5. Use of grainy rock material 6. Use of crushed rock aggregate (0 - 31 mm) 7. Use of asphalt concrete	2.1. railway stations, 2.2. open railway. 3.1. railway stations, 3.2. open railway. 4.1. railway stations, 4.2. open railway. 5. railway stations, 6. railway stations, 7. railway stations,
Transport of materials and equipment: • Equipment for water supply and sewage, • Equipment for electrical power supply installations • Equipment for the telecommunications system, • Signalization equipment, • Equipment for the upper layer **Transport of material to temporary dumpsites**	1. Emission of exhaust gases, 2. Emission of dust, 3. Emission of noise, 4. Soil and water pollution, 5. Fuel consumption. **Note :** The levels of the above impact, as well as fuel consumption, depend on the distance of the provider companies and the type of transport, but are certainly far lower when using railway transport. 5.1.consumption of transport fuel total in m^3 of this material to: (a) temporary dumpsites (b) to places of installation For a 3t truck: a) 10 rounds both ways (full and empty) and 0.35 litres per 1km of road	**Routes** 1 - 5. Construction site location of temporary dumpsites - places of equipment production - places of work **Routes :** 5.1. Construction site location of temporary dumpsites, (a) borrow-pits – locations of temporary dumpsites (unknown distance of borrow-pits)

Loading, transport of gravel-sand material and unloading to: a)locations for temporary disposal and vice versa, b) up to the construction site.	b) (1 round up to 0,5 km)(maxV = 0.4 L of fuel) (2 rounds up to max1 km),(maxV =1.4 L fuel) (2rounds up to max 2 km)(maxV =2.8 L fuel) (1round up to max 4 km) (maxV= 2.7 L fuel) 6. Accidents, fuel leakage and human injury	(b) location of temporary dumpsites – place of installation.
Transport, unloading and disposal of dug-up materials to dumpsites	1. Emission of exhaust gases, 2. Emission of dust, 3. Emission of noise, 4. Soil and water pollution, 5. Fuel consumption. 5.1. Fuel consumption for transport Fuel consumption for a truck of 5 t (full and empty): 5.1. a),b),c) and d). V = 35 L (fuel) (up to 100km distance) 6. Accidents, fuel leakage and human injury.	1-5. Dig location – selected dumpsite locations. 5.1.a) Dig location – locations at a distance of 1-2 km; b) Dig location - location at a distance of 2 - 4 km; v) Dig location – location of 4 - 6 km and g) Dig location – l location at a distance of over 6 km.
Assembly and testing of work equipment	• Emission of noise, • Soil pollution, • Waste water, • Solid waste matter, • Accidents, worker injuries.	

6.2 Quality of air, water, soil, noise level, intensity of vibration

6.2.1 Air

Construction phase

The main activities causing air pollution during the period of construction are the transport of materials, earthworks, operation of construction machinery. Pollution

emissions must be minimized by applying the best possible techniques. In order to prevent the occurrence of dust, vehicles transporting materials must be covered, while transport through settlements should be minimized by drafting a materials transport plan during the construction process. Construction machinery and heavy trucks should satisfy legal regulations regarding emissions. Adherence to such regulations should be regularly controlled.

Utilisation phase

Polluted air is a very important risk factor for the health of the population, both in developed, as well as developing countries. Polluted air damages resources required for the long-term sustainable development of the planet. Sources of air pollution are mostly the result of human activity and may be divided into three groups:

1. Stationary sources:

- Pollution sources linked to agricultural activity, mining and quarries,
- Pollution sources linked to industry and industrial areas,
- Pollution sources in communal environments, such as heating, waste incineration, individual hearths…

1. Mobile sources:

- Encompass any form of internal combustion vehicle

2. Pollution sources from enclosed spaces:

- Encompass cigarette smoke, biological pollution (pollen, mites, mould, yeasts, microorganisms, allergens originating from domestic animals)…

Pollutants are generally divided into gases, vapours, solid particles and odours. Suspended particles are further grouped by size of particle: dust, smoke, vapour and aerosol. According to the legal regulations in force, The Regulation on conditions and requirements for monitoring air quality ("Off. Gazette of RS", No. 11/10, 75/10 and 63/13) regulates the limits for emissions for certain pollutants emitted into the air.

Table 37:Limits for emissions

Pollutant	The target value
arsenic	6 ng/m^3
cadmium	5 ng/m^3
nickel	20 ng/m^3
Benzo (a) pyrene	1 ng/m^3

Pollutant	The concentration dangerous to human health
sulfur dioxide	500 µg/m^3
Nitrogen dioxide	400 µg/m^3

Pollutant	Permissible exposure level
soot	50 µg/m^3
suspended particles PM2,5	20 µg/m^3
Ground-level ozone	120 µg/m^3

The inequality of air quality in certain parts of the city depending on the presence of emission sources is characteristic. The corridor in question has several sources leading to air pollution.

Impact of road transport

Motorized road vehicles, with exhaust gases contributing to the deterioration of air quality, represent significant environmental pollutants. Exhaust gases impact the human population, flora, fauna, as well as material and cultural goods. Their impact is felt in areas around road transport lanes. Internal combustion engines emit a large number of gasses, with the most important (due to their proven negative impact on the human population): CO, NOx, SO_2, carbohydrates, lead, as well as solid particles in the form of soot. The share of motor vehicles in the total emission of certain pollutants, according to data from literature, is provided in *Table no. 38*.

Table 38:*Share of motor vehicles in the total emission of individual pollutants*

Pollutant	Share of motor vehicles in the total emission (%)
Carbon monoxide	60
Carbohydrates	45
Nitrogen oxides	34
Sulphur dioxide	5.9
Solid particles	6.8

The analysis of potential air pollutants leads to the conclusion that one of the sources of air pollution is road transport from existing transport lanes found in the corridor.

Impact of railway transport

The area of the City of Nis contains the main railroads E-85 and E-70, and the regional railroad Nis – Prahovo, the train stations Nis, Nis Marshalling, Crveni Krst, Trupale, Medjurovo, Matejevac, Cele Kula, Niska Banja. The railways are not electrified, therefore they have an additional impact on air quality. On the other hand,

the volume of railway transport is not high compared to road transport. Air pollution occurs due to railway transport, but indirect impact by road passenger transport held up for longer periods in the central city area is more significant. There are 51 road crossings in Nis, with only 11 de-levelled and 40 level.

Impact of industrial plants

Another source of air pollution in the corridor in question are certain industrial plants, representing sources of emissions of harmful pollutants into the atmosphere. The specific pollutants being emitted into the atmosphere depend on the type of industrial process. Various branches of industry are present in the corridor.

6.2.2 Water

Studying the issue of potential railway impact on surface and ground water from the environmental aspect is reflected in the potential change of water regimes and their pollution. Respecting specific location conditions characterizing the area of the planned railway, described in detail within the existing situation, can lead to the conclusion that taking all characteristics in consideration, an impact of interest for the subject matter analysis can be expected.

The process of water pollution for railways is characterized by two basic phases: pollution during construction and during utilisation.

Construction phase

Pollution during the construction phase is temporary, limited by volume and intensity, although it can have severe consequences in cases of accidents.

There are two types of impact caused by railway construction:

- Water pollution
- Change of regime of surface and ground waters

The leakage of dangerous and hazardous substances into open waters causes changes to the physical and chemical properties of waters. Therefore, controlled access of machinery to waterways and other surface flows is required, i.e. it is very important for the organization of the construction site and procedures during work to respect the environmental protection conditions prescribed by this study.

Earthworks, bridge-building and culvert-building causes changes to the terrain morphology, leading to changes in the flow rate, velocity and flow of surface waters.

Surface waters can be severely endangered during construction by pollution or physical disruption of riverbanks.

The justification of riverbed regulation works lies in preventing the occurrence of landslides and erosion, but on the other hand such works can have a negative environmental impact, primarily on the plant and animal life, and around waterways.

Conflicts may occur with the water flora and fauna because of increased retention of sediments due to construction works. The destruction of banks and riverbank vegetation will significantly diminish the value of these areas regarding plant and animal life.

Changes to the groundwater regime may occur due to the construction of pylons for bridges, the settling of soil under tall embankments, etc. The construction of engineering facilities will require the temporary reduction of the level of ground water. Effects on the vegetation may occur as a consequence of lowering the water level by drainage. All these changes to the ground water regime and effects on vegetation will be temporary in nature.

Utilisation phase

Pollution of soil, surface and ground waters during the operation of railway transport and infrastructure maintenance can occur due to:

- Railway vehicle transport:
  - Friction of tracks, wheels, brake lining (Fe, Cr, Ni, Cu, Si, Mn, V)
  - Drip remains (oil, fuel, lubricants, cleaning substances);
  - Corrosion (metals and colours);
  - Railcar toilets (faecal matter).
- Railway maintenance:
  - Surface;
  - Metal parts (anti-corrosion substances);
  - Points, signals (lubricants);
  - Platforms (cover substances).

Locations of culverts

Table 39:Locations of culverts on the situation

No.	Name of waterway	chainage km
1.	Medoševac stream	2+435
2.	Rujnički stream	4+825
3.	Brenički stream	11+140
4.	Matejevački stream	11+598
5.	Suvodolski stream	13+161

6.	Vrezina stream	15+203
7.	Malčanska River	17+742
8.	Radostina stream	19+548

Water supply infrastructure

The water supply network along the subject matter stretch is fed by the karst spring Ljuberadja, feeding parts of the settlements Novi Komren, Pantelej, Donja Vrezina and the tobacco factory.

Existing water supply network in the railway zone

1. At km 0+820 is a crossing with an existing pipeline PE Ø110 mm. A protective pipe is envisaged with a length of 24 m while at 9 m before and after the crossing manholes are envisaged with covers and ledges.
2. An existing pipeline is located in Vazduhoplovaca Street AC Ø200mm crossing the route of the designed railway at km 4+232. A protective pipe is envisaged with a length of 27 m while at 9 m before and after the crossing manholes are envisaged with covers and ledges.
3. At km 4+931 there is a crossing with an existing pipeline AC Ø300mm. An underpass is envisaged at this location with a displacement of the existing pipe at a length of 37 m due to collision with the structure.
4. From km 5+345 to km 5+456 there is a collision of the existing water supply pipe Ø100 with the second track of the railway. The length of pipe displacement is 76 m.
5. At km 5+482 there is a crossing with 2 existing pipes Ø100 transitioning to the left and right of the railway route into a pipeline ACØ200mm. No additional works are envisaged for this location.
6. At km (km 7+790 there is an existing pipeline Č Ø1000mm and an elevation zone up to the reservoir "Vinik I". The crossing with the railway route envisages a structure with a span of 5.0 m.
7. At km 8+564 there is a crossing with an existing pipeline DCL Ø250 mm. A displacement of the route is envisaged at a length of 21 m with a protective pipe.
8. At km 10+368 there is a crossing with an existing water supply pipe AC Ø400mm. An underpass is designed for this location. Pipeline displacement at a length of 70 m is envisaged.

9. 11+207 to km 11+503 is a collision with an existing water supply pipe ØDCL Ø150 mm. A displacement is envisaged for this part of the pipeline at a length of 296 m.
10. At km 11+578 there is a collision between the existing water supply pipe ØDCL Ø150 mm and the designed underpass. Pipe displacement is envisaged at a length of 52.50 m.
11. At km 20+604 there is a crossing at an angle of 61^{o} with an existing water supply pipe ČCØ1100 mm and the designed railway route. A culvert with a span of 5.0 m is planned for the crossing.

Crossings and collisions with the existing sewage network

The collection and evacuation of waste waters from Nis occurs by way of a mixed sewage system, of a general and separating type.

The general type of sewage covers the majority of the territory of the city. It consists of two subsystems, operating independently of one another. They are built on the left and right banks of Nisava.

Wastewater from the city sewage is released into Nisava without previous purification, since Nis does not have a wastewater treatment facility. The release of wastewater from the right bank channel system in collision with the planned railway route is implemented from a 150/150 cm collector, at around 460 m downriver from the railway bridge along the Belgrade-Nis railway.

Crossings with the existing sewage network

1. At km 0+824.29 there is a crossing of the designed railway route with the existing Popovac collector for used waters PEHD Ø500 mm. A new pipe is envisaged in the crossing zone in a protective pipe (L=20 m). New manholes are envisaged at 10 m before and after the crossing with the railway route.
2. From km 3+425 to km 3+584 the railway route is in collision with the existing faecal collector PEHD Ø400 mm. The displacement of the collector at a length of 334 m is envisaged. The displaced collector route crosses the railway at km 3+295.50.
3. At km 4+510 the existing rainwater collector Ø1000 mm is crossed at an acute angle. The crossing zone envisages a culvert with a span of 5.0 m,
4. From km 4+911 to km 4+997 the right track of the designed railway is in collision with the existing sewage Ø300 mm. The displacement of the existing pipe is envisaged with reconnection to the existing network in the underpass zone.

5. Along part of the 12. februar street – sewage AC Ø800mm crosses the planned railway route at km 4+982.81. An underpass is designed for that location (bridge with a span of 12 m), therefore no additional structures for the protection of this collector have been envisaged.
6. From km 5+309 to km 5+376 the left track of the designed railway is in collision with the existing sewage AC Ø400 mm. The displacement of the existing pipe is envisaged at a length of 65.80 m.
7. At km 6+592 the existing faecal collector Ø700 mm is crossed at an 82^{o} angle. The crossing zone envisages an inclined culvert with a span of 5.0 m.
8. The connection of the settlement Branko Mišić - Kamenko through the Kamenička street Ø300 mm (km 7+903.07-8+131.11). This pipe crosses at km 7+906, with further collision with the right track of the designed railway. The sewage crossing from the Branko Mišić Kamenko settlement will be implemented under a right angle in a protective pipe, with the total length of displacement 257 m.
9. At km 8+418 the existing sewage crosses the railway route. Namely, the connection of Lapovačka street and Ozrenskih partizana – sewage AC Ø500mm. This connection will be reconstructed at a length of 44 m. The planned sewage for used waters from Borska street will be directed towards this crossing.
10. At km 10+370 the existing rain sewage PEHD Ø600 mm crosses the designed railway route. An underpass is designed for that location. The existing used water sewage (PEHD Ø500mm) stretches in parallel with it.
11. At km 11+578 an underpass is designed in collision with the existing used water sewage I PEHD Ø300mm so that the existing pipes "float up". The reconnection of pipes under the underpass is envisaged in a zone level with the existing situation. The length of displacement is 39 m.

6.2.3 Soil

Soil as a basic natural element represents a very complex system, extremely sensitive to various influences. Therefore the overall issue of the relation between the railway and the environment is also defined by relations occurring in the domain of various impacts on the soil. Of particular note is the fact that soil as a complex ecological system reacts to very small changes, leading to the degradation of its basic characteristics. Potential soil impact can be systematized into two basic groups: soil pollution and soil degradation.

The term soil degradation, in the environmental impact sense, involves several different processes, with particular significance held by occurrences of slides and rockslides, erosion, changes to soil permeability, potential deterioration of soil characteristics in a broad zone, soil degradation due to opening borrow pits for construction materials, soil degradation due to forming dumpsites, as well as other impact that can have greater or lesser importance in the specific spatial conditions.

Regarding the impact of railway construction on soil, two important phases stand out: construction phase and utilisation phase.

Construction phase

Soil pollution can be caused by fuel storage and disposal of waste created during construction. The construction of the railroad encompasses a number of engineering activities that may impact the soil. The impact is the greatest within the zone of construction works, it is temporary and ends with the final works. With railway reconstructions the issue of soil impact (degradation) is reflected both in the need to remove the topsoil, as well as the need to transport large amounts of construction materials and heavy machinery. Soil pollution can occur in this phase due to incorrect manipulation of crude oil and its derivatives, used for construction machinery and other plants during construction, washing vehicles and machinery outside envisaged points, inadequate construction site organization, and other activities not implemented in accordance with the recommendations for technical protection measures during construction. Particular attention should be given to the disposal of hazardous substances ad hazardous waste.

Undesirable impact on soil and ground water is also increased by dumping large amounts of dirty gravel material (unless disposed of on properly prepared substrates or inserted onto the belt of a specialized machine).

Undesirable impact on soil will be reflected through:

- Soil degradation during construction due to large earth digs and removal of topsoil;
- Soil degradation on borrow pits (up to 10 km distant from the construction site) for material required to build the embankment of the railway bed due to securing the required amount of earth. The temporary disposal of this material will take up a certain amount of terrain for a dumpsite, used to transport material to certain locations along the railway route;
- Occupation and changes of purpose of use for construction areas:
  - A modern upper layer of a single-track railway, as well as noise protection structures – permanent character;

- Changes to the compactness, structure and porosity, as well as physical-chemical quality of soil due to the use of heavy machinery during execution of works and potential leakage of fuel and oil from their engines;
- Consequences of displacing ancillary installations: gas lines, hydrotechnical and mechanical installations, as well as electrical power lines in places where they cross the railway route (the precise displacement routes will be defined in the Final Design, following analyses and surveys to be implemented from the environmental protection aspect, as well);
- Soil pollution due to chemical accidents along the open railway;
- Occupation and pollution of soil at temporary solid waste dumping locations (removed layers of soil and vegetation, removed polluted gravel, trash, construction debris, etc.);
- Soil pollution at construction camp locations due to emissions of communal waste, sanitary and faecal waste water;

Positive impact is reflected in the following:

- Regulation and planting of areas at the locations of stations being recovered and adapted (stations Nis Marshalling, Nis Sever, Pantelej and Vrezina);
- Resolving issues with drainage of the railway bed and removal of these waters by channel;

Negative impact on ground waters can be reflected in the following:

- Locations of temporary disposal of solid waste (removed layers of soil and vegetation, removed polluted gravel, trash, construction debris, etc.) can produce pollution and a change in the quality of ground waters.
- Pumping and reduction of the reserves of ground waters at construction sites can lead to disturbances in the ground water balance (particularly at railway station locations).
- Waste and wastewaters caused by the construction of buildings may pollute surface and ground waters, namely with the following materials: heavy metals, carbohydrates, suspended particles, toxic substances, invasive particles, etc.
- Drainage of the railway bed and station complexes leads to the pollution of surface and ground waters, unless adequate protection measures are undertaken. A particular issue should be noted in the field of undesirable effects on ground water due to their high levels.

Positive impact on ground water is reflected in the following:

- Resolving issues of ground water pollution by sanitary and faecal waste waters through the reconstruction of the existing, or construction of a new sewage network at the locations of the 4 railway stations;

- Resolving the issue of drainage of the railway bed and removal of these waters by channel, along with designed measures of protection from potential pollution.

Utilisation phase

Soil pollution can occur during the operation of railway transport and infrastructure maintenance due to:

- Railway vehicle transport:
  - Friction of tracks, wheels, brake lining (Fe, Cr, Ni, Cu, Si, Mn, V)
  - Drip remains (oils, fuel, lubricants, cleaning substances);
  - Corrosion (metals and colours);
  - Toilets in railcars (faecal matter).
- Railway maintenance:
  - Surface,
  - Metal parts (anti-corrosion substances);
  - Points, signals (lubricants);
  - Platforms (cover substances).

Railway utilisation, i.e. regular transport carries certain consequences which are, regarding railway transport, minimum and may be defined as significant only in the first zone of impact (next to the railroad itself). This encompasses activities as part of regular infrastructure maintenance and regular railway transport, involving the following: maintenance of metal parts, maintenance of points, signals, platforms, drip remains of lubricants, corrosion, railcar toilets, friction of tracks and wheels.

Since the railway is planned to be electrified, this leads to the conclusion that there is no air pollution and there is no negative impact on the soil caused by settling of exhaust gases created by the internal combustion of fuel.

Of greater significance, as impact on agricultural land, may be the chemical suppression of weed vegetation (seasonal measure). The impact zone of this measure is a maximum 20 m to the left and right of the railway axis, taking into account the highest work coverage during treatment.

Under accident situations (in construction and during utilisation), numerous negative and hazardous factors occur as acute impact of much greater intensity than under normal conditions. Pollution caused by the above situations represents a particular problem and the approach to such occurrences is analysed separately under the chapter on potential accident situations.

Types of risk caused by the presence of weed

For railway facilities, as specific anthropogenic biotopes, weeds represent a problem, since they cause railway instability and reduce the speed of trains, thereby requiring their suppression. When planning and implementing weed suppression procedures, care must be taken regarding the economic cost-effectiveness of suppressing weed vegetation, environmental protection and water pollution.

Typical for the ruderal weed group is that on railway substrates (slag, sand, rock, gravel) the same plant species have different vegetation and procreation, therefore, depending on the options provided by the substrate, they take root and adapt the root system so that their growth and development damages railway facilities. Weeds and dead plant remains fill the space between small rocks and gravel, where they bind to water, which in turn, during the winter period, freezes, causing shifts in the geometry of railway elements, reductions of the stability of the railway track, as well as accelerated decrease of the lifespan of wooden elements.

The growth of weeds on sections of the railway increases the risk of train wheel slippage, i.e. extends the period of acceleration and significantly extends the period of braking for trains, potentially leading to trains not stopping at a given signal. If plant remains dry out during the summer and in high temperatures, there is a risk of fire due to sparks from train wheels. The destruction of weeds on railways, embankments and stops also prevents their further spread into agricultural systems in the immediate vicinity.

Weed species

During 2006 and 2007 the phytocenological survey of the railroad was implemented at over 50 points on PE “Serbian Railways” facilities along multiple routes. Phytocenological surveying was implemented with the presence and technological assistance of the competent persons from the ZPO section (Institute for Railway Maintenance) of PE “Serbian Railways”. The surveyed points were marked as GPS coordinates (Global Positioning System). The dominant weed species, as well as the combined number and coverage were established using the Braun-Blanquet method (1951), leading to proposed solutions for their chemical suppression.

The presence of annual and perennial grass and broad-leaf species of plants has been established, as well as perennial woody species spreading intensively. Some of the dominant weed species are: *Agropyron repens*, *Ambrosia artemisifolia*, *Arctium lappa*, *Crisum arvense*, *Cynodon daktylon*, *Digitalia sanguinalis*, *Menta longifolia*, *Prunus spinosa*, *Rubus caesius*, *Senecio vulgaris*, *Vicia cracca*, *Trifolium repens*, etc.

A significantly developed root system and severe damage to railroads can be caused by weed species such as wild blackberry (*Rubus caesius*), blackthorn (*Prunus sp*.), wild elderberry (*Sambucus nigra*) and desert false indigo (*Amorpha fruticosa*).

In accordance with the Convention on Biodiversity ("Official Gazette of FRY – International Agreements", no. 11/2001), we are obliged to prevent the entry, and control or eliminate "those alien species endangering natural ecosystems, habitats or (native) species". Their presence significantly increases the costs of maintaining public greenery. The usurped surfaces of the subject matter area show massive occurrence of ambrosia (*Atbrosia artetisiifolia*, one of the main allergens), wild tobacco (*Asclepias syriaca*) and ailanthus (*Ailanthis glandilosa*). Wetter habitats also show the spread of ashleaf maple (*Acer negindo*), desert false indigo (*Atorpha fruticosa*), common hackberry (*Celtis occidentalis*), green ash (Fraxinis pennsylvanica) and Japanese knotweed (*Reynoiria syn. Faloppia japonica*).

6.2.4 Noise levels

Noise may occur as the consequence of executing construction works, the transport and loading of materials. Construction materials will be transported using existing public roads. No other significant increases in noise levels are expected if the transport activities are adequately organized, i.e. the transport and construction activities should be implemented during daytime, selecting appropriate transport routes.

During construction, next to the railway area and neighbouring facilities, only those surfaces necessary for preparatory works should be occupied. Noise levels during the implementation of works should be minimized. Operating machinery involved in the construction process should satisfy environmental protection standards.

According to Article 12 of Government Decree no. 284/2007 General rules for protection from noise and vibrations, a contractor must harmonize activities in accordance with the requirements for protection from noise and vibration during construction. The monitoring of limits contained in the joint Decree of the Ministry of Environmental Protection and Ministry of Health 27/2008 on establishing the limits for protection from noise and vibrations is mandatory. A contractor may be excepted from the obligation of respecting the limits for noise levels, by special law at the request of competent institutions in the field of environmental protection.

During the construction of the railway in urban environments there may be high noise levels during certain brief periods of time.

Utilisation phase

Noise caused by the motion of trains is in the mid-frequency range. Generally speaking, noise levels for trains (freight, passenger and electric) at speeds of 50-60 km/h

vary within 90-92 dB(A). Sound levels at railway stations reach values of 90-101 dB(A). The noise occurring in railway stations is the consequence of:

- The passage of trains through low diameter bends or the point system on approaches to platforms and
- Trains parked to receive passengers.

Although trains move at low speeds when entering stations (around 35 km/h), the rolling noise is still considerable with significant environmental impact. High noise levels occur at places where trains stop to receive passengers and goods. The noise originates from the operation of motors and compressors. Protection is achieved by isolation around these sources. Maximum reduction is around 20 dB(A).

Railway transport is a large producer of noise (if the railway passes through a town). The International Railway Union determined that railway transport is producing the following noise levels on average:

- Rapid passenger train 65 dB(A);
- Freight train, speed 120 km/h 60 dB(A);
- Train in suburban transport 70 dB(A);
- In transit stations (during marshalling) 90-120 dB(A);
- In passenger railcar sections 63 dB(A).

The key sources of noise are the drive systems of locomotives and track vehicles. Noise levels in the locomotive are also (70 - 90 dB(A)), as shown in table 38.

Table 40: Noise levels in the locomotive control room

Frequency (Hz)	**Noise level dB(A)**
Up to 350	90
350 – 800	75
Above 800	70

Establishing noise levels caused by transport along the railway bypass around Nis was achieved using the CadnaA software package. The calculations used the Dutch

national method for assessing noise indicators for railway transport SRM II – 1996[2] recommended by Directive 2002/49/EC.

In order to complete an acoustic analysis, an acoustic model was formed, encompassing the 3D model of the terrain, technical and technological characteristics of the railroad and means of transport, amount of railway transport, and disposition and purpose of facilities. The analysed railway was divided into sections with different characteristics (number of trains, type of railway, speed limits, etc.)

The input parameters for noise modelling are data from certain parts of the Preliminary Design, the transport technology designs and the feasibility study. The following table shows the number of trains by section and periods of day used in the calculation.

*Table 41:*Total envisaged number of trains using the railroad

Section	Passenger trains			Freight trains		
	22-06	06-18	18-22	22-06	06-18	18-22
Trupale – Nis Sever	10	12	6	9	7	1
Nis Sever – Crveni Krst	10	12	6	12	11	2
Crveni Krst – Pantelej	11	18	7	3	2	0
Pantelej – Matejevac	3	5	2	3	1	0
Pantelej – Prosek	6	8	2	10	9	2

The existing vehicles and those planned for procurement by RS are taken into consideration when selecting the types of trains to use this railroad.

6.2.5 Vibration

The construction phase, as regards to vibration, is characterised by the operation of machinery and plants located along the transport route being built. The organization of the construction of a line facility, such as a railway, is characterized by the disposition of construction machinery along a relatively large space, preventing interventions for the protection of the environment from vibration during this phase. Exposure to such impact is limited in time, temporary, and of low intensity.

[2] Published in "Rekenen Meetvoorschrift Railverkerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996

Construction phase

Vibration from railway transport arises mostly due to the oscillatory motion of vehicles during transport. Oscillations occur as the consequence of driving across irregularities in the tracks and the impact of wheels and rotational platforms. These oscillations cause dynamic reactions at the rail-wheel contact, generating ground vibration, causing negative effects on people and buildings.

The spread of vibration essentially occurs through three types of wave motion: surface, shearing and compression waves. Surface waves are dominant, taking up around 70% of the total energy. Shearing waves represent around 25% of the total energy, while compression waves, spreading through the ground, take up only around 5% of the total energy.

Regarding the impact vibrations can have during the phase of railway utilisation, we may conclude that they cause a degradation of the urban environment. In all cases vibration spreads through ground and reaches the foundations of residential and communal buildings, transferring further through the structures to the walls of apartments and other rooms. During the transfer of vibration through foundations and the floor, hazards occur due to the unequal settling of the foundations and soil. This can lead to cracking in buildings. In any case, vibrations cause agitation or shifting.

Negative impacts of vibrations on buildings manifest mostly through material fatigue, leading to a decrease in the duration of buildings. Negative impact on people is manifested on the one hand through direct mechanical actions of variable acceleration on the body, while on the other hand there are secondary biological and psychological impacts due to agitation, or even damage to nerve receptors. Although the phenomenon of railway transport vibration is less pronounced compared to the phenomenon of noise, nevertheless in some cases it can represent a significant factor regarding negative impact. Since in this case the railroad is being built for trains with speeds of 160 km/h, the legally prescribed values are expected to be reached at a distance of around 50 m from the railway. Considering the fact that residential buildings and the population, as well as highly sensitive buildings or activities are endangered at short distances, this must be taken into consideration for buildings found in the endangered zone.

6.2.6 Non-ionizing radiation

The main goal of protection from non-ionising radiation is to reduce the risk of exposure to an “acceptable level”. The degree of exposure of the population is determined by the percentage of the level of electric, magnetic and electromagnetic fields in the environment, representing a very complex task considering the sudden increase in the number of new technical-technological sources in human environments.

The results of research implemented by scientists worldwide to date still do not provide a clear response to the issue of health risks due to exposure to electromagnetic fields. During the last thirty years, comprehensive research is under way in developed countries regarding the issue of the impact of these fields on the human body. The nature of the issue is multidisciplinary and gathers scientific teams of all profiles. Despite this, scientific knowledge is still incomplete, even the opinions of renowned experts on the mechanism of occurrence of biological effects are not uniform. The problem of protection in the area of electric, magnetic and electromagnetic fields (0 Hz ÷ 300 GHz) presents, at this point, only the most basic forms of protection, because of incomplete information on all biological actions of such fields on the human body and their health impacts, and therefore the risks of exposure.

In Serbia this field is regulated by the Law on Protection from Non-Ionizing Radiation ("Off. Gaz. RS", no. 36/09), as well as relevant rulebooks. The Rulebook on sources of non-ionizing radiation of special interest, types of sources, method and period of their testing ("Off. Gaz. RS", no. 104/09), defines sources of non-ionizing radiation of special importance to be plants and electric lines with a nominal voltage above 35kV.

The reference values of population exposure for the frequency of 50Hz are provided in the following table:

Table 42 Reference values of population exposure to electric and magnetic fields

Frequency f (kHZ)	Strength of electric field E(V/m)	Strength of magnetic field H(A/m)	Density of magnetic flux B (μT)
0.05	2000	32	40

Since the nominal voltage of the contact network is 25kV, the provisions on sources of non-ionizing radiation of special importance do not relate to the contact network. However, in order to determine potential exposure of the population, the calculation of the strength of electric and magnetic field surrounding the contact network follows below.

For a single-phase system of 25kV, 50Hz the calculations provide the following values:

- Electric field at a distance of 3.5m from the conductor of the CM under voltage is =1.91kV/m
- Magnetic induction at the platform, at a distance of 2.2m from the track axis and at elevation 1m, with a nominal current of 400A, is B = 32.4μT

Therefore, the strength of the electric field and magnetic induction in points that could be accessible to the population do not exceed the values determined in the table above, therefore their action has no impact on human health.

- Signalling – safety and telecommunication facilities

Cable facilities – local and railway cables, will be located in the area of the station, i.e. in the expropriation belt on the open railway. Their environmental impact is minimum, considering their volume and position (below ground surface), as well as their structure, since they are made of materials with low environmental impact. These materials are copper, aluminium, iron, paper, polyethylene and very low amounts of bitumen, which is not water soluble. The applied telecommunications cables do not contain lead. Telecommunications devices and the signalling-safety equipment for managing the signalization will be located in the station building or special purpose buildings in the station area, as well as along the railway belt. The heat dissipation and noise of these devices are negligible, therefore a lack of environmental impact may be stated. The operation of facilities and devices under normal utilisation will use public utility electric power, with diesel-electric generators turning on in case of blackouts. Consumption is minimum with a tendency of further decrease by introducing modern telecommunication facilities. Optic-thermal fire alarms will be used, not containing any radioactive or chemically harmful materials, nor having any negative impact on the environment.

6.3 Population health

The health impacts of the planned railway encompass impact on the population in settlements along the railway, as well as participants in the construction (drivers of construction machinery, construction site employees, pedestrians). This impact in the construction phase encompasses exposure to noise, vibration and air pollution. This impact is temporary in nature and spatially limited.

Negative environmental impacts during railway reconstruction (air, water, soil) are indirectly negative impacts for the population, as well.

Construction machinery with exhaust gases contributing to the deterioration of the quality of air represent environmental pollutants. Internal combustion engines emit a large number of gasses, with the most important (due to their proven negative impact on humans): CO, NOx, SO2, carbohydrates, lead, as well as solid particles in the form of soot.

The population is exposed to vapours of polycyclic aromatic carbohydrates (PAC) during the laying of asphalt layers along access roads and road crossings. Earthworks produce significant emissions of dust. Odours arising from handling materials include construction materials, sewage and waste.

The utilisation of the railway bypass around Nis will cause a certain impact on the population of settlements it passes through, travellers, drivers and employees in stations, as well as pedestrians.

The action of vibrations on the organism produces two types of effects: physical (mechanical, thermal) and biological (action on the hearing and vestibular system, proprioceptors and mechanoreceptors). Vibration reduces sensitivity to pain, temperature and touch (fingers, toes and the stomach area are particularly sensitive). Persons with coronary arterial diseases, hypertension and hypotension, inner ear diseases and ovarian cycle disturbances are particularly sensitive to vibration.

Negative environmental impacts during railway reconstruction (air, water, soil) are also indirectly negative impacts on the population. The modernization of the subject matter bypass railway will provide for greater train speeds along it, leading to reduced transport times for goods and passengers along this section, representing a positive impact on the population of the given area from a sociological standpoint.

Particular attention must be given to the part of the population remaining without their property and homes during the expropriation procedure. Despite receiving adequate material reimbursement, certain people, particularly the elderly population, find expropriation of property very hard. This may reflect on their psychological state and may cause refusal to integrate into the new environment.

6.4 Meteorological parameters and climate characteristics

Changes to microclimate characteristics in the area encompassed by he planned railway arising as a consequence of its construction can only be viewed in the domain of strictly local effects. These are, therefore, microclimate characteristics resulting from the existence of buildings in space and occurring primarily due to the artificial buildings causing consequences through their volume by changing relatively established microclimate regimes. Based on the familiar characteristics of certain microclimate phenomena that may be caused by elements of the planned railway, their concretization can be implemented under real spatial conditions.

The basic microclimate indicators that can be registered above the transport route on both sides (temperature, humidity, evaporation, radiation), and without expressed impact from artificial buildings, show established regularities valid for specific spatial relations. The space above the railway itself will be characterised in the microclimatic sense by increased temperatures on the very surface of tracks, regaining established values at a few meters from the edge of the road. The same nature of change is characteristic for evaporation and light radiation, while air humidity holds a reverse pattern, being lowest above the railroad. All these microclimatic changes are limited in space to a small belt along both sides of the road (order of magnitude up to 10 meters) and essentially have no negative effects that spread through space.

The second part of potential microclimate changes is typical for potential impact introduced into the local space by artificial structures (embankments and other ancillary facilities). Climate change is a consequence of the changes of the characteristics of the soil and the plant cover.

The third zone of microclimate impact are the high embankments and deep carvings. Microclimate changes are the consequence of the change in established air currents and, consequently, the local temperature regime, air humidity and insolation, produced near high embankments. Note that very small variations from the established regime can have significant consequences for the overall ecosystem.

Respecting the specific morphological characteristics with de-levelling of 1 to 3 m, rarely up to 7 m compared to the elevation of the surrounding terrain, the spatial characteristics of the planned railway route and local climate changes, with air mass currents of particular importance, certain conclusion may be drawn.

The subject matter railway bypass is, for the majority of its route, led by routes of the existing railway, therefore potential impact on microclimate changes makes sense only along segments where it leaves the existing corridors. Two such sections have been noted: for the first three kilometres the railway is lead in a carving up to 3m in depth, and the second at km 15+400, where the railway deviates significantly from the existing corridor, moving through arable land, in places on embankments and carvings at a length of around 4km. Considering the adapted cross-section elements, as well as width of land, all the above impacts will primarily be concentrated within these areas, therefore no particular negative impact by microclimate changes should be expected.

6.5 Ecosystem

Construction phase

Green surfaces may not be destroyed during the construction process. Potential negative impact on vegetation can occur during the execution of works – due to the presence of heavy machinery, the cutting of trees or accidental damage occurring if the contractor fails to adhere to rules of construction site organization. Marking protected areas (prior to commencing construction) is recommended in areas along the route in order to minimize the negative impact of project implementation.

Impact on fauna during the execution of works is of temporary character. It is realistic to expect for large species of animals (birds and mammals) to retreat from the corridor due to noise, although adaptation to the increased noise level is present with them as well.

Utilisation phase

No significant impact processes should be expected during the utilisation of the railway for the vegetation and flora of the subject matter transport route locations, since railways as line facilities are far less prone to negative implications than roads, i.e. highways. Extremely negative impact is still possible under the above in case of accidental, undesired situations of leakage and spillage of hazardous and harmful substances on the top and bottom layer of the railway in the subject matter section, as well as spatial areas of the railway belt and the right and left side of the route axis.

Contemporary transport infrastructure facilities, such as highways and railways, have multiple negative impacts on the living environment. This negative impact is exhibited directly and indirectly, both during the construction of the transport route, as well as during utilisation. Although the intensity and consequences of the negative impact is to an extent specific for every individual animal group, the overall effects are most frequently manifested through:

- Direct destruction of habitats,
- Degradation of the quality of habitats along the route,

- Fragmentation of habitats, change of shape and geometry,
- Cutting through ecological corridors and traditional migratory routes,
- Harder access to vital parts of the habitat,
- Population fragmentation due to the barrier effect of the route and inability of constant and unfettered communication,
- Increased hunting pressure and poaching due to facilitated access,
- Increased animal mortality due to being run over,
- Disturbed surface and ground water regime,
- Accumulation of liquid and solid, chemical and other waste,
- Increased light and sound pollution around the route.

The consequences of these effects are: interrupted normal living cycles of numerous animal species, behaviour changes, reduced ecological elasticity and disappearance of local populations, changes to the composition and structure of animal populations due to avoidance of the route by certain species, all finally resulting in a significantly impoverished biodiversity at all levels (genetic, species and ecosystem).

6.6 Population

Regarding the interest of certain social groups as users of certain areas and buildings contained therein, the construction of the railway can have a twofold impact on the socio-economic and economic development of a given area. Two basic interest groups of the population stand out for the planned railway. The first group are beneficiaries of the railway, while the second are owners of the land the analysed railway is being built upon. The construction of the planned transport route improves travel conditions while reducing costs and increasing the safety of users in the first group. The construction of the railway can improve communication of underdeveloped settlements with economically better developed urban centres. The retention potential of settlements is increased, causing positive social and economic effects for the local population. However, on the other hand, the railway passing in the immediate vicinity of settlements can reduce the intensity of use for certain settlement spaces and activities (due to noise, vibration, increased number of transit travellers), thereby contributing to changes in the use of spaces, reducing their value and reducing profits for the owners. The construction of a railway can harm living conditions in a settlement and its zones. This negative impact is exhibited in cases when the railway cuts through (separates) built-up parts of the settlement, i.e. disintegrates local space.

Although part of the subject matter railway passes through settlements where the population is exclusively working in agriculture, data indicates a decrease of the agriculturally active population compared to the overall population. This analysis can show that the work capable population is increasingly aimed towards the nearest economic and urban centres. Therefore the construction of this transport route will improve transport links, enabling the population greater access to the city core.

Comparing the effects of construction, positive and negative, in both cases leads to data showing that the benefits for the social environment, in case of the construction of the planned railway, are several times greater than the damage occurring as a consequence of construction.

6.7 Waste

Construction phase

During the execution of works along the railway certain amounts of waste will be created. We differentiate between communal waste created at the construction site and construction waste removed from the track (worn-out tracks, sleepers, surface material, track fittings). The created waste can be removed several ways, including reuse within the railway system, sale to other companies, transport to a temporary dumpsite or burning.

Based on experience, as well as the Catalogue of waste provided in the Rulebook on the categories, testing and classification of waste (Off. Gaz. RS no. 56/10), works on the reconstruction and modernization of railways and subsequent utilisation can produce the following categories of waste (Table 26).

13	**WASTE FROM OIL AND REMAINS OF LIQUID FUELS (other than edible oils and those under chapters 05, 12 and 19)**
13 01	**Waste hydraulic oils**
13 01 11*	Synthetic hydraulic oils
13 02	**Waste engine oils, oils for gearshifts and lubrication**
13 02 06*	Synthetic engine oils, oils for gearshifts and lubrication
13 02 08*	Other engine oils, oils for gearshifts and lubrication
13 05	**Contents of oil/water separators**
13 05 02*	Sludge from oil/water separators
13 07	**Liquid fuel waste**
13 07 01*	Drive fuel and diesel
15	**WASTE FROM PACKAGING, ABSORBENTS, WIPING RAGS, FILTER MATERIALS AND PROTECTIVE CLOTH, UNLESS OTHERWISE SPECIFIED**
15 01	**Packaging (including specially collected packaging in communal waste)**
15 01 01	Paper and cardboard packaging
15 01 02	Plastic packaging
15 01 10*	Packaging containing remains of hazardous substances or contaminated by hazardous substances
17	**CONSTRUCTION WASTE AND WASTE FROM DEMOLITION OF BUILDINGS (INCLUDING EARTH DUG UP FROM CONTAMINATED LOCATIONS)**
17 01	**Concrete, bricks, roof tiles and ceramics**
17 01 01	Concrete
17 01 02	Bricks
17 01 03	Roof tiles and ceramics
17 01 06*****	Mixed or individual fractions of concrete, brick, tiles and ceramics containing hazardous substances
17 01 07	Mixtures or individual fractions of concrete, brick, tiles and ceramics other than those listed under 17 01 06
17 02	**Wood, glass and plastic**
17 02 01	Wood
17 02 02	Glass
17 02 03	Plastic
17 02 04*	Glass, plastic and wood containing hazardous substances or contaminated by hazardous substances
17 03	**Bituminous mixtures, tar and tar products**
17 03 01*	Bituminous mixtures containing coal tar
17 03 02	Bituminous mixtures other than those listed under 17 03 01
17 03 03*	Coal tar and tar products
17 04	**Metals (including their alloys)**
17 04 01	Copper, bronze, brass
17 04 02	Aluminium

17 04 03	Lead
17 04 04	Zinc
17 04 05	Iron and steel
17 04 06	Antimony
17 04 07	Mixed metals
17 04 09*	Metal waste contaminated by hazardous substances
17 04 10*	Cables containing oil, coal tar and other hazardous substances
17 05	**Earth (including earth dug up from contaminated locations), rock and dug up materials**
17 05 03*	Earth and rock containing hazardous substances
17 05 04	Earth and rock other than those listed under 17 05 03
17 05 05*	Dug up materials containing hazardous substances
17 05 06	Dug up materials other than those listed under 17 05 05
17 05 07*	Waste falling off treads containing hazardous substances
17 05 08	Waste falling off treads other than that listed under 17 05 07
17 06	**Isolation and construction materials containing asbestos**
17 06 01*	Isolation materials containing asbestos
17 06 03*	Other isolation materials consisting of, or containing hazardous substances
17 06 04	Isolation materials other than those listed under 17 06 01 and 17 06 03
17 06 05*	Construction materials containing asbestos
17 08	**Gypsum-based construction materials**
17 08 01*	Gypsum-based construction materials contaminated by hazardous substances
17 08 02	Gypsum-based construction materials other than those listed under 17 08 01
17 09	**Other construction and demolition waste**
17 09 01*	Construction and demolition waste containing mercury
17 09 02*	Construction and demolition waste containing PCB (e.g. seals containing PCB, resin-based floors containing PCB, glazing containing PCB and condensers containing PCB)
17 09 03*	Other construction and demolition waste (including mixed waste) containing hazardous substances
17 09 04	Mixed construction and demolition waste other than that listed under 17 09 01, 17 09 02 and 17 09 03
20	**COMMUNAL WASTE (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL AND INDUSTRIAL WASTE), INCLUDING SEPARATELY COLLECTED FRACTIONS**
20 01	**Separately collected fractions (other than 15 01)**
20 01 01	Paper and cardboard
20 01 02	Glass
20 01 08	Biodegradable kitchen and restaurant waste
20 01 40	Metals
20 01 99	Other fractions, not otherwise specified

20 02	**Waste from gardens and parks (including graveyard waste)**
20 02 01	Biodegradable waste
20 03	**Other communal waste**
20 03 01	Mixed communal waste
20 03 04	Sludge from septic tanks

Table 43:Groups and types of waste occurring on construction sites

Treatment methods for the above waste:

- Containers will be set up during the execution of works for each of the specific types of waste. Locations are determined within stations;
- Waste collected from the construction site will, prior to transport to dumpsites, be stored at predetermined locations;
- Materials that may be recycled or reused will be separated from the remaining waste and adequately stored;
- Waste containing poisonous or potentially hazardous substances will be disposed of in specially marked containers within temporary construction sites wherefore it cannot leak out and contaminate soil and water;
- Measures will be implemented in order to prevent construction, waste, or other materials from the construction site to reach surrounding waterways or drainage channels;
- Waste materials will be sprinkled with water, to prevent dust emissions;
- Trucks for transporting construction materials and waste will be covered by tarps.

The ballast prism is made of gravel, its surface becoming black after a certain period, because the space under the surface is often filled with liquids and sludge. Gravel pollution also occurs through the treatment of the railway belt with herbicides, fungicides and pesticides, by releasing faecal matter on the railway (from the sewer lines of railcars), leakage of lubricant oils and grease from trains and railcars, by leakage of liquid and solid freight in transport. Since all the surface material will be replaced with new one, regarding the environmental protection aspect, adequate procedures are required with the replaced materials, as per the following: the replaced surface material will be removed from the construction site and must be disposed of in locations securing sufficient capacity, protection of surrounding areas and the potential for their reuse and transport.

According to the Rulebook on categories of waste with lists, gravel can be sorted under non-hazardous or hazardous waste. In order to be sorted according to the catalogue of waste, it needs to be characterized, providing data on its potential content, i.e. concentration of substances making it hazardous waste. Depending on the degree of contamination, decisions are made on its disposal, and/or reuse. Locations for dumping earth and old gravel are to be defined by the Final Design, along with their organization (substrate, fence, protection from leakage to surrounding areas).

Gravel is the waste that will occur in the largest amounts during reconstruction and modernization. There are several options for the use of old gravel. Gravel can be used for purposes not related to railways (e.g. for filling old holes, or at dumpsites). Finally, one modern method is the biological remediation of gravel, with environmentally acceptable chemicals.

Railway sleepers are covered with creosote oils to prevent degradation and periodically treated with pesticides, fungicides and herbicides. During the procedure of replacing worn-out sleepers, according to the Law on Waste Management, i.e. the Rulebook on categories of waste with lists, this type of waste must be adequately disposed of.

Since the majority of wood protection substances, organic or inorganic, are hazardous waste, it is possible that wood treated with these substances represents hazardous waste, therefore sample analysis is proposed prior to starting works.

The reuse of used sleepers is possible, ensuring certain technical conditions.

If the investor opts for burning old sleepers, temperatures of over 1200 °C need to be secured in order to prevent the emission of harmful and poisonous gases (dioxins, furanes, etc.). The location for disposing of old sleepers needs to be waterproofed, because the sleepers are oiled and in contact with water may contaminate the surrounding soil.

Wood waste can be found or produced at the very location during preparatory works, where a certain amount of trees and bushes will be removed during the clearing of terrain. Likewise, places where wood waste can occur are packaging used in reconstruction and modernization (e.g. wooden pallets). Wood waste can be sorted and cut up, and used to produce other wood products, or can be given to the local population after collection to be used for heating, under the condition that it has not been oiled or coloured with colouring.

Procedures for other replaced materials will be envisaged similarly (earth, rails, points, etc.), while part of the dug-up inert materials can be immediately reused upon completed works on the lower layer for regulating inclines on embankments and carvings. The greatest amounts of earth waste will be created by digging up materials from the protective and transitional layer of the rail bed, to be replaced with a new one. This waste will also be temporarily disposed of at the (broader) location of stations.

In addition to waste that will be generated during the execution of works, specific for certain locations along the railway, there is waste occurring throughout all phases and all activities, such as various types of foil and nylon bags used to pack construction materials, various types of plastic and glass bottles, cans, barrels, etc. Temporary dumpsites at the construction site must be provided for all these types of waste, until final handover to the companies tasked with the further treatment of the same.

Plastic products can also be collected separately, but also processed through the recycling process, in a clean state. The repeat melting of plastic leads to the creation of granules that can replace the raw materials. When collecting and disposing of waste plastic (bottles, barrels, etc.) particular attention needs to be given to plastic packaging for oil, lubricants, fuel, etc. The above packaging is not treated as plastic, but as hazardous material.

Waste oil from replaced points will require special treatment, as well as waste oil from machinery to be used during the reconstruction and modernization.

Metal waste will represent, for the most part, replaced elements of the upper layer (including rails, fastenings, etc.). This waste will be stored in working units of SR already intended for this purpose.

For temporary keeping of hazardous waste the Contractor will identify and adapt a covered space protected from outside influence (wind, rain, etc.). Waste with characteristics of hazardous waste needs to be secured in the short term and transported away for treatment in an environmentally acceptable way. It is particularly important to pay attention to the land it will be placed upon. To secure and further treat hazardous waste, a contract must be signed with a company authorized to receive such waste.

Locations are to be determined for the immediate securing of waste in places it occurs, and containers procured for various types of waste in order to be able to separate it and collect it separately. Since different types of waste are secured differently, instructions need to be prepared on the method of disposing of certain types of waste. The contractor shall adopt a decision appointing a waste management person during the execution of works. Containers for metal waste, for packaging waste, etc. will be marked separately. The final treatment of waste will be the task of companies with whom the Contractor signs contracts on final care and treatment of waste. Upon the completion of works, all locations with temporary dumpsites need to be returned to their previous state. All waste will be temporarily disposed on land owned by SR. Temporary construction sites are to be equipped with communal waste containers, as well as recycling waste containers.

Collection and disposal of waste

The collection of waste is very important, both for preserving the health of people and the environment, as well as aesthetic and financial reasons. The term collection of waste does not involve only its collection, but also transport of materials after collection to the place designated for dumping. Construction waste involves all types of waste materials and by-products produced during the construction process. Construction waste can be hazardous and non-hazardous according to its characteristics. Every generator of waste, in this case the Contractor, is obliged to store waste in accordance with regulations.

Since this is mostly waste that is oiled to an extent, it needs to be disposed of at organized dumpsites. Organized dumpsites in this context involve waterproofing and impossibility of water penetrating the dumpsite. This can be achieved by spreading adequate quality foil on the ground, to be used for disposal and covering upon the end of disposal, to prevent rain contact with the disposed waste.

The contractor tasked with waste management shall request a permit from the competent Municipality for disposing of construction waste. The transport of waste from the construction site to the dumpsites will be implemented using vehicles of the Contractor or whomsoever the Contractor selects for implementing such work.

Non-hazardous waste is disposed into containers (mostly of larger volume) to be regularly transported and emptied by the utility company.

Hazardous waste needs to be secured in the short-term and handed over to companies tasked with disposal or permanent securing, in order to be treated in an environmentally acceptable way. For securing and further treatment of waste the Contactor should sign a contract with a company authorized to receive such types of waste.

The municipal body competent for spatial planning affairs determines and approves the location for placing earth from the construction digs and other construction waste. In accordance with the above, the Contractor shall request a permit from the competent Municipality for the disposal of construction waste. During the creation of construction waste documents must be produced recording the amounts and types of waste.

Utilisation phase

The generation of waste during the period of utilisation is expected as a consequence of the following activities:

- Maintenance of railroad and equipment,
- Installation and operation of lubricating equipment,
- Maintenance of the surroundings of the railway, weed control,
- Collection of waste dumped along the railroad.

The following types of waste may be generated during utilisation:

- Waste from engine lubricants and the transmission mechanism,
- Hydraulic oil waste,
- Communal waste (similar to waste from residential, commercial, industrial and similar buildings), waste from the use and emptying of toilets,
- Liquid fuel waste,
- Waste from the regulation of green surfaces.

It is hard to envisage the amounts of the above waste, but attention should be given to its disposal in accordance with regulations.

Existing waste management system of the PE "Serbian Railways" company

PE "Serbian Railways" adopted the Waste Management Plan in May 2010, containing documentation on the types, composition and amounts and measures for the reduction of waste, particularly hazardous waste. Procedures and methods for separating, storing and treating waste have also been listed. A cadastre of waste matter at the company level has been produced, and the formation of 4 centres has been envisaged for receiving hazardous waste in 4 railway hubs across the entire network of railways in Serbia.

During the working process, "Serbian Railways" ad generates a dangerous and non-hazardous waste:

- Hazardous waste is waste that by its origin, composition or concentration of hazardous substances may cause danger to the environment and human health and has at least one of the hazardous characteristics regulated by law, including the packaging in which hazardous waste was or is packed. Hazardous waste can be in the form solid and liquid state.

- Non-hazardous waste is waste that has no characteristics of hazardous waste.

The table below shows the types of hazardous and non-hazardous waste generated within the "Serbian Railways" JSC according to the Waste Catalogue.

Table 44: Types of hazardous and non-hazardous waste generated within the "Serbian Railways" JSC according to the Waste Catalogue

the character of waste	Categorization according to the European Waste Catalogue (EC) Directive 2000/532 / EC and the Regulation on categories, testing and class-classifying waste ("Off. Gazette of RS" no. 56/10)	The index number from the Waste Catalogue	Name of waste
	Packaging containing residues of hazardous substances or contaminated by dangerous substances	15 01 10	Metal packaging contaminated fats and oils
hazardous	The batteries of nickel-cadmium	16 06 02	Used batteries and accumulators (NiCd)
hazardous	lead acid batteries	16 06 01	Used batteries and accumulators (Pb)
	Wastes not otherwise specified	13 08 99	Mixed waste oil (motor, currency exchange, hydraulic)
hazardous	Non- Chlorinated mineral engine oils, gear oils and lubricating	13 02 05	Waste motor oil
hazardous	Waste oil for insulation and heat transfer	13 03 01	Old transformer oil
hazardous	Other oil for insulation and heat transfer	13 03 10	Waste transformer oil from voters voltage on the electrical locomotive
hazardous	Fluorescent tubes and other waste containing mercury	20 01 21	Waste fluorescent tubes and mercury and sodium lamps
hazardous	Wastes not otherwise specified	13 08 99	The emulsion of water and oil separator
hazardous	Motor fuel and diesel	13 07 01	Sludge from the bottom of oil tank
hazardous	Other fuels (including mixtures)	13 07 03	A residual amount of fuel oil from power plants
hazardous	Antifreeze containing dangerous substances	16 01 14	antifreeze

hazardous	Hazardous components removed from discarded equipment	16 02 15	Electrical and electronic waste containing hazardous components (computers, monitors, printers, tele-foni, ammeters)
hazardous	End of life vehicles	16 01 04	Waste electrical and diesel locomotives
hazardous	Oil filters	16 01 07	Waste oil filters, fuel and air
Hazardous	Scrap metal contaminated with dangerous substances	17 04 09	TRACK oily waste metal accessories (steel nuts, screws, staples, screws, wires)
Hazardous			Scrap metal from electric locomotives 441/461 contaminated fats and oils
Hazardous			Scrap metal with a diesel locomotive 641/661 contaminated fats and oils
hazardous	Other insulating materials which consist of or contain hazardous substances	16 01 21/ 17 06 03	Waste glass wool with electric locomotive 441/461
hazardous	Construction materials containing asbestos	17 06 05	Waste asbestos panels
hazardous	Insulation materials containing asbestos	17 06 01	Waste glass wool
hazardous	Absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing, which are contaminated with hazardous substances	15 02 02	Waste cotton and woolen cloths, gloves, work clothes contaminated with oil
hazardous	Discarded inorganic chemicals consisting of or containing dangerous substances	16 05 07	Waste chemicals for water softening (NALCO)
hazardous	Mixtures of grease and oil from separating oil / water other than those mentioned in 19 08 09	19 08 10	Liquid waste from OMS The plant effluent (water from the washing process locomotive Makiš)
hazardous	Wood containing dangerous substances	17 02 04/ 20 01 37	Prague oak - old
hazardous			Prague beech - old
			Prague beech - old length 2.5 m
			Prague beech - old length 2.6m
nonhazardous	Concrete	17 01 01	Old broken concrete
			Prag concrete - old
			Prag broken concrete

nonhazardous	Glass	17 02 02	Glass scrap
nonhazardous	Mixed waste from construction and demolition other than those mentioned in 17 09 01 and 17 09 02 and 17 09	17 09 04	Broken stone-old
nonhazardous	Waste arrangements of metal accessories (steel nuts, screws, staples, screws, wires)	16 01 17	Old tool of the iron Bandage - old Monoblock - old Lim steel - up to 3 mm Steel - iron from carriages and locomotives Parts of the carriages and locomotives - Class IV Steel - scrap iron scrap - 3 Steel - scrap iron scrap - 6 Steel - scrap iron scrap - over 10 mm Steel - old iron wire Steel - old springs Axles and sets - from old wagons and locomotives Bumper Plunger - old
nonhazardous	Iron and steel	17 04 05	Rails - old Rail in the trial cheats Rails abbreviations win over welded rails Shunting parts - old miscellaneous Rail accessories - old - various Iron bridge - old
nonhazardous	Ferozni metal	16 01 17	Brake shoes - old

			Gus – old
			Paleta boxing metal - old
			Scrap metal from electric locomotives 441/461 which is not contaminated
			Scrap metal with a diesel locomotive 641/661 which is not contaminated with fats and oils
			Aluminium - the old wastes
nonhazardous	Aluminijum	17 04 02	Aluminium - sheet metal remains
			Aluminium - an old poles p.p bumper
			Aluminium cords - old
nonhazardous	Non-ferrous metal	16 01 18	Copper - Old wastes
			Copper - wire without insulation - old
			Copper - wire with insulation - old
			Copper sheets - remains
			Bronze - Old wastes
			Silicon - bronze / wire /
			Silicon - bronze / wastes /
			Brass - an old wastes
			Brass shavings - Veneer
			Brass sheet metal remains
			Scrap copper from electric locomo-tives 441/661
nonhazardous	Tin	17 04 06	80% white metal - old
			White metal shavings - Veneer
	Zinc	17 04 04	Galvanized sheet metal wastes
			Galvanized pipe wastes
	Metals	20 01 40	Cables - old
	Lead	17 04 03	Lead - old

	Components that are not otherwise specified / cables other than those mentioned in 17 04 10	16 01 22/ 17 04 11	Waste copper wires and cables with a diesel locomotive 641/661
nonhazardous	Wood	17 02 01	The boards of the old wagon
			Waste of hard wood - MR 33
			Waste of hard wood - MR 42
			Waste of soft wood - MR 33
			Waste of soft wood - MR 42
			Build crossover - old
			Build The bridge - old
	Textile	20 01 11	Leather - old
	Plastic	16 01 19	Plastic wastes
	waste tires	16 01 03	Rubber - old
	Paper and paperboard	20 01 01	Paper - old
	Ash, slag and dust from boilers	10 01 01	ash
nonhazardous	Concrete, bricks, tiles and ceramics	17 01 02	Brick, opeka- old
		17 01 03	Tiles and ceramics - old
nonhazardous	Mixed municipal waste	20 03 01	Mixed municipal waste
nonhazardous	Other functions not otherwise specified	20 01 99	porcelain
nonhazardous	Mixtures or individual fractions of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	17 01 07	Tile plain old
*Data on types of waste generated in the "Serbian Railways" JSC were obtained from the Directorate of Infra-structure and Directorate of transport			

Temporary storage of hazardous and non-hazardous waste is carried out in a total of 279 stocks at 283 locations (individual stocks / warehouses are located spatially in multiple locations), "Serbian Railways" JSC. Most stocks (with buildings), and the site does not meet the legal standards for temporary storage of secondary raw materials.

Secondary raw materials that are enlisted performing maintenance work on the railway infrastructure and railway vehicles (old crushed stone, old wooden sleepers, waste wood, waste sheets and steel, old rail for rail accessories and old crossover parts, waste oil, old batteries, used batteries, electronic and electrical waste ...) must be temporarily stored in specially designated locations and warehouses (facilities) designated and equipped for the storage of these wastes.

“Serbian Railways” ad does not perform the treatment nor permanent disposal, but only the sale / submission of the authorized operator. Sale of waste is carried out in accordance with applicable laws and the Company's current price list "Serbian Railways" ad public auctions and individual sales.

Sale / delivery of waste follows the document of movement of waste. Testing of the waste in order to launch the procedure for selling / delivering waste.

6.8 Natural goods of special value

Determining the impact of the planned railway in the domain of natural heritage involves potential impact related to protected natural goods or natural heritage facilities that do not carry this categorization, but deserve special protection measures because of their characteristics.

Along the final section of the route, at a length of approximately 2.6 km, the railway enters the protected natural good – Nature Park “Sicevacka klisura”, III degree protection regime (Provision on the protection of Nature Park “Sicevacka Klisura”, Official Gazette of RS, 16/00). Part of the route prior to entry into the Sicevacka Gorge from approximately km 18+400 passes through a PBA area (Prime Butterfly Areas in Serbia), i.e. a potentially selected area for daytime butterflies in Serbia, as well as an International Plant Area (IPA). Likewise, part of the Sicevacka Gorge where the route passes, from approximately km 19+700, belongs to an international Important Bird Area (IBA), declared based on the criteria of the international bird protection organization Birdlife International. Based on the decision of the Nature Protection Institute no. 019-118/2, works involving digging up rocks to expand the subject matter railway corridor are prohibited, i.e. only a reconstruction of the existing railway track is possible.

Insight into the registry of protected natural goods showed that there are three sites along the analysed space that belong under this category. They are: Ribnik at the newly designed station Pantelej, Ornicje near Prosek, and Kovanluk to the west of Ornicje. Determining the impact of the planned railway on these facilities is a task requiring precise information on the sites and indicators related to the railway itself. The registered sites represent unexplored spatial environments without even the basic information on the precise spatial disposition, with data on the significance of these sites and required degrees of protection particularly lacking.

Should earthworks and other works encounter an archaeological find or objects, the contractor shall cease works without delay and notify the National Institute for the Protection of Heritage – Belgrade, and undertake the required protection measures to avoid damage or destruction of the find, and to preserve it at the place and position it was discovered in. The investor shall notify the National Institute for the Protection of Heritage in a timely manner on potential changes to the subject matter corridor, as well as the dynamics of works and the start of all earthworks.

The Law on Cultural Heritage obliges the investor and contractor, in case of encountering new, unregistered sites, to enable and provide for archaeological intervention. It consists of immediate cessation of works and the notification of the competent Institute for the Protection of Heritage on the discovery. This certainly requires occasional archaeological supervision during construction. The investor shall provide financial funds for all envisaged works – probing archaeological surveying, occasional archaeological supervision, protective archaeological interventions, etc.

6.9 Landscape

During construction certain areas will be temporarily used for setting up construction sites. Although they will only be used temporarily, the area will lose its vegetation cover, soil productivity and original morphology.

Localized impact will occur in places used to construct underpasses. Harmful impact on the landscape will be produced by local material borrow pits, depots and dumpsites.

Regarding the landscape, a large part of the spatial units along the route is degraded by the construction of existing transport connections and haphazard urbanization.

The construction of the bypass railway should not produce damage to the landscape. The railway route follows the lines of natural elements, all works will be undertaken in the existing corridor, therefore interventions in nature will be significantly reduced after the construction of the railway.

7 Environmental Impact Assessment in Case of Accidents

7.1 Expected type, amounts and characteristics of waste matter and potential accidents

According to data received from PE "Serbian Railways", the following hazardous substances are most frequently transported along the more frequent Serbian railways: glacial vinegar acid, sulphuric acid, gasoline, diesel fuel, propylene, 1.3-butadien, methyl TERT-Butyl Ether, methyl benzene. The above 9 hazardous substances were selected for this study to produce an environmental impact assessment in case of accidents.

According to data from the Catalogue of vehicles, hazardous substances use cisterns with steel reservoirs for liquids and gases, type Z 790 0 (volume 48 m^3) and Z 788 2 (volume 66 m^3).

Table 45:Characteristics of hazardous substances transported by railway

Name of hazardous substance	UN no.	Content ratio	Basic property	Hazard label	Warning label
Nitrous acid, HNO_3	2031	69%	Corrosive substance	C R35	S23; S/36/37/39; S26; S45;
Hydrofluoric acid, HF	1790	37%	Very toxic substance	T+; C; R26/27/28 R35	S24/25 S26; S28; S/36/37/39; S38; S45; S60
Oleum, sulphuric acid, H_2SO_4	1831/ X886	40%	Corrosive substance	R14 C, R35 Xi, R37	S1/2; S26; S30; S24/25
Hydrochloric acid, HCl	1789	33%	Corrosive and harmful substance	C Xi, R35,37,41	S1/2; S7/9; S23; S24/25; S26; S/36/37/39; S45
Glacial vinegar acid, CH_3COOH	2789/ 83	99.7%	Flammable liquid and vapours; Corrosive substance	R10 C, R35 H314 H226	S24/25; S26; S/36/37/39; S45 S51
Methyl TERT-Butyl Ether	2398/ 33		Highly flammable liquid	F; Xi R11-38	S 9-16-24
Liquid nitrogen	1977		Non-flammable gas	R35; R41; R44;R45	S2;S9;S12;S15; S/36; S/51
1.3-butadien	1010/ 239		Flammable gas	R1;R45	S9;S16;S33; S53;
NH_4OH	2672	24%	Harmful and irritating substance	Xi; R36/37/38	S2/26;

The Law on the Transport of Hazardous Freight "Off. Gaz. of RS", no. 88/10 of 1.12.2010) regulates the authorizations of state bodies and specialized organizations in the transport of hazardous waste, procedures in case of extraordinary events in the transport of hazardous waste and supervision over the enforcement of this law in road, railway, air and water transport.

According to this law:

- An extraordinary event is one where the transport of hazardous waste has been interrupted or stopped due to the hazardous freight being loose or the potential for the hazardous freight becoming loose.
- The transport of hazardous freight between sender and recipient encompasses: loading and transport from the dispatching to the receiving location, holding hazardous freight in the vehicle, cistern and container caused by traffic conditions prior to, during and after transport, as well as reloading to change the mode of transport and/or means of transport and temporary disposal and unloading of the hazardous freight.
- A participant in the transport of hazardous freight is a company, other legal person or entrepreneur who is the: sender, transporter, recipient, loader, packer, filler, user of the container cistern or mobile cistern, transport organizer and provider of reloading services while changing the mode of transport during the transport of hazardous freight.
- According to Article 8 of the above law, a participant in the transport of hazardous freight shall be ensured in case of damage to persons, property and the environment during transport, in accordance with the law.

Ratified international agreements for the transport of hazardous freight are:

- European agreement on the international road transport of hazardous freight (ADR);
- Agreement on accepting uniform conditions for the homologation and mutual acceptance of homologation of equipment and parts of motor vehicles ("Official Gazette of FPRY-International Agreements", no. 5/62);
- Appendix C to the Convention on International Rail Transport (COTIF)-Rulebook for International Rail Transport of Hazardous Goods (RID);
- Annex 18 of the International Civil Aviation Convention – Safe Transport of Hazardous Freight by Air and ICAO Doc.9284 AN/905 – Technical instructions for the safe transport of hazardous freight by air;
- European Agreement on the International Transport of Hazardous Freight by Interior Waterways (ADN);
- Convention on the Physical Security of Nuclear Materials.

These agreements also apply to the transport of hazardous freight occurring in its entirety within the territory of the Republic of Serbia.

The danger of consequences occurring in the transport of hazardous freight due to failure to apply ratified international agreements, laws on the transport of hazardous freight and bylaws adopted based on this law, is classified under three categories:

1) I category danger is danger for the lives of people or environmental pollution with long-term and expensive remediation of consequences;
2) II category danger is the danger of severe bodily harm to persons or considerable environmental pollution, as well as environmental pollution across a large area;
3) III category danger is the danger of inflicting light bodily harm to persons or slight environmental pollution.

In order to implement executive and related inspection and expert work in the field of hazardous freight transport, a Hazardous Freight Transport Administration is formed as an administrative body within the ministry competent for transport affairs (Article 9 of the Law on the Transport of Hazardous Freight).

A participant in the transport of hazardous freight shall use the type of packaging, i.e. vessels under pressure or cisterns with approval and valid reports on the testing of packaging, and/or vessels under pressure or cisterns for the transport of hazardous freight in accordance with the above international agreements.

Approval for the type of packaging, and/or vessels under pressure or cisterns for the transport of hazardous freight is a document issued by the Administration based on the Report on Testing, notifying the public thereof in the established way. A participant in the transport of hazardous freight in road, rail or water transport with its seat in the Republic of Serbia must have at least one advisor for safety in the transport of hazardous freight, other than in cases established by the above international agreements.

Candidates for Advisors are provided professional training by the company, and/or other legal person, based on the Advisor licence issued by the Administration. Certificates on the professional training for advisors are a document issued by the Administration. The classification of hazardous substances is implemented as per the international agreements for the transport of hazardous freight (ADR/ RID), under the following nine classes:

Class 1. Explosive substances
Class 2. Gasses under pressure, liquid or dissolved under pressure
Class 3. Flammable liquids
Class 4. Flammable solid substances
Class 5. Oxidizing substances
Class 6. Poisonous (toxic) and infective substances
Class 7. Radioactive substances
Class 8. Corrosive substances
Class 9. Mixed hazardous substances.

The basic characteristics of chemical accidents are as follows:

- They occur suddenly;
- Their location cannot be foreseen, impeding permanent prevention;
- They are accompanied by damage to vehicles and transport routes;
- The time of notification in case of accidents on open railways is delayed;
- There is immediate contamination of the immediate vicinity with large concentrations of the hazardous substance, and the development of contaminating clouds or penetration into waterways and ground water can make pollutants spread to larger areas.

The transport of hazardous substances is implemented in freight cars, cistern-cars, containers and container-cisterns. The hazard of occurrence of chemical accidents along the railway route exists, and it is possible due to the occurrence of traffic accidents and potential breakdowns on freight cars and cisterns used to transport hazardous substances. In case of such accidents, the most frequent occurrence is leakage of hazardous substances from damaged cisterns and pollution of the upper layer of the railway and surrounding soil, as well as ground and surface waters through the soil, and the destruction of plant life. Workers immediately participating in the transport or hazardous substances, and/or in the intervention for remedying the irregularity are also endangered.

7.2 Prevention measures

The “Serbian Railways” company has a Centre for internal control, safety and protection, closely cooperating with around 700 people from the immediate work processes in 12 railway hubs in Serbia. This staff submits reports of significance in this area to the above centre every morning, providing information on technical disasters. This information is regularly registered and processed at the Centre.

7.3 Liability measures

In case of technical accidents adequate activities are implemented, consisting of reporting on the accident to the dispatcher of the station by field workers, who in turn notifies their supervisors and the local police.

According to internal rulebooks a commission is formed, visiting the accident site.

Actions by railway staff in case of extraordinary events:

In case of disappearance-loss of hazardous substance during transport, in accordance with Rulebook 120 on the method of transporting hazardous substances in railway transport, the station personnel should undertake measures to locate it, and if needed report to the public on the hazard the substance represents for people and the environment. All stations along the SR network are obliged undertake the required measures for the protection of people and securing the environment in case of extraordinary events (accidents). If the type of hazardous substance cannot be determined, the intervention of a specialized team must be requested through the nearest police station.

Extraordinary events in transporting hazardous substances occurring in the station must immediately be reported to the dispatcher of the station or telecommand dispatcher, while extraordinary events on open railways are reported to the dispatcher of the nearest station. In addition to oral notification (by the fastest route), the railway worker reporting the extraordinary event must submit a written report to their supervisor.

The oral notification on the extraordinary event submitted by the railway worker must contain the key data, namely: the place and type of the event, whether there are human casualties and injured, as well as the temporary measures undertaken to secure the accident site. The dispatcher, upon receiving notification on the extraordinary event, immediately reports orally to the station chief, followed by the submission of a written report.

Extraordinary events in transporting hazardous substances, as a rule, are reported by the station chief within whose area the extraordinary event occurred.

The following need to be notified on extraordinary events in transporting hazardous substances:

- Dispatcher of the operational service, notifying the ZTP dispatch service,
- Nearest professional firefighting service,
- Nearest police station, and
- Technical-track service, train drive, ZIP and ETD.

In case of extraordinary events in transporting hazardous substances leading to one of the following consequences: death, severe injury or endangerment of human life, material damage or interruption of train transport, actions should be undertaken as per the provisions of Instruction 79 and the operating rules of the station.

Important telephone numbers: emergency stations, firefighting commands, trauma clinics and police, should be posted in a visible place.

If the leakage of the hazardous substance is of greater intensity, making the collection of hazardous substance into intervention vessels impossible and the unavoidable seepage of hazardous substance into the environment occurs, notifications must be issued to:

› Municipal alert centres,
› Regional water management company,
› General sanitation services, and
› Municipal civil protection staff.

In case of larger extraordinary events in transporting hazardous substances, of importance to the general public, PE SR must notify the national body competent for railway transport and the PR community upon receiving notification from the station chief, in turn notifying the Federal Committee for Transport and Communications.

Official notifications on extraordinary events in transporting hazardous substances to competent institutions must contain:

› First and last name of the notifying person,
› Location of extraordinary event (railway track in the station or kilometre distance between stations),
› Time of discovery of extraordinary event,
› Type of hazardous substance,
› Amount of potentially leaking liquid,
› Cause of leakage (type of irregularity or event), and
› Weather conditions.

7.4 Measures for remedying the consequences of accidents and recovery measures

The workers of PE “Serbian Railways” participate in the remedying of the consequences of the accident if the leakage of hazardous substance is of low intensity, and when collection of hazardous substance into intervention vessels is possible.

In case of larger extraordinary events in transporting hazardous substances, recovery procedures need to be implemented in the presence of representatives of the mobile eco-toxicological unit and experts of the Emergency Situation Sector of the MoI of the Republic of Serbia. The recovery procedure is implemented by specialized companies holding licences for implementing such interventions.

8 Description of Measures Envisaged to Prevent, Reduce and Remedy Any Harmful Environmental Impact

Based on the fact that any human activity causes disturbances to the natural environment, and hazards cannot be completely avoided, i.e. full protection from air, soil, surface and ground water pollution cannot be ensured, measures and procedures are proposed to minimize risk.

8.1 Measures envisaged by law

List of legal regulations in the field of environmental protection and railway infrastructure:

- Environmental Protection Law (Off. Gazette of RS no. 135/04,36/09 and 72/09, 43/11 i 14/16),
- Law on the Environmental Impact Assessment (Off. Gazette of RS no. 135/04, 36/09),
- Law on Planning and Construction (Off. Gazette of RS, no. 72/2009, 81/2009 - corr., 64/2010 – CC decision, 24/2011, 121/2012, 42/2013 – CC decision, 50/2013 – CC decision, 98/2013-CC decision, 132/2014 and 145/2014)
- Nature Protection Law (Off. Gazette of RS, no. 36/09, 88/10, 91/10 and 14/16,),
- Air Protection Law (Off. Gazette of RS, no. 36/09,10/13),
- Law on the Protection from Noise in the Environment (Off. Gazette of RS, no. 36/09 and 88/10),
- Law on Waste Management (Off. Gazette of RS, no. 36/09, 88/10 and 14/16),
- Law on Waters (Off. Gazette of RS, no. 30/10 and 93/12)
- Law on Health and Safety at Work (Off. Gazette of RS, no. 101/05, 91/15),
- Law on Cultural Heritage (Off. Gazette of RS, no. 71/94, 52/2011 – oth. laws and 99/2011 oth. law),
- Law on Agricultural Land (Off. Gazette of RS, no. 62/06, 65/08 and 41/09 and 112/15),
- Law on Forests (Off. Gazette of RS, no. 30/10, 93/12 and 89/15),
- Law on the Transport of Hazardous Freight (Off. Gazette of RS, no. 88/2010),
- Law on Explosive Substances, Flammable Liquids and Gasses (Off. Gazette of FRS, no. 44/77, 45/85, 18/89, Off. Gazette of RS, no. 53/93, 67/93, 48/94),
- Law on Fire Protection (Off. Gazette of RS, no. 111/2009 and 20/2015)

- Rulebook on the contents of the environmental impact assessment study (Off. Gazette of RS, no. 69/05),
- Rulebook on the permitted level of noise in the environment (Off. Gazette of RS 54/92),
- Rulebook on the methodology of acoustic zones (Off. Gazette of RS no. 72/10),
- Rulebook on the methods for measuring noise, contents and volume of reports on measuring noise (Off. Gazette of RS no. 72/10),
- Rulebook on protection at work in implementing construction works (Off. Gazette of RS, no. 53/97),
- Rulebook on preventive measures for safe and healthy work with noise exposure (Off. Gazette of RS, no. 96/2011 and 78/15)
- Rulebook on the categories, testing and classification of waste (Off. Gazette of RS, no. 56/10),
- Rulebook on the conditions and method for sorting, packaging and preserving secondary raw materials (Off. Gazette of RS no. 55/201, 72/09),
- Rulebook on the method of storage, packaging and labelling of hazardous waste (Off. Gazette of RS, 92/10),
- Rulebook on the method and minimum number of testing of the quality of waste water (Off. Gazette of RS, no. 47/83, 13/84),
- Rulebook on hazardous substances in waters (Off. Gazette of FRS, no. 31/82)
- Rulebook on the method for determining and maintaining zones of sanitary protection for water supply sources (Off. Gazette of RS, no. 92/08),
- Rulebook on abolishing the Rulebook on limits, methods of measuring emissions, criteria for establishing measurement points and data recording (Off. Gazette of RS, no. 54/92, 30/99, 19/2006), Off. Gazette of RS, no. 75/2010
- Rulebook on the content of air quality plans (Off. Gazette of RS, no. 21/10),
- Rulebook on the permitted amounts of hazardous and harmful substances in soil and water for irrigation and methods for their testing (Off. Gazette of RS, no. 23/94),
- Rulebook on fuel transport (Off. Gazette of SFRY, no. 26/85);
- Rulebook on the methodology for the assessment of danger of chemical accidents and environmental pollution, measures for preparation and measures for eliminating the consequences (Off. Gazette of RS, no. 60/94, 63/94),
- Rulebook on the construction of fuel supply stations for motor vehicles and storage and transfer of fuel (Official Gazette of SFRY, no. 27/71 and 29/71 - corr. and Off. Gazette of RS, no. 108/2013),

- Rulebook on the conditions, method and procedure for managing waste oils (Off. Gazette of RS, no. 71/10),
- Rulebook on special technical-technological solutions preventing unfettered and safe communication of wild animals (Off. Gazette of RS, no. 72/10),
- Rulebook on the limits of exposure to non-ionizing radiation (Off. Gazette of RS, no. 104/09)
- Rulebook on sources of non-ionizing radiation of special interest, types of sources, methods and periods of their testing (Off. Gazette of RS, no. 104/09)
- Provision on establishing the List of projects requiring mandatory impact assessments and List of projects that may require environmental impact assessments (Off. Gazette of RS, no. 114/08),
- Provision on the methodology for the development of emissions inventories and projections of air pollutants (Off. Gazette of RS, no. 3/16)
- Provision of the measurements of emissions of air pollutants from stationary sources of pollution (Off. Gazette of RS, no. 5/16)
- Provision on limit values for emissions of air pollutants from combustion plants (Off. Gazette of RS, no. 6/16)
- Provision on the limits for emissions of polluting substances in the air (Off. Gazette of RS, no. 71/10).
- Provision on the programme of systemic monitoring of the quality of soil, indicators for the assessment of risk of soil degradation and methodology for drafting remediation programmes (Off. Gazette of RS, no. 88/10),
- Provision on noise indicators, limits, methods for the assessment of noise indicators, disturbance and harmful effects of noise in the environment (Off. Gazette of RS, no. 75/10),
- Provision on the conditions for monitoring and requirements of air quality (Off. Gazette of RS, no. 11/10, 75/10 and 63/13),
- Provision on the limits for emissions of polluting substances in waters and deadlines for achieving them (Off. Gazette of RS, no. 67/2011 and 48/2012);
- Provision on the limits of polluting substances in surface and ground waters and sediment and deadlines for achieving them (Off. Gazette of RS, no. 50/2012);
- Provision on the limits of priority and priority hazardous substances polluting surface waters and deadlines for achieving them (Off. Gazette of RS, no. 35/2011);
- Provision on health and safety at work at temporary or mobile construction sites (Off. Gazette of RS, no. 14/2009 and 95/2010)
- Instruction 79 on procedures in case of extraordinary events (Off. Gazette of the CYR no.9/92 and 10/92),

› Rulebook 120 on the method of transporting hazardous substances in railway transport (Off. Gazette of the CYR no. 7/92, 25/92)

Table 46 provides a tabular overview of legal obligations in the field of environmental protection for numerous elements of the environment – management of hazardous substances, release of waste waters, protection of natural and cultural heritage, noise, soil and water pollution, storage of hazardous substances.

Table 46:List of legal obligations in the field of environmental protection

Legal requirements		
Environ-mental elements	Limitation, obligation or recommendation	Comment
Management of hazardous substances	Appoint persons re-sponsible for man-agement of hazardous substances	Appoint an employee to be re-sponsible for hazardous sub-stance management
	Identification or clas-sification of hazard-ous substances used in the company and records of hazardous substance movements	Identify and sort hazardous sub-stances in the company Keep records of the movement and hazardous substances in the company (entry, movement, use)
	Keeping records on chemical accidents	Keeping a central registry and book of minutes (type of sub-stance, amount, consequence, remediation measure, etc.)
	Implementing re-sponse measures to chemical accidents in accordance with the programme of measures	The company undertakes re-sponse measures to the accident
	Elimination of conse-quences of chemical	In case of chemical accidents, the company undertakes

	accidents and keeping records on the activities undertaken	measures to eliminate environmental consequences (remediation and recultivation).
	Reporting to competent bodies on the annual movement of hazardous substances.	Annual reporting to the competent ministry on the movement of hazardous substances.
Soil and water pollution	Select locations where accident leakage will cause the least damage	Avoid flood areas, locations near potable water sources, poor hydro-geological conditions, etc. Choose the lowest category and utility value soil. Where possible and economically justified, apply equipment not containing oil (e.g. transformers, switches and separators filled with SF6)
	Planning protection measures from uncontrolled oil leakage during construction and reconstruction of TS and laying of underground cables	Design protective beds of adequate volume, separate oil sewage, oil separators. Maintenance should periodically refresh equipment and change seals, regardless of their state.
	Securing pylon transformers by protective beds	Provide adequate protection at least in settlements and special protection zones.
	Monitoring of oil leakage	Regular supervision over equipment with oil, particularly in locations without human crews.
	Notification of competent services on all accidents that may lead to soil and water pollution	Notify competent services upon identifying an accident.

	Elimination of the consequences of pollution by hazardous substances	In case of accident, the company shall apply adequate measures to decontaminate the soil and waters.
	Recording accidents with oil leakage	Record all oil leaks, particularly leakage of greater amounts that may lead to soil and water contamination.
	Regular training of employees and control of readiness to react in case of accidents	Implement an employee training programme and control of their training and readiness to act in case of accidents
Waste management	Selection at the collection of hazardous waste	Maximize the degree of waste separation.
	Categorization and characterization of collected waste.	Implement categorization and characterization in accordance with the law.
	Securing conditions for temporary storage of waste, particularly hazardous waste, preventing soil and water pollution	Use technical measures to eliminate risks of pollution of soil and water by waste (safety beds, reservoirs, etc.)
	Measuring and recording waste	Introduction of a system for measuring and recording the creation and movement of waste
	Implementing measures for the prevention of the creation and reduction of the amounts of created waste	Company obligations prescribed by law.

	Recycling of collected waste	Collection and regeneration of used oil Oil is to be sent for recycling to the Belgrade Oil Refinery (RNB*).
	Handover of waste for treatment to licenced companies.	Hazardous waste is to be submitted for treatment to authorized companies (e.g. batteries and accumulators)
	Reporting to the Ministry and Environmental Protection Agency on waste flow	Report to competent bodies
	Close cooperation with competent bodies	Contacts with the competent ministry and Environmental Protection Agency.
Waste water release	Produce technical documentation in accordance with the water conditions	Harmonize practice with limitations defined by law.
	Waste water quality control	The water management permit will prescribe the subject and frequency of control for waste water quality.
	Implementing supplemental protection measures in case of inadequate waste water quality.	In case of deviations of the quality of waste water from the defined levels, competent bodies order the implementation of supplemental protection measures.
Noise	Planning of protection measures (sound barriers)	-If an increased level of noise in the environment is indicated (Impact Assessment), the design is to envisage supplemental protection measures

		-Choose equipment with the lowest noise emission (in accordance with EU standards) -Implement noise protection measures during the construction phase, particularly in settlements: mobile sound barriers, choice of work hours, construction site organization, etc.
	Identifying critical points for noise above permitted levels	Analyse the disposition of equipment, immediate environment, identify the most critical points of emission of excess noise.
	Periodic noise control at critical points.	Measuring noise environmental noise levels by engaging an authorized organization.
	In case the noise is at the limit of permitted levels, implement supplemental noise protection measures	If increased noise levels are registered, the competent inspection shall order supplemental noise protection measures.

8.2 Measures to be undertaken in case of accidents

The workers of PE "Serbian Railways" shall participate in eliminating the consequences of accidents if the leakage of hazardous substance is of lower intensity, when the collection of the hazardous substance in intervention vessels is possible.

In case of extraordinary events in transporting hazardous substances of greater amounts, a recovery procedure needs to be implemented in the presence of representatives of the mobile eco-toxicological unit and experts from the Emergency Situation Sector of the MoI of the Republic of Serbia. The recovery procedure is implemented by specialized companies holding permits to implement such interventions.

8.3 Environmental protection plans and technical solutions

8.3.1 Testing the environmental baseline

The measurement of the baseline noise should be implemented prior to initiating construction at predefined measurement points, particularly in places where noise protection structures will be set up, in order to monitor noise levels both during construction and during utilisation.

Prior to construction produce a **Monitoring Plan** for environmental factors (air, water, soil, noise) for the subject matter section of the railway.

8.3.2 Measures of protection during railway construction

Table 47: Environmental impact during construction and measures planned to mitigate the impact

No.	Direct impact	Prescribed measures
1.	Water and soil pollution by oil, fuel, lubricants during storage and transport	Waste oil is to be disposed of in closing barrels. If waste oil is not transported away immediately upon replacement, provide such space for temporary storage of barrels providing for avoidance of leakage to surrounding areas (in bays, under eaves).

		Cover the disposal area with concrete, and capture all atmospheric waters from that surface and lead to a grease and oil separator. The procedure of oil replacement on machinery should be implemented on surfaces planned for this and by laying protective beds underneath points of potential leakage. Vehicle maintenance at the construction site is prohibited. Vehicles are to be maintained only in the designated workshops.
2.	Silting and pollution of waterways during construction works	The entry of vehicles into waterways during construction is prohibited. If it is necessary to cross waterways in machinery at certain construction points, the construction of crossings in such points is mandatory, in order to avoid direct contact of machinery with the waterway.
3.	Soil, surface and ground water pollution due to inadequate drainage of surface waters at official points	Adequately solve drainage in stations and at stops in order for water from atmospheric precipitation to collect rapidly and efficiently and prevent soil, surface and ground water pollution.
4.	Soil, ground and surface water pollution during disposal of construction waste to temporary dumpsites along the railway	Depending on the type of material, cover in concrete or foil, fence off and adequately level the dumpsite so that all potential polluted atmospheric waters are led through a drain or by eaves to the sedimenter and separator of oils and grease.
5.	Air pollution by the operation of asphalting machinery.	Use and apply control equipment to prevent air pollution.

6.	Local creation of emissions of dust, noise and vibration that may present disturbances to the surrounding population and animal life	Periodic wetting of materials and terrain during railway construction. The contractor shall cover trucks during transport. Install protection on machinery and construction equipment. Limit working hours (e.g. until 6-7 PM) in settlements. Prohibit the operation of machinery in neutral shift. Application of mobile noise protection structures. Temporary construction sites and vehicle parking are to be set up as far as possible from settlements.
7.	Waste at official points and along the railroad on the open railway	Set containers at official points for communal, recyclable and hazardous (electronic) waste. Provide waste containers along the railway to be driven by the utility company to the communal waste dump.
8.	Poor sanitary protection and disposal of solid communal waste in camps and construction sites.	Provide adequate sanitary rooms and containers for communal waste and containers for recyclable waste.
9.	Disposal of dirty gravel during the demolition and dismantling of the existing railway	Determine the type of waste (hazardous, non-hazardous) Define a space for disposal, as well as conditions for disposal in order to avoid soil pollution (laying down foil or soil remediation)

	Digging up of earth and disposing of excess earth at the contractors discretion	The Final Design must define locations for earth borrow pits, as well as locations for disposing of excess earth.
10.	Potential transmission of communicable diseases to the local population	Secure regular medical check-ups for workers and their treatment.
11.	Movement of heavy machinery and vehicles with materials and equipment along existing roads	Bypass roads for vehicles used in construction to improve travel times along existing roadways. Secure priority roadways and transport lanes for bringing materials and equipment in and out.

Nature protection measures

According to the Decision on the protection of nature 03 number 019-118 / 2 of 26.06.2015., Issued by the Institute for Nature Conservation of Serbia, RJ Niš, the area in bypass lines, a distance of about 2700m is located on a protected natural good nature park "Sićevačka Klisura", the III degree protection regime. Consequently must be observed the following conditions:

• On the part of the bypass rail route in the city of Nis, which is located in the Park "Sićevačka Klisura", which coincides with the already existing alignment stripes, it is forbidden to carry out works which include excavation wall for enlargement of the railway corridor, that is possible only reconstruction of the existing railway line. Also, in the Nature Park "Sićevačka Klisura", especially with the entrance of the cave, for-defended the plan urine and distort the natural structure of the high and low vegetation, cutting cave flowstone, etc .;

• Plan to woody and shrub vegetation along the planned route of the respective stripes provide a way to avoid the same damage, its root system, etc., due to the manipulation of construction machinery, transport vehicles, as well as the storage of equipment, installations, etc .;

• If the project foresees the removal of woody vegetation it is necessary to obtain a remittance of JP "Srbijasume";

• It is forbidden to plan changes the existing regime of surface and ground water, or perform any exploratory drilling and hydraulic works without having proper documentation and previously acquired relevant opinions, conditions or consent of the competent institutions. The aforementioned means that it is not allowed to plan backfilling, rearrangement and relocation of the river Nisava and other watercourses in the area concerned. Also, it is forbidden to plan the work, which can cause blurring of waterways for more than five consecutive days;

• Planned works and measures on regulation of the banks of the river Nisava should not cause changes to the hydrological regime downstream from the regulation, which anticipates the post-possibly to regulate the flow Nisava be carried out as much as possible the so-called. Natural way, using natural materials such as earth and stone. In addition, it is prohibited to disturbing or changing the direction of flow of the river Nisava, rearrangement of the watercourse, the expansion of the building by-area belonging to the shores of the watercourse, and it is necessary to provide for measures prohibiting the closing of the migratory aquatic animals, planning, execution of any work in the coastal zone that may threaten stability and morphology of the coastal belt, with the aim of maintaining the physical structure of stream banks;

• It is forbidden to carry out work that may cause engineering geological processes. In the event that during the execution of the planned works comes to soil erosion from the surrounding slopes, the project is to urgently take appropriate anti-erosion measures;

• During the execution of works it is necessary to separate the eventual humic materials and later use it with the terrain along the route of the railway;• Space on the route of the railway infrastructure need to be fully equipped according to environmental standards, which prevent a negative impact on nature;

• If the planned construction of ancillary facilities to the relevant bypass tracks, it must fit into the ambience of the area, and plan to connect them to the existing network infrastructure. If there is no possibility of connecting the facility to the existing sewer network to plan the construction of septic tanks;

• During the execution of works on the construction of the railway, it is prohibited to discharge decomposition by-line, as well as the dumping of waste into waterways and soil. Quite-piece construction, and when using the respective stripes predict areas for temporary storage of waste (construction, etc.). By the same evacuation to landfill. Construction and municipal waste generated during construction is with the protected area and go to the dedicated containers;

• It is forbidden to light fires in the area of protected natural asset;

• Approximately existing and newly planned facilities on the respective bypass rail plan the planting protective vegetation. When choosing planting material to use species that are biologically resistant, resistant to adverse impacts (exhaust gases, etc.),

Aesthetically acceptable and adapted the surrounding area and its intentions. Avoid allergens and invasive species;

• During the execution of works it is necessary to take all measures to prevent spillage of fuel, lubricants and other harmful and hazardous substances in the won-ljište, surface water and groundwater;

• After finishing the work necessary to repair the terrain along the route of the respective bypass line;

• If the area of the route line encountered geological and paleontological documents (fossils, minerals, crystals, etc.), Which could assume a protected natural value, in accordance with the provisions of the Law on protection of nature, the finder is obliged that within eight days since the invention of the findings to inform the ministry responsible for environmental protection and take measures to protect against destruction, damage or theft to the arrival of an authorized person.

Immovable cultural goods and goods under previous protection measures

According to the Act on the conditions of storage, maintenance, use and established measures to protect cultural property and goods that enjoy previous protection of importance for the General Regulation Plan bypass railway in the city of Nis, which issued the Institute for Protection of Monuments of Culture Niš, no. 814/2 of 19.06.2015., It is necessary to implement the following measures for the protection of goods with monumental traits:

• If during the execution of construction and other works finds archaeological sites or archaeological objects, Contractor shall immediately, without any delay, stop work and inform the competent Institute for Protection of Monuments of Culture and to take measures to report destroyed and damaged and to be kept in place in a position where it is detected;

• The investor of the facility is required to provide funding for research, protection, preservation, publishing and exhibiting good that enjoys previous protection that are discovered during the construction of investment object - to the deposit protection authorized institution;

• Plan to provide for archaeological research on the possible newly discovered sites, in terms of protection and presentation of immovable cultural heritage;

• Ensure conditions for the development of the necessary studies on the evaluation of goods with monumental traits in the territory of the area bypass rail, which should contain all the information about all relevntne buildings or sites, processed so as to provide the individual may establish specific conditions and protection measures

(Study creates territorial competent Institute for protection of Cultural Monuments of Niš, and funded by investors of the Plan)

• Creating a complete professional and detailed technical documentation of all goods recorded under the previous protection;

• It is necessary to plan solutions that emphasize the value of goods under previous protection (except for goods that have a documentary character and will not be permanently kept);

• Create conditions for full and permanent protection of goods under previous protection, revitalization and presentation, conservation and restoration works and other appropriate methods, primarily by engaging in further development flows;

• The obligation of owners, users and other entities that have good, that every object with monumental traits devote full attention by obtaining and implementing special conditions and measures for the protection by the competent Institute for the Protection of Cultural Monuments of Niš, in any interventions in accordance with the law;

• Increasing the size and number of floors with upgrades and similar interventions in goods with monumental traits protection should be planned with the greatest responsibility in exceptional, justified cases and in close consultation with the territorially competent Institute;

• It is necessary to create the conditions for the correction all negative occurrences in relation to goods with monumental traits. This is primarily related to the elimination of planned and implemented interventions in space, which directly or indirectly endanger the monumental value, but also to all implemented or planned inadequate and undesirable intervention in certain protected objects;

• Insist on establishing a harmonic spatial harmony in environments with monumental values, designing in context, reliance on the value of cultural heritage in the region and other methods that contribute to achieving higher range and improvement of architectural creativity in the covered area.

8.3.3 Protection measures during railway utilisation

Based on the fact that any human activity causes disturbances to the natural environment, the following measures and procedures are proposed for minimizing risk:

Air protection measures

The utilisation of the newly designed electrified bypass railway does not significantly harm air quality in the given area, therefore no protection measures are required.

Soil, ground and surface water protection measures

The project foresees the removal of surface water and storm water drainage system of the railway to the town storm sewers (where the city storm sewer exists) or planned (where planned urban storm sewer).

Until the construction of the city's storm sewer (where planned urban storm sewer), surface water and storm water drainage system from the railway to the open drain channels onto the rails.

In open channels the rails drains and atmospheric and surface water drainage from the area where there is not planned construction of the city's storm sewer.

It is not allowed the disposal of rainwater and drainage of surface waters in the city fecal sewage network.

In new railway stations Sever Niš, Pantelej and Vrežina project is planned sewerage system and connection to the city sewer future in this area. Drainage of storm water is provided for designing storm sewers and their connection with the planned urban sewage.

In case if railway stations are buid before before the construction of fecal sewage network for the collection of sanitary-faecal waste water from stations in the Project for execution foresee watertight septic tanks of appropriate volume, or other technical solutions that prevent soil and water pollution due to their uncontrolled release.

If watertight septic tanks are build, the same discharged by an authorized public utility company.

It is prohibited to discharge of sanitary fecal waste water in open channels, black holes, etc.

According to the conditions prescribed by the public utility company for water supply and sewerage "Naissus" (no. 5862/2 of 30.04.2014.- given in the appendix), as well as the conditions for the development of general regulation bypass rail in the City of Nis no. 15732/1 of 08.06.2015. requires the following::

- During the elaboration of General and Preliminary Design for the construction and the exploitation take care of safety of water supply facilities built and channeling the subject area. In the protection zone of the pipeline prohibits any construction objects that can disrupt the pipeline's stability.

- In case of relocation / reconstruction of water supply and sewerage network at the intersection or parallel keeping with the proposed route of the bypass rail development projects is necessary relocation / reconstruction of existing public facilities of water supply and sewage systems. During the development of projects of relocation / reconstruction of water supply and sewage are obliged to consult with the responsible designers sector investment and development JKP 'Naissus' s related to water supply and sewage crossing with the railroad, to determine the profile of plumbing, pipe material selection and the selection of fittings.

- It`s not allowed the drain connections of the track from the existing public sewerage water use

- It is necessary to construct storm sewers to the planning documents in the streets where it is planned to join the drainage outfall

- For the foundations of bridges minimum distance from the nearest outer edge of the foundations and pillars of any facilities and installations related to most of the public water supply and sewage is 2m.

- For a more accurate determination of conditions for the project documentation of new bypass rail is necessary to define future public protection zone lines, or border railway land, leveling solution and elements related to the electrification of railways, telecommunications and relay devices.

- Setting up a new bypass rail within the new route should be coordinated in accordance with the terms of the current planning documents for the city of Niš especially when it comes to the development of the sewage system, which will be given in terms of the Institute of Urban Planning Niš.

- From the aspect of environmental protection, in order to maintain proper drinking water at all stages as well as in the planning stage, to undertake all activities related to the protection zones of sources, reservoirs and all the objects important to the water supply of the City of Nis.

It is required to make a water regulation in the following streams, at the intersection with the railroad facilities:

Name of watercourse	chainages route line (km)	crossing facility
Rujnički stream	4+825	bridge
Matejevački stream	11+598	bridge
Suvodolski stream	13+161	bridge
Stream Vrežina	15+203	culvert
Malčanska river	17+742	bridge
Stream Radostina	19+548	culvert

Table 48: Places on the line where the necessary water flow regulation

The projected railway route runs alongside the right concave banks of the river on the section km 18 + 448 - km 18 + 679 chainage railvay. In this part of the route to build a railway on the plateau, formed by filling shoreline behind the retaining wall along the right bank of the river Nisava, founded on piles. Retaining wall has a length of 230m and a height of 9.0m. The crown of the wall at a height 218.53mnm, that 6m above the thousand-knows-like water of the river Nisava. In order to protect the coast and the retaining wall from the harmful effects of water on this stretch of coastline provide Nisava a distance of about 250 m, dam made of crushed stone, mean diameter 50 - 70cm, the slope of 1: 2.

In official places set up containers for communal, recyclable and dangerous (e) waste.
Somewhat more pronounced impact on the quality of groundwater and surface water occurs in the treatment of weeds with herbicides. To this impact to a minimum are defined safeguards against the use of herbicides.

Railroad maintenance through the use of herbicides

Chemical suppression was proven to be the most efficient method for eliminating annual and perennial herbaceous and bush weeds. During phytocenological surveys in 2006 and 2007, the dominant weed species, as well as their numbers and coverage were determined, used to propose solutions for their suppression. Earth herbicides (flumioxazine) were applied from April to May, while foliar (flazasulphuron, triklopir and glyphosate) in early May and during June. A combination of earth and foliar herbicides was applied during May and June, when the growth of woody and perennial weed vegetation is strongest. Efficiency assessments were conducted after 30, 60 and 300 days following application (EPPO/OEPP, 1998).

Following the assessment of herbicide efficiency, the best action was determined to be produced by a combination of earth and foliar herbicides: flumioxazine+glyphosate (0.24 kg/ha+6 l/ha) with the use of 300 l of water per hectare. This combination is recommended for treating sections of the railroad with increased weeding of annual and perennial broad-leaf and narrow-leaf weed species. This combination does not act on woody weed species, where a preparation based on the active substance triklopir (5 l/ha) is recommended, or a combination with preparations based on glyphosate (6+6 l/ha). The combination of foliar herbicides triklopir + glyphosate (6+6 l/ha) has proven to have a high efficiency against perennial herbaceous and woody species, while the combination flazasuphuron+glyphosate (0.25 kg/ha+6 l/ha) was proven more efficient for perennial herbaceous species. The combinations flumioxazine+glyphosate and triklopir+glyphosate stand out with their efficiency. The list of preparations whose production, trade and use are permitted in our country have been published on the website of the Ministry of Agriculture (http://www.uzb.minpolj.gov.rs/index.php?option=com_content&view=article&id=250%3A2012-07-13-16-41-29&lang=en). The amounts of applied herbicides cannot be calculated in advance, since they depend on the situation in the field:

- Degree of weed presence along the route,
- Type of preparation to be used,
- Time of application of substances.

Roughly speaking, the amounts of application have their end limits: minimum 2 l/ha, maximum 12 l/ha, also valid for preparations based on Glyphosate. Approximately similar amounts are used for other preparations applied to non-agricultural surfaces.

The treatment of weed vegetation could impact surrounding agricultural systems unless the contractors adhere to the prescribed instructions, because only correct selections of active substances, proper use and proper disposal of empty packaging minimize negative effects.

Weed treatment on non-agricultural surfaces is implemented once to twice per year, depending on the situation in the field, i.e. depending on which area of the railway route is to be freed of present weed species and what amount of vegetation may be tolerated. Earth herbicides are used during intensive weed growth, during the period April to May, while foliar herbicides are used in early May and during June, during the phase prior to the full blooming of weeds.

Measures of protection from the use of herbicides

Treatment cannot be implemented near fruit orchards (particularly stone fruits) and treelines, as well as inclined surfaces where it can wash off and damage cultivated plants. Local residents must be informed of the beginning and duration of treatment of weeds (by placing signs and notices in local media), in order to prevent access by domestic animals as many days as envisaged by the instructions of the applied preparation. Water protection zones should be respected during treatment, and water contamination should be prevented (waterways, wells, water springs), by treatment at least 20 m away from them, and 300m away from forest springs. Keep account of wind velocities, do not spray in strong wind. Avoid application during the hottest part of the day. During treatment, personnel must wear protective equipment. In case of accidents or nausea, request medical advice and show the label and instructions to the doctor. Empty herbicide packaging, as well as expired amounts of unspent pesticides should be treated in accordance with the Rulebook on the types of packaging for pesticides and fertilizers and the destruction of pesticides and fertilizers (Official Gazette of FRY, no. 35/99 and 63/01), i.e. they are returned to agricultural pharmacies for further transport, storage, destruction or recycling.

As an alternative to chemical measures, physical methods of weed elimination may be used, involving manual removal, reaping of weeds before fruition and application of overheated water, i.e. water steam. Physical methods are safer, but harder to implement and less efficient for eliminating vegetation. Attention should be given to the economic justification of such undertakings. Physical methods can be the solution where the risk of applying chemical methods is excessive.

Measures for the protection of flora and fauna

On protected areas and within their protection zones it is forbidden to:
- Open borrow pits and dispose of waste materials;
- Temporarily and permanently dispose of hazardous substances;
- Set up any kind of temporary building or materials required for railroad works;
- Park and repair machinery, pour fuel and lubricants, etc. In case of accidental leakage of hazardous substances.

Within the Sicevacka Gorge, under the III degree protection regime, it is prohibited to: disturb, destroy and collect protected species of flora and fauna; introduce alien plant species, other than to prevent erosion and landslides in construction areas; cut and destroy trees, bushes and other vegetation, when this endangers biodiversity and the stability of natural ecosystems and causes erosion processes; implement works and activities that would disturb the geomorphological properties of the area; build infrastructural and other facilities or implement works that pollute the air, soil and waters; dispose of communal and industrial waste and secondary raw materials.

Waste protection measures

Serbian Railways" and Contractors will adopt a hierarchy of waste management in the work of railways (prevention, reuse, recycling, refurbishment, and disposal), including the following:

• It provides the public garbage cans in passenger trains and stations inside buildings;

• Waste containers for use by maintenance personnel and personnel the railway train station will be provided, and the waste will be separated;

• Hazardous waste from maintenance of the railway will be separated and temporarily stored inside the adequate equipped space. Hazardous waste will be delivered to authorized companies for waste management in the manner and in accordance with legal regulations on the transport, treatment and disposal of waste, and will be accompanied by appropriate documentation.

Noise protection measures

Reducing the impact of noise can be achieved by various methods:

- Planting protective areas growing between the the railway and endangered objects

- Placing windows with acoustic insulation on facades exposed to noise - passive protection measures

- Appointment of sound barrier - walls for protection against noise.

Since the immediate vicinity of the given section holds a large number of residential facilities, it is necessary to implement adequate measures of protection from undesirable impact by traffic noise. The most important measures to protect the construction of walls for protection against noise.
This measure of protection primenitii in places where there are the most vulnerable groups of objects. When choosing the type of wall should take care of criteria to be met:

- Resistance to weather conditions

- Rational construction

- Visual effect

- The possibility of pre-fabricated construction

- The ability to upgrade

- Spatial harmonization

- Easy maintenance

For permanent way, open line and in the stations, use the elastic fastenings, and on bridges, overpasses and through the urban city zone elastic rugs under the surface, which will contribute to mitigating the potential impacts of noise.

Noise monitoring is recommended during railway utilisation, and not only in settlements, in order to adequately react in case of exceeding permitted values.

It is also important, as an additional protection measure, to ensure that in the future the construction of residential facilities is not permitted at distances from the track axis where permitted noise levels may be exceeded, which was not the case until now, monitor the state of noise with increasing traffic load.

Vibration protection measures

For permanent way, open line and in the stations, use the elastic fastenings, and on bridges, overpasses and through the urban city zone elastic rugs under the sur-face, which will contribute to mitigating the potential impacts of vibration.

Radiation protection measures

The project envisages reconstruction of electric traction substations (EVP) in Nis. How pursuant to Article 4 of the Ordinance on the sources of non-ionizing radiation is of particular interest, the manner and period of their studies ("Official Gazette of RS", no. 104/09) reconstructed sources belong to the sources of non-ionizing radiation is of particular interest, it is necessary (in accordance with Articles 6 and 7 of the said Ordinance):

- obtaining conditions and environmental protection measures issued by the competent authority in accordance with regulations governing the protection of the environment;

- Assess the environmental impact in the proceedings conducted by the competent authority before issuing permits for their construction or installation and use in accordance with the regulations governing the assessment of the impact on the environment.

After the construction, installation or facility that contains a source of non-ionizing radiation, before issuing a permit to start work or use permit shall be the first test, and measure the level of electromagnetic fields in the vicinity of the source. For the purposes of the first tests the user can source electromagnetic fields put into trial operation in the period not longer than 30 days or for telecommunication facil-ities can perform measurements within the technical inspection. The body responsible for technical inspection, or for the issuance of permits to begin work or occupancy permit for the building that contains the source of non-ionizing

radiation is of particular interest can be started if the source is determined by measuring the level of electromagnetic fields do not exceed the prescribed limit values and building blocks, or placed object will not endanger their work environment. Provision elektromagenetnog field measurements every 4 years.

• Contact Network

Protection from accidental contact with segments under voltage is achieved by applying the prescribed distance from lines under voltage, isolation, protective barriers, warning plates and labels. Short circuit protection in the 25 kV network is achieved by distance protection of the CN and vacuum switches in the output fields of ETS. Protection from excessive contact and step voltages is achieved through grounding of the bearing structures of the CN and all other metal structures, 8m from the track axis of the grounded rail by the track for the return CN line in accordance with the regulations and reliable and rapid shutdowns of voltage in the CN in case of error. Protection from inexpert handling is provided by organizing a CN maintenance network and using the relevant instructions, rulebooks and manuals. Fire and explosion hazards have been eliminating by using standard equipment elements that are not flammable and do not support burning. The use of electric drives in spaces exposed to explosive mixtures is not permitted. Protection from electromagnetic impact on surrounding lines is achieved by using SS devices and TC devices and lines envisaging relevant protection measures during their design and construction, cables with small reduction factors. The strengths of the electric field and magnetic induction do not exceed the permitted values even in the most critical points that would be accessible to staff or passengers, therefore there are no harmful effect of their action.

- Signalling-safety devices and telecommunication facilities

Cables are built so that their outside protection of PE is water insoluble, while mechanical and electrical protection made from Al and Fe, even in case of direct contact with ground water, does not produce harmful chemical compounds. The measures of setting up PA devices are envisaged by the design. Likewise, the design defines an area covered by the sound signal, and as needed this can be next to the station and public surface (station square). The level of sound signal is defined so that it cannot act harmfully on the listeners, nor disturb the environment. Radio-devices are used in accordance with the conditions prescribed by the Regulatory Agency for Electronic Communication and Postal Services – RATEL, so that there are no disturbances for other users of radio-frequencies. Fire alarms are produced, transported and installed in accordance with the relevant regulations, therefore no harmful radiation can occur. The level of radiation is such that it cannot act harmfully on the environment during normal utilisation regimes.

Power supply for TC devices from the alternating current network of 3x380 V or 220 V/50 Hz is implemented with the usual protection (grounding, isolation, fuses, etc.). Power supply of direct current is implemented using 48 V or less, harmless even in

case of direct contact. In any case, it is important for measures undertaken on existing facilities to continue being implemented. It should also be noted that increasing the efficiency and functionality of the SS and TC systems facilitates the operation of railway transport, having direct consequences for reducing environmental impact.

Population protection measures

Population protection measures have mostly been covered already under previous chapters (noise protection, vibration, etc.).

The railway bypass around Nis envisages the crossing of the railway and road crossings out of level, therefore the safety of participants in traffic and the local population will not be endangered.

Through permanent contact with the local population (mostly through municipal bodies and local councils), as well as penal measures, prevent the disposal of communal waste to the space along the tracks and in stations, and the creation of "wild" and uncontrolled dumpsites. This kind of "disposal" of waste at a conditionally safe distance from the place of residence is in fact a delusion, since potential negative effects (disease, foul odours, etc.) very easily "return" precisely to those who threw such waste out, either by wind, through domestic animals, etc.

Fire protection measures

In accordance with the Law on Fire Protection ("Off. Gazette", Nos. 111/09 and 20/15) is legality-installation must be checked at least twice a year by the authorized legal person (by the Ministry), in accordance with technical regulations and the manufacturer's instructions for periodic monitoring. About completed tests shall maintain records which shall contain information on performing verification and issue expert finding. Employees who carry out checks must have passed the certification exam.

8.4 Other measures that may impact the prevention of hazardous effects on the environment

8.4.1 General environmental protection measures

General environmental protection measures encompass information from this domain adapted to a global strategy, local spatial conditions and the characteristics of the planned railway:

- All activities implemented as part of the overall development policies at the level of the Republic of Serbia, made specific through the highest planning documents, must be respected regarding rational environmental management for the specific investment undertaking,
- As part of the overall development policy, provide for consistent respect of regulations of broader significance regarding limits for certain impacts,
- Secure setups for constant monitoring of the state of the environment in the planned railway bypass zone by providing data obtained by measurements,
- Secure setups for the continuous maintenance of the railway.

8.4.2 Measures of health and safety at work

In accordance with the Law on Health and Safety at Work (Off. Gazette of RS, no. 87/05), measures of protection at work need to be envisaged to prevent hazards that may occur during the construction of a building. The prevention of hazards during the execution of works requires engaging an organization to implement the works registered for the type of activity subject to the technical documentation hereof. The organization must have a person at the construction site authorized to manage works, having passed the professional examination and in compliance with other conditions as per the Law on Planning and Construction ("Off. Gazette of RS", no. 72/2009, 81/2009 - corr., 64/2010 – CC decision, 24/2011, 121/2012, 42/2013 – CC decision, 50/2013 – CC decision and 98/2013 – CC decision). The authorized person and all other persons involved in the execution of works shall adhere to the regulations, standards and norms for the type of activity they engage in, as well as the Law on Health and Safety at Work (Off. Gazette of RS, no. 87/05).

The investor shall provide expert supervision over the execution of works. Prior to the commencement of works the precise position of all installations must be determined and all measures undertaken to avoid damage to them, as well as injury to workers and other persons located at the construction site. The contractor shall produce a Report on the Organization of the Construction Site, produced as separate documentation based on the Final or Contractor Design. The Report on the Organi-

zation of the Construction Site must be signed by the professional drafting the documentation. The Report on the Organization of the Construction Site shall be provided by the contractor (manager of works) with certification by the representative of the investor or the supervision service, and thereafter the works may commence. The Report on the Organization of the Construction Site contains three sections:

- Schematic view of the construction site, i.e. situation plan;
- Description of works;
- Measures for health and safety at work.

When the works at the construction site are implemented by a single employer, or if the works are implemented by several employers in sequence, each of the employers shall produce a report on the organization of the construction site, containing a schematic view of the site, i.e. a situation plan, a description of works and measures for health and safety at work.

An employer implementing works at the construction site where, in accordance with regulations on health and safety at work, a Plan of Preventive Measures needs to be secured, drafts a report on the organization of the construction site containing a description of works and measures for health and safety at work, taking over the site schematics, i.e. the situation plan from the Plan of Preventive Measures.

The contents of the report on the organization of the construction site should be available at the construction site, correspond to the factual situation, and encompass required and updated appendices, namely:

- List of workplaces with increased risk;
- List of employees appointed to workplaces with increased risk and medical examinations of employees appointed to such places;
- List of employees trained for healthy and safe work, including a signed list of employees introduced to the health and safety at work measures established in the relevant report.

Measures of protection at work, as per the Rulebook on the content of the report and organization of the construction site (Off. Gazette of RS 121/2012), encompass:

- Measures to eliminate, mitigate or prevent risks regarding works implemented at the construction site;
- Method of organizing the provision of first aid at the site, rescue and evacuation in case of danger;
- Measures to eliminate, mitigate or prevent risk in the use of explosives (unloading, storage, loading, transport, disposal at the place of use and use of explosives), as well as undertaking measures, if the presence of hazardous objects is established (unexploded devices), and/or substances and measures for the professional removal;

- Measures to eliminate, mitigate or prevent risk during prefab construction, encompassing unloading, storage, setting into the lifting position, lifting of elements, setting into the designed position and securing from falling over or falling in the raised position;
- Measures for the protection of employees from vehicles and measures for the unfettered operation of traffic, when a public road passes through the construction site area.

The contractor may only start work when the construction site is completed as per the provisions of the Rulebook on protection at work during the implementation of construction works (Official Gazette of RS no. 53/97). The report whereby the company, as per the regulations on workplace protection, reports to the competent labour inspection on the commencement of works shall contain data defined by Article 237 of the Rulebook on protection at work during the implementation of construction works. The contractor likewise submits the Report on the Organization of the Construction Site to the labour inspection along with the report on the commencement of works.

8.4.3 Administrative environmental protection measures

Administrative protection measures encompass a number of activities regarding administrative regulation of certain occurrences that, unless regulated in time, may cause certain negative effects that are hard to bring into acceptable limits. These protection measures encompass the following activities:

- During the phase of drafting the technical documentation, and prior to commencing the implementation of works, administrative measures must be used to sanction potential individual construction in the immediate vicinity of the railway in question. This prevents negative impact such facilities would be exposed to, and subsequent requests for protection measures. The further construction of residential facilities in the zone of the future railway needs to be prohibited.
- Secure instruments, within the contractual documentation formed by the Investor with the Contractors, on the need to respect all prescribed protection measures during the phase of execution of works.
- Secure instruments whereby in the implementation of works in the domain of construction and utilisation such bodies are to be engaged that have professional staff to meet the defined tasks in the domain of environmental protection.
- Secure instruments on the necessity for professional training of experts in the domain of railway utilisation from the standpoint of environmental management in the specific spatial circumstances.

In addition to the defined environmental protection measures, a number of other procedures and activities need to be implemented, mostly of an organizational nature, and aimed at reducing the potential negative consequences. These are primarily the

collection of solid waste and its storage in the envisaged containers, maintenance of cleanliness, as well as the control of the work of employed staff in the field of activities that may impact the degradation of the environment.

9 Environmental Impact Monitoring Programme

The monitoring system involves measuring, testing and evaluation of parameters of the environment, which includes monitoring of natural factors, changes in status and other characteristics of water, air, soil, noise, radiation, waste and more. Monitoring is with multiple purposes: managing, information, including planning and scientific purposes. Monitoring can be done in real time, when information must be submitted and used immediately (accident), or reports for the past period of time, usually on an annual basis. During the construction and operation of the railway concerned is necessary to implement procedures for monitoring the state of the environment in accordance with applicable regulations of the measure, as already mentioned, and prescribes.
The holder of the project and relevant entity hires authorized to perform professional tasks of monitoring. Emission measuring tasks can be performed by legal entities that are accredited as testing laboratories in accordance with the Law on Standardisation ("Off. Gazette of SR", No.36 / 09, 46/15).

Persons authorized to measure emissions and immissions are obliged to immediately inform the ministry or the competent authority in case of registered pollutant limit values are exceeded. Recommendation processor of this study is that the results of measurements forwarded to the competent inspection body, in agreement with the same. In order to examine the parameters of the environment at the location it is necessary to provide for:

- Monitoring water
- Monitoring of air
- Monitoring of soil
- Monitoring Noise

9.1 Overview of the situation prior to commencing construction

The state of the environment in terms of the existing dominant influence on the analyzed area marked by the negative consequences that are primarily product of urbanization wider area.

In water flows in this area (streams Medoševac, Rujnička, Brenička, Matejevački, Suvodolski, Vrežina, Radostina, Malčanska rivers and river Nišava) pollution originating from inadequate treatment of industrial and municipal wastewater discharged into the same and application of certain agrotechnical measure of in processing agricultural areas.

When it comes to sources of traffic noise this prostror characterized by traffic on the existing railway line Niš-Dimitrovgrad on the highway E-80.

Table 49:Showing the current quality of the environment in the impact zone of the future the railway bypass around Nis

The analyzed parameters	Existing quality
air quality	In urban environment disrupted because of road and rail transport
water quality	Compromised due to inadequate treatment of industrial and municipal wastewater
noise	increased noise levels in the area of the airport and along major traffic routes
Soil quality	Minimum disturbed because it`s potentiates the production of healthy food
population health	Not evidenced negative impacts on health
Meteorological parameters and climate	are not endangered
vegetation	is not endangered
Animal world	is not endangered
Population density and concentration of population and migration	Reducing the number of residents, expressed migration
Natural and cultural values	preserved

The overview of the state of the environment must contain data obtained by measurements prior to the start of the functioning of the project.

9.2 Parameters for establishing negative environmental impacts

The relevant parameters for assessing the impacts on soil are: pH, concentration of heavy metals, oils and organic substances. Land near the route of the railway should be tested for hazardous materials such as pesticides and metals.

The relevant parameters for assessing the impact on surface water are: pH, dissolved oxygen, waste material, turbidity, concentration of organic compounds and mineral oil.

The relevant parameters for assessing the impacts on groundwater are examined in the context of geological-hydrogeological and physicochemical and chemical parameters. The first group of parameters includes impacts to groundwater level, dynamics and quantity, while the second group includes the impacts on groundwater quality (eg, mineral oils, organic compounds and heavy metals).

The parameter relevant for establishing whether the environment is endangered by noise is the amount of noise indicators being measured, followed by the relevant noise level calculated and assessed in accordance with the provisions stated under: the Law on Protection from Noise in the Environment ("Official Gazette of RS", no. 36/09); Provision on the noise indicators, limits, methods for the assessment of noise indicators, disturbance and harmful effects of noise in the environment ("Official Gazette of RS", no. 75/10), Rulebook on the methodology of acoustic zones ("Official Gazette of RS", no. 72/10), Rulebook on the methods of measuring noise, contents and volume of the report on measuring noise ("Official Gazette of RS", no. 72/10) and the Rulebook on the methodology for drafting action plans ("Official Gazette of RS", no. 72/10) and Serbian standards these rulebooks refer to (SRPS U.J6.090:1992, SRPS ISO 1996-1:-2010 (sr), SRPS ISO 1996-2: 2010, SRPS U.J6.205:2007).

Limits for the concentration of harmful substances in soil

The provision on the programme on the systemic monitoring of soil quality, indicators for the assessment of risks from soil degradation and methodology for drafting remediation programmes ("Official Gazette of RS", no. 88/10) provides the limit and remediation values for concentrations of hazardous and harmful substances and values that may indicate significant soil contamination. The values for heavy metals in the soil are provided in the following table:

Table 50: The values of maximum permissible levels of heavy metals in the soil

		Land (mg / kg absolutely dry matter)	
		Limit value	remediation value
Metal			
cadmium (Cd)		0,8	12
chrome (Cr)		100	380
copper (Cu)		36	190
Nickel (Ni)		35	210
Lead (Pb)		85	530
Cink (Zn)		140	720
mercury(Hg)		0,3	10
Arsenic (As)		29	55
Barium (Ba)		160	625
cobalt (Co)		9	240
molybdenum (Mo)		3	200
Antimony (Sb)		3	15

Limits for noise indicators

The Provision on noise indicators, limits, methods for assessing noise indicators, disturbance and harmful effects of noise in the environment ("Official Gazette of RS", no. 75/2010) prescribes the following highest permitted levels of exterior noise for settlements, Table 51.

Table 51:Values of highest permitted levels of exterior noise

Zone	Purpose of space	Highest permitted level of exterior noise dB (A)	
		Day	Night
1.	Areas for rest and recreation, hospital zones and recovery areas, cultural-historic sites, large parks	50	40
2.	Tourist areas, small and rural settlements, camps and school zones	50	45
3.	Purely residential settlements	55	45
4.	Business-residential areas, commercial residen-tial areas, children's playgrounds	60	50
5.	City centre, trade, commercial, administrative zone with apartments, zones along highways and main transport lanes	65	55
6.	Industrial, storage and repair areas and transport terminal without residence	At the borders of the zone the noise may not exceed the levels in the zone it borders	

Reference levels of exposure to magnetic and electric fields

Reference documents:

- Rulebook on the limits of exposure to non-ionizing radiation, Official Gazette of RS, no. 104/09 of 16.12.2009.
- Rulebook on sources of non-ionizing radiation of special interest, types of sources, method and period of their testing, Official Gazette no. 104/09 of 16. 12. 2009.

The Rulebook on the limits of exposure to non-ionizing radiation defines the basic limits and reference limits for population exposure to magnetic and electric fields changing in time. The basic limits for exposure of people to time-variant magnetic and electric fields are based directly on the health and biological effects. Table 53 provides reference limits for population exposure to time-variant magnetic and electric fields for a field frequency of 50 Hz.

Table 52:Reference limits for population exposure to time-variant magnetic and electric fields (effective values, frequency 50 Hz)

B [μT]	E [V/m]
40	2000

The reference limits were established with the goal of comparisons with values of measurable amounts. The Rulebook on sources of non-ionizing radiation of special interest, type of sources, method and period of their testing, defines sources of non-ionizing radiation of special interest as those sources of electromagnetic radiation that may be harmful for the health of people and whose electromagnetic field in the zone of increased sensitivity reaches at least 10% of the amount of the reference limit prescribed for the given frequency (4 μT for a magnetic field, i.e. 200 V/m for an electric field with an industrial frequency of 50 Hz). According to the Rulebook, zones of increased sensitivity include: areas of residential zones where persons may remain 24 hours per day, schools, dormitories, preschool institutions, birth clinics, hospitals, tourist facilities, children's playgrounds or parcels envisaged for the construction of the above facilities.

9.3 Places, method and frequency of measuring the established parameters

Aiming to monitor the state of the environment and prevent pollution, noise monitoring must be established both during construction, as well as the utilisation of the railway.

It is also necessary to conduct a control measurement of the electric field and magnetic induction along the tracks in the exploitation phase.

Program for monitoring of soil, surface water and groundwater

To minimize of pollution of soil, surface water and groundwater in the treatment of weeds, must be strictly take care of the use of herbicides, according to the manufacturer's instructions, and use of Ordinance 309, for chemical control of weeds and bushes on the lines of "Serbian Railways".

It is necessary to monitor the quality of the land in accordance with the Agricultural Land Act (Sl. Gl. RS, Nos. 62/06, 65/08 - dr. Law, 41/09 and 112/5) and special regulations that are based on it Law, as well as in accordance with the Regulation on a program of systematic monitoring of soil quality indicators for evaluation risk of soil degradation and methodology for development of remediation programs (see S.. RS, no. 88/10).

The program of systematic monitoring of soil quality include:

1) the number and layout of the site, the position of the measuring points shown Gauss - Krigerovim coordinates;

2) a list of parameters that will be collected at the sampling area;

3) a list of methods and standards used for soil sampling, sample analysis and data processing;

4) defining the temporal dynamics of soil sampling, sample analysis, processing and display of data;

5) determination of professional accredited institutions that will carry out systematic monitoring of soil quality.

Taking into account the fact that the information on soil quality rare and inadequate, it is necessary to make a preliminary assessment test before any long-term impact during the exploitation. Typical parameters will then be measured with the inclusion of total hydrocarbons, lead and other heavy metals that are related to the exploitation of the railway. During a preliminary test of the city of sampling will be determined on the spot, a number of samples to be pre-limit.

Monitoring of land within the zone of influence of the respective the railway should run at least 5 years, sampling once every three months.

Checking the quality of groundwater should be run in parallel to the review of the quality of land, in order to assess the possible accumulation of pollutants. Groundwater sampling is performed using piezometers and is combined with the analysis of samples.

In the construction phase should take water samples upstream and downstream of the place works. Samples must be collected before the the start of work at a time when it is done removal of humus and when running excavation or filling soil. Sampling is done at monthly intervals. With all measurements begins one month before the start of preparatory work. Each contractor should set a platform for sampling before starting of works. Measurements of the water quality should only perform at the following locations:

- Potok Medoševac 2+435,00
- Rujnički potok 4+825,00
- Brenički potok 11+140,00
- Matejevački potok 11+598
- Suvodolski potok 13+161,00
- Potok Vrežina 15+203,00
- Malčanska reka 17+742,00
- Reka Nišava 18+659,20
- Potok Radostina 19+548,00

In the phase of works in the mentioned chainages carry out sampling the occurrence of authoritative precipitation in the first 15 minutes. Throughout the period observed, it is essential that the measurements and processing of data carried out continuously every four months (January, April, July, and October). This will be possible to control the concentration of pollutants in the swollen waters.

It is necessary to foresee precipitators oils and fats, as follows: in landfills oils, fuels and lubricants; the landfill construction waste in temporary storage near the tracks and during the construction and reconstruction of substations and laying cable podzermnih. Waters from working and maneuvering areas treated by the dregs, and then grease and oil separator. It must simultaneously be the place where need to monitor, and check the function of the fuel filter (separator). Separator fats and oils regularly maintained and controlled as follows:

- Every 15 days or after each heavy rain to open the cover of the separator chamber, and execute the release of fat oils in the grounds container, and then close the zipper,
- Every six months to clean the inlet chamber separator of solid material (sand, earth).

Behind grease separators and oil to carry out inspection shaft, which will be used for sampling for quality control of purified water. Conduct an analysis of the water quality at the outlet of the last chamber separators of fats and oils, and before embarking on the river bank, two times during the year.

Programme for monitoring noise and vibration

The equipment for measuring noise levels will be used to measure existing noise levels and noise during construction in order to determine increases in such levels and their deviation from values established by standards. The best approach to noise control during construction is noted to require the use of equipment satisfying noise standards, such as 85 dB(A), noise monitoring with simultaneous inclusion in the process of reactions to discomfort complaints by the local population or employees. If the permitted noise levels are exceeded, mitigation measures will be implemented, such as mobile screens for noise protection, or adjustment of works on site, the responsibility of the contractor for the execution of works and environmental protection.

In the context of monitoring noise during construction works is necessary to:

• Execute the measurement zero state

• To carry out measurements of the highest level (peak) noise during construction

• If it is significantly exceed the limits of the permissible levels, in agreement with the owner of the object shall take the necessary protection measures.

The programme of noise monitoring in practice, using equipment and professional know-how, is implemented by authorized professional organizations.

For all the consequences arising from high levels of noise during the construction phase is responsible contractor.

- Establishing the relevant noise levels

Relevant noise levels are established based on measurements of equivalent noise levels or only A – weighted noise levels, with added corrections for various types of noise. Measurements of noise levels and corrections of the measured levels depending on the type of noise are implemented using methods described in standard SRPS U.J6.090:1992 When noise is measured at several points, the result of the measurements is taken to be the arithmetic mean of noise levels, i.e. the equivalent noise levels at individual measurement points, if all measured values are in a 5 dB(A) range. Otherwise, all individual results must be provided in a table.

- Establishing measurement intervals

The measurement interval (reference time – as a span of time related to the relevant noise level) is established in accordance with the type of noise. As a rule, the minimum measurement interval must be long enough to encompass the entire cycle of changes to the level of noise being observed. With changing noise, levels are measured during the day at least during three intervals of measurement, two intervals during the night, with each interval lasting at least 15 minutes. The measurement interval for day is maximum from 6.00 to 22.00 hours, and for night from 22.00 to 6.00 hours (SRPS U.J6.090:1992).

- Choice of measuring points

The goal of monitoring is to follow noise impact on the population and buildings within the impact zone, and in accordance with the obtained results, timely reaction, i.e. undertaking adequate protection measures.

Noise in buildings is measured at the minimum distance of 1m from the walls and 1.5m from windows, at a height of 1.2 to 1.4 m from the floor, when the windows and doors are closed. Noise outside buildings (in the communal environment) is measured at a height of 1.2 to 1.5 m from the surface of terrain, at a distance of at least 3.5 m from the walls of buildings (if conditions permit) and other reflecting surfaces, or from the regulation line where there are no buildings. If measurements are of noise exposure for buildings, noise levels are measured at 1 to 2 m in front of the façade, i.e. at 0.5 m in front of an open window. Meteorological conditions are monitored and recorded during noise measurement. If wind is blowing from the source towards the receiver, it may have a velocity not exceeding 5 m/s.

During the exploitation of the noise should be controlled in order to control the efficiency of the measures envisaged noise protection. Measurements of noise levels during the period of exploitation the railway should be performed once a year, in the case of complaints of the local population. Places that are chosen to monitor the noise level during the exploitation are those which are most vulnerable to these facilities chainages:

- Km 0+500,00
- Km 5+100,00
- Km 10+950,00
- Km 20+750,00

Control measurement of electric field and magnetic induction

Measurement of the electric field at predefined locations on the railway in the exploitation should be carried out according to the Regulations on the limits of exposure to ionizing radiation, Official. Gazette of RS, no. 104/09 of 16.12.2009. god. and according to the Regulations on the sources of non-ionizing radiation is of particular interest, the types of sources, manner and time of their examination, Official Gazette No. 104/09 of 16. 12. 2009 governing the safety of the population when exposed to ionizing radiation of low frequency. Tests carried out according to the methodology and standard requirements Measurement of low-frequency magnetic and electric fields with regard to exposure of human be-ings - Special requirements for instruments and guidance for measurements, IEC 61786: 1998.

Measurement should be entrusted exclusively organization authorized for this type of measurement.

Monitoring of waste

As part of the monitoring of the waste it is necessary to:

• sort waste in place of origin in accordance with the Regulation on categories, testing and classification of waste

• temporarily store waste in a way that least affects human health and the environment

• hand over waste to the person authorized for waste management

• Maintains records on waste generated, which will be submitted or deposited

• Determine who is responsible for waste management

• Enable authorized inspector control locations, buildings, equipment and documentation

Waste owner is responsible for all costs of waste management. The ownership of waste ceases when the next owner take the waste and return on waste movement document certifying that the waste is received.

The waste is stored in places that are technically equipped for temporary storage of waste at the location of the manufacturer or owner of waste in collection centers, transfer stations and other locations in accordance with this Law. Hazardous waste can not be stored temporarily at the location of the producer or owner of waste for more than 12 months. Movements of waste accompanied by a special Document on movement of waste, except for household waste. The producer or owner of waste must classify waste before the start of the movement of waste. The waste is classified according to the catalog of waste.

Waste Catalogue is compiled list of non-hazardous and hazardous waste to the place of origin, provenance, and according to method of treatment. The producer or owner of waste shall keep copies of the documents on the shipment of waste until it receives a copy of the completed document on the movement of waste from the recipient confirming that waste has been accepted. If the manufacturer or the owner within 15 days does not receive a copy of the completed document on the movement of waste from the recipient must run a procedure to check movement of waste and it is obliged to implement the findings of the ministry. The producer or owner of waste keeps completed Document on movement of waste for at least two years.

10 Non-Technical Brief Overview of Data Provided under Items 2) to 9)

The regarded railway route lies in the Niska Valley, one of the larger valleys in Serbia, representing part of the spacious South-Morava basin of the same morphological type. It extends along the east-west direction, with an irregular ellipsoid shape with a length of 44km and width of 22km, representing 70% of the territory of the City of Nis. It is set apart in a separate geomorphological unit, surrounded by a marked tall mountain ridge. Various types of settlements have developed within this borderline, with different agricultural production character and a relatively thick transport network. The overall climate characteristics within the area of the city of Nis are within the limits of average parameters for moderately continental climate. The basic elements of climate are: mean annual air temperature 11.6°; mean annual precipitation amount 586mm. Snowfall occurs from October to May, an average of 24.7 days during the year; regarding winds, the highest frequency of occurrence within the broader area of Nis are for calm periods, followed by north-western winds, with the lowest frequency of the north wind. The dominant north-western wind occurs most frequently in the summer, and is rarest in autumn. The highest mean velocity of the north-eastern and north-western wind is 3.2m/sec, while the lowest is of the south and eastern wind, 1.7m/sec. The complex geographic structure and specific climate conditions lead to the area of the city of Nis forming alluvial soil of clay, fluvisol, diluvium and brunipodsol soils as the basic pedological skeleton wherefrom different subtypes of soil developed.

Geographically, Nis is at the crossroads of the key Balkans and European transport routes. The main route, leading from the north through the Morava valley from Belgrade diverges in Nis towards south, through the Vardar valley towards Thessaloniki and Athens, and towards east, through the Nisava and Marica valley towards Sofia, Istanbul and further towards the Middle East.

The existing railway Nis-Dimitrovgrad-state border (no. 22 as per Rulebook 325 of CYR) passes through the city core and thereby has a negative impact both on the development of the settlements, as well as development of transport (numerous collisions with level streets, high pollution in the centre, prevented further development of passenger and freight transport). The railway is single-track and non-electrified. Considering the poor state of the railway infrastructure and vehicle pool, the need for reconstruction becomes clear.

"Railway modernization – design documentation for a bypass railway around the city of Nis" involves the reconstruction and construction of a single track railway from the Nis Marshalling station, i.e. a two-track railway from the Trupale station, through new official locations Nis Sever, Pantelej and Vrezina, up to the inclusion into the existing railway Nis – Dimitrovgrad at the Prosek settlement. Further on, the newly designed railway moves as a single-track one up to the entry into Sicevo station. The length of the new railway is around 22 km.

Long term environmental impact is impact occurring during railway utilisation. The basic characteristic of these impacts is that they are of lower intensity compared to the existing situation, representing a positive effect of the construction of the bypass railway from an environmental protection standpoint.

Soil, surface and ground water pollution can occur during the operation of railway transport and infrastructure maintenance, due to:

Railway vehicle transport:

- Friction of tracks, wheels, brake lining (Fe, Cr, Ni, Cu, Si, Mn, V)
- Drip remains (oils, fuel, lubricants, cleaning substances);
- Corrosion (metals and colours);
- Railcar toilets (faecal matter).

Railway maintenance:

- Surface
- Metal parts (anti-corrosion substances);
- Points, signals (lubricants);
- Platforms (covering substances).

Since there is a large number of residential facilities in the immediate vicinity of the section in question, the implementation of relevant protection measures from the undesirable impact of transport noise is mandatory.

The design envisages the setting of noise protection walls. The height and length of noise protection walls is established based on noise level calculations, using the CadnaA software. The calculations provide the required lengths and heights of walls.

The height of walls is defined so as to provide a reduction in the level of transport noise below the permitted level in settlements along the planned railway. Noise protection walls, 11 of them, are envisaged along the left or right side viewed in the direction of forward chainage, at a total length of 2580m.

It was found that after the implemented reconstruction and modernization of the railway no vibration protection measures are required. Vibration level monitoring is recommended, in order to react adequately in case of exceeding permitted values.

A decrease in the time of transport for goods and passengers due to developing higher train speeds will have a positive impact on the population of the given area from a sociological standpoint.

This bypass railroad will be electrified, and as such will have minimum impact on air quality. Air pollution may potentially occur by evaporation of point maintenance substances.

The railway, as a line facility and under normal operation of transport, represents a type of route with relatively low impact on pollution of soil, surface and ground waters. A somewhat more expressed impact on the quality of soil, ground and surface waters occurs during treatment of weeds by herbicides. In order to minimize this impact, measures of protection from the use of herbicides have been defined.

The Preliminary Design envisages the construction of non-levelled road crossings, leading to the maximum possible safety of participants in transport.

In order to monitor the state of the living environment and prevent pollution, monitoring of the quality of soil, surface and ground waters, noise and vibration needs to be established.

It is also necessary to conduct a control measurement of the electric field and magnetic induction along the railroad in the exploitation phase.

Programme for monitoring soil, surface and ground waters

To minimize of pollution of soil, surface water and groundwater in the treatment of weeds, must be strictly take care of the use of herbicides, according to the manufacturer's instructions, and use of Ordinance 309, for chemical control of weeds and bushes on the lines of "Serbian Railways".

It is necessary to monitor the quality of the land in accordance with the Agricultural Land Act (Sl. Gl. RS, Nos. 62/06, 65/08 - dr. Law, 41/09 and 112/5) and special regulations that are based on it Law, as well as in accordance with the Regulation on a program of systematic monitoring of soil quality indicators for evaluation risk of soil degradation and methodology for development of remediation programs (see S.. RS, no. 88/10).

In the construction phase should take water samples upstream and downstream of the place works. Samples must be collected before the the start of work at a time when it is done removal of humus and when running excavation or filling soil. Sampling is done at monthly intervals. With all measurements begins one month before the start of preparatory work. Each contractor should set a platform for sampling before starting of works. Measurements of the water quality should only perform at the following locations:

- Potok Medoševac 2+435,00
- Rujnički potok 4+825,00
- Brenički potok 11+140,00
- Matejevački potok 11+598
- Suvodolski potok 13+161,00
- Potok Vrežina 15+203,00
- Malčanska reka 17+742,00
- Reka Nišava 18+659,20
- Potok Radostina 19+548,00

In the phase of works in the mentioned chainages carry out sampling the occurrence of authoritative precipitation in the first 15 minutes. Throughout the period observed, it is essential that the measurements and processing of data carried out continuously every four months (January, April, July, and October). This will be possible to control the concentration of pollutants in the swollen waters.

It is necessary to foresee precipitators oils and fats, as follows: in landfills oils, fuels and lubricants; the landfill construction waste in temporary storage near the tracks and during the construction and reconstruction of substations and laying cable podzermnih. Waters from working and maneuvering areas treated by the dregs, and then grease and oil separator. It must simultaneously be the place where need to monitor, and check the function of the fuel filter (separator). Separator fats and oils regularly maintained and controlled as follows:

- Every 15 days or after each heavy rain to open the cover of the separator chamber, and execute the release of fat oils in the grounds container, and then close the zipper,
- Every six months to clean the inlet chamber separator of solid material (sand, earth).

Behind grease separators and oil to carry out inspection shaft, which will be used for sampling for quality control of purified water. Conduct an analysis of the water quality at the outlet of the last chamber separators of fats and oils, and before embarking on the river bank, two times during the year.

Noise and vibration monitoring programme

In the context of monitoring noise during construction works is necessary to:

• Execute the measurement zero state

• To carry out measurements of the highest level (peak) noise during construction

• If it is significantly exceed the limits of the permissible levels, in agreement with the owner of the object shall take the necessary protection measures.

The programme of noise monitoring in practice, using equipment and professional know-how, is implemented by authorized professional organizations.

For all the consequences arising from high levels of noise during the construction phase is responsible contractor.

During the exploitation of the noise should be controlled in order to control the efficiency of the measures envisaged noise protection. Measurements of noise levels during the period of exploitation the railway should be performed once a year, in the case of complaints of the local population. Places that are chosen to monitor the noise level during the exploitation are those which are most vulnerable to these facilities chainages:

- Km 0+500,00
- Km 5+100,00
- Km 10+950,00
- Km 20+750,00

Control measurement of electric field and magnetic induction

Measurement of the electric field at predefined locations on the railway in the exploitation should be carried out according to the Regulations on the limits of exposure to ionizing radiation, Official. Gazette of RS, no. 104/09 of 16.12.2009. god. and according to the Regulations on the sources of non-ionizing radiation is of particular interest, the types of sources, manner and time of their examination, Official Gazette No. 104/09 of 16. 12. 2009 governing the safety of the population when exposed to ionizing radiation of low frequency. Tests carried out according to the methodology and standard requirements Measurement of low-frequency magnetic and electric fields with regard to exposure of human be-ings - Special requirements for instruments and guidance for measurements, IEC 61786: 1998.

Measurement should be entrusted exclusively organization authorized for this type of measurement.

Monitoring of waste

As part of the monitoring of the waste it is necessary to:

• sort waste in place of origin in accordance with the Regulation on categories, testing and classification of waste

• temporarily store waste in a way that least affects human health and the environment

• hand over waste to the person authorized for waste management

• Maintains records on waste generated, which will be submitted or deposited

• Determine who is responsible for waste management

• Enable authorized inspector control locations, buildings, equipment and documentation

11 Data on Technical Deficiencies or Lack of Adequate Professional Knowledge and Skills or Inability to Obtain Adequate Data

The subject matter railway route was adopted through the General Design with the Previous Feasibility Study for the construction of a single-track railway for a bypass around Nis, positively assessed by the Republic Audit Commission. The City of Nis, at the City Assembly session held on June 2014, adopted the decision on amending the General Regulation Plan of the Bypass Railway within the Territory of the City of Nis (Official Gazette of the City of Nis 57/2014). In accordance with this decisions, permitting deviations from valid plans of general and detailed regulation, the designer proposed an optimum technical solution with the route of the bypass railway, adapting to conditions in the field, spatial limitations and requirements of beneficiaries and the end-user. This technical solution will be entered into the amended General Regulation Plan of the Bypass Railway within the Territory of the City of Nis, currently under development by the City of Nis, PE Urban Planning Institute, therefore the location of the railway will be covered by the valid planning documentation.

References

1. GENERAL DESIGN For the construction of a single-track railway for the bypass around Nis: Volume 3. Previous analysis of environmental impact with a social analysis

2. PRELIMINARY DESIGN For the construction of a single-track railway for a bypass around Nis

1/1 DESIGN OF THE RAILWAY ROUTE
1/2 DESIGN OF ARCHITECTURAL FACILITIES
2/1 DESIGN OF STRUCTURES
2/2 DESIGN OF TRANSPORT ROUTES
3 DESIGN OF HYDRO-TECHNICAL FACILITIES
4 DESIGN OF ELECTRICAL POWER INSTALLATIONS
5 DESIGN OF TELECOMMUNICATION AND SIGNALLING INSTALLATIONS
6 DESIGN OF MECHANICAL INSTALLATIONS
7 DESIGN OF TECHNOLOGY
8 DESIGN OF TRANSPORT AND TRANSPORT SIGNALIZATION
9 DESIGN OF EXTERIOR REGULATION
10 DESIGN OF PREPARATORY WORKS
Report GEOTECHNICAL CONDITIONS FOR CONSTRUCTION
Report EXPROPRIATION
Report FIRE PROTECTION
Study FEASIBILITY STUDY

3. The drafting of this Study used data available at the following websites:

   - www.wikipedia.org
   - http://www.sepa.gov.rs/
   - http://www.ni.rs/
   - http://www.izjz-nis.org.rs/

Appendices

4. Review map
5. Normal cross-sections
6. Noise maps

Investitor / *Contracting Authority*:

European Union Delegation to the Republic of Serbia
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[XXX]	[dd/mm/yyyy]	[XXX]	[XXX]	[XXX]	[XXX]

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MODERNIZACIJA ŽELEZNICE - PROJEKTNA DOKUMENTACIJA ZA IZGRADNJU JEDNOKOLOSEČNE PRUGE ZA OBILAZNICU OKO NIŠA
MODERNIZATION OF RAILWAYS - PROJECT DOCUMENTATION FOR CONSTRUCTION OF A SINGLE TRACK RAILWAY BYPASS AROUND NIŠ

Faza projekta / *Phase*:
IDP - IDEJNI PROJEKAT
PRELIMINARY DESIGN

Vrsta projekta / *Design type*:
1/1 TRASA PRUGE
1/1.1 Projekat trase obilazne pruge i postojećih rekonstruisanih pruga
1/1 RAILWAY ALIGNMENT AND TRACK GEOMETRY
1/1.1 Design for the railway bypass alignment and the alignment of reconstructed existing railway lines

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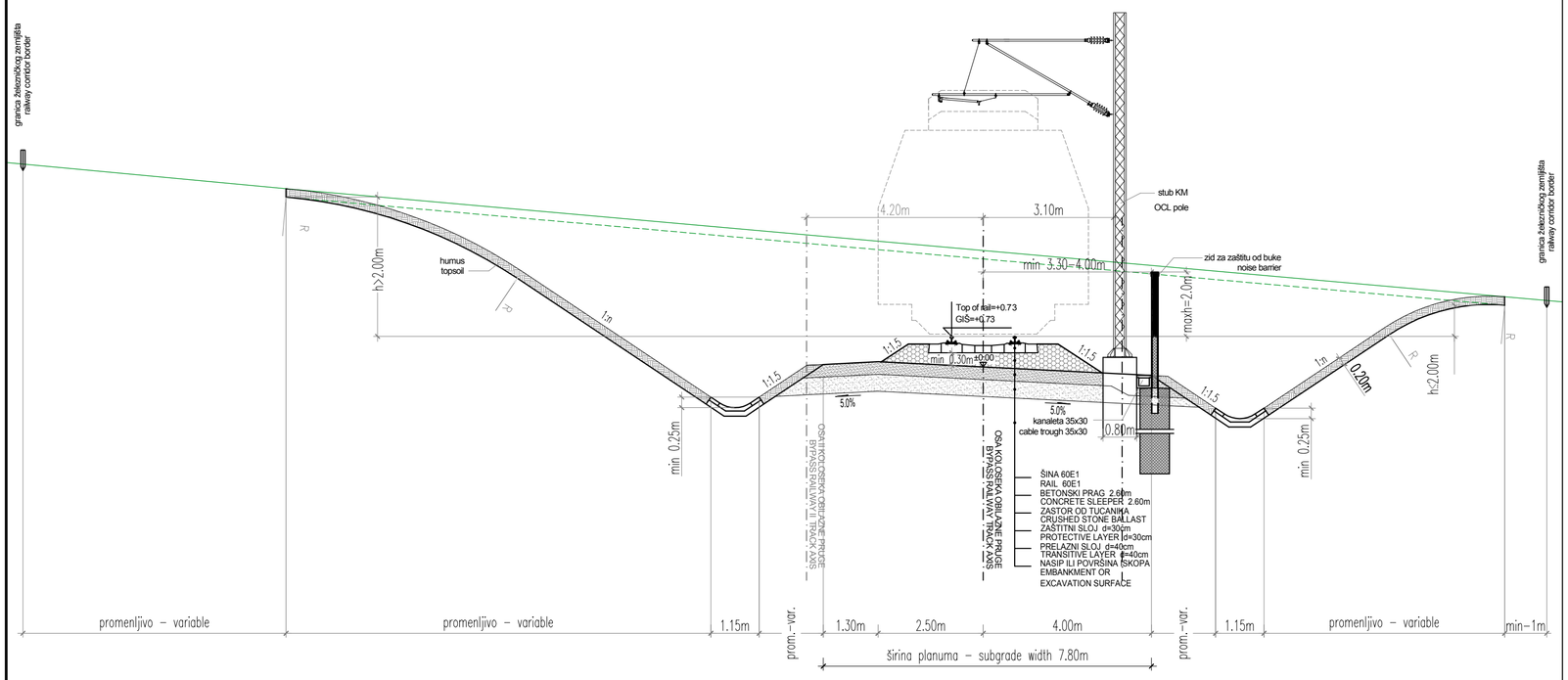

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Investitor / *Contracting Authority*:

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European Union Delegation to the Republic of Serbia
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Krajnji korisnik / *Final Beneficiary*:

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Naziv crteža / *Drawing title*:

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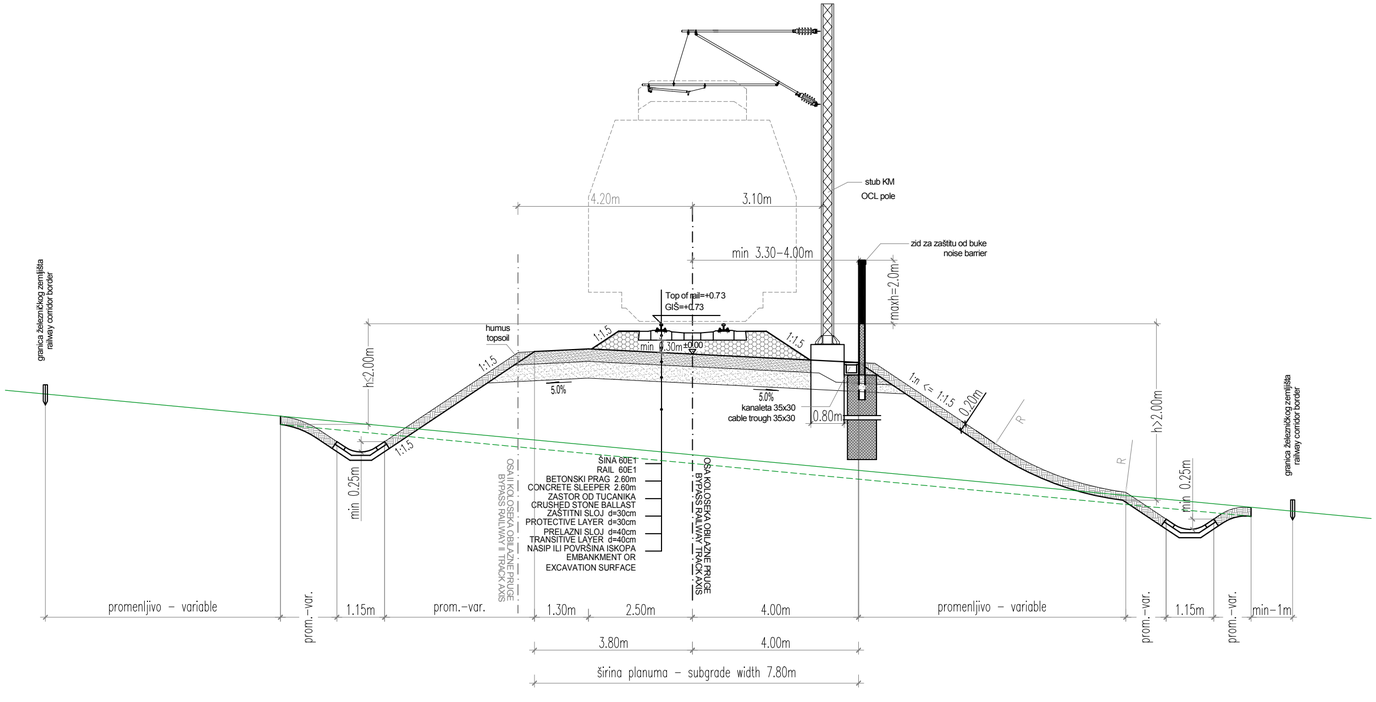

Beleške / *Notes*:

Investitor / *Contracting Authority*:

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Faza projekta / *Phase*:
IDP - IDEJNI PROJEKAT
PRELIMINARY DESIGN

Naziv sveske / *Volume title*:
1/1 TRASA PRUGE
1/1.1 Projekat trase obilazne pruge i postojećih rekonstruisanih pruga
1/1 RAILWAY ALIGNMENT AND TRACK GEOMETRY
1/1.1 Design for the railway bypass alignment and the alignment of reconstructed existing railway lines

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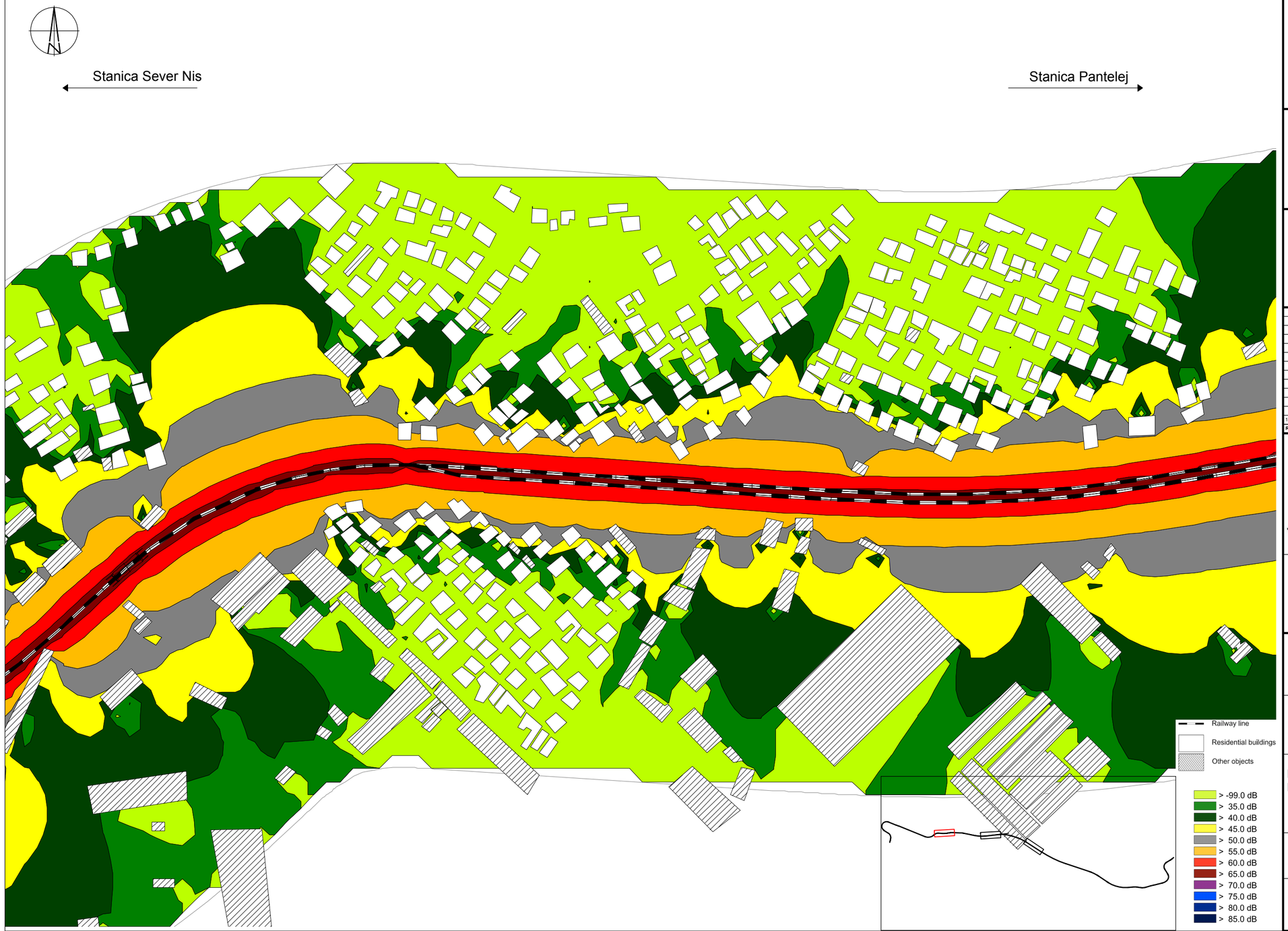

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MODERNIZACIJA ŽELEZNICE - PROJEKTNA DOKUMENTACIJA ZA IZGRADNJU JEDNOKOLOSEČNE PRUGE ZA OBILAZNICU OKO NIŠA
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Faza projekta / *Phase*:
IDP - IDEJNI PROJEKAT
PRELIMINARY DESIGN

Vrsta projekta / *Design type*:
2/ 1.6 - Projekta zidova za zaštitu od buke
2/ 1.6 - Design of the noise protection walls

Naziv crteža / *Drawing title*:
Karta buke bez mera zaštite
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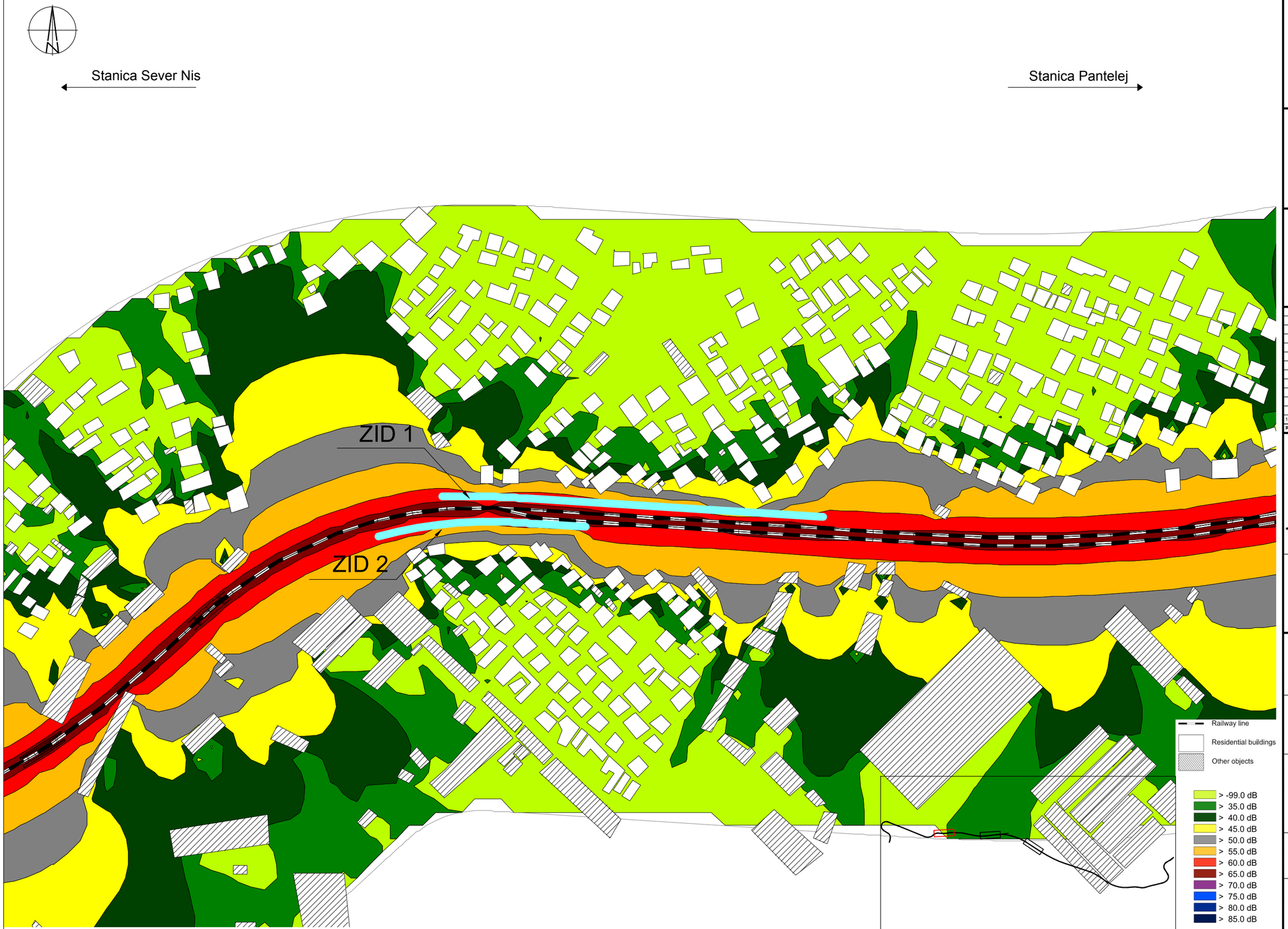

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IDP - IDEJNI PROJEKAT
PRELIMINARY DESIGN

Vrsta projekta / *Design type*:
2/ 1.6 - Projekta zidova za zaštitu od buke
2/ 1.6 - Design of the noise protection walls

Naziv crteža / *Drawing title*:
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Noise map with noise barriers

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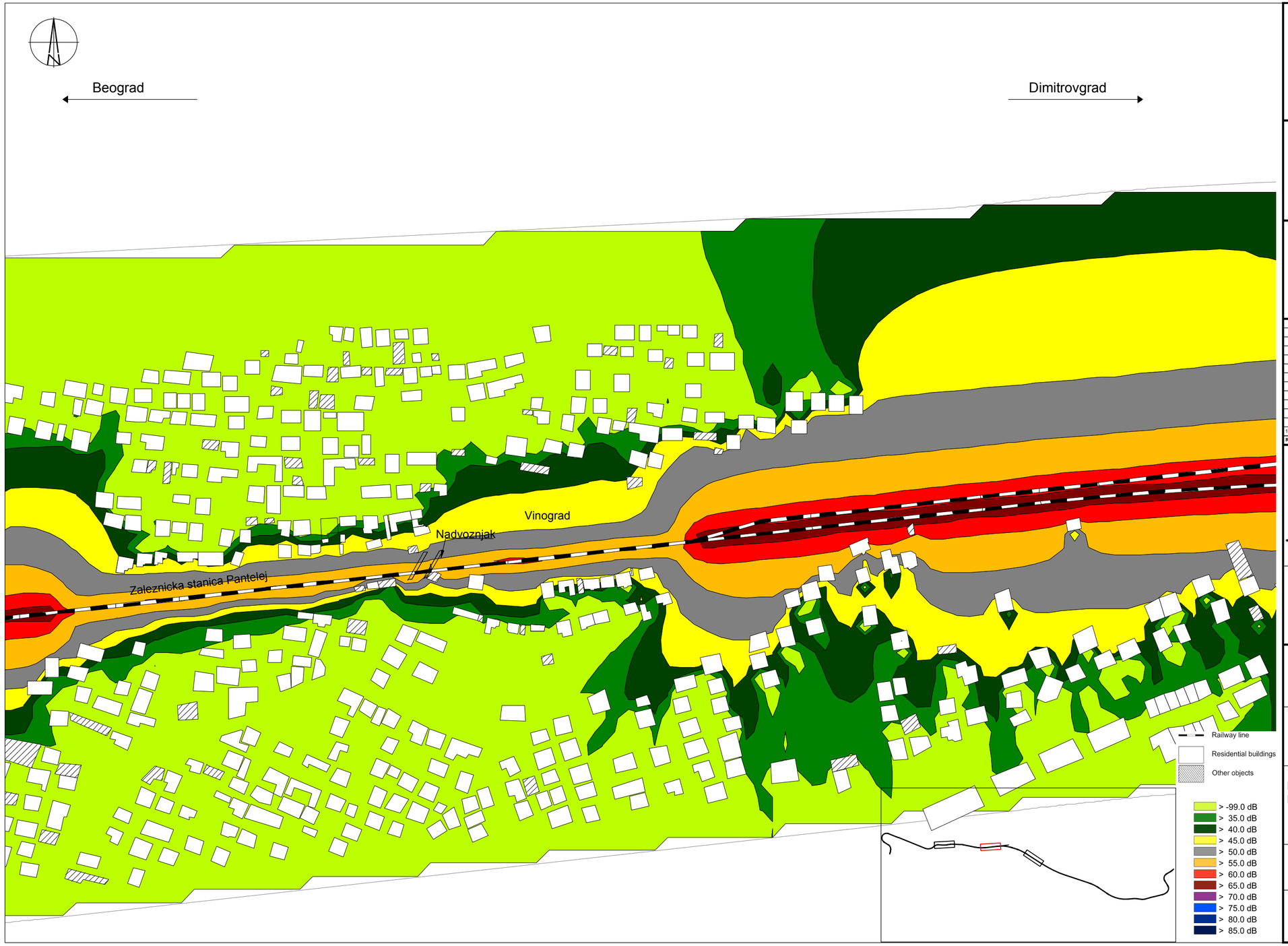

Investitor / *Contracting Authority*:

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MODERNIZACIJA ŽELEZNICE - PROJEKTNA DOKUMENTACIJA ZA IZGRADNJU JEDNOKOLOSEČNE PRUGE ZA OBILAZNICU OKO NIŠA
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2/ 1.6 - Projekta zidova za zaštitu od buke
2/ 1.6 - Design of the noise protection walls

Naziv crteža / *Drawing title*:

Karta buke bez mera zaštite
Noise map without protective measures

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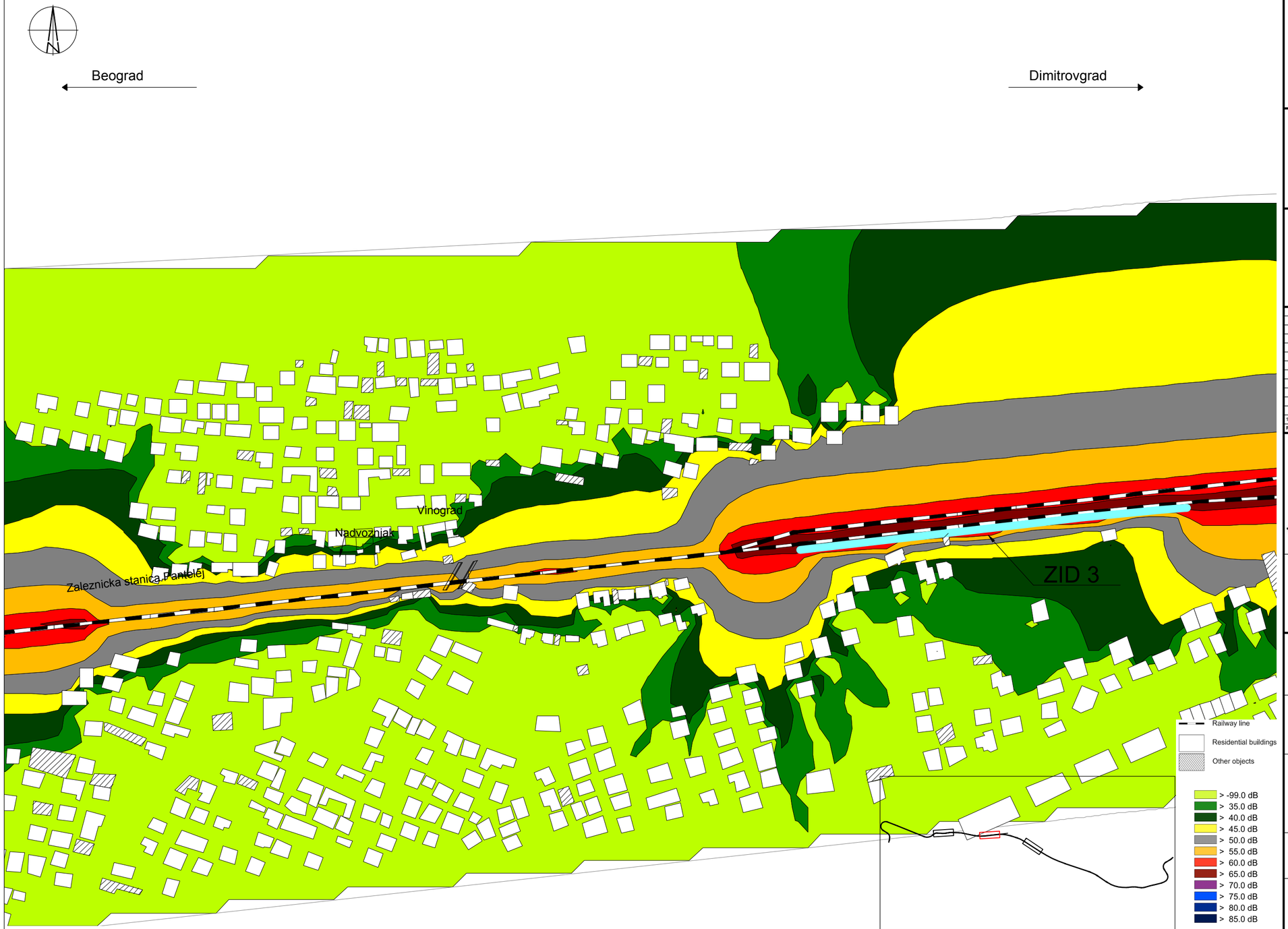

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Krajni korisnik / *Final Beneficiary*: Инфраструктура железнице Србије а.д.

Korisnik / *Beneficiary*:

Projektant / *Consultant*: CeS.COWI

A project implemented by a consortium led by **CeS COWI d.o.o.** and its partners **NET ENGINEERING** and **SUDOP PRAHA**

Podizvođač / *Subcontractor*:

NET ENGINEERING SUDOP PRAHA

Logo firme Naziv firme

REV.	DATE	PREPARED	CHECKED	APPROVED	DESCRIPTION
1	14/06/2016	A. Trifunovic	V.Jovanovic	T.Simic	Response to comments SRC and ISR Revision Committee

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MODERNIZACIJA ŽELEZNICE - PROJEKTNA DOKUMENTACIJA ZA IZGRADNJU JEDNOKOLOSEČNE PRUGE ZA OBILAZNICU OKO NIŠA
MODERNIZATION OF RAILWAYS - PROJECT DOCUMENTATION FOR CONSTRUCTION OF A SINGLE TRACK RAILWAY BYPASS AROUND NIŠ

Faza projekta / *Phase*: **IDP - IDEJNI PROJEKAT** *PRELIMINARY DESIGN*

Vrsta projekta / *Design type*: **2/ 1.6 - Projekta zidova za zaštitu od buke** *2/ 1.6 - Design of the noise protection walls*

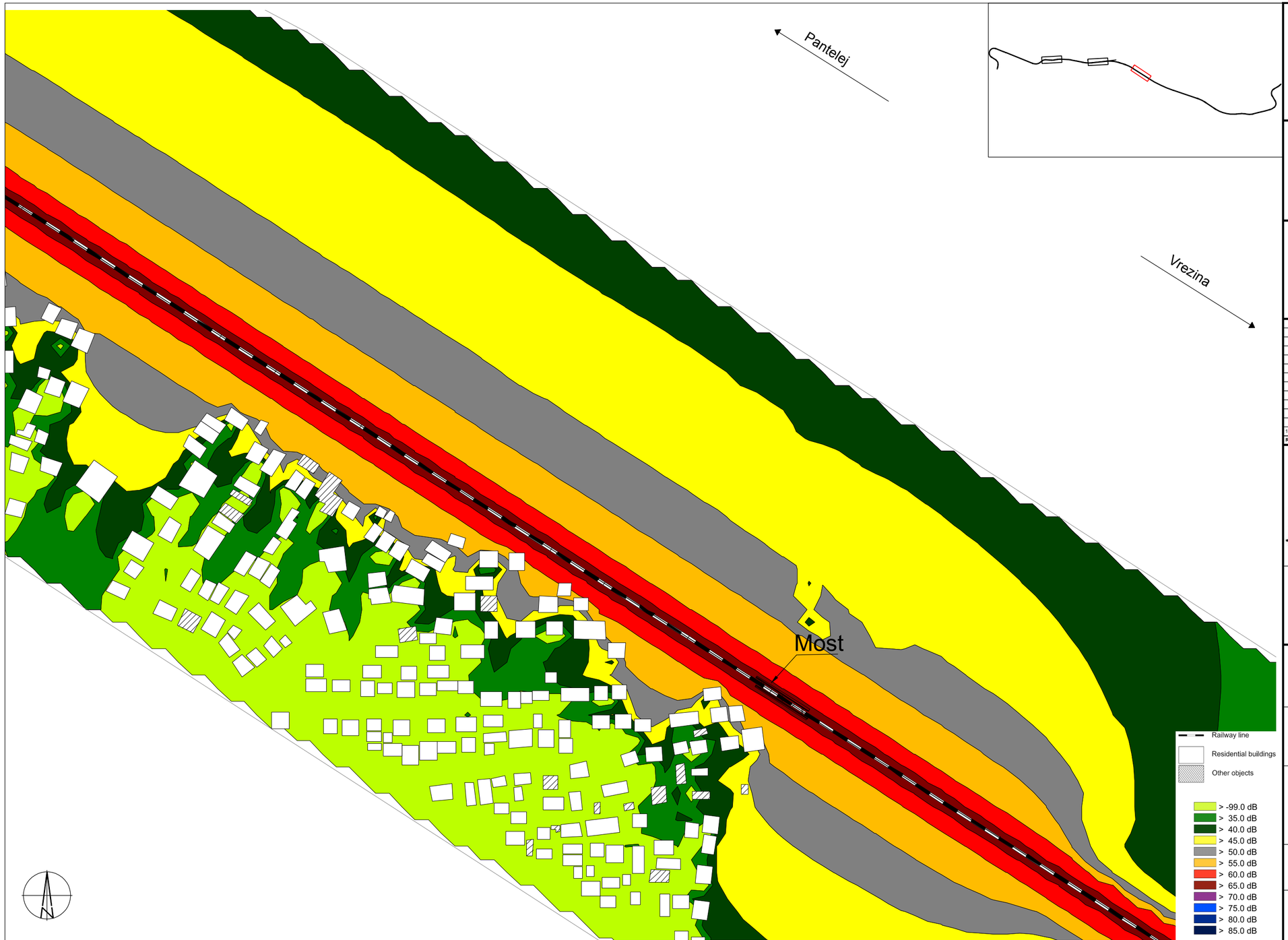
Naziv crteža / *Drawing title*:

Karta buke sa merama zaštite
Noise map with noise barriers

Razmera / *Scale*:	Datum / *Date*:	List br. / *Sheet No.* :
1:-	**14/06/2016**	**4 / 6**

Šifra crteža / *Drawing code*: **CRIS2013-323-409_PD-B.4_G_000**

Rev. / *Rev.* : **1.1**



Investitor / *Contracting Authority*:

European Union Delegation to the Republic of Serbia
2011 IPA Programme for the Republic of Serbia
EuropeAid/131854/C/SER/RS

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Krajni korisnik / *Final Beneficiary*:

Инфраструктура железнице Србије а.д.

Korisnik / *Beneficiary*:

Projektant / *Consultant*:

CeS.COWI

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REV.	DATE	PREPARED	CHECKED	APPROVED	DESCRIPTION
1	14/06/2016	A. Trifunovic	V.Jovanovic	T.Simic	Response to comments SRC and ISR Revision Committee

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MODERNIZACIJA ŽELEZNICE - PROJEKTNA DOKUMENTACIJA ZA IZGRADNJU JEDNOKOLOSEČNE PRUGE ZA OBILAZNICU OKO NIŠA
MODERNIZATION OF RAILWAYS - PROJECT DOCUMENTATION FOR CONSTRUCTION OF A SINGLE TRACK RAILWAY BYPASS AROUND NIŠ

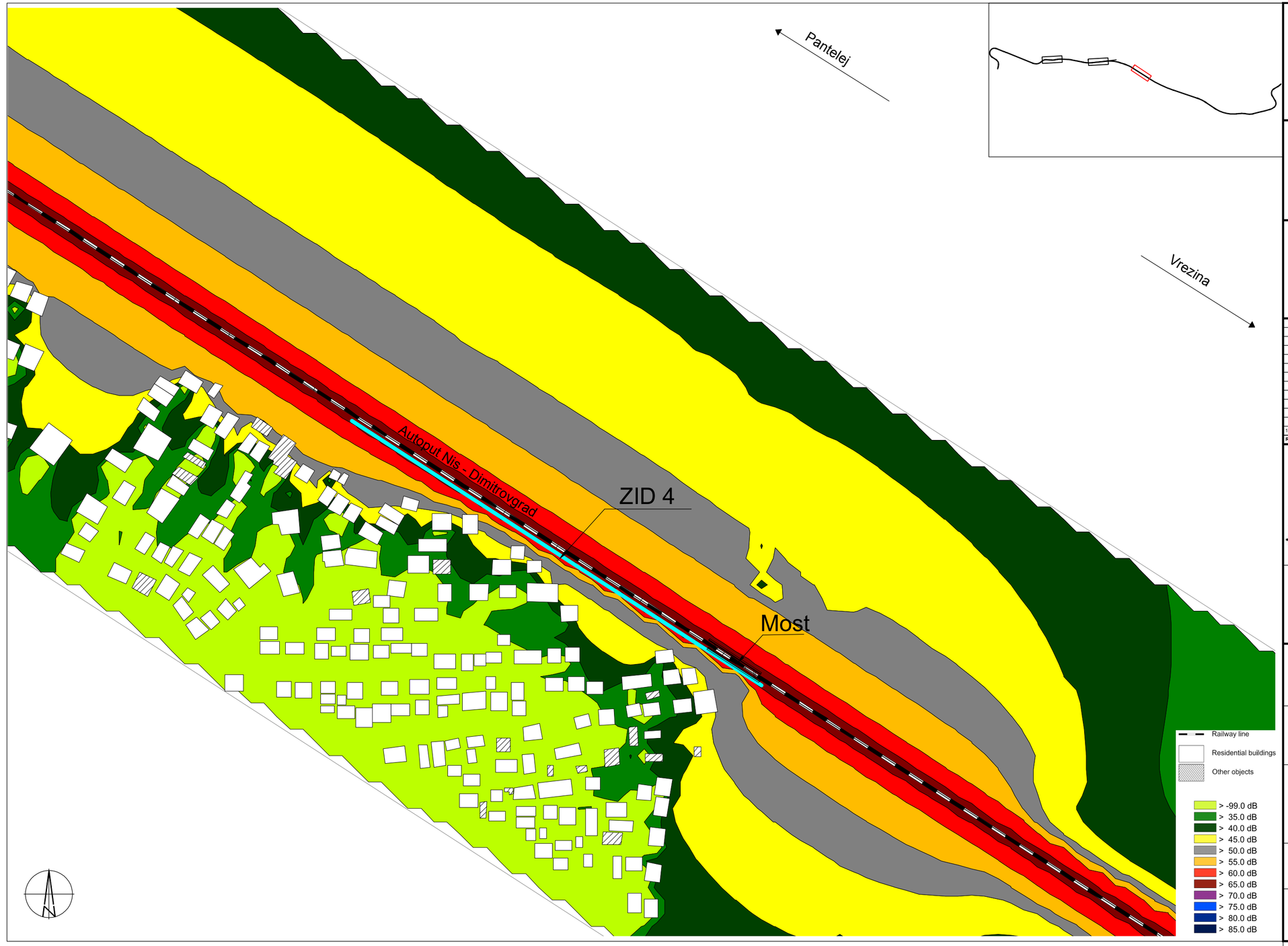
Faza projekta / *Phase*:
IDP - IDEJNI PROJEKAT
PRELIMINARY DESIGN

Vrsta projekta / *Design type*:
2/ 1.6 - Projekta zidova za zaštitu od buke
2/ 1.6 - Design of the noise protection walls

Naziv crteža / *Drawing title*:
Karta buke bez mera zaštite
Noise map without protective measures

Razmera / *Scale*:	Datum / *Date*:	List br. / *Sheet No.* :
1:-	14/06/2016	5 / 6

Šifra crteža / *Drawing code*:	Rev. / *Rev.* :
CRIS2013-323-409_PD-B.4_G_000	1.1



Investitor / *Contracting Authority*:

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Инфраструктура железнице Србије а.д.

Korisnik / *Beneficiary*:

Projektant / *Consultant*:

CeS.COWI

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Podizvođač / *Subcontractor:*

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REV.	DATE	PREPARED	CHECKED	APPROVED	DESCRIPTION
1	14/06/2016	A. Trifunovic	V.Jovanovic	T.Simic	Response to comments SRC and ISR Revision Committee

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MODERNIZACIJA ŽELEZNICE - PROJEKTNA DOKUMENTACIJA ZA IZGRADNJU JEDNOKOLOSEČNE PRUGE ZA OBILAZNICU OKO NIŠA
MODERNIZATION OF RAILWAYS - PROJECT DOCUMENTATION FOR CONSTRUCTION OF A SINGLE TRACK RAILWAY BYPASS AROUND NIŠ

Faza projekta / *Phase*:
IDP - IDEJNI PROJEKAT
PRELIMINARY DESIGN

Vrsta projekta / *Design type*:
2/ 1.6 - Projekta zidova za zaštitu od buke
2/ 1.6 - Design of the noise protection walls

Naziv crteža / *Drawing title*:
Karta buke sa merama zaštite
Noise map with noise barriers

Razmera / *Scale*:	Datum / *Date*:	List br. / *Sheet No.* :
1:-	**14/06/2016**	**6 / 6**

Šifra crteža / *Drawing code*:	Rev. / *Rev.* :
CRIS2013-323-409_PD-B.4_G_000	**1.1**