BC
Beo Čista
Energija d.o.o.

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

PROJECT: NEW LANDFILL WITH THE ACCOMPANYING FACILITIES AT VINČA LOCATION IN BELGRADE

BELGRADE, SEPTEMBER 2019

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

PROJECT: NEW LANDFILL WITH THE ACCOMPANYING FACILITIES AT VINČA LOCATION IN BELGRADE

INVESTOR: **„BEO ČISTA ENERGIJA"** DOO
Tošin Bunar 272v
11000 Beograd

DRAFTED BY: **„DVOPER"** DOO
11000 Beograd
Dečanska 5

PARTICIPANTS:

NEBOJŠA POKIMICA, Chemist/specialist in toxicological chemistry

Dr TANJA RADOVIĆ, Chemical engineer/Ph.D.
license number 371 M423 13

BRATISLAV KRSTIĆ, Chemical engineer
license number 371 C790 06

DOBRIVOJE DŽIPKOVIĆ, Mechanical engineer
license number330 D733 06

NATAŠA ĐOKIĆ, geologist

PAVLE CVETIĆ, Landscape architect

BOJANA LALOVIĆ, Environmental engineer

Belgrade, September 2019.

GENERAL SHEETS

Република Србија
Агенција за привредне регистре

Search of economic entities

Back to search

Basic data

Business Name: Beo Čista Energija d.o.o.Belgrade
Status: Active company
Identification number: 21319775
Legal form: Limited Liability Company Seat: Municipality: Belgrade-Novi Beograd | City: Belgrade-Novi Beograd | Street and number: Tošin Bunar 272 v
Date of establishment: 12.09.2017
Tax ID: 110224482

Business data

Data of establishment

Registration date: 12.09.2017

Time of duration

Duration limited to: Unlimited

Main activity

Activity Code: 3821
Name of activity: Non-hazardous waste treatment and disposal

Other identification data

Tax Identification Number Tax ID: 110224482

Legal representatives

Natural persons

First name Last Name: Mitsuaki Harada
Position: Director
First name Last Name: Philippe Pierre Marie Auguste Thiel
Position: Director
First name Last Name: Vladimir Milovanović Position: Director

Република Србија
Агенција за привредне регистре

Registry of Business Entities 5000131503543 BD 90335/2017

On 26.10.2017 Belgrade

Registrar of the Registry of Business Entities kept by the Business Registers Agency pursuant to Article 15, paragraph 1of the Law on Registration Procedure at the Business Registers Agency ("Official Gazette of RS", no.99/2011, 83/2014), deciding on the registration application for data change with Beo Čista Energija d.o.o.Belgrade, identification number:21319775, submitted by:

Name and surname: Iskra Lazić

adopts the

DECISION

The registration application, SHALL BE ADOPTED and a change of data is registered in the Registry of Companies at:

Beo Čista Energija d.o.o.Belgrade

Identification/registration number: 21319775

the following changes:

Change of legal representatives:
Natural persons:
The following is omitted:

- Name and surname: Belinda Faith Howarth
  Passport number and country of issue: 531723769 United Kingdom Position in the company: Director
  Mode of representation: jointly
  Restriction on the power of representation by co-signature:
  - A valid representation of the Company requires the signature of two directors.

- Name and surname: Stéphane Cédric Heddesheimer
  Passport number and country of issue: 07CF52294 France
  Position in the company: Director
  Mode of representation: jointly
  Restriction on the power of representation by co-signature:
  - A valid representation of the Company requires the signature of two directors.

- Name and surname: Jean-François Gagnaire
  Passport number and country of issue: 11AV09118 France
  Position in the company: Director
  Mode of representation: jointly
  Restriction on the power of representation by co-signature:

- A valid representation of the Company requires the signature of two directors.

The following is registered:

- Name and surname: Mitsuaki Harada
  Passport number and country of issue:TZ1237381
  Japan Position in the company: Director
  Representation mode: jointly
  Restriction on the power of representation by co-signature:
  - A valid representation of the Company requires the signature of two directors.

- Name and surname: Philippe Pierre Marie Auguste Thiel
  Passport number and country of issue:15FV32897 France
  Position in the company: Director
  Mode of representation: jointly
  Restriction on the power of representation by co-signature:
  - A valid representation of the Company requires the signature of two directors.

- Name and surname: Vladimir Milovanović
  Unique citizen's number:1002961710207
  Position in the business entity: Director
  Representation mode: jointly
  Restriction on the power of representation by co-signature:
  - A valid representation of the Company requires the signature of two directors.

Justification

On 25.10.2017, the applicant submitted the registration application for the change of data Number BD 90335/2017 and with the application it submitted the documentation specified in the certificate on the received registration application.

Verifying the fulfilment of the conditions for registration of the change of data prescribed by the provision of Article 14of the Law on Registration Procedure at the Business Registers Agency, the Registrar determined that the conditions for registration were fulfilled, and decided as in the operative part of the decision, in accordance with the provision of Article 16of the law.

The amount of the fee for conducting the registration procedure is determined by the Decision on fees for registration activities and other services provided by the Business Registers Agency ("Official Gazette of RS", no.119/2013, 138/2014, 45/2015 and 106/2015).

INSTRUCTIONS ON LEGAL REMEDIES:

An appeal may be lodged against this Decision to the Minister responsible for the position of companies and other forms of business, within 30 days from the day of their publication on the Agency's website, and through the Agency.

REGISTRATOR ___________________
Miladin Maglov

8000041375268

ИЗВОД О РЕГИСТРАЦИЈИ ПРИВРЕДНОГ СУБЈЕКТА

Република Србија
Агенција за привредне регистре

ОСНОВНИ ИДЕНТИФИКАЦИОНИ ПОДАТАК

Матични / Регистарски број	20407441

СТАТУС

Статус привредног субјекта	Активно привредно друштво

ПРАВНА ФОРМА

Правна форма	Друштво са ограниченом одговорношћу
Извор средстава за оснивање и пословање задруге	улози

ПОСЛОВНО ИМЕ

Пословно име	DRUŠTVO ZA ZAŠTITU ŽIVOTNE SREDINE I ODRŽIVI RAZVOJ DVOPER DOO BEOGRAD (STARI GRAD)
Скраћено пословно име	DVOPER DOO BEOGRAD

ПОДАЦИ О АДРЕСАМА

Адреса седишта

Општина	Београд-Стари Град
Место	Београд-Стари Град
Улица	Дечанска
Број и слово	5
Спрат, број стана и слово	/ /

ПОСЛОВНИ ПОДАЦИ

Подаци оснивања

Датум оснивања	11. април 2008

Време трајања

Време трајања привредног субјекта	Неограничено

Претежна делатност

Шифра делатности	7120

Назив делатности	Техничко испитивање и анализе
Остали идентификациони подаци	
Порески Идентификациони Број (ПИБ)	105557340
Подаци о статуту / оснивачком акту	
Не постоји обавеза овере измена оснивачког акта	Датум важећег статута
	Датум важећег оснивачког акта

Законски (статутарни) заступници

Физичка лица

1.	Име	Небојша	Презиме	Покимица
	ЈМБГ	0101972780015		
	Функција	Директор		
	Ограничење супотписом	не постоји ограничење супотписом		

Директори / чланови одбора директора

Директори

Чланови одбора директора

1.	Име	Небојша	Презиме	Покимица
	ЈМБГ	0101972780015		

Прокуристи

Појединачна прокура

1.	Име	Ратко	Презиме	Ђорђевић
	ЈМБГ	0405943330077		

Чланови / Сувласници

Подаци о члану

Пословно име	DVOKUT-ECRO DOO
Регистарски / Матични број	00539651

Подаци о капиталу

Новчани

износ	датум
Уписан: 3.000,00 EUR, у противвредности од 247.026,90 RSD	

износ	датум
Уписан: 3.752.973,10 RSD	
износ	датум
Уплаћен: 3.000,00 EUR, у противвредности од 247.026,90 RSD	28. март 2008
износ	датум
Уплаћен: 3.752.973,10 RSD	4. март 2015

	износ(%)
Сувласништво удела од	**100,00000**

Основни капитал друштва

Новчани

износ	датум
Уписан: 3.000,00 EUR, у противвредности од 247.026,90 RSD	
износ	датум
Уписан: 3.752.973,10 RSD	
износ	датум
Уплаћен: 3.000,00 EUR, у противвредности од 247.026,90 RSD	28. март 2008
износ	датум
Уплаћен: 3.752.973,10 RSD	4. март 2015

Регистратор, Миладин Маглов

EXCERPT ON THE REGISTRATION OF A BUSINESS ENTITY

BASIC IDENTIFICATION DATA

Registration / Identification number | 20407441

STATUS

Business entity status | Active company

LEGAL FORM

Legal form: Limited liability company

Source of funds for establishing and operating a cooperative:DEPOSITS

BUSINESS NAME

Business name DRUŠTVO ZA ZAŠTITU ŽIVOTNE SREDINE I ODRŽIVI

RAZVOJ DVOPER DOO BEOGRAD STARI GRAD

Short business name | DVOKUT DOO BELGRADE

ADDRESS DATA

Head Office address

Belgrade-Stari Grad Municipality

City | Belgrade-Stari Grad

Street Dečanska -

Number and letter 8 - -

Floor, apartment number and letter

BUSINESS DATA

Establishment information

Foundation date April 11, 2008

Duration

Duration of business entity Unlimited

Main activity

Activity code 7120

Activity name: Technical testing and analysis

Other identification information

Tax Identification Number (PIB) 1 | 105557340

Information on the statute/articles of association

There is no obligation to certify the changes

of acts of association

Date of valid statute

Date of the founding act in force

Legal (statutory) agents

Natural Persons

Name:Nebojša

Surname:Pokimica

Unique citizen's number (JMBG) 0101972780015

Position | Director

Co-signature restriction

there is no restriction by co-signature

by co-signature

Directors/members of the Board of Directors

Directors

Board members

First Name Nebojša Surname Pokimica

Unique citizen's number (JMBG) 0101972780015

Procurators

Individual procura

Name Ratko Surname Đorđević

Unique citizen's number (JMBG) 0405943330077

Members/Co-owners

Member information

Business name | DVOKUT-ECRO doo

Registration/

Identification number 00539651

Information on the capital

Payment amount

amount date

Subscribed:EUR 3,000.00, in counter value of RSD 247,026.90

Amount date

Subscribed:RSD 3,752,973.10

Paid:EUR 3,000.00, in counter value of March 28, 2008.

RSD 247,026.90

Amount date

Paid:RSD 3,752,973.10 March 4, 2015

Amount (%)

Co-ownership of the share of 100,00000

The share capital of the company

Cash

amount date

Subscribed:EUR 3,000.00, in counter value of

RSD 247,026.90

amount date

Subscribed:RSD 3,752,973.10

amount date

Paid:EUR 3,000.00, in counter value of

RSD 247,026.90

March 28, 2008

Amount date

Paid:RSD 3,752,973.10 March 4, 2015

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

Тања Т. Радовић

дипломирани инжењер технологије
ЛИБ 11580077263

одговорни пројектант

технолошких процеса

Број лиценце
371 M423 13

У Београду,
4. јула 2013. године

ПРЕДСЕДНИК КОМОРЕ

Милован Главоњић
дипл. инж. ел.

License

of the CHIEF DESIGNER

In accordance with Law on Planning and Construction

of the Statute of the Serbian Chamber of Engineers

BOARD OF DIRECTORS OF THE CHAMBER OF ENGINEERS OF SERBIA

establishes that

Tanja T.Radović

Graduate Engineer of Technology

LIB 11580077263

is the Chief Designer

of technological processes

License No.

371 M423 13

PRESIDENT OF THE CHAMBER

Chamber President

Milovan Glavonjić

B.Sc. El. Eng.

In Belgrade,

July 4, 2013

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

Братислав Б. Крстић

дипломирани инжењер технологије
ЈМБ 0708959710131

одговорни пројектант

технолошких процеса

Број лиценце
371 C790 06

SERBIAN CHAMBER OF ENGINEERS

LICENCE

of the CHIEF DESIGNER

У Београду,
26. јануара 2006. године

ПРЕДСЕДНИК КОМОРЕ

Милан Вуковић
дипл. грађ. инж.

In accordance with Law on Planning and Construction
of the Statute of the Serbian Chamber of Engineers

BOARD OF DIRECTORS OF THE CHAMBER OF ENGINEERS OF SERBIA
establishes that
Bratislav B. Krstić

Graduate Engineer of Technology
JMB 0708959710131

Chief Designer

of technological processes

License No.
371 C79006

Chamber President

Milan Vuković
BSc Cons. Eng.

In Belgrade,
January 26, 2006

Број: 12-02/336525
Београд, 14.02.2019. године

На основу члана 75. Статута Инжењерске коморе Србије ("СГ РС", бр. 88/05,16/09 и 27/16), а на лични захтев члана Коморе, Инжењерска комора Србије издаје

ПОТВРДУ

Којом се потврђује да је Братислав Б. Крстић, дипл.инж.техн.

лиценца број

371 С790 06

за

одговорног пројектанта технолошких процеса

на дан издавања ове потврде члан Инжењерске коморе Србије, да је измирио обавезу плаћања чланарине Комори закључно са 26.01.2020. године, као и да му одлуком Суда части издата лиценца није одузета.

М.П.

Потпредседник Управног одбора
Инжењерске коморе Србије

Латинка Обрадовић, дипл. грађ. инж.

Number:12-02/336525
Belgrade, 14.02.2019

Pursuant to Article 75of the Statute of the Serbian Chamber of Engineers ("OG of RS", no.88/05, 16/09 and 27/16), and at the personal request of a Chamber member, The Serbian Chamber of Engineers issues

CERTIFICATE

Confirming that Bratislav B.Krstić, B.Sc.Tech.
licence No.

371 C790 06

for
the chief designer of technological processes

on the day of issue of this certificate is a member of the Serbian Chamber of Engineers, that he settled the obligation to pay the membership fee to the Chamber as of 26.01.2020.

and that his license had not been revoked by a decision of the Court of Honor.

Vice President of the Board of Directors

of the Chamber of Engineers

Latinka Obradović BSc Constr.Eng.

TERMS OF REFERENCE

In accordance with the positive legislation and the Decision on determining the scope and content of the Study on environmental impact assessment of the project for the construction of a new landfill with accompanying facilities at the Vinča site in Belgrade, Ministry of Environment, number 353-02-00815/2018-03 of 09.05.2019, prepare an ENVIRONMENTAL IMPACT ASSESSMENT STUDY: PLANT FOR THE ENERGY UTILIZATION OFMUNICIPALWASTE AND THE LANDFILL GAS "VINČA".

Belgrade, September 2018

INVESTOR

____

Pursuant to Article 128 of the Law on Planning and Construction ("Official Gazette of RS" No. 145/2014), the Law on Environmental Protection ("Official Gazette of RS" No. 14/2016 and 95/2018) and the Law on Environmental Impact Assessment ("Official Gazette of RS" No. 36/09), I adopt the following

DECISION
ON THE DESIGNATION OF THE CHIEF DESIGNER

For the production of the

ENVIRONMENTAL IMPACT ASSESSMENT STUDY OF PROJECT: PLANT FOR THE ENERGY UTILIZATION OF MUNICIPAL WASTE AND THE LANDFILL GAS "VINČA"

of Project Leader "BEO ČISTA ENERGIJA" DOO from Belgrade, the following shall be appointed as the Chief Designer:

PhD Tanja Radović, BSc in Tech. Eng./PhD

The appointed is obliged to do all the relevant documentation in accordance with the above laws, professional rules and engineering practice.

JUSTIFICATION

For the purposes of Article 128 of the Law on Planning and Construction, it is stipulated that the preparation of technical documentation is carried out by a responsible designer who must meet the prescribed conditions.

Belgrade, September 2018

Director

Nebojša Pokimica

Pursuant to Article 19of the Law on Environmental Impact Assessment ("Official Gazette of RS", No. 36/09), I adopt the following

DECISION

A multidisciplinary team is designated to draft the ENVIRONMENTAL IMPACT ASSESSMENT STUDY: PLANT FOR THE UTILIZATION OF MUNICIPAL WASTE AND LANDFILL GAS "VNČA", of Project Leader "BEO ČISTA ENERGIJA" DOO from Belgrade, in the following composition:

Chief Designer: PhD Tanja Radović, B.Sc.Tech./Ph.D.License number:371 M423 13

Team members: NEBOJŠA POKIMICA, BSc in Chemistry/ Spec. of Toxicological Chemistry BRATISLAV KRSTIĆ, BSc in Tech. Eng.
License number: 371 C790 06
DOBRIVOJE DŽIPKOVIĆ, BSc in Mech. Eng. *License number 330 D733 06*
NATAŠA ĐOKIĆ, BSc in Geol. Eng.
PAVLE CVETIĆ, BSc in Landscape Architecture and Horticulture BOJANA LALOVIĆ, Master Environmental Engineer

Appointees are required to comply with environmental legislation, technical norms, standards and professional rules when drafting the Environmental Impact Assessment Study.

Belgrade, September 2018

Director

Nebojša Pokimica

Based on the Law on Planning and Construction ("Official Gazette of RS" 145/2014) and the Law on Environmental Protection ("Official Gazette of the Republic of Serbia” No. 14/2016 and 95/2018)

I DECLARE

When drafting the

ENVIRONMENTAL IMPACT ASSESSMENT STUDY OF PROJECT: PLANT FOR THE ENERGY UTILIZATION OF MUNICIPAL WASTE AND LANDFILL GAS "VINČA"

I fully complied with:

- Terms of Reference
- Relevant legal regulations pertaining to the project in question -
Rules of the profession regarding the solutions given in this project

In Belgrade, September 2019

Chief Designer:

PhD Tanja Radović,
B.Sc.Tech./Ph.D.License
number:371 M423 13

CONTENTS

Legend of used abbreviations

English		Serbian	
BAT	Best Available Techniques	NRT	Najbolje raspoložive tehnike
BCE	Beo Čista Energija d.o.o.	BČE	Beo Čista Energija d.o.o.
BOD	Biological Oxygen Demand (5days)	BPK	Biološka potrošnja kiseonika(5 dana)
BREF	Best Available Techniques (BAT) Reference document developed under the IPPC Directive and the IED	NREF	Najbolje raspoložive tehnike (NRT) Referentni dokument razvijen pod IPPC Direktivom i DIE
CHP	Cogeneration or Combined Heat and Power	KTE	Kogeneracija kombinovane toplote i energije
City/CoB	City of Belgrade	Grad	Grad Beograd
CO	Carbon Monoxide	CO	Ugljen monoksid
COD	Chemical Oxygen Demand	HPK	Hemijska potrošnja kiseonika
CPU	Central Processing Unit	CJP	Centralna jedinica za preradu
CV	Calorific Value	KV	Kalorijska vrednost
E&S	Environmental and Social	ZŽSSZ	Zaštita životne sredine i socijalna zaštita
EfW	Energy from Waste	EiO	Energija iz otpada
EMS	Elektromreža Srbije (Transmission Network Operator)	EMS	Elektromreža Srbije (Operater dalekovodne mreže)
EPS	Elektroprivreda Srbije (Distribution Network Operator)	EPS	JP Elektroprivreda Srbije
ESIA	Environmental and Social Impact Assessment Study	PUŽSSP	Procena uticaja na životnu sredinu i socijalna pitanja
EU	European Union	EU	Evropska Unija
FGT	Flue Gas Treatment	TDG	Tretiranje dimnog gasa
GC	Gradska čistoća Beograd	GČ	Gradska čistoća Beograd
GHG	Greenhouse Gases	GSB	Gasovi staklene bašte
HCl	Hydrochloric Acid	HCl	Hidrohlorna kiselina
HDPE	High-Density Polyethylene	PVG	Polietilen visoke gustine
HF	Hydrogen Fluoride	HF	Vodonik fluorid
Hg	Mercury	Hg	Živa
IBA	Incinerator Bottom Ash	PDI	Pepeo na dnu insineratora
LFG	Landfill Gas	DG	Deponijski gas
LTP	Leachate Treatment Plant	PPPV	Postrojenje za prečišćavanje procednih otpadnih voda
m.a.s.l.	Meter Above Sea Level	m.n.m.	Metara iznad nivoa mora
MEP	Ministry of Environment Protection	MZŽS	Ministarstvo zaštite životne sredine
MSW	Municipal Solid Waste	KČO	komunalni čvrsti otpad
NOx	Nitrogen Oxide	NOx	Azot oksid
PPP	Private Public Partnership	JPP	Javno privatno partnerstvo
PUC	Public Utility Company	KP	Komunalno preduzeće
RAP	Resettlement Action Plan	APR	Akcioni plan za raseljavanje
RO	Reverse Osmosis Unit	JRO	Jedinica za reverznu osmozu
RWD	Republic Water Directorate	RDV	Republička direkcija za vode
TOC	Total Organic Carbon	UOU	Ukupni organski ugljenik
WWT	Waste Water Treatment	PPOV	Postrojenje za prečišćavanje otpadnih

English		Serbian	
			voda
DRP	Detailed Regulation Plan	PDR	Plan detaljne regulacije
CiM	City Municipality	GO	Gradska opština
CaM	Cadastral Municipality	KO	Katastarska opština
CP	Cadastral Plot	KP	Katastarska parcela
RHSS	Republic Hydrometeorological Service of Serbia	RHMZ	Republički hidrometeorološki zavod
MCL	Maximum Continuous Load	MCR	Maksimalno kontinualno opterećenje
CDW	Construction & Demolition Waste	OIR	Otpad od izgradnje i rušenja
EPARS	Environmental Protection Agency of the Republic of Serbia	SEPA	Agencija za zaštitu životne sredine Republike Srbije

INTRODUCTION

The “Vinča” Landfill was established in 1978. In the mid-1990s, it was decided to close the locations of all city dumps, except the “Vinča” landfill. Since 1998, “Vinča” has been the only landfill in the city of Belgrade. Currently, it receives about 6,000 tons of waste per day, which makes it the largest landfill in Serbia.

Landfill Vinča has been used for more than 40 years for disposal of municipal solid waste from the territory of the City of Belgrade, and receives 550,000 tons of municipal solid waste (MSW) each year from 13, out of the 17 Belgrade municipalities.

In the process of harmonization of the legislation of the Republic of Serbia with the EU regulation, the incorporation of EU directives related to municipal solid waste was also implemented. Given the size and importance of the Vinča landfill, as well as the many problems that arise in its operation, the City of Belgrade initiated this project with the aim of rehabilitating and maintaining the Vinča landfill, ie. taking care of the existing landfill (old landfill), construction and arrangement of the new landfill, as well as construction (EFW) of the waste treatment and heat production plant.

As part of the municipal waste landfill project in Vinča, the following will be included:

- Remediation of the old landfill (with perimeter embankments and cover), including temporary long-term storage of construction waste (CDW) processed for new use,
- Inert materials landfill for inert construction waste at the top of a rehabilitated landfill;
- Landfill extension: temporary landfill, unprocessed waste landfill and landfill for post-processing waste;
- Rainwater, leachate water and biogas drainage and collection network;
- Leachate and rainwater collection pools;
- Leachate and biogas treatment platforms;
- Crushing Platform: A platform for the treatment and processing of construction waste for reuse;
- Access and inland roads,

Facilities and work capacities:

- Control zone at the entrance, which includes: wheel scales, supervisor station and parking;
- Inner wheel scales (to be adjusted according to material flow);
- Landfill platform, which includes a zone for cleaning and work machines parking, parking for light vehicles, landfill maintenance facility, offices and locker room.

This Project also includes:

- The facility for the municipal waste utilization plant (EfW) is being designed by “Energoprojekt-Entel”, which is integrated into the general disposition of the global landfill site. The bottom incinerator ash settling zone (IBA) - (intended to deposit ash from the bottom of the incinerator before being reused as construction material or storing that ash at the landfill after treatment) is located on the platform of the municipal waste utilization facility (EfW);
- Crushing and sorting plant for construction waste, designed by “Energoprojekt-Industrija”, including earthworks and water drainage systems
- The supporting building that lies downstream of the rehabilitated landfill - obligations of the City (designer "Hidrozavod”).

The project envisages the implementation of conventional and proven technological solutions and technologies, in conjunction with the EU, IFC (SU), EBRD, GSB and Serbian standards.

The entire project is carried out according to the contract on Public Private Partnership concluded between the City of Belgrade and the special purpose company " Beo Čista Energija" doo.

The subject of this study is the assessment of the environmental impact of the new landfill with accompanying facilities construction on the existing municipal landfill site in Vinča.

The study is made on the basis of the Law on Environmental Impact Assessment (“Official Gazette of the RS” Nos. 135/2004 and 36/2009), Rulebook on the content of the study on environmental impact assessment (“Official Gazette of the RS” No. 69/2005) and Decision on Determining the Scope and Content of the Environmental Impact Assessment Study of the New Landfill with Accompanying Facilities Construction Project at the Vinča Site in Belgrade, Ministry of Environment Protection, No. 353-02-1686 / 2018-03 of 8/29/2018..

1.0. INFORMATION ABOUT THE INVESTOR

„BEO ČISTA ENERGIJA“ DOO

Company name:	„BEO ČISTA ENERGIJA“ DOO Beograd
Short company name:	„BEO ČISTA ENERGIJA“ DOO
Head office/Address:	Tošin Bunar 272v
Activity:	Treatment and disposal of non-hazardous waste
Business activity code:	3821
Registration number:	21319775
TAX ID	110224482
Directors	Mitsuaki Harada Philippe Pierre Marie Auguste Thiel Vladimir Milovanović
Representative:	Malik Kerker
Telephone:	011/715 88 84
Fax:	011/715 88 86
E-mail:	*bce@bceenergy.rs*

2.0. LOCATION DESCRIPTION

Macro location

The landfill "Vinča" is located in the eastern part of Belgrade (approximately 12 km from the city center), in the settlement Vinča.

In the wider surroundings of the landfill "Vinča", in a radius of more than 900 m, there are settlements: Slanci, Veliko selo and Mirijevo. To the south, the nearest settlement is Vinča, whose center is located approximately 3 km from the landfill body, however, parts of the settlement are located no further that 1.7 km from the landfill. To the north, the nearest parts of the settlement Veliko Selo are also located 1.7 km from the landfill body. The first parts of the suburban areas of Kaluđerica and Mirijevo are located over 2 km towards west. In the east, on the other side of the Danube River, there is a suburban area of Starčevo, 7 km away from the landfill. Town Pančevo, with its numerous industrial elements, is located 8 km northwest, also on the other side of the Danube.

Figure 1 Macro location of Landfil complex "Vinča"

Distances (in the air line) of the "Vinča" landfill complex, from surrounding facilities, are given in the following tables:

Vulnerable object	Distance, m	Orientation
Old cemetery Vinča	900	SE
Gravel exploitation	1000	SE
Danube River	1500	E
The nearest house in Vinča	1700	SE
The nearest group of houses in Vinča	1700	S
The Vinča Institute of Nuclear Sciences	2300	S
The nearest group of houses in Kaluđerica	2500	W
Smederevski put	3600	SW
The nearest house in Mirijevo	2800	NW
The nearest group of houses in Mirijevo	4000	NW
The nearest house in Veliko Selo	1600	N
The nearest group of houses in Veliko Selo	1100	NE
Monastery of Holy Archbishop Stephan	1200	N

The Belo Brdo archaeological site is approximately 3km away from the Vinča landfill complex, southeastward. The precise location of the Veteran's Villa was not determined by the competent Institute for Immovable Cultural Property.

The listed objects are shown in Figure 2.

Figure 2 Significant spatial elements of project site surrounding

Monastery of Holy Archbishop Stephan (Slanci Monastery) is located 1.2 km north of the existing landfill site. It is visually separated by a dense forest and hill southward. A new complex was built in 1960s on the site of the historic monastery, and consequently, the area is protected as an archaeological site. Northeast of the monastery is a cemetery, 1.6 km away from the landfill.

The old ("country") cemenetery is located 0.9 km southwest from the landfill. On the east side of cemetery is a hiking trail that connects Vinča and Veliko Selo settlements. The church of St. Apostles Petar and Pavle is located in the center of Vinča, i.e. 3 km from the landfill. The largest cemetery in the area is the Lešće cemetery, located 4 km northwest from the landfill complex.

Schools and sacral buildings are located in all major settlements surrounding the landfill. The nearest school is in Veliko Selo, about 2 km north of the landfill.

The Vinča Institute of Nuclear Sciences is surrounded by forests and partially separated from the settlement. It is located 2.2 km southwest from landfill.

An asphalt production plant is located southwest from the landfill body (approx. 400 m).

Larger industrial areas are located in the western parts of Belgrade. In relation to the landfill, they are 5 km southwest, west and northwest. The high-voltage switchyard is located 3 km northwest from the landfill site (by skyline).

The most significant industrial area is located in the southern part of Pančevo, where an oil refinery, chemical industry complexes and a river port are located. In relation to the landfill, they are about 8 km northeast by skyline.

The Danube River is located 1.5 km east from the landfill site. About 3 km northeast there is the Danube Canal - Dunavac, and northern of it there are several river islands.

The following pictures show the distances of the closest houses from the Vinča landfill complex border.

First house across from the cemetery, 1080 m, southeast

First houses in Vinča, 1850 m, southeast

First house in Stara Kaluđerica, 1930 m, southwest

First house in Mirijevo, 2850 m, east

First house in Slanci, 1070 m, northwest

First house in Veliko selo, 1600 m, northwest

Facility in the orchard at the cemetery, 850m, southeast

Micro location

Landfill Vinča is located on the teritory of municipalities: Grocka, Palilula and Zvezdara, on the right bank of the Danube River. The "Vinča" landfill complex is located on parts of the territory of 3 city municipalities, ie.3 cadastral municipalities:

- Grocka municipality, CM Vinča
- Zvezdara municipality, CM Mali Mokri Lug and
- Palilula municipality, CM Slanci

The municipal waste landfill Vinča covers an area of approximately 140 ha, located in the valley of the Ošljanski potok (Ošljan stream). Landfill location falls to the north-east and it is surrounded by hills on the southern and western side. Below the landfill body flows Ošljanski potok, which flows into Ošljanska bara (Ošljan Pond). Road connection of the landfill is through Beogradska ulica to Smederevski put – in the length of about 3 km.

The narrower area around the landfill is mainly used for agriculture (fruit and vegetable production), however, some of the parcels are now abandoned (there is a succession of agricultural land). A smaller number of agricultural land is located next to the landfill. Forests are reduced to smaller forest communities.

The project of the New Landfill with the accompanying facilities is planned within the complex of municipal waste landfill in Vinča. Within this study, the following contents and facilities are considered:

1. **Entrance and control zone**
2. **CDW plant**
3. **New landfill**
4. **Operative platform**
5. **Upper platform with lagoons for leachate and rain water**
6. **Lower platform with lagoons for leachate and rain water**
7. **Protective dam around the old landfill (support structure)**
8. **Torch system**

Based on the project documentation, within the comprehensive project for the arrangement of the location of landfill municipal waste in Vinča, rehabilitation, recultivation and closing of the existing "old" landfill will be carried out.

In accordance with the Rulebook on Methodology for Preparation of Rehabilitation and Remediation Projects ("Official Gazette of the Republic of Serbia" No. 74/2015), it is the Investor's responsibility to prepare the Design for Rehabilitation and Remediation of the "Old" Municipal Waste Landfill and to obtain consent of the competent Ministry of Environment Protection.

Planned contents of the new landfill project are distributed in the free space around the existing body of the "old" landfill.

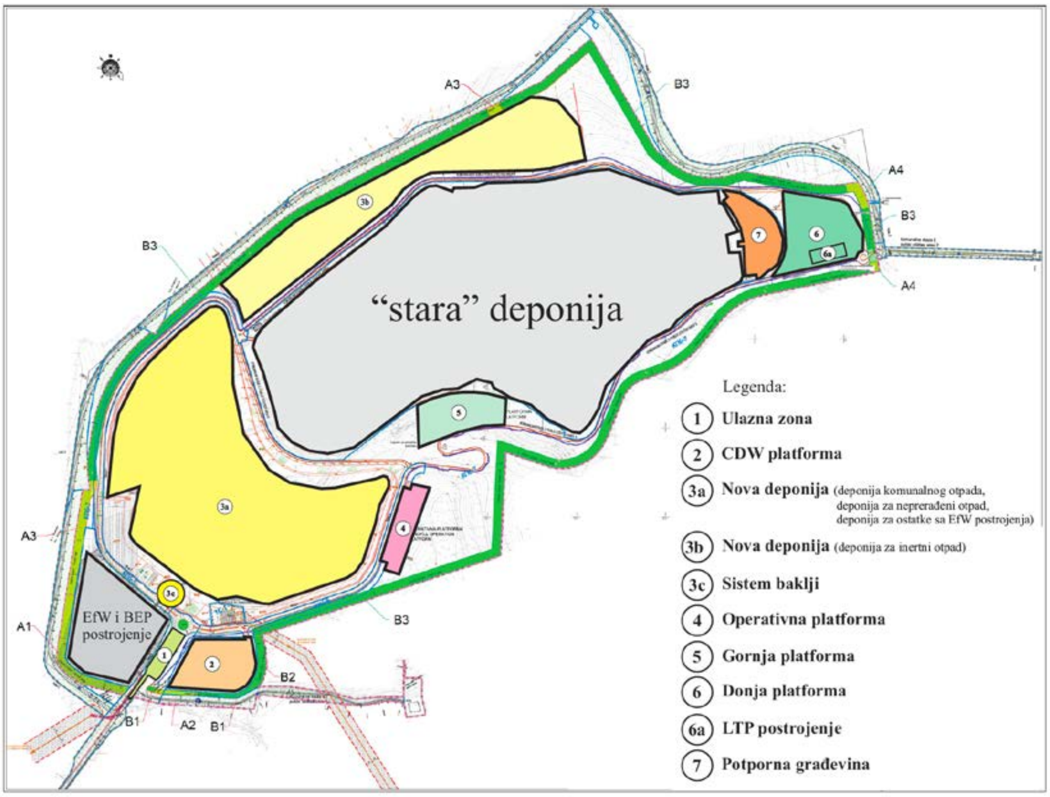

Figure 3 Situation of planned facilities within the New Landfill project

The entire landfill complex in Vinča is defined by the Amendments to the Detailed Regulation Plan of the Vinča Sanitary Landfill ("Official Gazette of the City of Belgrade" No. 86/2018).

Predmetnim PDR dokumentom, na kompleksu postojeće deponije komunalnog otpada u Vinči definisano je 5 prostorno-funkcionalnih celina (K1-K5):

The Plan of Detailed Regulation on the complex of the existing municipal waste landfill “Vinča” has 5 spatially-functional units defined (K1-K5:

K1 – area for construction of energy utilization of municipal waste plant;

K2 – platform for construction waste and construction waste treatment plant;

K3 – construction area for the new sanitary landfill of municipal waste (new landfill body) and torch system;

K4 – recultivated area (the area of the existing landfill body), retaining structure and internal roads and

K5 - facilities in the function of sanitary landfill of municipal waste, leachate treatment plants, landfill for inert waste, internal roads and protective green belt.

The subject of this study is the contents that are located within the defined DRP frames:

Unit K2 - a platform for the Construction and Demolition Waste (CDW) treatment. The CDW platform will be set up as a heavy platform, equipped with crushers and sieves for aggregates production. The plant will have heavy machinery (hydraulic excavator with multiple connections and loader). The platform will be equipped with the necessary infrastructure.

Unit K3 – area for construction of the new sanitary landfill for municipal waste. The construction of the new sanitary landfill for municipal waste is planned west of the existing landfill body, and will be formed from several cassettes. The cassettes will be successively formed and opened, in accordance with the plan and needs. The construction of cassettes itself should enable permanent, controlled, organized and safe disposal of waste. The entire bottom surface of the landfill will be insulated to be waterproof. Isolation of the bottom surface for the waste disposal is done by artificial barriers, gradually during the work of the landfill.

Unit K4 - recultivated area (the area of the existing landfill body), retaining structure and internal roads. The closing procedure for the landfill body ends with the recultivation of the closed landfill area part and its fitting in the surrounding landscape. The existing landfill body is characterized by the existence of a system for the collection and evacuation of the filtrates and systems for the collection and control of gases, which occur in the interior of the landfill body. A supporting structure (protective support construction) is planned in the pillar part area of the landfill body and aims to stabilize it. In addition to the above mentioned, a circumferential embankment with drainage channels around the body of the old landfill, as well as the communal track, are foreseen.

Unit K5 – facilities in the function of sanitary landfill for municipal waste, leachate treatment plants, inert waste landfill, internal roads and protective green belt. In this functional unit there are facilities, traffic and infrastructure networks and systems that serve and connect other functional units, such as:

- control entrance in the complex;
- truck and weightbridge;
- operative landfill plateau/platform (administrative facility, workshops, flammable liquids storage, diesel fuel station, mechanization, trucks and other vehicles washing and parking area);
- upper and lower platform with facilities for leachate and atmospheric water collection and leachate water treatment (lagoons, leachate water treatment plant);
- inert waste landfill;
- internal roads, communal paths and infrastructure facilities and areas;
- other facilities and areas used in municipal waste management.
-

Besides mentioned, this unit also includes:

- protective green belt and
- free areas reserved for possible expansion of functional units or construction of new facilities used in municipal waste management.

The detailed regulation plan also defines the construction plots for communal areas (KP6-1 to KP6-7):

- building plot KP6-1 (Unit K1) – EfW plant, approximate area of 4.75 ha
- **building plot KP6-2** (Unit K2) – CDW platform, approximate area of 2.13 ha
- **building plot KP6-3** (Unit K4) - Existing landfill body which recultivation is planned with support structure, approximate area of 48.44 ha
- **building plot KP6-4** (Unit K5) - Access road area (internal road - part Nova 1), approximate area of 1.18 ha
- building plot KP6-5 (Unit K5) - Access road area (internal road - Nova 5), approximate area of 2.07 ha
- building plot KP6-6 (Unit K5) - Access road area (internal road - Nova 4), approximate area of 1.46 ha
- **building plot KP6-7** (Unit K3 and K5) - areas for new municipal waste landfill construction and facilities in its function, leachate treatment plant, inert waste landfill, internal roads and protective green belt, approximate area of 69.37 ha; In addition to this, internal roads, weighing scales, truck parking lots, water tank, TS35 / 10kV substation, torch, etc. are foreseen. The new landfill body is also characterized by the existence of a filtrate collection and evacuation system and a gas collection and control system, occurring inside the landfill body

The subject of this study is the objects that will be realized on building plots KP6-2, KP6-3, KP6-4 and KP6-7.

For the phase construction and arrangement of the Vinča Waste Management Complex in Belgrade - Public-Private Partnership Project of the City of Belgrade for the provision of treatment and municipal waste disposal services at the Vinca landfill, the Locational Conditions, number 350-02-00104 / 2019-14 from April 12th, 2019. are obtained from the Ministry of Construction, Transport and Infrastructure.

2.1. CADASTRAL PARCELS WHERE THE PROJECT IS REALIZED

The construction of the new landfill with accompanying facilities is planned, in accordance with Location conditions, on cadastral parcels given in the following table, all in CM Vinča, Municipality Grocka - City of Belgrade.

Public surface name	Cadastral parcels
Building plot **KP6-2** (Unit K2) – CDW platform, approximate area of 2.13 ha; Building plot **KP6-3** (Unit K4) - Existing landfill body which recultivation is planned with support structure, approximate area of 48.44 ha Building plot **KP6-4** (Unit K5) - Access road area (internal road - part Nova 1), approximate area of 1.18 ha Building plot **KP6-7** (Unit K3 and K5) - areas for new sanitary landfill for municipal waste construction and facilities in its function, leachate treatment plant, inert waste landfill, internal roads and protective green belt, approximate area of 69.37 ha;	431/6; 431/5; 441/3; 438/10; 457/3;457/2; 461/4; 458/6; 458/3; 438/9; 438/8; 461/2; 458/2; 438/4; 438/2; 438/1; 439/4; 466/15; 466/14; 14/3; 466/13; 466/12;466/11; 466/10; 466/8; 465/3; 466/5; 466/4; 466/3; 462/4; 463/3; 463/2; 463/1; 464/1; 443/2; 16/5; 17/4; 7/5; 7/4; 6/3; 17/3; 11/2; 423/5; 423/3; 420/7; 420/5; 419/3; 428/9; 428/5; 428/4; 427/5; 427/4; 425/5; 446/2; 428/2; 427/2; 427/1; 420/3; 420/1; 422/5; 423/4; 2666/7; 2666/6; 2666/5; 422/4; 422/3; 421/6; 421/5; 421/4; 2688/2; 2668/7; 2668/6; 405/4; 411/6; 400/2; 400/1; 390/3; 396/2; 392/1; 2692/5; 917/3; 917/2; 918/4; 918/3; 919/3; 920/3; 921/3; 937/14; 937/13; 937/9; 937/8; 5/4; 915/1; 924/2; 499/5; 498/4; 2676/8; 2676/7; 496/3; 2668/13; 497/3; 496/2; 655/4; 495/4; 495/3; 497/2; 654/7; 651/8; 654/5; 654/4; 499/4; 499/3; 2676/5; 654/3; 654/2; 499/2; 2679/7; 500/12; 500/11; 500/10; 381/15; 381/14; 381/8; 940/2; 942; 919/2; 920/2; 921/2; 482/2; 482/1; 488; 487; 659/2; 662/2; 656/2; 656/1; 655/3; 650/3; 651/10; 652/9; 652/8; 652/7; 652/4; 652/3; 651/5; 939/3; 948/4; 943/2; 687/2; 685/2; 681; 959/1; 957/1; 948/2; 948/1; 1034/2; 688/47; 688/44; 688/43; 688/41; 688/6; 680/6; 2679/11; 2679/10; 678/166; 678/165; 679/2; 2679/3; 678/21; 962/3; 963/1;997/7; 961/2; 955/2; 952; 1031/2; 1038/8; 1038/7; 1038/6; 1038/5; 1037/6; 1037/5; 1036/4; 1036/3; 689/6; 1036/2; 689/9; 689/7; 688/61; 688/60; 688/58; 688/49; 688/46; 688/45; 688/42; 688/12; 689/3; 689/2; 688/56; 688/55; 688/54; 688/53; 688/37; 688/36; 688/34; 688/33; 688/32; 688/31; 688/30; 688/20; 688/19; 688/22; 2679/14; 678/184; 678/183; 678/182; 678/181; 2679/12; 688/28; 678/170; 678/169; 994/3; 993/2; 2693/8; 965/3; 1000/2; 998/2; 1042/4; 1041/1; 1041/2; 1041/4; 1040/4; 1043/2; 690/4; 1004; 1002/2; 1022/3; 1023/3; 1023/2; 1024/2; 1025/2; 1045/4; 1045/3;1048/2; 691/6; 1044/2; 1005/7; 991/11; 996/8; 996/7; 1015/9; 1014/9; 1014/8; 1014/7; 1014/6; 1015/8; 1015/7; 1013/12; 1013/10; 1013/9; 1014/3; 1015/3; 1015/2; 1014/2; 1013/4; 1005/2; 996/4; 1015/13; 1016/7; 1017/6; 1017/4; 1016/5; 1014/5; 1018/2; 1018/1; 900/87; 1051/4; 900/73; 900/12; 900/74; 1051/9; 1051/6; 1050/5; 1050/3; 1050/1; 1050/2; 977/4; 978/4; 1108/6; 987/6; 1108/4; 979/5; 991/10; 991/8; 991/7; 990/6; 1007/6; 1006/4; 990/2; 1007/3; 1006/2; 991/4; 1011/2; 1012/2; 986/6; 1007/15; 1007/13; 1007/10; 1006/5; 1008/10; 1008/9; 2693/6; 1008/7; 1008/5; 1008/4; 2693/2; 1013/14; 1009/6; 438/11; 461/3; 462/3; 464/4; 464/3; 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993/1; 994/2; 994/1; 964/3; 1021/1; 1027/2; 1027/1; 1003/1; 1003/2; 1000/1; 1044/1; 1042/5; 1042/3; 1041/3; 1040/3; 1043/1; 1045/2; 1045/1; 1046; 1042/2; 1042/1; 1040/1; 690/1; 1013/7; 991/9; 991/5; 1013/3; 1013/5; 1014/11; 1015/11; 1016/8; 1011/1; 1014/10; 2668/16; 2668/15; 900/88; 2668/9; 1017/3; 900/77; 900/76; 1013/1; 1049/2; 986/7; 989/3; 455/1; 438/14; 438/13; 438/12; 457/1; 439/3; 440/3; 454; 439/1; 438/3; 440/1; 441/1; 4/2; 5/3; 5/1; 916/2; 916/1; 917/1; 937/5; 937/4; 2692/1; 914/1; 918/2; 918/1; 919/1; 920/1; 921/1; 924/1; 923/2; 923/1; 922; 937/1; 935/1; 925; 911; 912; 913; 2665; 655/2; 682; 683/2; 683/1; 657/4; 492; 491/2; 491/1; 489; 478/2; 478/1; 477; 476; 475; 490; 480; 479; 451; 450; 500/16; 500/15; 500/14; 650/4; 650/5; 655/8; 655/7; 655/5; 653/2; 653/1; 654/8; 651/7; 2677/4; 2677/3; 654/6; 2676/4; 395/2; 2677/2; 651/6; 651/3; 651/2; 651/1; 398; 381/1; 962/2; 962/1; 995/2; 995/1; 996/2; 997/4; 963/2; 1021/3; 1021/2; 1022/2; 1022/1; 1023/1; 1024/1; 1025/1; 1039/4; 1039/3; 690/2; 1038/4; 1038/2; 1002/1; 1038/1; 1037/4; 1037/3; 1037/2;1028; 1038/3; 1039/1; 1001; 1029; 932; 1026; 1040/2;1039/2; 997/8; 998/3; 999/2; 999/1; 1033/3; 1033/2; 1033/1; 693/3; 693/1; 694/2; 695/2; 688/29; 688/27; 688/16; 688/21; 688/2; 688/1; 680/10; 680/12; 979/8; 1007/11; 969/7; 969/6; 979/6; 987/5; 986/10; 1008/6; 1007/9; 1007/8; 979/3; 989/2; 968/2; 1008/2; 1007/1; 1010/3; 1051/5; 1010/1; 1051/2; 1051/1; 1051/3; 10/3; 9/3; 9/2; 8/3; 16/1; 17/9; 939/8; 939/4; 939/2; 676/2; 495/6; 495/5; 494/4; 494/5; 2668/14; 420/8; 662/1; 655/6; 661/3; 420/6; 420/4; 419/1; 428/8; 429/2; 427/6; 427/3; 445/3; 445/2; 444/2; 444/1; 2679/4; 496/1; 661/1; 655/1; 495/2; 424/2; 467/2; 466/1; 14/2; 423/2; 423/1; 428/1; 420/2; 452/2; 452/1; 467/1; 466/6; 466/2; 453; 449; 448; 447; 1015/15; 1014/14; 1013/17; 1013/15; 1005/6; 992/3; 966/3; 1009/7; 1012/1; 1049/3; 1048/1; 691/7; 995/3; 996/10; 996/9; 965/1; 1015/6; 1009/3; 1020/3; 1020/2; 1020/1; 2668/1; 1013/2; 1006/1; 1047; 996/1; 996/3; 996/6; 996/5; 997/3; 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2.2. DATA ON AREA

The territory covered by the Detailed Regulation Plan is 149.8 ha. The area of “Vinča” landfill for municipal waste complex is about 132 ha. The total (net) area of the planned facilities is about 50 ha.

Table 1 Net area of planned contents and facilities

Content	Facilities	Area, m^2
Entrance and control zone	Supervising station and weighbridge	13.380
CDW platform	- Administrative building (office, sanitary and storage container) - CDW plant platform (storage, treatment and sorting of construction demolition waste) - Areas for disposal of secondary raw materials (CDW non-hazardous waste) - Area for disposal of finished product (fractions from CDW plant) - Parking and internal road at the platform	21.054
New landfill	- Temporary (sanitary) municipal waste landfill - Untreated waste landfill - Landfill for residues produced after waste treatment at the EfW plant	289.735
Inert waste landfill	-	86.075
Operative platform	- Administrative building - Workshop with vehicle washing area - Storage for hazardous substances - Diesel fuel pumping station - Storage/containers for hazardous waste - Parking: mechanization, delivery vehicles, trucks and passenger vehicles - Sedimentation pool/separator of light petroleum products - Fecal wastewater treatment plant (WWT)	5.000
Upper platform	-	16.430
	Lagoon for atmospheric water	1.700
	Lagoon for leachate	2 x 960
Lower platform	-	38.680
	Lagoon for atmospheric water	1.760
	Lagoon for leachate	3 x 1.900
	Zone for leachate treatment (LTP)	1.050
Support structure	-	15.868
Total		49.84 ha

2.3. OVERVIEW OF PEDOLOGICAL, GEOMORPHOLOGICAL, GEOLOGICAL, HYDROGEOLOGICAL AND SEISMOLOGICAL CHARACTERISTICS OF THE TERRAIN

Pedology

According to the pedological cover at the Grocka municipality, there are two major geomorphological units. Valley part with fluvisol type of soil, formed in the area towards the Danube river at 250-300 m elevation. In the higher parts of the municipality, above powerful loess deposits, chernozem and its subtype - eroded chernozem is located. Vertisol in not present in large quantities. North-eastern Šumadija hill area is characterized by kambisol soil and kambisol in the podzolization process with much lower productive capacity compared to chernozem and fluvisol. Soils in the territory of the Municipality of Grocka are characterized by very heterogenous physical and chemical properties.

Topography and morphology

In geomorphological terms, most of the Belgrade area consists of hilly parts of the terrain, with smaller areas of plain terrain. On the hilly, slightly stratified relief, on which the largest part of the city of Belgrade is located, as well as a number of suburban settlements, the mountain Kosmaj stands out with an altitude of 626 m above sea level. Of all the geomorphological processes, the most important role in shaping the relief of this area certainly had a fluvial process. The karst process, the marine process, the proluvial process, deluvial process, and eol process had and still have their share in shaping the relief. The most visible forms of the fluvial process are the alluvial plains of the Sava and Danube and river terraces.

At the "Vinča" landfill location, the terrain is hilly and characteristic for the right bank of the Danube. The altitudes in the wider area range from 70 meters above sea level along the Danube bank to 200-250 meters above sea level west of the Danube.

In terms of morphology, two units can be distinguished within the subject terrain: the Danubian alluvial plain and its sloping, hilly hinterlands. Within the sloping part of terrain, two units can be distinguished. The first unit is the immediate part of the right Danubian slope, whereas the second unit includes the slopes of Ošljanski potok (Ošljan stream), which have been developed in the western hinterlands of the Danubian slope. The Danubian slope strikes in N-S direction, and in the landfill zone its width is 500-600 m, with a vertical rise of 80-170 m a.s.l. The Danubian slope gradient south of Ošljanski potok (Ošljan stream) is 6-12° and even up to 30-40°, whereas its northern part is much milder, with the gradient ranging from 4-15°. Slopes of Ošljanski potok (Ošljan stream) are relatively mild, with gradients ranging from 6-9° (3.8-5.7%) on the average, extremely they amount to 5° (3.0%) and maximally 15-18° (9.5-11.0%). Southern branch of the valley is considerably more sinuous than its western and northern part.

Geological and hydrogeological characteristics of the terrain at the site of the New Landfill Project

Geological and geotechnical investigation for the design and construction of a new municipal waste landfill complex in Vinča were carried out by Energoprojekt Niskogradnja a.d. in November 2017. Geological and geotechnical investigations covered the whole Vinča landfill complex, which includes not only the New landfill, but also all other supporting contents, ie functional units (*Figure 4. Presentation of piezometers and other excavated boreholes and pits*).

Investigations include exploring the contains, characteristics and state of geological conditions of area by performing geological, hydrogeological, geophysical, geomechanical, seismological and other investigations.

Considering ground water quality investigation, it was performed and planned to be performed (in total 2 campaigns) investigation on 6 sampling points, from installed and equipped piezometers as presented in the following table. More boreholes and research pits were excavated during wide investigation, as well.

Table 2 Review on installed investigation piezometers, Geological-geotechnical testing for the design and construction of a New Landfill in the municipal waste landfill complex in Vinča Energoprojekt Niskogradnja, 2017.

Code of investigation work	Type of investigation work	Y	X	Depth [m]	Groundwater level [m]
Pz-1	piezometer	7468958.44	4960564.25	20	7,35
Pz-2	piezometer	7469090.51	4960244.82	20	12,50
Pz-3	piezometer	7468353.07	4960560.54	25	12,50
Pz-4	piezometer	7468366.38	4959997.38	25	4,00
Pz-5	piezometer	7467691.28	4959733.85	25	17,90
Pz-6	piezometer	7467987.38	4959418.89	25	22,30

Also, hydrogeological characteristics of subject field were determined during investigations on some piezometers, through the performing of permeability coefficient and filtration coefficient of the field material, porosity, compactness and mineralogical contain, as well as the analysis of the ground water level measurements in piezometers. Obtained filtration characteristics for subject piezometers are presented in the following table.

Table 3 Filtration properties and lithological level description – overview, Geological-geotechnical testing for the design and construction of a New Landfill in the municipal waste landfill complex in Vinča Energoprojekt Niskogradnja, 2017.

Piezometer	Level (m)	Kf (m/s)	Litological level description
Pz-1	5.50 -6.50	1.45×10^{-8}	Sandy dust (ML/SM) to silty sand, lithologically heterogeneous zone, brittle, easily crushable, olive color.
Pz-1	9.00 -10.00	1.23×10^{-8}	Degraded marly clay (CL/ML), sporadically sandy, with low plasticity, easily splittable, easily crushable, with Fe hydroxide spurts, delaminated by silty sand interbeds with thickness up to 0.50 m, brown-yellow color.
Pz-2	2.00-3.00	2.28×10^{-6}	Loess-like sediments – silty sand to sandy silt (ML/SM),

Piezometer	Level (m)	Kf (m/s)	Litological level description
			dry, loose, without visible impurities, yellow in color.
Pz-2	7.00-8.00	9.71×10^{-8}	Degraded marly clay (CL), dry, brittle, easily crushable, low plasticity, delaminated by spurts of fine-grained sand and marly cement, of brown-yellow color.
Pz-3	4.00-5.00	6.20×10^{-8}	Degraded marly clay (ML), with a brittle fracture and crumbly structure, with Fe hydroxide impurities, sand spurts, locally with fissures filled with carbonate silt up to 6.70 m, uniform i.e. homogeneous at larger depths, relatively hard, partially sandy, yellow in color, dappled with pale greyish hue.
Pz-3	12.00-13.00	7.38×10^{-7}	Degraded marl clay, hard, dry, with a portion of thin silt sand spurts, dark-gray color.
Pz-4	4.00-5.00	7.71×10^{-9}	Degraded marly clay (Cl) of medium plasticity, at the beginning of the layer with plenty of carbonate impurities, at larger depths occurs in a shape of spurts, hard, well-packed, poorly permeable, dappled with marlstones along the layer, of olive to olive-yellow color.
Pz-5	2.50-3.50	6.06×10^{-10}	Deposits of silty-clayey composition, with low plasticity, poorly packed, low moisture, of yellow-olive color.
Pz-5	7.00-8.00	6.07×10^{-7}	Degraded marly clay with fissure porosity and with abundance of impurities in the shape of carbonate silt and concretions, with laminae of Fe hydroxide, sand and spurts of high-plasticity clays – down to the eight meters, further down it is homogeneous, i.e. uniform, relatively hard, with locally brittle fractures due to portion of silty particles and carbonate silt, basically yellow to yellow-olive color.
Pz-6	4.00-5.00	/	Clay (CL/CI) with low to medium plasticity, hard, highly compact, with low moisture and uniform composition, of brown color.
Pz-6	7.00-8.00	2.06×10^{-7}	Diluvial deposits – clay (Cl) of medium plasticity, hard, well-compacted, poorly permeable, with inclusions of carbonate concretions at lower parts of the layer, of brown color.
Pz-6	9.70-10.70	2.06×10^{-7}	Sandy silt (ML/SM) to silty sand, lithologically heterogeneous medium colored by Fe hydroxides, brittle, easily crushable, delaminated by clay interbeds of medium plasticity in the interval from 12.00-12.60 m, of brown-yellow color.

Levels of ground water in all mentioned piezometers were determined and information on that is presented in the following table.

Table 4 Ground water level measured in the periods 25.10.-13.12.2017. and 01.02.-30.03.2018.

Piezometer	Top pipe level (m.a.s.l)	Groundwater level (m.a.s.l)						Average, m
		25.11.	01.12.	13.12.	01.02.	07.03.	30.3.	-
Pz-1	121,7	114,0	113,2	112,9	113,7	/	121,3	5,0
Pz-2	121,5	108,0	108,1	108,1	108,5	108,8	109,0	12,5
Pz-3	175,0	161,6	162,4	162,7	162,9	162,9	162,8	12,5
Pz-4	167,1	161,9	162,3	162,4	162,4	162,5	162,6	4,3
Pz-5	214,8	196,1	196,2	196,1	196,1	196,0	195,0	18,3
Pz-6	220,2	197,3	196,9	197,0	197,1	197,1	197,1	22,5

Chemical analysis of the ground water sampled from piezometers (Pz-1 to Pz-6) was performed in order to determine the aggressiveness of ground water on concrete and reinforced concrete, in accordance with the Rulebook on technical normative for concrete and reinforced concrete in objects under the influence of aggressive environment (Official gazette of SRJ, No. 18/92).

According to performed analysis, it can be concluded:

Pz-1: ground water sample does not show an aggressive effect of excretion, the general acidic or magnesia aggressiveness, but shows carbonated, sulfate and ammonia aggressiveness.

Pz-2: ground water sample shows aggressive effect of excretion, but does not show general acidic, carbonated, sulfate, ammonia or magnesia aggressiveness.

Pz-4: ground water sample shows aggressive effect of excretion and carbonated aggressiveness, but does not show general acidic, sulfate, ammonia or magnesia aggressiveness.

Pz-6: ground water sample shows aggressive effect of excretion, but does not show general acidic, carbonated, sulfate, ammonia or magnesia aggressiveness.

Chemical analyses of the ground water sampled from piezometers (Pz-1 to Pz-6) and some other existing boreholes (NP-11 and asphalt base well) were also performed in order to determine the ground water quality, in accordance with the Regulation on the Program of Systematic Monitoring of Soil Quality via Indicators for Assessment of Soil Degradation Risk and Methodology for Creation of Remediation Programs ("Official Gazette of the Republic of Serbia", No. 88/10), Annex 2: Remediation values of concentrations of hazardous and deleterious substances and values that could indicate significant groundwater contamination (a new Regulation was adopted in 2018).

Results on these investigations are presented within particular document named "Report on Groundwater Quality", prepared by Energoprojekt Hidroinženjering a.d. in April, 2018.

For the assessment of groundwater quality, two series of water sampling and analysis were performed by the certified Laboratory for Occupational Safety and Environmental Protection "Beograd" Ltd. and they are as follows:

− Series I: sampling was performed in November 2017 at the following locations: NP-11, Pz-1, Pz-2, Pz-4, Pz-5, Pz-6;

− Series II: sampling was performed in March 2018 at the following locations: NP-11, Pz-2, Pz-4, Pz-5 and water from asphalt base well.

The piezometer locations were selected for investigation in order to analyze the impacts of the existing landfill on groundwater quality (NP-11, Pz-1, Pz-2 and possibly Pz-4, which is located downstream from the existing landfill) and groundwater quality in the part that should not be exposed to the impact of the existing landfill (Pz-5, Pz-6 and asphalt base well, which are located upstream from the existing landfill).

Results of groundwater quality chemical analysis indicate the following conclusions:

pH value

pH value of water in piezometers varies in the slightly alkaline range, amounting to 7.2–8, except in NP-11 and Pz-1, where values in Series I were 6.7 and 6.9 (slightly acid medium).

Turbidity and suspended solids

Values of turbidity are mostly high, ranging from 2.06 to 136 NTU. Total suspended solids are in the range of 13–390 mg/l. High values were registered in the impact zone of the existing landfill (NP-11), which is logical, but also in the asphalt base well (185 mg/l). It is interesting to note that the highest values of turbidity and suspended solids were registered in Pz-5, which is not exposed to the impact of the existing landfill (136 NTU and 390 mg/l).

Mineralization

Electric conductivity is highest in the impact zone of the existing landfill i.e. in Pz-1 (12,620 µS/cm), Np-11 (4,380 µS/cm), Pz-4 (1,349 µS/cm) and Pz-2 (1,234 µS/cm). Total residue after evaporation at 180^{o}C correspondes to values of electric conductivity.

Out of mineral substances, macro components, chlorides are most frequent in the impact zone of the existing landfill: Pz-1 (3,711.31 mg/l) and NP-11 (10,515.32 mg/l), while other values ranged from 6-134 mg/l. The lowest value was registered in the asphalt base well.

High value of sodium was registered in the landfill impact zone, in Pz-1, being 2,156.9 mg/l. Other values range from 8.1 to 232.8 mg/l.

Concentration of bicarbonates is highest in NP-11 (1017 mg/l), while values of this parameter in other piezometers range from 24.5 to 699.2 mg/l. Calcium concentration is highest in Pz-1 (434.4 mg/l) and NP-11 (30.3 mg/l).

Nutrients

The highest concentration of nitrate concentration was registered in Pz-1 (370.91 mg/l). Values of this parameter in other piezometers range from < 0.04 mg/l to 12.92 mg/l. Concatenation of ammonia is also highest in Pz-1 (21.4 mg/l), followed by Np-11 (2.72 mg/l). In other samples, it was below 1 mg/l. Nitrite concentrations in the majority of samples were <0.04 mg/l and they were 0.08 mg/l only in Pz-2 and 0.3 mg/l in Pz-5. Concentrations of phosphates and total phosphorus in all samples were < 0.08 mg/l and < 0.01 mg/l, respectively.

Content of organic matter

The value of biological oxygen demand (BOD) was highest in Pz-1 (398 mg/l) and NP-11 (63 mg/l). On the other hand, very low BOD values (1 and 2 mg/l) were registered in Pz-2, although this piezometer is under impact of the existing landfill. BOD values in other piezometers ranged from < 1 to 5 mg/l. Values of chemical oxygen demand (COD) corresponded to BOD values.

Content of dissolved oxygen

Sadržaj rastvorenog kiseonika

Oxygen concentration depends directly on the presence of oxidable substances. Concentrations of dissolved oxygen were lowest in NP-11 (3.5 mg/l) and Pz-1 (5 mg/l), where the lowest values of BOD and COD were also registered. Low value of oxygen concentration was also registered in the asphalt base well (4.1 mg/l). The well is very deep (300 m) and water has remained in a long time period, while inflow of fresh (storm) water rich in oxygen through around 80 m thick soil layer is very slow.

Heavy metals

Concentrations of heavy metals were below the remediation values, in accordance with the Regulation on limit values for pollutants, harmful and dangerous substances in soil ("Official Gazette of RS", No. 30/2018), Annex 2 Remediation limits of pollutants, harmful and dangerous substances in the aquifer. The only exceptions were:

- Chromium concentration in Pz-1 (0.1 mg/l) while remediation value is 0.03 mg/l;
- Copper concentration in Pz-1 (0.13 mg/l) while remediation value is 0.075 mg/l;
- Zinc concentration in Pz-2 (1.62 mg/l) and Pz-5 (1.27 mg/l) while remediation value is 0.8 mg/l;
- Nickel concentration in Pz-1 (0.73 mg/l) and NP-11 (0.13 mg/l) while remediation value is 0.075 mg/l.

Organic micropollutants

The analyses included control of mineral oils and cyanides. Concentrations of these parameters were below the respective remediation values, in accordance with the Regulation on limit values for pollutants, harmful and dangerous substances in soil ("Official Gazette of RS", No. 30/2018), Annex 2 Remediation limits of pollutants, harmful and dangerous substances in the aquifer.

General conclusion

Based on the analyses of water quality preformed in November 2017. and March 2018, it was concluded that water samples from piezometers that are exposed to the impact of the existing landfill (NP-11, Pz-1, Pz-2 and possibly Pz-4) and the ones that are not under the landfill impact differ with respect to their physical-chemical composition. It was noted that increased concentrations of some parameters (turbidity, suspended solids, nitrites, zinc) were registered in Pz-5, which is not under the impact of the existing landfill. This situation was explained as a consequence of wash-off from the surrounding terrain (out of the existing landfill zone) and import of pollutants in groundwater.

Namely, the Pz5 piezometer is made at the watershed, where there is no water runoff, so "dead water" remains in that zone for a long time. For this reason it is turbid water, with a slightly higher concentration of suspended solids and nitrites. It is not about groundwater pollution, but about local pollution. In support of this, the Pz5 piezometer was constructed on a section that represents the pathway by which secondary raw material collectors convey secondary raw materials, resulting in an increase of organic matter at that site.

Regarding the deep well at the asphalt base located just upstream of the landfill complex, it was concluded, based on one analysis performed in March 2018, that the existing landfill has no impact on water quality in this well.

The positions of the piezometer boreholes, in base and cross-sections of the terrain, are shown in the following pictures.

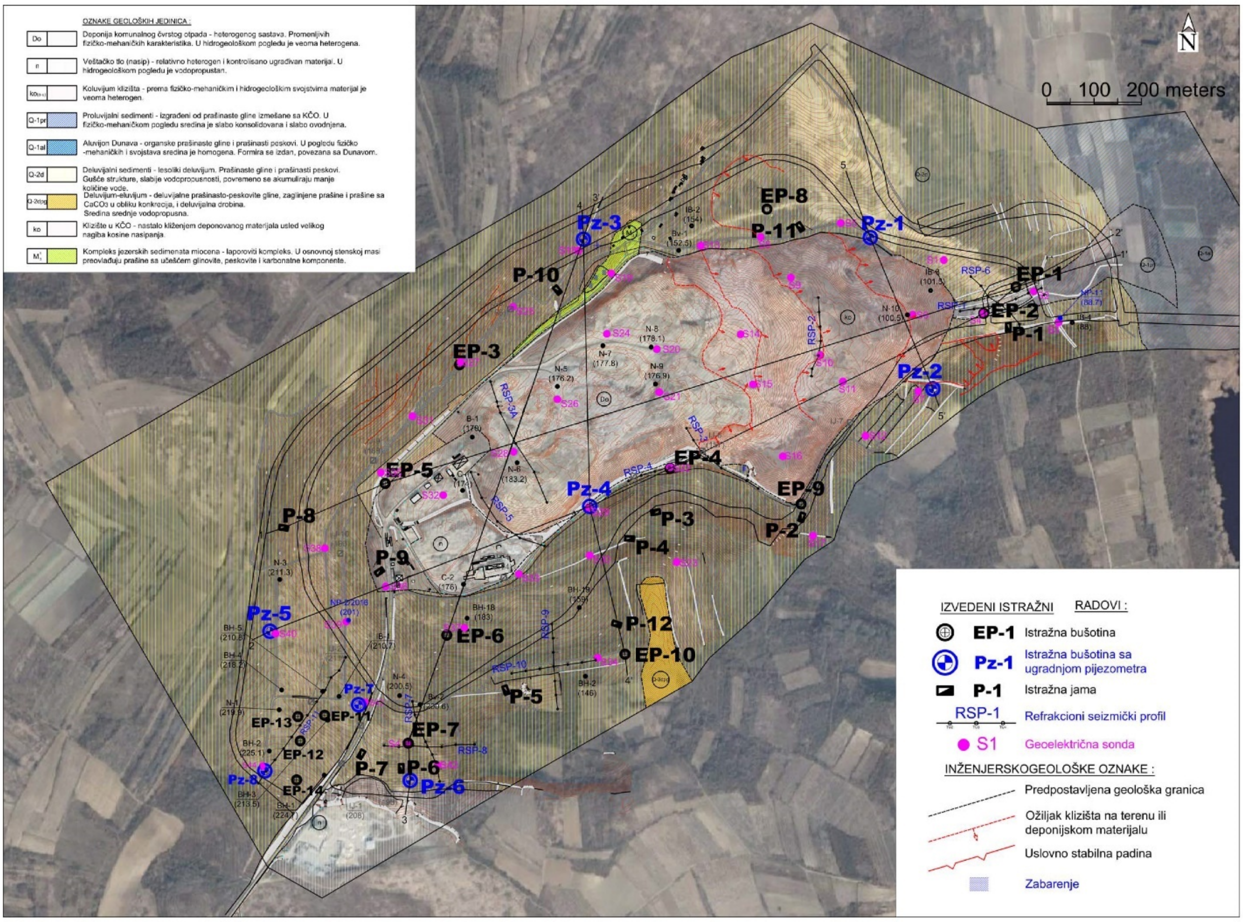


Figure 4 Location of piezometer boreholes and other excavated boreholes and pits, Geological-geotechnical testing for the design and construction of a New landfill in the municipal waste landfill complex at Vinča Energoprojekt Niskogradnja, 2017.

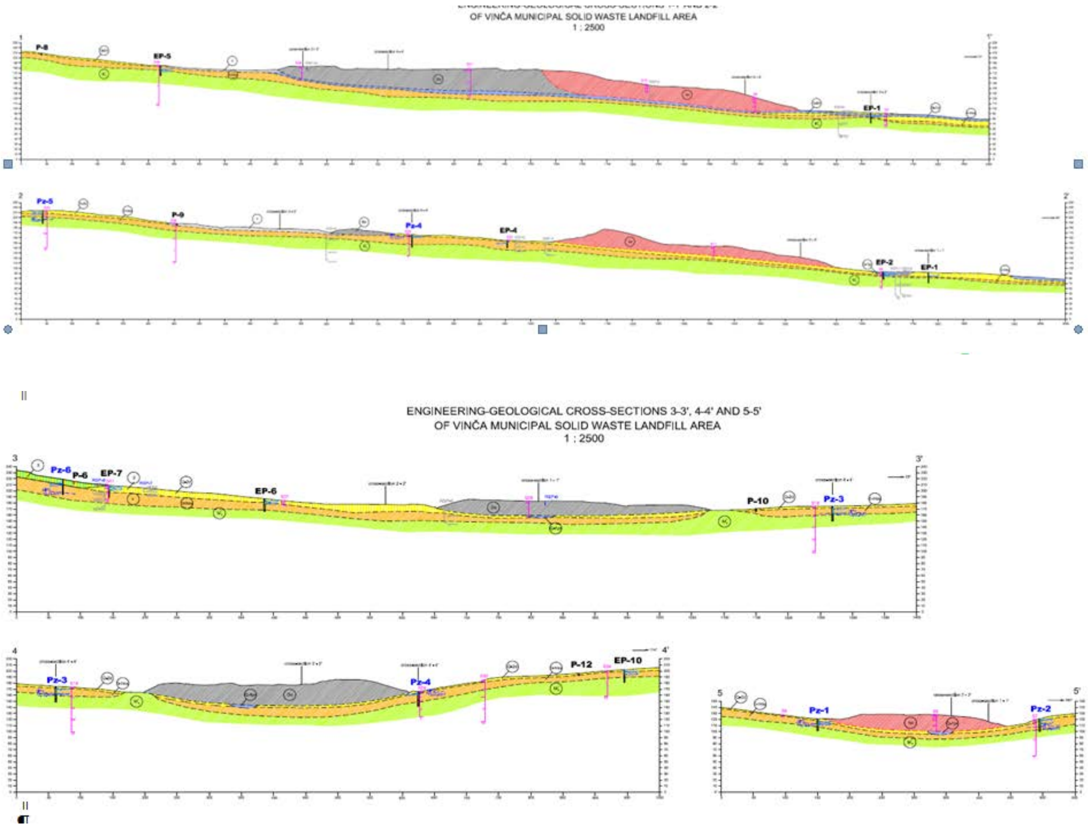


*Figure 5 Piezometer position, cross-section, Geological-geotechnical testing for th*e design and construction of a N*ew landfill in the municipal waste landfill complex at Vinča Energoprojekt Niskogradnja, 2017.*

Groundwater quality testing was also carried out on 04/02/2019. The accredited "Anahem" Laboratory from Belgrade has sampled and analyzed with the methods specified in SPRS EN ISO 5567-1, SRPS ISO 5567-3, SRPS ISO 5567-11 and SRPS EN ISO 19458. Within this campaign, water from 13 piezometers has been sampled, and 76 different parameters were tested and analyzed.

The results of these analyzes are presented within the document "19040102 Vinča Sampling 02042019". Overview of basic parameters of tested samples:

General parameters

None of the measured values exceeds the remediation levels.

Salinity

None of the measured values exceeds the remediation levels.

Oxygen regime

None of the measured values exceeds the remediation levels.

Metals

None of the measured values exceeds the remediation levels except nickel (Ni) in water sampled in the piezometer Np-11, whose concentration is slightly higher than the remediation level (measured: 96 µg / l; remediation level: 75 µg / l).

Organic compounds

None of the measured values exceeds the remediation levels.

Geotechnical conditions at the Supporting structure site

Study on geotechnical conditions for design and construction of Supporting structure (dam) in new municipal waste landfill complex was carried out by Hidrozavod DTD Novi Sad in 2018.

Within the Study, chemical analysis of the ground water samples taken from three piezometers Bvp-2, Bvp-5 and Bvp-7, positioned directly adjacent to the landfill body at the site of landfill completion and continuation of surface water flow, was performed in order to determine the aggressiveness of ground water on concrete and reinforced concrete, in accordance with the Rulebook on technical normative for concrete and reinforced concrete in objects under influence of aggressive environment ("Official gazette of SRJ", No. 18/92). Analysis of ground water was performed by Occupational Safety and Environmental Protection "Beograd" Ltd., during March 2017.

Having in mind that the supporting structure has already been constructed (during the preparation period of this study) based on the Regulations on the establishment of state reconstruction program in the process of emergency landslide remediation in the city of Belgrade, part of the municipality Grocka, caused by floods in May and June 2018. (attached to the study), an analysis of groundwater aggressiveness towards concrete and reinforced concrete was performed for the purposes of the standard design procedure of concrete mix in relation to designing project performance (PP).

For the purpose of designing concrete structures, an analysis of groundwater aggression from 2017. is sufficient. Prior to the commencement of the concrete works, additional analysis will be carried out, as part of the standard procedure for the design of concrete mixes within the PP phase.

Table 5. Review on installed investigation piezometers, Study on geotechnical conditions for the design and construction needs of the Supporting building in the municipal waste landfill complex at Vinča, Hidrozavod, 2018.

Code of investigation work	**Type of investigation work**	**Y**	**X**	**Depth [m]**	**Relative groundwater level**
Bvp-2	piezometer	7469162	4960393	30	1,60
Bvp-5	piezometer	7469132	4960479	25	1,90
Bvp-7	piezometer	7469202	4960443	20	0,85

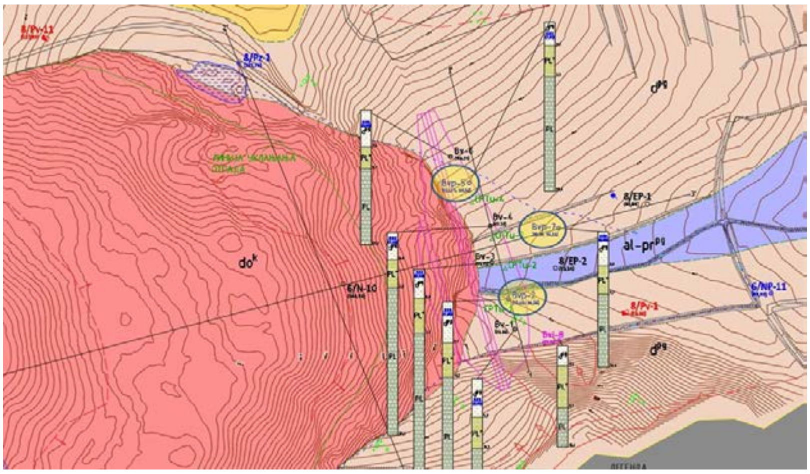


Figure 6. Position of piezometer wells and other boreholes and pits, Study on geotechnical conditions for the design and construction needs of the Supporting building in the municipal waste landfill complex at Vinča, Hidrozavod DTD Novi Sad, 2018.

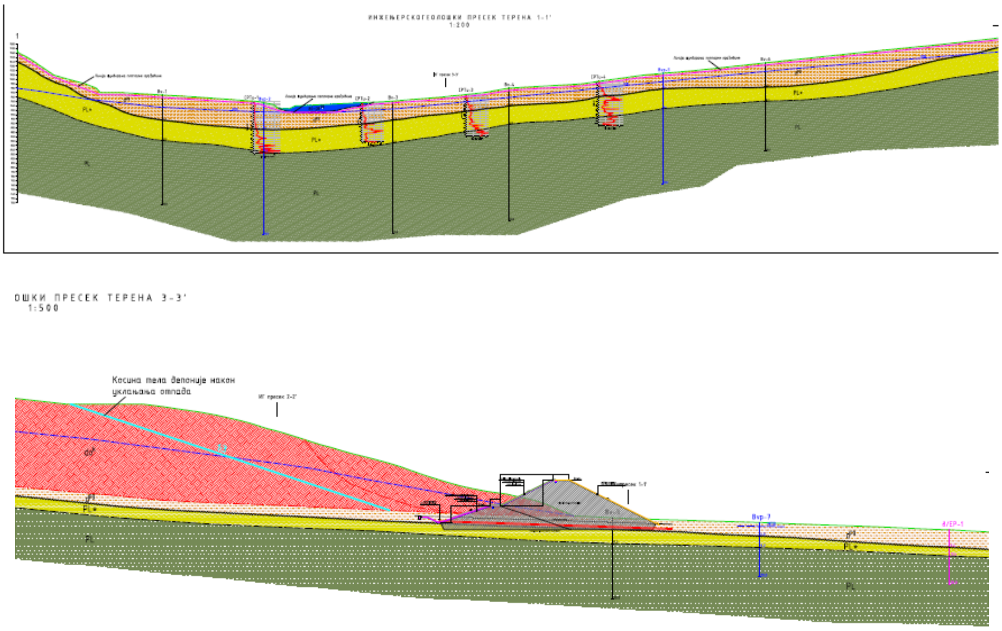


Figure 7 Position of piezometer wells, cross-section, Study on geotechnical conditions for the design and construction needs of the Supporting building in the municipal waste landfill complex at Vinča, Hidrozavod DTD Novi Sad, 2018.

Results of groundwater quality chemical analysis indicate:

Bvp-2: ground water sample shows an aggressive effect of excretion and sulfate aggressiveness, but does not show general acidic, carbonated, ammonia or magnesia aggressiveness.

Bvp-5: ground water sample shows an aggressive effect of excretion, carbonated and sulfate aggressiveness, but does not show the general acidic, ammonia and magnesia aggressiveness.

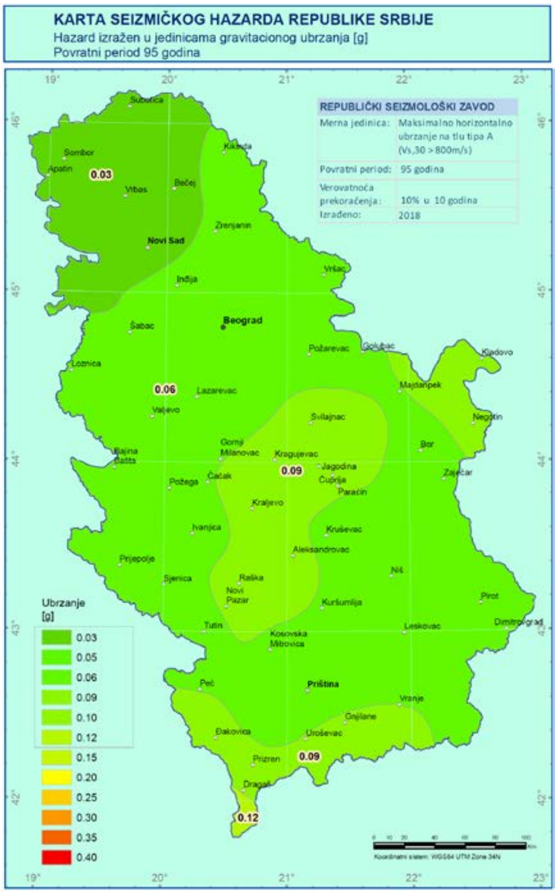
Bvp-7: ground water sample shows an aggressive effect of excretion, sulfate and carbonated aggressiveness, but does not show general acidic, ammonia or magnesia aggressiveness.

Seismological characteristics

According to the latest regional research of the Republic Seismological Institute of Serbia (*Source: www.seismo.gov.rs*), parameters of seismicity for the territory of the Republic of Serbia have been determined. According to the map of the seismic hazard for the expected maximum horizontal acceleration on the base wall - Acc (g) and the expected maximum intensity of the earthquake - I_{max} in the units of the European macroseismic scale (EMS-98), during the return period of 95, 475 and 975 years, maximum intensity and acceleration earthquakes shown in the table can be expected.

Table 6 Seismic parameters

Seismic parameters	Return period (years)		
	95	475	975
Acc(g) max.	0,03-0,12	0,05-0,25	0,05-0,30
I_{max} (EMS-98)	V-VII	VI-VIII	VII-IX



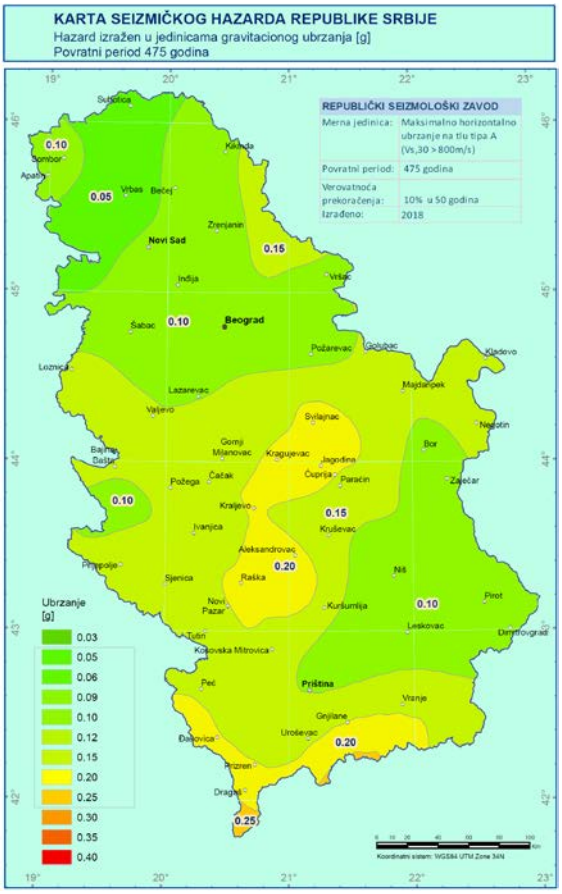


Figure 3 Map of the seismic hazard according to the horizontal acceleration parameter (return period 95 years (left) and return period 475 years (right)

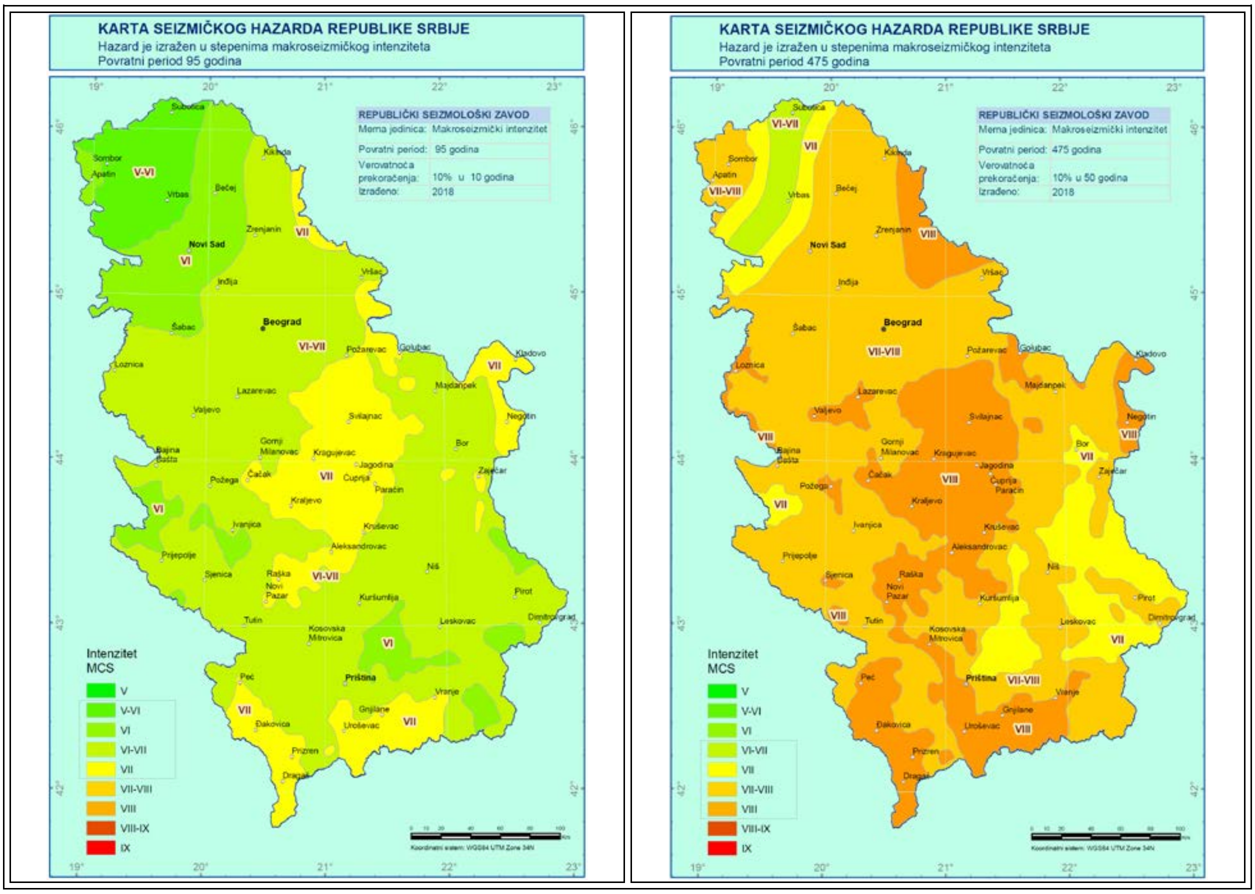


Figure 4 Map of the seismic hazard according to the macroseismic intensity parameter (return period 95 years (left) and return period 475 years (right)

Based on the maps of seismic hazard (Source: www.seismo.gov.rs), according to the macroseismic intensity parameter, the territory of the City of Belgrade is located in the VI-VIII MCS zone (Mercalli intensity scale).

2.4. DATA ON THE SOURCE OF WATER SUPPLY

Today, the Belgrade Waterworks is a complex water management system and consists of following hydrotechnical facilities:

- water source area,
- transport of raw water,
- wastewater treatment plant and
- distribution system:
  - primarni transport (tunnel system),
  - water supply network,
  - pumping stations and
  - reservoirs.

The length of the water supply network is 3,263 kilometers, the diameter is 25-2,500 millimeters. It has 135,000 main connections, 15,000 hydrants, 27 reservoirs with a capacity of 240,000 cubic meters and 28 pumping stations with a power of 36 megawatts.

Water is processed in 5 plants: Bele vode, Banovo brdo, Bežanija, Makiš and Vinča. The projected capacity of the groundwater plant is 8,060 l/s, and the water supply system is 3,580 l/s. Makiš has production plants: "Makiš I" and "Jezero".

Groundwater is treated in plants Banovo brdo, Bežanija and part of Bele vode. The following technological processes are applied: aeration, retention, filtration and chlorination.

In the second part of the Bele vode, Makiš and Vinča plants, river water is processed. In Makiš and Jezero production plants, modern processing technology is applied with more complex technological processes which, in addition to clarification, sand filtration and final disinfection with chlorine, include ozonation and filtration of water with activated carbon filters.

The water supply system in Vinča was included into the Belgrade water supply system in 1997. This water supply supplies drinking water to around 15,000 inhabitants of the Vinča and Leštane settlements, and the water that is being processed is by origin superficial and drained from the Danube.

Rulebook on the Method of Determining and Maintaining Sanitary Protection Zones of Water Supply Sources (Official Gazette of RS, No. 92/08), Article 24, defines the Zone of direct sanitary protection (Zone I) of water intake in an open watercourse that includes the water area and the territory around the water intake facility, which is marked by buoys in the watercourse and by a fence on the shore, preventing the uncontrolled access of humans and animals, so that Zone I upstream extends at least 100 m, both sides laterally in relation to the flow of water 30 m and downstream 20 m.

Based on the above, the location of the municipal waste landfill in Vinča is located outside the zone of direct sanitary protection of the Vinča river water treatment plant.

2.5. OVERVIEW OF CLIMATE CHARACTERISTICS WITH RELEVANT METEOROLOGICAL INDICATORS

By their climate characteristics, the study area belongs to humid continental climate, with warm summers and cold winters, as basic characteristics of this type of climate. Basic climate characteristics of the study area are determined by its geographical position, its wide openness to the Pannonian Planes, as well as its relief. In addition to this, topographic and morphological characteristics classify Belgrade as a “Košava” area. Summers are warm and on average, 31 days per year temperatures are above 30°C, and for 95 days per year are above 25°C. Winters are cold and snowy, with an average of 21 days per year bellow 0°C.

Due to being completely open to the north and northwest, and the absence of any significant orographic obstacles, this area is frequently under the influence of cold air masses, which easily penetrate to the south through northern and central Europe. To the northwest of Obrenovac, at the air distance of 60 km, there is a mountain range Fruška gora (538 m.a.s.l.), which is the only orographic obstacle to these currents of air masses. For the purpose of determining the climate characteristics of the study area, data on average annual precipitation for the Belgrade precipitation measuring station were analyzed, as well as the data on average annual temperatures and air humidity for the Belgrade meteorological station. Data on climate parameters are obtained from the Meteorological Observatory Belgrade (44° 48' W and 20° 28' E, 132 m.a.s.l. in Karađorđe Park) and refer to the period 2000-2018.

Precipitation

Full analysis and interpretation of the precipitation represents one of the bases for the study of groundwater, but also of other environmental parameters in the study area. Precipitation amounts which annually fall on the study area are different and depend on the relief, altitude, precipitation exposition; also, precipitation is unevenly distributed during the course of the year, with widely varying values.

The data of the Republican Hydrometeorological Institute of Serbia for Belgrade rain gauge stations were used to determine the precipitation regime in the study area. Average annual precipitation sums for the period 2000-2018 were analyzed.

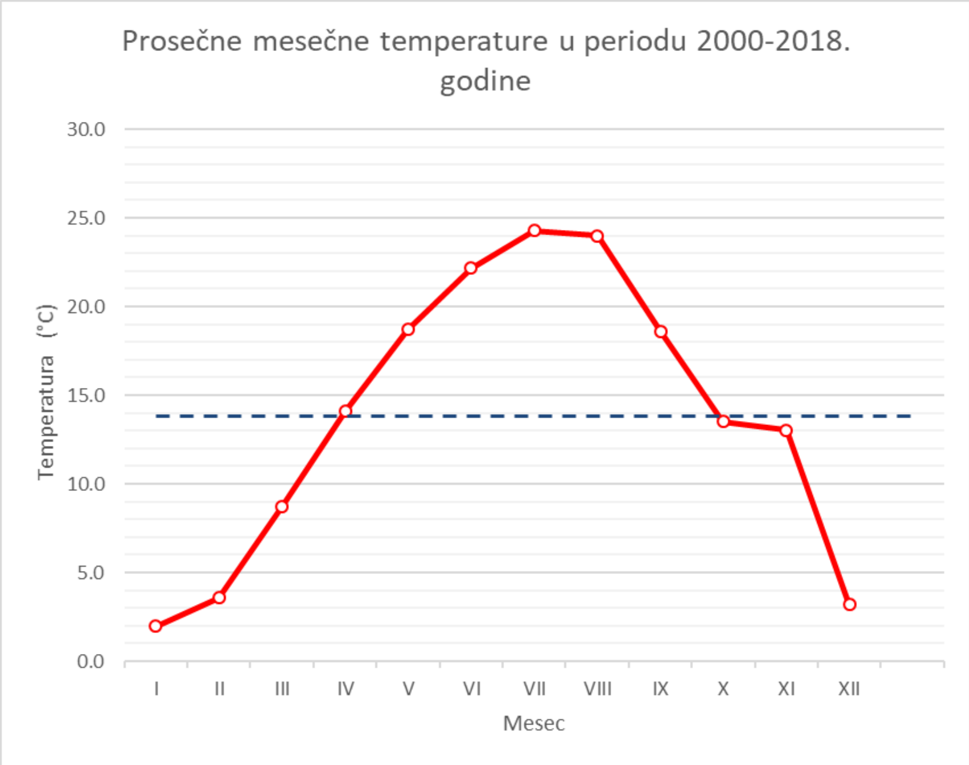
Table 7 Average monthly and annual precipitation (mm) for the Belgrade meteorological station for the period 2000-2018 (RHMZ, Belgrade)

year/month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	TOTAL
2000	27,3	28,3	30,3	41,9	34,5	19,1	29,3	7,8	70,7	16,6	20,7	41,2	367,70
2001	35,3	27,2	65,6	157,9	47,0	186,0	19,7	56,7	183,7	16,7	63,4	33,9	893,10
2002	15,1	14,0	14,8	53,7	20,9	79,6	60,7	106,8	51,9	88,3	35,8	52,8	594,40
2003	62,9	26,5	11,4	23,1	39,5	33,4	111,8	6,4	57,6	115,2	23,4	36,7	547,90
2004	93,5	29,4	18,9	71,7	63,3	113,8	94,6	89,3	45,0	32,9	129,5	50,3	832,20
2005	52,2	84,2	33,9	54,7	47,4	95,1	91,4	144,3	54,1	28,6	23,5	78,8	788,20
2006	43,2	59,1	104,4	97,0	42,3	137,8	23,3	120,6	24,3	20,9	24,5	51,9	749,30
2007	49,3	56,0	99,6	3,8	79,0	107,6	17,5	72,5	84,1	103,6	131,5	34,5	839,00
year/month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	TOTAL
2008	44,6	8,3	79,7	34,9	60,6	43,3	53,0	45,6	68,5	18,4	51,0	79,0	586,90
2009	55,1	85,2	64,9	6,1	34,7	151,0	80,0	44,5	3,9	98,9	59,5	120,6	804,40
2010	91,6	112,8	47,2	43,7	86,4	181,7	41,4	53,5	51,8	48,8	45,2	36,1	840,20
2011	47,8	55,6	27,9	14,1	66,8	41,1	95,0	14,0	47,7	36,1	5,0	48,0	499,10
2012	87,2	61,5	2,4	66,9	127,9	16,0	39,0	4,5	30,7	44,9	28,1	55,1	564,20
2013	76,9	53,4	95,4	21,3	104,4	50,1	2,9	3,0	58,7	52,0	40,0	7,9	566,00
2014	24,1	19,9	48,7	85,3	280,4	60,3	250,6	63,5	126,0	61,2	8,8	66,3	1,095,10
2015	48,6	52,4	132,9	30,7	80,7	38,6	10,6	49,5	101,4	71,8	63,4	3,8	684,40
2016	46,3	38,5	102,6	53,9	71,3	152,2	35,0	60,8	47,8	76,8	71,8	2,6	759,6
2017	23,4	23,5	27,0	51,8	86,1	53,0	26,4	19,5	48,5	65,9	41,2	45,2	508,8
2018	29,3	58,1	64,8	39,7	56,2	121,6	53,0	44,8	11,2	18,6	35,3	60,7	603,3
Monthly precipitation (average)	50,19	47,05	56,44	50,12	75,23	88,49	59,75	53,03	61,45	53,48	47,45	47,65	690,73

As can be seen from the table above, the rainiest month for the analyzed period is June, while the least precipitation is excreted during February and November. The mean perennial precipitation for the study area is 690.73 mm of water column. Due to the size of the study area, as well as the different altitudes of individual parts of the city, the average annual precipitation varies from 367-1095,1 mm.

Air temperature

Air temperature represents a direct indicator of the amount of solar energy received by a certain area, which is consided as a very important parameter in assessment of water evaporation from surface, ie determining the water balance. Data obtained from measurements performed at the “Belgrade” meteorological station for the period 2000-2018. were used for defining the temperature regime and they are presented graphically.



Slika 10. Diagram of average monthly air temperatures for the Belgrade Meteorological station (for the period 2000-2018)

Air temperatures in a given period are continuously increasing during the year from the coldest month of January until the hottest month of July, after which the temperatures tend to decrease until the month of December. Lowest average temperatures occur in January (2°C) and highest during July (24.3°C). Mean perennial temperature value for the study period is 13.8°C.

Relative humidity

Knowing relative humidity is very important due to its influence on the formation of fog, clouds and precipitation in a certain area. Also, relative humidity is inversely proportional to the air temperature; which means when the temperature rises, relative humidity decreases and vice versa.

Tabela 8. Average monthly and annual relative humidity for the Belgrade meteorological station for the period 2000-2018 (RHMZ, Belgrade).

year/month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
2000	78.6	67.6	61.6	57.3	54.5	47.3	50.9	44.9	66.3	67.3	68.0	78.3	61.9
2001	75.2	68.1	61.0	64.6	62.9	67.5	66.5	61.5	76.8	75.0	79.6	80.7	70.0
2002	75.9	62.8	55.1	62.8	57.3	57.0	61.8	68.0	69.8	72.2	68.1	77.0	65.7
2003	82.3	77.1	58.5	55.9	55.5	53.0	62.9	49.8	64.1	74.4	76.5	77.6	65.6
2004	80.3	73.8	64.3	67.2	65.0	68.4	62.4	69.1	69.7	75.3	76.0	81.2	71.1
2005	78.3	82.8	68.1	60.9	64.8	62.4	67.6	75.0	74.6	70.9	75.5	80.8	71.8
2006	74.1	77.6	68.4	66.3	61.1	68.7	55.9	70.7	65.1	64.8	69.6	81.0	68.6
2007	66.0	69.0	61.0	44.0	62.0	58.0	46.0	59.0	68.0	78.0	76.0	83.0	64.17
2008	75.0	64.0	63.0	63.0	58.0	61.0	57.0	55.0	67.0	69.0	69.0	76.0	64.75
2009	95.0	75.0	65.0	53.0	57.0	67.0	60.0	60.0	59.0	73.0	78.0	81.0	68.58
2010	80.0	76.0	63.0	67.0	67.0	73.0	66.0	61.0	70.0	73.0	68.0	79.0	70.3
2011	92.0	77.0	63.0	54.0	66.0	61.0	59.0	55.0	55.0	67.0	78.0	76.0	66.9
2012	76.0	75.0	50.0	59.0	66.0	52.0	50.0	41.0	53.0	69.0	72.0	79.0	61.8
2013	78.0	76.0	70.0	58.0	59.0	66.0	52.0	54.0	66.0	68.0	76.0	79.0	66.8
2014	75.0	68.0	66.0	69.0	67.0	61.0	65.0	66.0	73.0	72.0	74.0	80.0	69.7
2015	77.0	77.0	68.0	56.0	64.0	61.0	48.0	53.0	67.0	78.0	70.0	85.0	67.0
2016	76.0	68.0	68.0	57.0	63.0	66.0	59.0	66.0	63.0	76.0	72.0	76.0	67.5
2017	77.0	69.0	61.0	59.0	65.0	56.0	49.0	50.0	63.0	68.0	77.0	75.0	64.1
2018	75.0	79.0	72.0	56.0	59.0	68.0	69.0	61.0	58.0	60.0	74.0	80.0	67.6
Average	78.2	72.8	63.5	59.5	61.8	61.8	58.3	58.9	65.7	71.1	73.5	79.2	67.0

The mean perennial value of relative humidity for the observed period is 67.0%. The month with highest relative humidity values is December, with 79.2% and the month with lowest relative humidity values is July with 58.3%.

Wind

Like other climate parameters, the wind rose is primarily affected by relief, topography, city structure i.e. built structures, vegetation, pollution etc. In the case of Belgrade, the most influential factors are the Danube, Avala and Kosmaj and other aforementioned parameters. Frequency of winds by directions, the so-called “wind rose”, obtained using the data gathered from the Vračar Meteorological Observatory (φ 4448 N λ 2028E mnm 132), has a shape that is characteristic for the entire Košava area. Two directions are dominant: southeast and west-northwest. The southeastern direction is generally known as Košava, and the west-northwest direction is called Gornjak. It is more accurate to view these two directions as sectors, where the first is the sector between east and south, and the second is the sector between west and northwest. This is due to the fact that, in different situations, during the “Košava process” the direction of the wind may vary from eastern to southern direction. The Gornjak can blow from west to northwest direction.

Table 9. Relative frequency of winds by direction in ‰ and average wind speed in m/s, (for the 2000-2018. period)

	S	SI	I	JI	J	JZ	Z	SZ	C
Relative frequency (‰)	89,8	81,7	69,3	216,3	173,7	61,3	194,8	172,9	41,4
Average speed (m/s)	2,3	2	2,1	3,4	3,0	1,9	2,3	2,4	-

Note: Frequency and wind speed data at Belgrade Observatory station are not available in the RHMZ Yearbook for 2017.

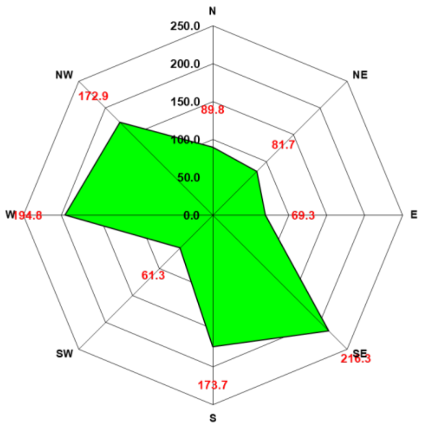


Figure 11 Relative frequency of winds by direction and silence in ‰ and average wind speed in m/s (for the period 2000-2018)

Based on the above mentioned and wind rose for the city of Belgrade, the air masses from the Vinča landfill complex will move, depending on the blowing direction of the dominant wind, in the direction south-southeast/west-northwest, ie. towards the settlements of Vinča (in the south), ie. Slanci and Veliko selo (northwest/north).

Fog and smog

The complex topography of Belgrade has an effect on differences in types of fog and smog in some topoclimatic zones of the city. Based on the monitoring performed at the Vračar Meteorological Observatory, according to the Atlas of the Climate of Yugoslavia for the period 1931-1960, the annual number of days with fog in Belgrade is 39. At the Zeleno brdo Observatory types and frequency of fog correspond to “mountain” stations. During the winter, the fog is 30% more frequent at the Zeleno brdo Observatory compared to Vračar, even though it is located quite a distance away from the sources of pollution. More frequent winter fogs at the Zeleno Brdo are caused by the fact that at that altitude, low clouds occur ten to fifteen times a year, and on that site the inside of the clouds registers as fog. (Source: Ecological Atlas of Belgrade, City Institute of Public Health Belgrade, 2002).

2.6. DESCRIPTION OF THE FLORA AND FAUNA, NATURAL ASSETS OF SPECIAL VALUE (PROTECTED) RARE AND VULNERABLE PLANT AND ANIMAL SPECIES AND THEIR HABITATS AND VEGETATION

In Serbia nature areas are protected based on different national legal frameworks and international conventions:

- Protected areas - defined by the following acts: Law on National Parks (Official Gazette of RS 33/93 and 44/93), and Law on Nature Conservation (Official Gazette of RS 36/09, and 88/10)
- Emerald Network Areas are defined based on the Bern convention
- Important Bird Areas (IBA) - defined by international organization BirdLife International
- Important Plant Areas (IPA) - defined by international organization Plantlife International
- Prime Butterfly Areas (PBA) – defined by various criteria (as Red books, EU Habitats Directive 32/43, individual research etc)
- Ramsar sites – defined by global organization Wetland International based on Ramsar Convention.

Ecological Network of Serbia is composed of Areas of Special Ecological Importance (ASCI) and Ecological corridors.

Based on the decision of the Institute for Nature Conservation of Serbia, 03 number 020-670/3 of 03/30/2018, in the scope of the PDR of the Vinča sanitary landfill, there are no protected areas for which a protection procedure has been carried out, identified ecologically significant areas and ecological corridors of international importance for the ecological network of the Republic of Serbia, nor recorded natural resources.

Within 5 km from the site, approx. 4.5 km to the southeast, on the opposite riverbank of Danube, protected area Strict Nature Reserve Ivankovo is located.

Emerald network candidate site “Pančevačke ade” RS0000056 is located approx. 2.6 km to the north – northeast from the planned project area and is the only one located within the 5 km from the site. Pančevačke ade are a complex system of river islands with well-developed wetland vegetation and accompanying wetland species of fauna.

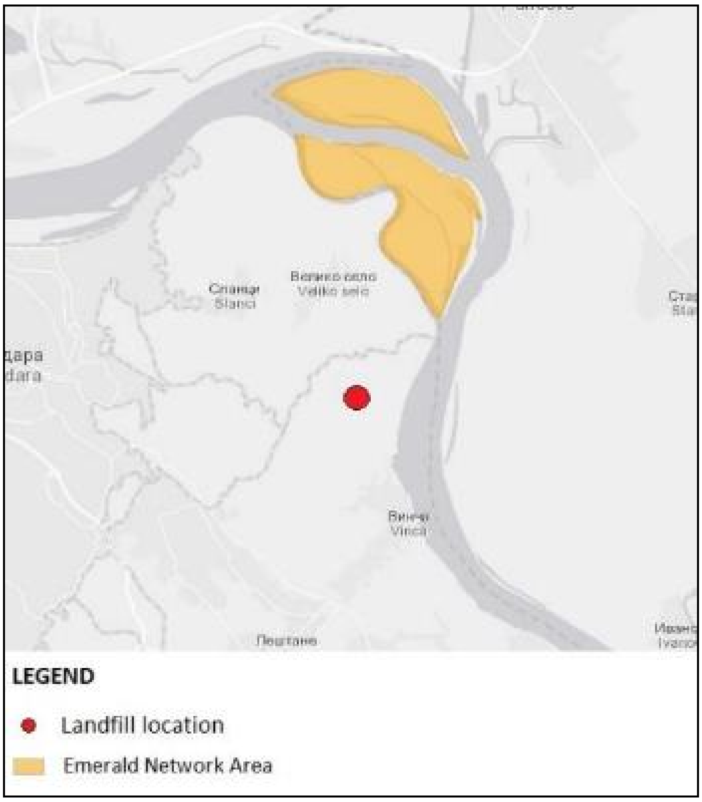


Figure 5 Emerald Network Area in vicinity of the landfill, Source: Official online GIS browser of Council of Europe (http://emerald.eea.europa.eu)

In the vicinity of the landfill, the following areas of the Ecological Network of Serbia are located:

- Area of Special Ecological Importance "Ušće Save u Dunav", and
- Ecological corridor of international importance "Dunav i njegova zabarena/plavna područja uzvodno i nizvodno".

Area of special ecological importance "Ušće Save u Dunav" is located at the confluence of the river Sava and the Danube river. It is protected for its aquatic and wetland habitats that support a wide variety of animal species.

This area has the same boundaries as the Important Bird Area (IBA), also named "Ušće Save u Dunav" RS017IBA. The closest development planned under the project is approximately 180 m west of the IBA / Ecological Network area. It includes protected areas Landscape of extraordinary characteristics Veliko ratno ostrvo in Belgrade, part of the Landscape of extraordinary characteristics Forland leve obale Dunava kod Beograda, and part of the Protected habitat area Veliko blato; all these areas are situated more than 9 km to the northwest from the planned project site. Also, it includes the area of Emerald network candidate site Pančevacke ade RS0000056. Ošljan oxbow ponds (Ošljanska bara) are part of the Area of special ecological importance "Ušće Save u Dunav".

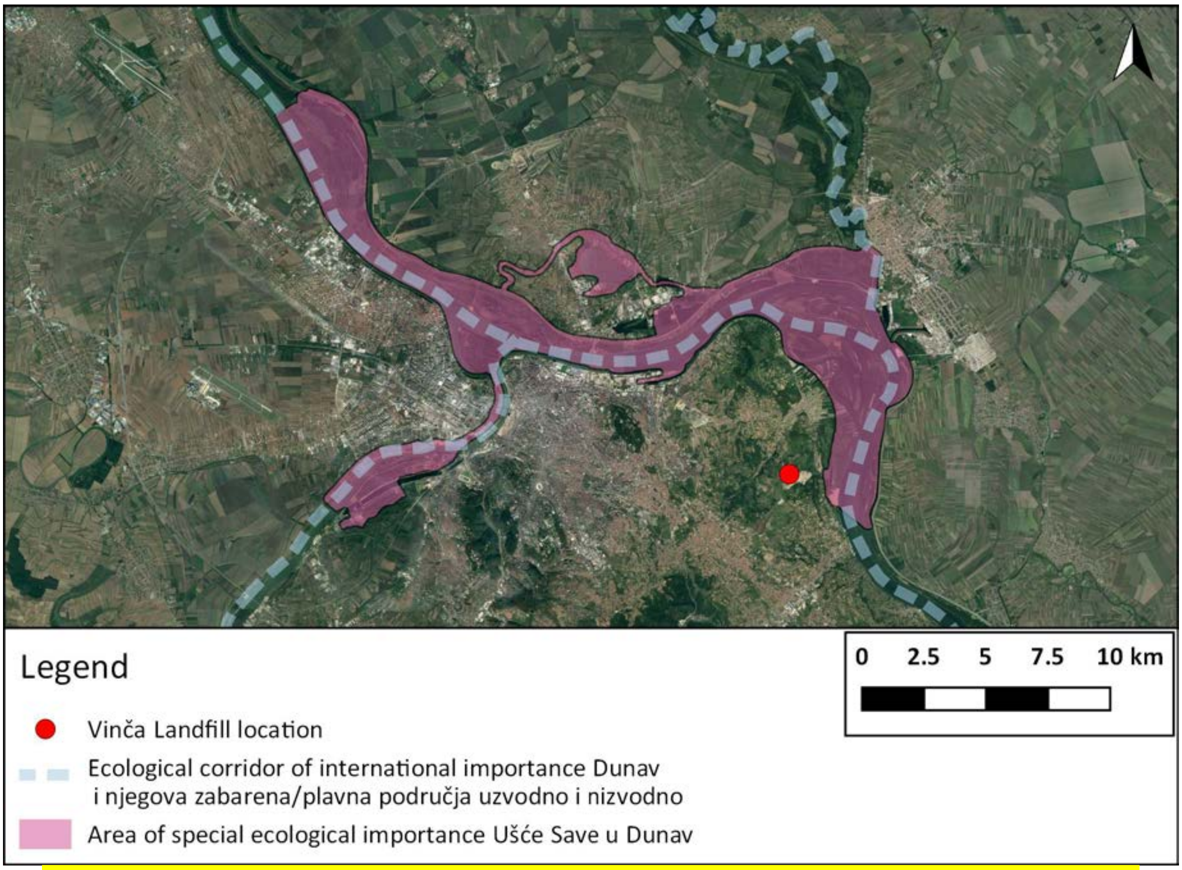


Figure 13 Ecological corridor„Dunav i njegova zabarena/plavna područja uzvodno i nizvodno“and area of special ecological importance„Ušće Save u Dunav“ locations

Ecological corridor of international importance “Dunav i njegova zabarena/plavna područja uzvodno i nizvodno” is a large corridor that extends over the Danube river and parts of its floodplain with standing water (ponds, oxbow ponds etc).

This area includes protected areas Special Nature Reserve “Bagremara”, Nature Park “Begečka jama” and three Nature Monuments “Kamenički park”, “Ivanovačka ada”, “Ritske šume na Mačkovom sprudu”. Also, it is overlapping with the area in the process of being proclaimed as a protected area named “Ribarsko ostrvo”, and three areas planned to be protected in the future “Bogojevački rit”, “Rit između Plavne i Bačkog Novog Sela” and “Ritovi Podunavlja”.

2.7. BASIC LANDSCAPE TYPES

Basic landscape features are defined with terrain, natural conditions and human activities. In a wider area, which can be roughly described as 20 km buffer zone, there is four basic landscape types:

- Agricultural landscape of Vojvodina. It is characterized with thick relief and intensively used arable land. There is a negligible share of forests and natural areas, with the exception of those parts along watercourses. The Danube River is the dominant water course. Visibility is limited due to relief flatness. Landscape character can be described as dominantly anthropogenic agricultural landscape
- River landscape - Danube and Sava Rivers. They are the most important line elements of the landscape and important determinant of terrain motion. In some places along the river banks, embankments are constructed, but in the significant part a natural condition with bayous, river islands and wetland areas can be found.
- Intensive urbanized areas. Here stands out the Belgrade agglomeration with suburban areas and satellite cities (e.g. Požarevac). They are carriers of anthropogenic urban landscape character. Landscape is mainly characterized with dense population, a large spatial scope and numerous infrastructural and industrial elements
- Southern mosaic areas. Landscape character is determined with hilly relief covered with mosaic mixture of small agricultural surfaces, small forests and suburban areas. Share of agricultural surfaces is proportional with increasing distance from the City core. The area includes suburban settlements: Grocka, Voždovac, Barajevo, Sopot, Mladenovac, Lazarevac, Obrenovac and continues southward

Project location is settled on the crossroads of described landscapes. It is a hilly relief area between agricultural landscape on the east and north and urbanized areas of Belgrade and Požarevac on the west and north. Southern suburban areas are about 5 km away. Alongside east and north is Danube stream with natural wetland habitats.

A 5 km buffer zone can be considered as the narrower area. This is an area of potential significant visual contact with the planned project components. Narrower area is divided on basic landscape patterns and presented in form of a map. This method has provided the basis for a quality analysis of the structural landscape elements and the process that affects the landscape condition.

Project site, e.g. existing landfill, is dominant landscape element. Compared to the rest of the areas, it possesses the opposite visual and character features. It represents a spatial element perceived as a negative phenomenon. The landfill is settled on slight slope oriented towards east. It is visible from the immediate surroundings and from east side of the buffer zone. These are areas along the river Danube and agricultural area on east side of the Danube river. Asphalt base is located on the southwest of the landfill, on the edge of project borders. Because of the proximity of landfill and industrial character, it can be considered a negative spatial phenomenon.

Agricultural landscape with mosaic structure surrounds the landfill. This is a mixture of small scale agricultural areas, which are mostly orchards, meadows and areas under various stages of natural succession. Agriculture is an important factor of the landscape structure. The appearance of agricultural parcels, which in this case are shaped organically in relation to relief, in a large degree influences the landscape structure and visual dynamics.

Near the more densely populated parts (Belgrade suburban settlements), locally isolated objects can be seen. In regard to the existing landfill, they are located at a distance of 1.5 km minimum. These are locations southward of Veliko selo end eastward of Mirijevo and Kaluđerica. There is also a monastery and a graveyard about 1 km north of the landfill, and graveyard 0.9 km southward. The described elements do not take up significant space coverage and therefore are not a significant factor of the landscape.

Visual contact of the mentioned settlements with the landfill is prevented due to the hilly relief, vegetation and microlocation of the landfill site.

Danube river with riverside is a landscape element with natural character. They represent a linear element of landscape structure. A large area of intensive agriculture is on the east side of Danube River. Landscape image is composed of agricultural areas and macadam roads on a flat relief. Urban structures of Starčevo and Pančevo are settled on the north side. Due to relief flatness, significant visual contact is stronger towards hilly area in the west.

Industrial landscape of Pančevo is located outside the 5 km buffer zone and can be described as anthropogenic landscape with strong industrial character. As such, it's a spatial phenomenon that causes negative visual and symbolic connotations.

The following photos represent heads of landscape features of the area described:

Figure 14 Landscape west of project location

Figure 15 Example of natural succession at the base of a landfill, west of the project site

Figure 16 Characteristic suburban area - Kaluđerica, about 4 km west of the project site

Figure 17 Specific landscape of Veliko Selo, about 3 km north of the project site

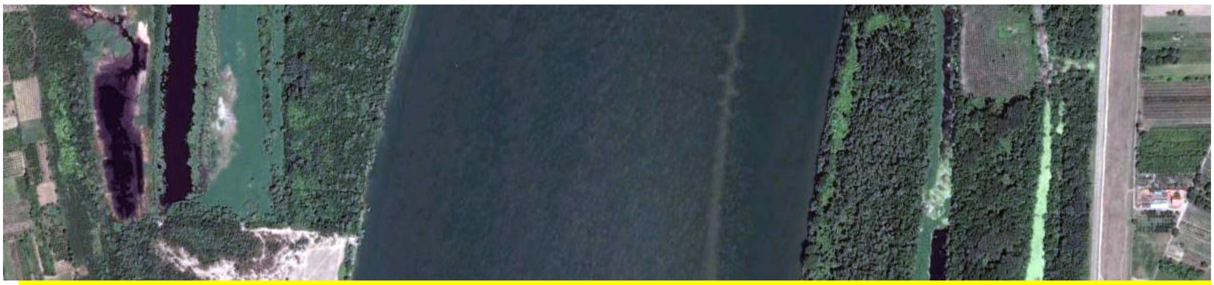


Figure 18 Specific landscape and river banks of the Danube, about 1.5 km east of the project site

Figure 19 View from the landfill towards the Danube and river banks

Figure 20 Specific landscape of intensively developed agricultural land about 4km east of the project site

2.8. IMMOVABLE CULTURAL GOODS

Within the administrative area of Belgrade, which includes the area of Grocka municipality, there are about 350 protected immovable cultural goods. In addition, there are numerous cultural heritage sites at lower levels of protection. The highest concentration of cultural goods is in the central part of Belgrade and their number decreases towards the peripheral areas.

Given its very favorable geographic position in the immediate vicinity of the Danube, the territory of today's Grocka municipality has since ancient times been a perfect place for the formation of human settlements. The first and oldest traces of settlements in this area date back to the Neolithic - New Stone Age. The remains of settlements from this period were found at several archaeological sites in the settlements of Grocka municipality. Certainly, one of the most important, by which an entire culture was named, is the archaeological site Belo Brdo in Vinča - a cultural heritage - archaeological site that has the status of significant importance for the Republic of Serbia (Decision of the Bureau No. 653/5 from 10 November 1965, Cultural resource of extraordinary importance, Decision, "Off. Gazette of the SRS" No. 14/79). The archaeological site of Belo Brdo in Vinča is located on the right bank of the Danube, near the area covered by the Plan. The Belo Brdo archaeological site is approximately 3km away from the Vinča landfill complex, southeastward. The precise location of the Veteranska vila (Veteran's Villa) was not determined by the competent Institute for Immovable Cultural Goods.

The project’s impact on the cultural and historical facilities and sites (cultural goods) can be viewed as direct and indirect. Given the concept of the project in question and possible effects on the elements of cultural heritage, 2 zones of influence are defined.

- Direct influence is every physical destruction of facilities/sites within the project area, as well as any violation of context of cultural heritage elements that are outside the project area’s borders. Given the nature of the project, the zone within 100 meters from the project boundaries is considered a zone of direct impact. Hereinafter, the area of direct impact is marked as Zone 1.
- Violating the integrity of the related area of cultural goods is considered to be indirect impact, and this refers to the area at a distance of 100 meters to 2000 meters from the project borders. Taking into account the final appearance of the planned project and the clear view on the area, this is an area in which the negative impacts are possible on the cultural context of archaeological and ethnological sites and zones and historical urban, rural and religious complexes. Hereinafter, the zone of indirect impact is marked as Zone 2.

Within zone 1 and 2 there is no UNESCO sites. (www.srbija.com, Serbian UNESCO World Heritage Sites). The site of the landfill in Vinča is part of the former borders of the Roman Empire.

Within Zone 1 (under the project boundaries), there is a registered archaeological site “Ošljane”, defined as a cultural good, enjoying preliminary protection under the Cultural Property Act. The place is in the valley of the Ošljanski potok (Ošljan stream), west of the village Vinča - Veliko Selo, on a gentle slope on the right bank of the stream. The location is known to archaeologists because of accidental discovery of Roman pottery. In 1975 the

Belgrade City Museum carried out exploratory excavations of a smaller scope. Archaeological finds contain remains of the Veteranska vila from the second to the third century.

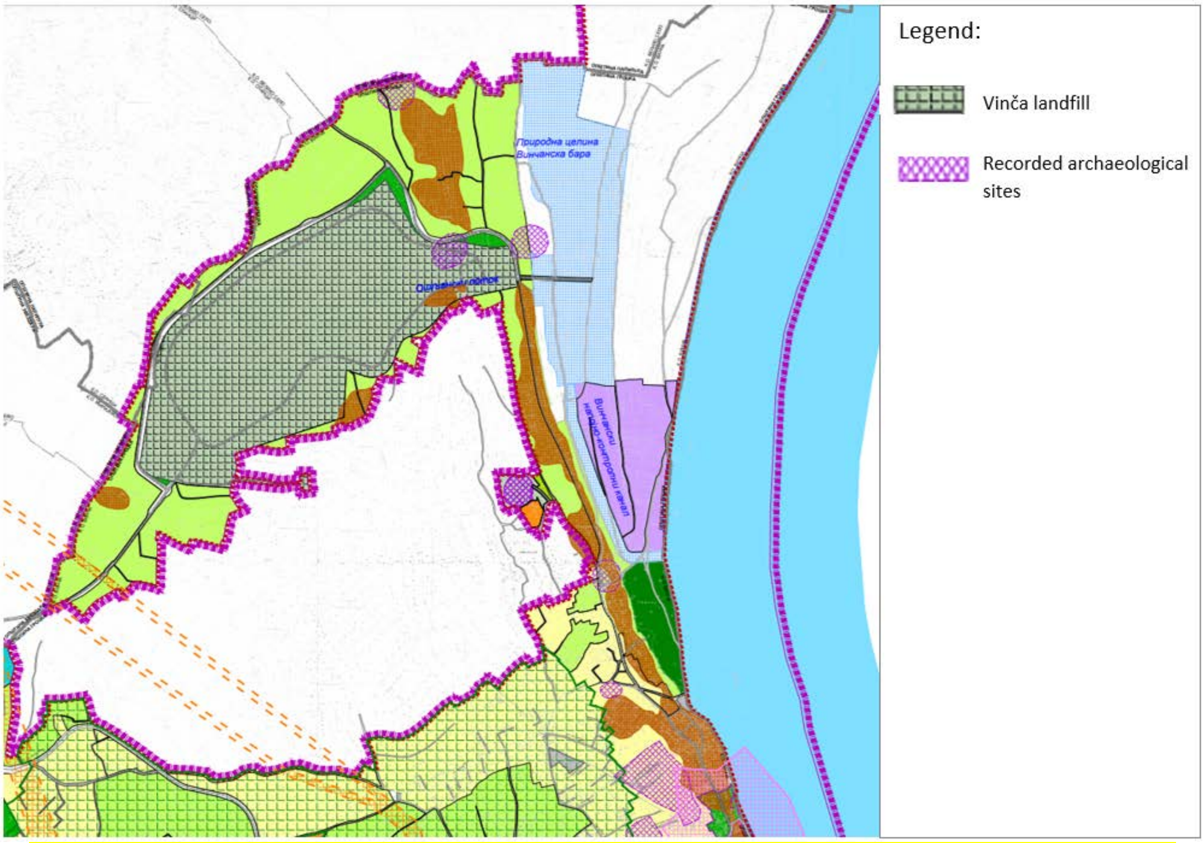


Figure 21 Location of the project in the Drawing - Planned use of the area, 2.1 - General Regulatory Plan for the Construction of the City of Belgrade - Unit XX, Municipality of Grocka, Palilula, Zvezdara and Voždovac (Kaluđerica, Leštane, Boleč, Vinča and Ritopek settlements) ("Official Gazette of the City") Belgrade "No. 66/17)

It is also important to note that the location of the archaeological site Ošljane, in the conditions issued by the Institute for Protection of Cultural Monuments, is spatially very imprecisely shown, without clearly defined location of the described Veteran's Villa. The question is where the detected object is located within the defined zone.

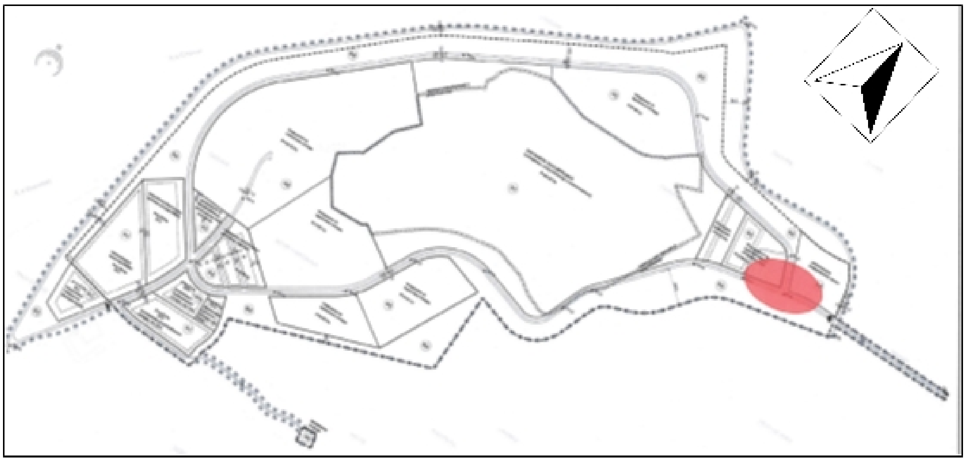


Figure 22 Spatial location of the archaeological site "Ošljane"

Within the Zone 2, there is an archeological site at the location of today's Monastery of Holy Archbishop Stephan (Slanci Monastery). It's located 1.2 km north of the existing landfill site. New complex was built in 1960. The site was previously used for religious purposes, and due to the conquest of the Ottoman Empire site, it was completely destroyed on several occasions.

Manastirsko groblje (Monastery cemetery) is located about 0.7 km northeast of the monastery. The monastery and cemetery do not have visual and functional contact with the project site due to relief and vegetation impediments.

Staro "seosko" groblje (Old "village" cemetery) is located about 1 km southward from the project site borders. This is a sacral element of local significance.

According to General Plan of Belgrade 2021 ("Official journal of the City of Belgrade", No. 27/03, 25/05, 34/07, 63/09 and 70/14) there are two cultural goods (archaeological sites) about 1 km northeast of the existing landfill, on Gornje Ošljane territory.

2.9. DATA ON THE POPULATION DENSITY AND CONCENTRATION

According to the Census from 2011, there are 1,659,440 inhabitants in the City of Belgrade. The total population increased by 5% in the period 2002 – 2011. Average population density in the City of Belgrade is 514 inhabitants/km^2 and is higher than the average population density in Serbia.

The municipality of Grocka has the area of 289 km^2 and 83,907 inhabitants (2011 Census data). According to that Census, Vinča settlement had 6,779 inhabitants (358 inhabitants/km^2).

There are 1831 households in the Vinča settlement, and the average number of members per household is 3.18. The Vinča settlement area is 18.95 km^2.

In northern part of the planned construction complex, in the proximity of the current landfill fence, an informal settlement is formed. The settlement is populated by families collecting, classifying and selling secondary raw materials from the landfill.

In this area 17 households (85 people) are identified, and their members were present at their households in the period running from 2014 to June 8th, 2016. Out of these, there are 41 men and 44 women; 38 underage children (under 18), 47 adults – noting that 6 (six) persons did not have any valid documentation based on which their age could be determined. The Action Plan envisages the resettlement of families who live in an informal settlement at the location of the Vinča landfill - . which is described in more detail in Chapter 5.1.

2.10. DATA ON EXISTING COMMERCIAL AND RESIDENTIAL OBJECTS, FACILITIES OF INFRASTRUCTURE AND SUPSTRUCTURE

The asphalt base and complex of the Institute for Nuclear Sciences "Vinča" are important commercial objects for the project near the Vinča landfill complex.

Larger industrial areas are located in the western parts of Belgrade. In relation to the landfill, they are 5 km southwest, west and northwest. The high-voltage switchyard is located 3 km northwest from the landfill site.

The most significant industrial area is located in the southern part of Pančevo, where an oil refinery, chemical industry factories and a river port can be found. In relation to the landfill, they are about 8 km northeast.
Residential buildings are in the suburbs of Vinča, Veliko selo, Slanci and Mirijevo. The listed settlements are with high density of housing, and the nearest inhabited households are more than 1000 m away from the landfill complex in Vinča[1].

[1] As a reference, we can cite the decree „Official Gazette of RS", No. 54/9. This regulation stipulates that the distance from the nearest settlement must be at least 1,500 m and the distance from individual houses must be at least 500 m..

The traffic connection to the Vinča landfill has been realized through Beogradska Street from the Smederevski Put diversion. According to the General Plan of Belgrade 2021 ("Off. Journal of the City of Belgrade", No. 27/03, 25/05, 34/07 and 63/09), Smederevski put is equal to the highway road, and Beogradska Street and road to the landfill are equal to the second-class streets. Total annual traffic from the landfill complex to the public roads is around 135,348 vehicles.

Within the border of DRP, a TS of 10/0,4 kV "Beogradska bb, landfill", an underground grid of power lines of 10 kV, overhead and underground lines of 1 kV, as well as public illumination installations (PI), have been constructed. The existing power lines have been constructed under the free space, following the corridor of the existing traffic areas. For existing overhead lines of 35kV, a 30 m long protective corridor (15m from the line axis) has been provided.

The Vinča landfill complex is at a distance of about 2200 m from the existing water pipeline route Ø200, which is located at the base of the Smederevski Put. The traffic connection from Smederevski Put to the Vinča Landfill Complex has a Ø100mm pipeline of about 450 m in length.

The sewage network does not exist from the Smederevski Put to the landfill complex.

In this area there is no gas pipeline network and gas stations (GMRS, MRS, etc.).

The landfill complex is connected to an automatic telephone exchange (ATE) " Kaluđerica". The access telecommunication network is made by underground cables.

Supstructure facilities (catering facilities, galleries, exhibition, congress, entertainment facilities, etc.) are located at a distance of more than 1000 m from the Vinča complex.

2.11. DATA ON HEALTH CARE IN SERBIA

According to the data published by the Institute of Public Health of Serbia (Source: Health Statistical Yearbook of the Republic of Serbia 2016) the most common causes of death in 2016, (if the group Symptoms, signs and abnormal clinical and laboratory findings (4.9%) is excluded) belong to the following diseases groups:

- Diseases of the circulatory system 51.8%
- Neoplasms 21.8%
- Diseases of the respiratory system 4.8%
- Endocrine, nutritional and metabolic diseases 3.3%
- Diseases of the digestive system 3.2%

In the year 2015, the most common causes of death, if the group Symptoms, signs and abnormal clinical and laboratory findings (5.4%) is excluded, belong to the following diseases groups:

- Diseases of the circulatory system 52.7%
- Neoplasms 20.6%
- Diseases of the respiratory system 5.3%
- Diseases of the digestive system 3.2%
- Injury, poisoning and certain other consequences of external causes 2.8%

Chronic non-communicable diseases: cardiovascular diseases, malignant tumors, diabetes, obstructive lung disease, injury and poisoning, mental health disorders and other chronic diseases dominate for decades in national pathology.

Cardiovascular diseases and malignant tumors accounted for more than two thirds of all deaths in Serbia in 2016. More than half of all lethal outcomes (51.7%) are the consequence of dying from the diseases of circulatory system and almost one in five persons who died (21.3%) was the victim of malignant tumor.

In Serbia 2.8% population died because of injury and poisoning, 3.1% as a consequence of diabetes complications, while 2.6 % died as a consequence of obstructive lung disease. In period 2007 to 2016 in Serbia was observed 2.6% a slight increase in overall mortality due to higher mortality from leading chronic noncommunicable diseases. In the observed period, the highest mortality increase was associated with malignant diseases (10.3%), diabetes (10.0%) and obstructive lung disease (7.4%). The lowest decrease of mortality was recorded for injury and poisoning (22.7%) and circulatory diseases (5.4%).

Even though increased death rate can partly be explained by better diagnostics and recognition of cause of death, it is a fact that majority of population in Serbia aches and dies out of coronary and heart diseases. It is known that 75% of heart diseases are caused by conventional risks in a relation with the life style - smoking, hypertension, high level of cholesterol, improper nutrition, obesity and physical inactivity. In addition, many socio-economic studies indicate a link between low socio-economic status and heart and coronary diseases.

In 2016, 52,102 people in Serbia died from cardiovascular diseases. Cardiovascular diseases account 51.7% of all causes of death and are the leading cause of death in Serbia. Women were dying from cardiovascular diseases more often (54.3%) than men (45.7%). Ischemic heart diseases and cerebrovascular diseases are leading causes of death in this group of diseases.

In the observed ten-year period, death rates for cardiovascular diseases in Serbia decreased from 780.4 per 100,000 to 738.2 per 100,000 inhabitants. In the period between 2007-2016, mortality rates in women declined by 5.2%, and in men by 5.7%.

Between 2005 and 2014 in Central Serbia, the average number of people diagnosed with malignant diseases was 25,834 annually, while 14,755 persons died from cancer yearly. According to data from Cancer Registry of Central Serbia, in 2014, 26,362 new cases (422 malignant tumors) were registered, and 15,152 died of cancer.

The City of Belgrade has one of the highest mortality rates registered (men 178.5 per 100,000/ women 121.3 per 100,000).

According to the Cancer Register data, men were mostly diagnosed with and died of cancer of bronchus and lung, colon, rectum and prostate cancer. In women, the most frequent sites of malignant tumors were breast, bronchus and lungs, colon and rectum. At the same time, women were mostly victims of breast cancer, bronchus and lung, as well as colon and rectum cancer (Source: Health Statistical Yearbook Of Republic Of Serbia, 2016).

According to the Statistical Annual Report of the Republic of Serbia, in the period from 2011 to 2016, in the health system of the Republic of Serbia, the number of doctors and dentists decreased by 1049 and 542. The number of pharmacists decreased by 12761. The population per doctor increased slightly, while the number of residents per hospital bed decreased compared to 2011. The coverage of vaccinated persons against diphtheria, tetanus and pertussis was 94.1% and from poliomyelitis to 94.2%. MMR vaccination was performed in 81% of cases, while infant BCG vaccination coverage was 98%.

Compared to 2015, there were 837 newly diagnosed patients with all forms of tuberculosis in 2016, representing a drop of 125 cases. The highest number of newly registered patients was noticed in the age group of 60 years and older. The WHO Global Tuberculosis Program and the Directly Supervised Treatment Strategy were implemented in 2002. These data were collected by the Institute of Public Health of Serbia "Dr Milan Jovanovic Butut".

3.0. PROJECT DESCRIPTION

Landfill works will take place in stages, which dynamic is conditioned by the construction of a new landfill in stages. The construction of the new landfill is planned in three phases regarding the disposal of waste material. The mentioned works by phases are determined on the basis of the required technological units of the landfill operation.

Phase one of the new landfill construction is planned for a period of one year from the beginning of works on the landfill and includes a transitional period, the so-called. temporary landfill (interim landfill). The first phase of construction of a new landfill involves:

- Making the bottom of the new landfill and the necessary layers at the bottom and slopes, the drainage system for this phase, system for the evacuation of atmospheric water from the body outside the temporary landfill, as well as the construction of biothorns for that phase,
- Complex entrance construction with all planned structures and equipment for entrance and exit control, measuring waste quantities and directing vehicles to the waste treatment platforms,
- Construction of the roads Nova 1, Nova 5, the section towards the entrance and exit to the EfW plant, Nova 4, public utility road 3, public utility road 5,
- Construction of the upper platform with lagoons,
- Construction of the lower platform with lagoons,
- Construction of the CDW platform,
- Construction of the operating platform,
- Construction of the LTP,
- Construction of the outer perimeter canal for collection of atmospheric water from the southern part of the basin,
- Construction of part of the inert waste landfill.

Phase two of landfill construction is planned after completion of Phase 1, in duration of 2.5 years, and includes:

- Construction of the bottom of the new landfill on the surface of the excavation of this phase, emplacement of required layers at the bottom and on the slopes and construction of a drainage system for this phase, a system for evacuation of atmospheric water out of the landfill body and out of the landfill, partition cassettes separating the interim landfill from the Phase 2 landfill, Phase 2 biotrns and biogas collection network,
- Construction of the outer perimeter canal for collection of atmospheric water from the northern and western part of the basin,
- Construction of the remaining part of the inert waste landfill.

Treća faza izgradnje nove deponije je planirana nakon završetka druge faze u trajanju od 22 godine i obuhvata:

- Construction of the bottom of the landfill, emplacement of required layers at the bottom and on the slopes and construction of a drainage system for this phase, a system for evacuation of atmospheric water out of the landfill body and out of the landfill, partition cassettes separating the Phase 3 landfill from the Phase 2 landfill, Phase 3 biotrns and biogas collection network,
- Completion of construction of the outer perimeter canal for atmospheric water from the northern and western part of the basin,

- After completion of the third phase, the so-called buffer zone remains as a free, spare area that will enable the potential deposition of new quantities of municipal waste.

The New landfill Project foresees the following waste disposal plan, which will be adapted to the actual amount of waste generated during operation:

From 2020, by mid-2021, a transitional period, it is expected that 765.000 tons of municipal solid waste will be disposed directly into temporary cassettes on the sanitary landfill, with a net capacity of about 722.000 m3.

From mid-2021 to mid-2024, it is expected that 170.000 tons of waste will be deposited annually in cassettes at the landfill for "Untreated waste 1", a net capacity of about 480.000 m^3 and 88.000 tons of residues after treatment of waste at the EfW plant will be disposed in cassettes at the landfill for "Residues 1", with a net capacity of about 175.000 m^3.

From mid-2024 to mid-2046, it is expected that 170.000 tons of waste will be deposited in cassettes at the landfill for "Untreated waste 2", a net capacity of about 3.530.000 m^3 and 88.000 tons of residues after treatment of waste at the EfW plant will be disposed in cassettes at the landfill for "Residues 2", with a net capacity of about 1.300.000 m3.

Figure 6 Layout of the municipal waste landfill complex in Vinča
(Source: IDP Book 7.1 Technological Design, Energoprojekt-Hidroinženjering, 2019)

3.1. DESCRIPTION OF FACILITIES, PLANNED PRODUCTION PROCESS OR ACTIVITIES, THEIR TECHNOLOGICAL AND OTHER CHARACTERISTICS

In this study, based on the substrates used, the following basic contents and facilities will be addressed:

1. Control zone at the entrance:
- Supervisory station
- Weighbridges
- Radioactivity detection system
- Wheel washing system (belongs to this zone, but is not positioned in it)

2. CDW plant platform:
- Administrative building (office, sanitary and storeroom container)
- Plateau of the crushing - CDW plant (storage, treatment and separating of contruction waste)
- Surface for depositing raw material (construction non-hazardous waste)
- Surface area for disposal of the finished product (fractions from the CDW plant)
- Parking and internal road at the platform

3. New landfill:
- 3a. Temporary (interim) sanitary landfill for municipal waste
- 3a.Sanitary landfill for untreated waste
- 3a. Landfill for residues produced after waste treatment in EfW plant
- 3b. Inert waste landfill
- 3c. Torch system

4. Operation platform (technical maintenance):
- Administrative building
- Workshop with vehicles washing area
- Storage of hazardous materials
- Diesel fuel pump station
- Storage/container for hazardous waste (4 items)
- Parking: mehanizacije, dostavnih vozila, kamiona i putnička vozila
- Parking: mechanization, delivery vehicles, trucks and passanger vehicles
- Sedimentation tank/Separator of light petroleum products
- Facility for treatment of sanitary-foul wastewater (WWTP)

5. Upper platform:
- System for collection and evacuation of atmospheric water
- System for collection and evacuation of leachate water

6. Lower platform:
- System for collection and evacuation of atmospheric water
- System for collection and evacuation of leachate water
- 6a. Zone for leachate treatment plant (LTP)

7. Protective dam of the old landfill body (support structure)

Of the accompanying contents, the following are planned:
- Power transformer stations,
- Access and internal roads, internal and temporary roads,
- Protective greenery etc.

1. Control zone at the entrance

The existing entrance to the Vinča landfill complex is enabled from the access road, at a distance of about 400m from the junction with the road to the Vinča Institute for Nuclear Sciences. At the entrance there is a doorman's booth and a canopy.

Design documents of the New landfill with accompanying facilities envisage all existing utilities, tubular culverts for rain sewer Ø600, old asphalt and dirt roads, prefabricated and masonry structures and fence to be removed i.e. they shall be demolished and disassembled and all the existing canals for atmospheric water drainage at Vinča landfill shall be backfilled. *(Source: IDP Book 3/1 Design of hydrotechnical installations, Energoprojekt Hidroinženjering, May 2019).*

The existing pavement structure is demolished mechanically, layer by layer. Bulldozers, graders, loaders, etc. are used for demolition.

The newly designed solution for the entrance into the landfill complex is moving towards the southwest, by about 500 m from the current situation.

At the very entrance into the landfill complex, there will be a barrier gate. From the gate, about 180 m long asphalt road leads to the control zone, which comprises the control area and the truck wheel scales (i.e. weighbridges).

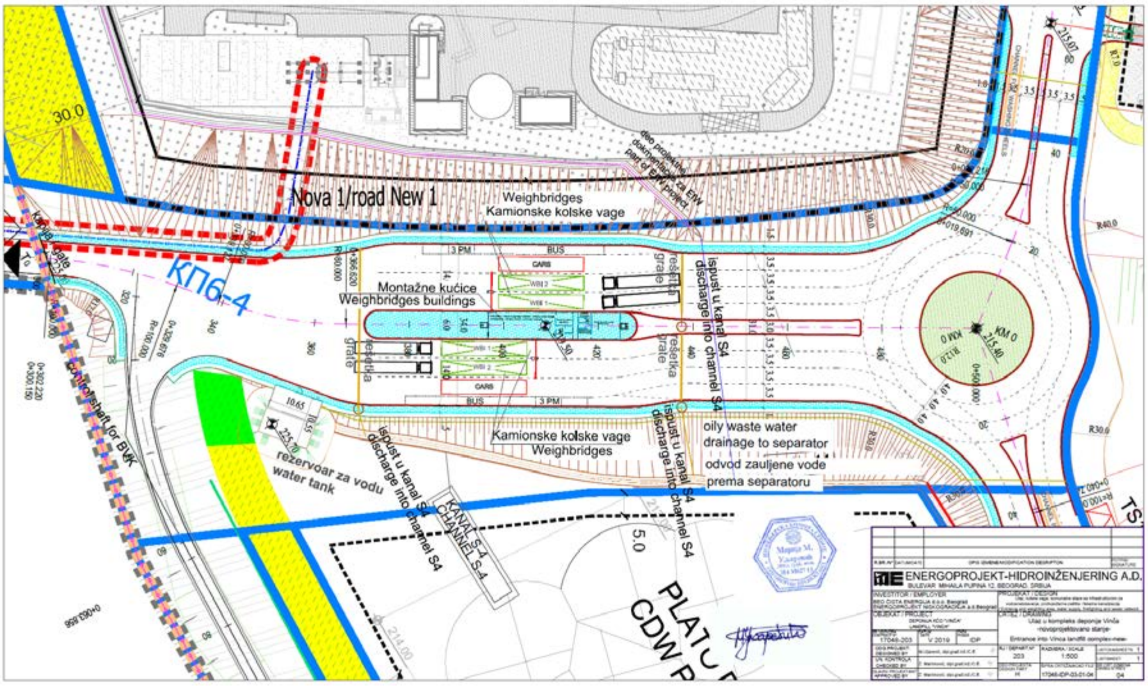


Figure 7 Layout of the Control zone at the entrance (Source: IDP Book 3/1 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019)

Barrier gate

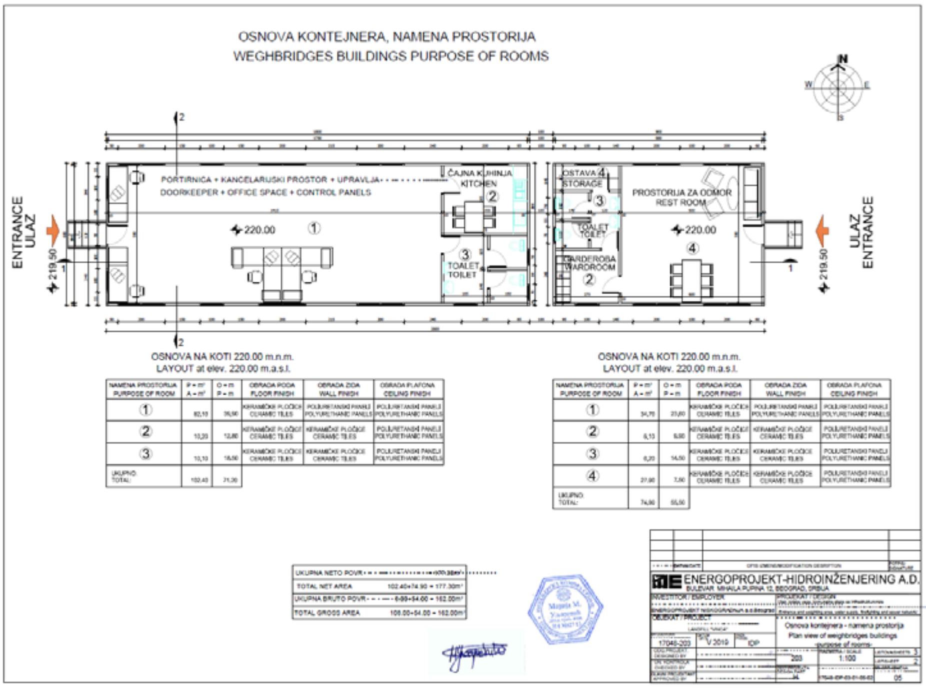
The barrier gate shall be installed at the entrance into the landfill complex. The barrier gate will consist of four parts - two parts at the entrance and two parts at the exit from the landfill complex. The gates for the vehicles and pedestrians have been envisaged at the entrance/exit. Gate for the vehicles passing in one direction, shall consist of two leafs - each leaf shall be 3.5 m long and 2.0 m high. The steel structure made of steel sections, with the infilling made of flat profiled iron and the wire mesh is foreseen. The gate will be opened, closed and locked manually. The entry/exit barriers shall be installed at the entrance into the landfill complex itself, immediately after the gate.

Control Zone at the Entrance

Control zone at the entrance into the landfill complex comprises the control area and the truck wheel scales. Three prefabricated small houses are located within the control area (two of them are joined and one is separate). Within joined houses, the doorman’s booth, control panels, vehicles control system, video surveillance control room, office spaces, kitchenette, toilets and the common rooms for the drivers, are located.

A separate prefabricated small house is intended for providing general services to the truck drivers. This house consists of: work room, rest room, wardrobe, storage room and toilet.

In order to enable direct communication with the drivers of the vehicles, 360^{0} visibility shall be enabled from these small houses.



Truck Scales (Weighbridges)

There are four truck scales planned in the control zone, two for the trucks arriving at the landfill complex and two for the trucks leaving the landfill complex. The truck scales enable control of waste flows - both of the waste arriving at the landfill complex and of the waste leaving Vinča landfill complex.

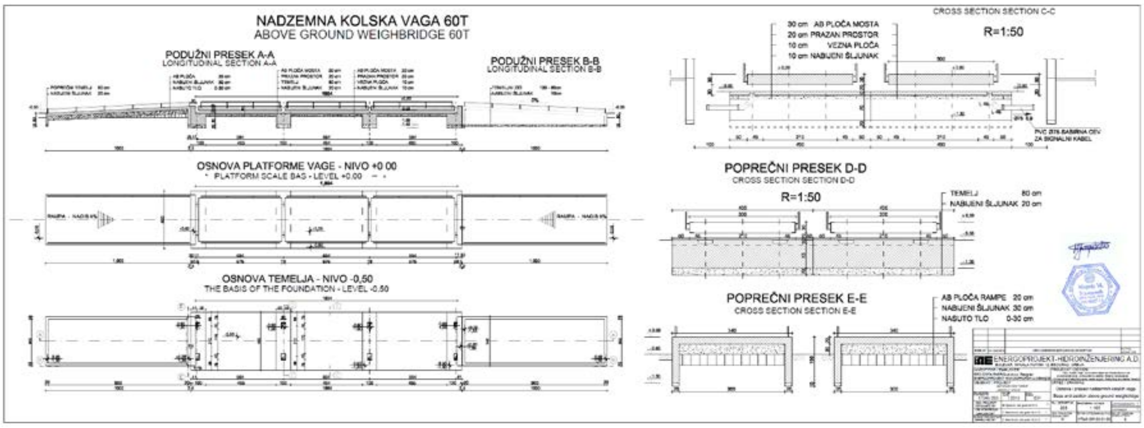
The wheel scales shall be raised from the ground surface and shall be able to perform weighing in both directions - in case of failure of one scale.

Length of the scale amounts to 18 m, its maximum capacity amounts to 60 tons and the access ramp has to provide the maximum inclination of 5%.

Consoles of the truck scales are electronically connected with the vehicles control computer system, thereby enabling the operation without staff. In addition to the weight and type of the waste at the entrance to /exist from the landfill complex, the console also records and memorizes the scale number, the date and the time of transaction, the vehicles plates number, name of the company which supplies/takes over the waste, the unit price and the total price. Deleting or correction of the data which entered the system, shall not be enabled.

The approximate technical characteristics of the weighbridge (to a reduced extent):

- weighbridge dimensions 3 x 18 m,
- height of the weighbridge structure 22~37 cm,
- weight measurement range 400 kg - 60.000 kg and the smallest scale division is 20 kg
- temperature range: - 10°C do + 40°C
- weighbridge surface is made of the ribbed sheet metal, in order to prevent slippage of the vehicles
- weighbridge is in accordance with the standard from the Directorate for Measures and Precious Metals…



Slika 26. Weighbridges in the control zone (Source: IDP Book 3/1 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019)

Radioactivity detection

Having in mind that storing of the hazardous matters, including the radioactive matters, has not been foreseen within the landfill complex, detection and preventing the entry of such matters is mandatory. The radioactivity detection system with the alarm and with the appropriate software shall be installed at the entrance of incoming truck scales.

The system shall be equipped with several levels of alarm, which will be determined for each detector, in accordance with the radiation level. In case of radioactivity detection, the rotation signal installed next to the truck scales shall be activated, as well as the audible alarm installed in the vicinity of scales and in the command booth. A typical configuration of the control-measurement zone is shown on the figure below:

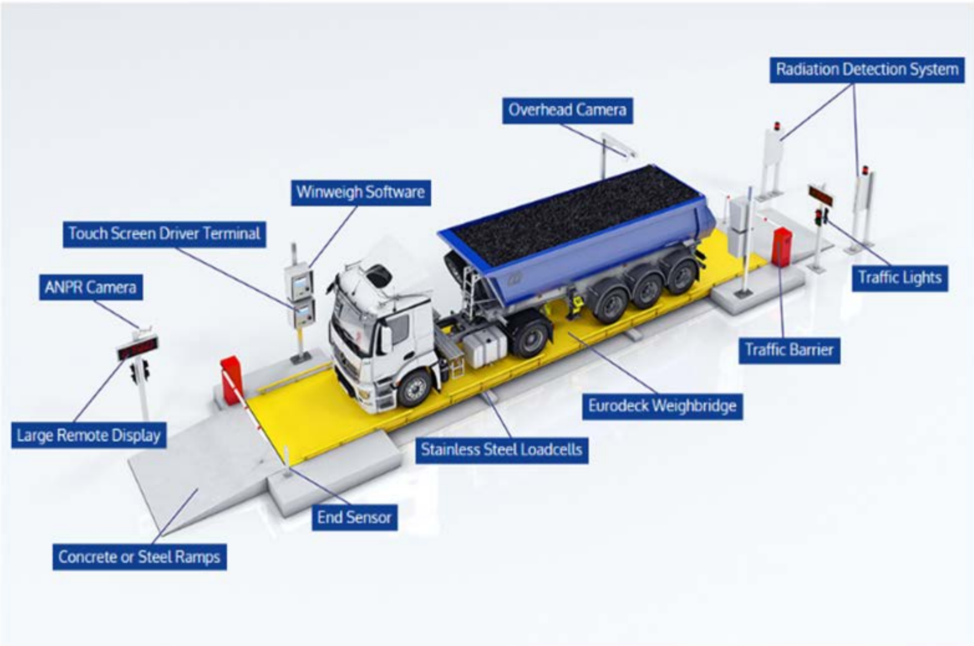


Figure 27 Symbolic representation of the measurement zone configuration with the radioactivity detection system

Wheel washing system

Immediately before the roundabout, in the zone of Nova 4 and Nova 5 roads, before leaving the complex and measuring weight at the exit of the landfill complex, it is envisaged to wash the truck wheels with water. The wheel washing system is situated in a concrete canal, at the bottom of which a ribbed structure will be installed. Under the ribbed structure, mechanical separation / shaking of accumulated mud, waste, etc on tires. is carried out under the weight of the vehicle. Water must be added regularly, in order to maintain the level suitable for wheel washing.

Water intended for washing of the vehicles is supplied to the entrance zone by DN100 mm pipeline, from the lagoon for the atmospheric water, which is located on the Upper platform.

After discharging, the water from the wheel washing is conveyed to the separator located on the CDW platform.

Atmospheric water discharge system from the Control zone at the entrance

The newly designed system for the removal of atmospheric water from the inlet zone of the landfill complex includes line grids and pipes that collect atmospheric water and oily atmospheric water. All collected water from the entrance area is channeled to a separator on the CDW platform. This canal also collects surface water from the escarpment to the CDW platform.

The oil separator with the sedimentation tank, which is located on the CDW platform, has the capacity of 130 l/s.

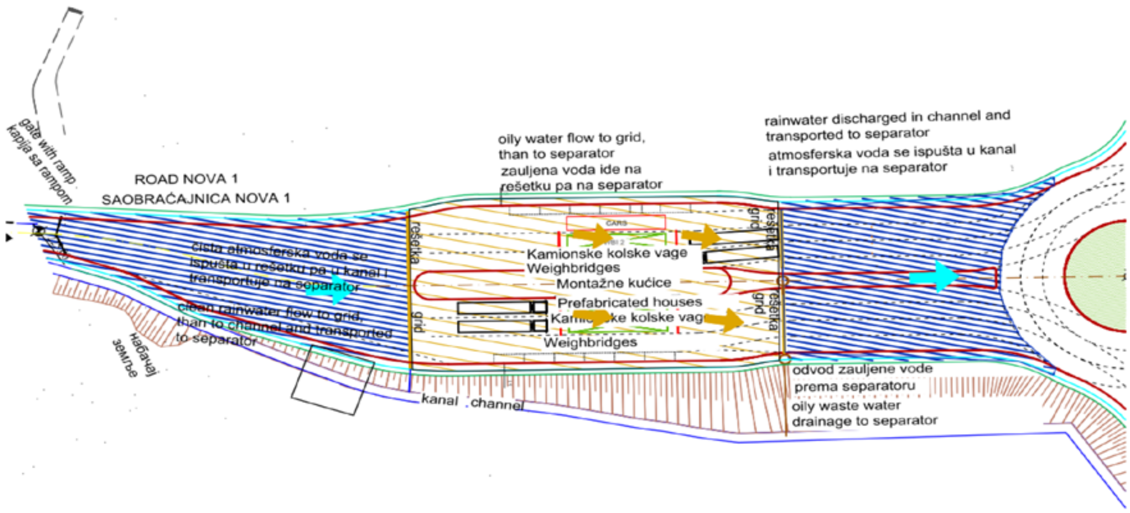


Figure 28 Scheme of atmospheric water discharge system from the Control zone at the entrance (Source: IDP Book 3/1 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019.)

Telecommunication and Signaling functional units of the Control zone at the entrance

Telecommunication and Signaling functional units of the Control zone at the entrance (Source: IDP Book 5/2 Telecommunication and Signalling Installations Design, Energoprojekt Hidroinženjering, May, 2019) are:

- Electronic communication network (ECN)
- Video monitoring system (VMS)
- Fire alarm system (FAS)
- Fixed telephony system
- Telecommunication (TC) connections
- TC infrastructure

Electronic communication network

A unique electronic communication network (ECN) is formed on the landfill complex level, that will enable an integrated flow of all types of messages: within the individual landfill facilities, among the facilities, as well as towards the external telecommunication service operators.

The central devices of ECN network are installed, together with TC terminal (for external connections of the landfill), in the dedicated area within the Entrance Area. This site connects with cables to all other facilities within the complex that need TC connections.

Video Monitoring System

On the landfill level a video monitoring system is foreseen, which will enable security surveillance of: the waste unloading areas (new landfill, inert waste landfill), the platforms (operating landfill, leachate treatment, biogas treatment, construction waste), mobile installations and around the fence.

Functioning of the video surveillance system as a whole, is enabled by the central server & storage that accquires the signals from the video cameras and records them in predefined time intervals, in case of alarm states and when necessary. These data are stored for minimum 30 days.

At the entrance to the landfill, video surveillance will be provided to cover the entrance gate and truck wheel scales. Two cameras are installed for each scale: one for license plate recognition and the other for load control.

The cameras are installed on the lighting poles or the portals intended for traffic signalization, at the height of approx. 6 m. All these cameras will be connected with the local ECN network

Fire Alarm System

Role of the fire alarm system is automatic fire detection and alarming. It is connected to ECN network, for the purpose of integration of all security systems and for further connection with higher level surveillance and control systems. Fire alarm system is organized with four FA (Fire Alarm) units. Fire detection central unit will be installed in the Gatekeepers room, at an easily noticeable and accessible place.

Optical and thermal detectors, as well as manual call points and alarm sirens are foreseen for automatic fire detection and alarming. The basic type of detectors is optical smoke detector, that reacts to visible light and dark smokes.
At the points where fast temperature rise is expected, the thermal fire detectors, which react to the temperature change speed or to exceeding of the fixed, maximum allowable temperature, will be used. Each fire detector will have two levels of fire detection (warning and alarm).

All detectors, as well as all the system elements, are permanently monitored and any deterioration of the characteristics will be displayed by the audible warning and the appropriate textual caption.

Addressable automatic fire detectors and manual call points are foreseen, so that each element has its own address which undoubtedly defines its position within the system. By means of two-wire addressable loops, the addressable fire detectors are connected to the central unit. Each addressable loop connects several addressable elements: automatic detectors, manual call points and transponders.

Automatic fire detectors will be distributed over all the premises in which the fire load is expected. Manual call points and alarm sirens are installed nearby the exits and along the evacuation routes.

In case of fire hazard, two-stage local alarming has been foreseen: electronic flashlight and alarm sirens.

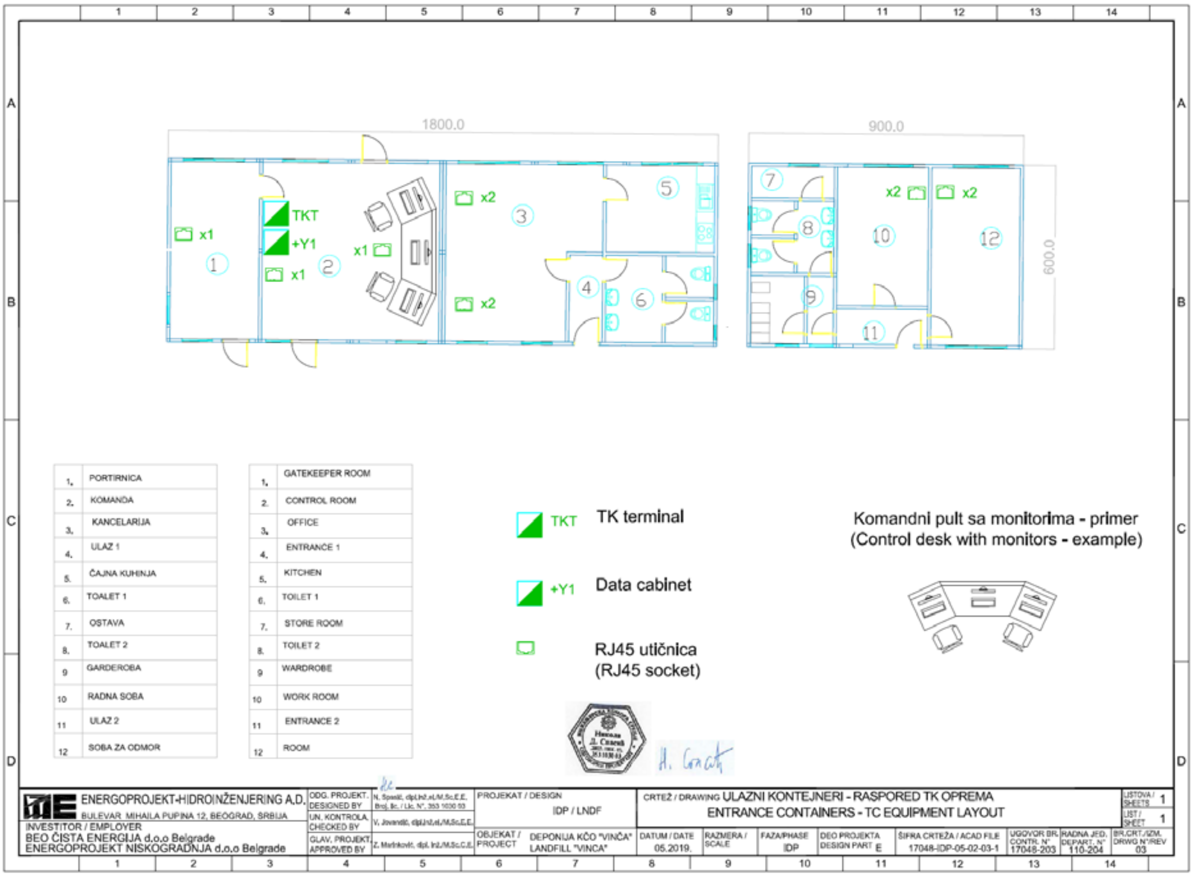


Figure 29 Schematic display of the FA equipment layout in the Control zone (Source: IDP Book 5/2 Telecommunication and Signalling Installations Design, Energoprojekt Hidroinženjering, May, 2019)

Fixed telephony system

An IP PBX, with a capacity of up to 50 phones, allows voice communication of staff inside and outside the Vinča Landfill. The telephone exchange is located in the Administrative Building on the Operating Platform. Two IP phones in EVA containers are connected via local ECN. ECN installations with RJ45 connectors are common to telephone connections.

Telecommunication Connections

In compliance with the guidelines for application of modern technologies for the new business facilities, the FTTB (FibreTo The Building) concept has been adopted. The access fibre optic cable will be laid up to the TC terminal within the landfill complex. This terminal should enable connection of the landfill with the external telephone and broadband networks (Ethernet, IPTV, xDSL) of the selected telecommunication operator. Cabinet with active and passive equipment will be installed within the dedicated area in the Entrance Area.

TC infrastructure

Two PE pipes are planned for the installation of optic cables, Ø50 mm along all internal roads. except on the parts towards the circular flow where 4 pipes are foreseen. As a rule, these pipes are placed in a joint trench with power cables for electrical lighting. Inside the facilities, installation cables run along the lattice cable girders, along the duct rails and on the walls using cable clamps.

Water supply for the complex

The main parameter for dimensioning of water supply to the landfill is the inlet pressure from the city water supply network, which amounts to 4.5 bar. The existing reservoir within the landfill complex is not in function, but will remain as a reserve, as defined in the Amendments to the Detailed Regulation Plan of Vinča sanitary landfill.

The water quantity that can be provided by Belgrade Waterworks and Sewerage to Vinča municipal waste landfill complex is 24 l/s (charging at night, between 22 - 06 h). The supply pipeline is planned with PEHD Ø200 mm. In front of the entrance to the landfill a new shaft is foreseen.

A PEHD pipe Ø200mm runs from the new shaft to the newly designed tank for sanitary and FF water. The tank consists of two chambers: with the capacity of V=50 m3 for sanitary water and with the capacity of V=72 m3 for firefighting water. Having in mind that the pressure of 4.5 bar at the landfill entrance is sufficient to ensure adequate pressure even for the most distant consumers, the sanitary and firefighting water tanks (old and newly designed) only serve as a reserve, in case of failure of water supply from the city water supply network.

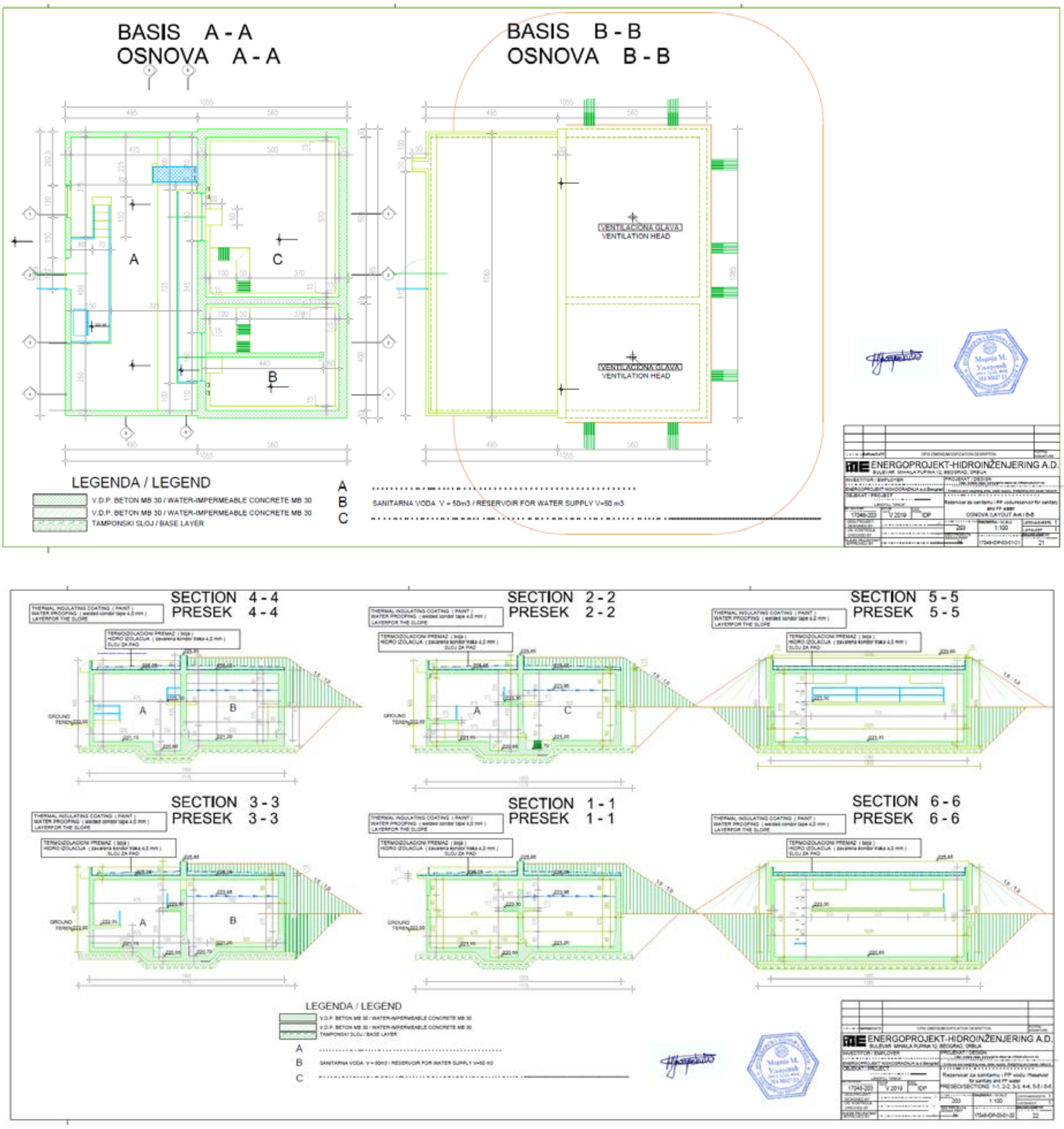


Figure 30. Sanitary and firefighting water tank (Source: IDP Book 3/1 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019)

City water is supplied to the complex through a valve chamber containing a T-manifold, where one branch separates toward EfW plant for sanitary and FF water, as well as FF water to the landfill and the other branch supplies sanitary water to the landfill and the tank. Behind each branch there is an electromagnetic flowmeter.

The valve chamber also contains booster pumps for sanitary and FF water, which should ensure pressure for landfill consumers in case of failure of water supply from the city water supply network.

Firefighting water shall be transported from the valve chamber to hydrants on the CDW platform and on the LOP platform.

The following pipelines branch off from the sanitary water pipeline: DN 25 for consumers at the entrance, DN 50 for consumers at the CDW platform and DN 50 for consumers at the LOP platform. After the LOP platform, a pipeline DN 50 shall supply technical water to the LTP.

Characteristics of firefighting water pump are: Q=22.22 l/s, H=16 m, P=4.0 kW and of sanitary water pump: Q=4.2 l/s, H=39 m, P=1.1 KW

The firefighting water tank will be filled in two independent manners: directly from the water supply network, through DN 200 pipe, and from the atmospheric water lagoon on the Upper platform.

This pond will collect surface atmospheric water from the entire new landfill (this excludes leachate from the landfill body).

A diagram showing the complex's water supply system is shown in the Figure below.

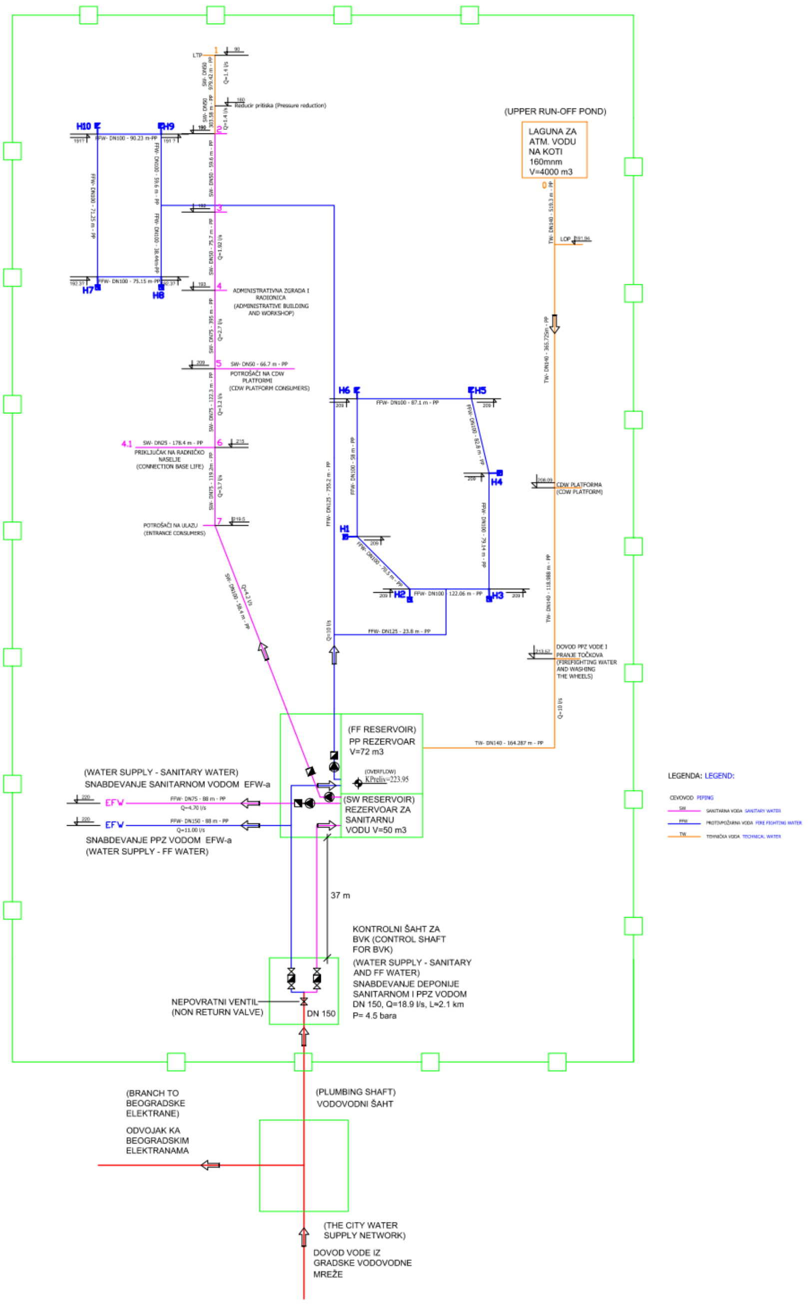


Figure 31 Scheme of Water Supply to Landfill Complex (Source: IDP Book 3/1 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019)

Foul water sewerage system at the complex

A foul water sewerage network is envisaged for collection and discharge of foul wastewater (from sanitary blocks) from the landfill complex that collects water from the following facilities (platforms, units, cadastral parcels):

- EfW plant (the subject of another project),
- Entrance-control zone,
- CDW platform,
- LOP platform,
- construction site.

The planned sewerage network consists of PVC sewerage pipes DN 160 and DN 200 for sewers collecting foul wastewater from the above-mentioned platforms and facilities.

Foul water sewerage runs from sanitary blocks in the landfill entrance part, along the centreline of Nova 1 road and further across the roundabout, where it collects wastewater from the EfW platform and construction site along the edge of Nova 5 road. Then the foul water sewerage runs along the edge of Nova 4 road, where it collects foul water from the CDW platform. After the CDW platform, the foul water sewerage runs along the same route, along the edge of Nova 4 road to the operating platform, where all foul wastewater are collected. The total amount of foul water from the complex is about 5 l/s.

After collection of all foul waters, they are channelled to the wastewater treatment plant i.e. to the package unit for treatment of foul wastewater located within the Operating platform. The device capacity is 100 PE. Treated water is discharged into the perimeter rain water canal, which transports these waters to the lagoons on the Upper platform.

2. Platform of the CDW plant

The platform for storage and treatment of construction waste is planned across the EfW and BEP plant, on the construction plot KP6-2. The CDW plant platform consists of the following units:

- Entrance road – asphalted
- Administrative building (on concrete slab):
  - Office container
  - Sanitary container
  - Storage container
  - Parking spaces (3 PS)
- Plateau of the crusher plant
  - Process area – CDW plant (screening, crushing) – concrete slab
  - Areas for storage of raw materials – gravel area
  - Area for disposal of end product - gravel area
- Internal gravel road

CDW plant platform is going to be fenced and equipped with access control. In addition to the fence, the areas of protective greenery (aprox. 950 m2) are foreseen. Platform is aprox. 17.500 m2.

Recapitulation and purpose of surfaces on the CDW platform	
Spatial-functional unit K2	Approx. 21.00 m²
Construction plot (fenced)	Approx. 17.500 m²
Concrete slab for Administrative building	Approx. 300 m²
Concrete slab for Process area	Approx. 1700 m²
Asphalt area – access road	Approx. 1700 m²
Green area	Approx. 950 m²
Gravel area – for disposal of raw materials and fractions	Approx. 13.000 m²
Surfaces for the obtained fractions on the CDW plant	
Crushed/sorted material (gravel)	Approx. 1.150 m²
Raw material	Approx. 5.800 m²
fraction 0-30mm	250 m²
fraction 32-80mm	150 m²
fraction 80-150mm	150 m²

Administrative building

The administrative building on the plateau consists of three containers with same dimensions: Office container, Sanitary container and Storage container. Containers are 6.06x2.44 m base and 2.59 m high. They are installed on a reinforced concrete slab 0.15 m thick, over a layer of lean concrete and a layer of compacted gravel.

Office container is an office, sanitary container is equipped with dressing room and sanitary blocks. Storage container is intended for holding spare parts in assembly racks.

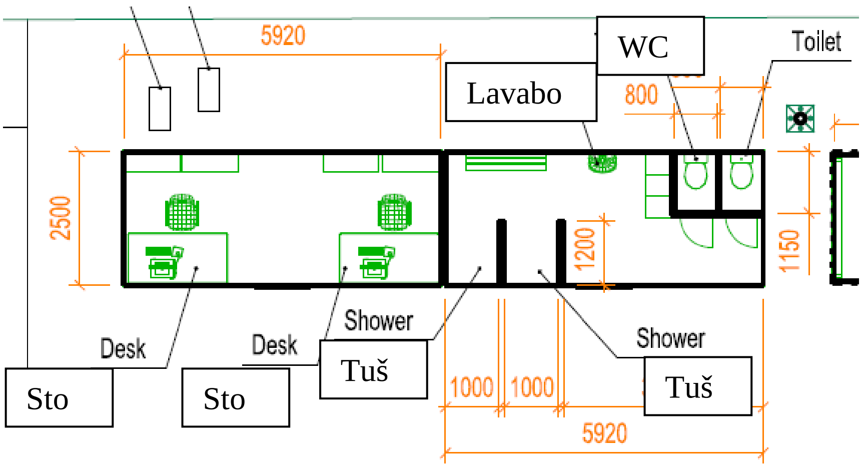


Figure 32 Office and sanitary container (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019.)

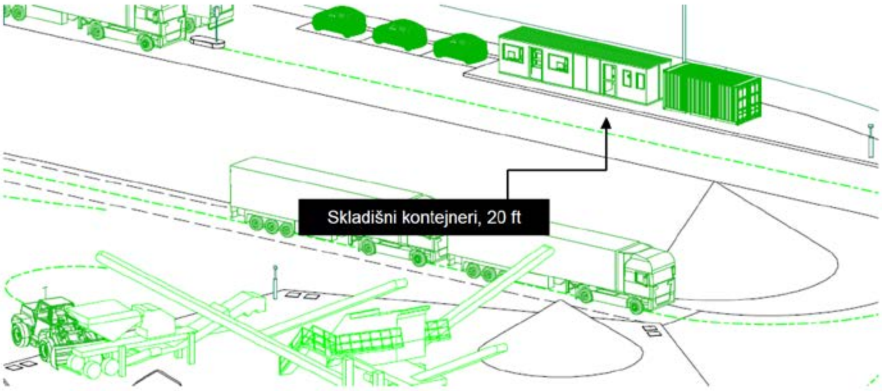


Figure 33 Disposition of the Administrative building with parking (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019)

Plateau of the crusher plant

Process area (screening, crushing and loading) of the CDW platform is approx.1 700 m^2, made of reinforced concrete slab. The slab is basically hexagonal. The length of the hexagonal slab side is 25.403 m, the diameter of inscribed circle is 44.00 m, and the circumscribed radius diameter is 50.81 m. The thickness of the slab is 0.40 m. The slab is laid through a layer of lean concrete and a layer of compact gravel. The foundation has a surface drop of ~ 2% defined by elevation marks.

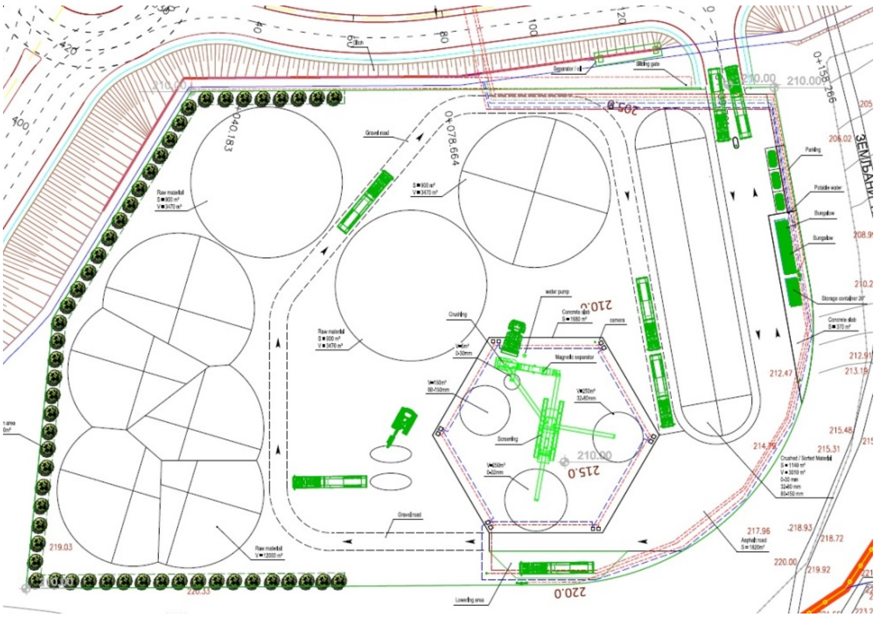


Figure 34 Plot Layout of the CDW platform (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019)

Construction and demolition waste material is delivered by trucks. The trucks are being measured with weighbridges, located at the entrance into the complex. The weighbridges' capacity is of 60 tons and 18x3 m dimensions. Once the trucks have unloaded their material, the empty trucks go again over the weighbridge, in order to measure and record the flows of material in and out of the CDW plant. The scale support equipment is placed in the room next to the scale.

Visual inspection of waste in open containers is done with cameras. In the case of closed containers, the truck goes to a designated container detection section to carry out a load check. Radioactivity detection is also performed at the entrance to the complex.

A temporary storage (buffer) space is provided at the entrance of the CDW Plant Platform. Trucks coming from wheel scales unload construction waste in this part, where approx. 7,000 m3 (two storage sites of approx. 3,500 m3 each) can be stored. Additional storage spaces are provided on the left side of the CDW plant plateau, space for approx. 15,500 m3.

Process area – CDW plant

The following equipment is foreseen for the operation of the CDW plant:
- An excavator with a waste shredder for pre-sorting of the incoming material
- Two loaders for transportation of incoming material suitable for crushing plant
- A mobile crushing plant with a sifter to separate fine fractions, conveyors for transporting materials to the open air temporary storage areas, magnetic separator to remove ferrous metal waste.

Basic concept of the process of the CDW plant consists of:

- Reception of construction waste
- Basic sorting of construction waste
- Crushing and screening of inert waste into different size ranges, in order to produce:
    - granulates
    - material for road base course
    - backfill materials, etc.
- Storage of sorted material on a dedicated area

The process concept of a CDW plant can, with the time of exploitation, be adapted to current market requirements, either in relation to the construction waste inflow or in terms of changing the demand of a particular fraction in terms of quality and / or quantity. The evolution of the process would in this context be realized by modifying the crushing and sifting equipment according to new requirements with respect to the granulation of individual fractions and / or the redistribution of the reserved volumes for receiving and storing sorted material.

Three fractions are separated at the plant and the largest fractions are returned to the crusher inlet.

Characteristics of material (construction non-hazardous waste) delivered to the CDW plant:

- Material: construction and demolition waste and soil (from excavation)
- Entrance material: 0 - 600 mm
- Capacity: 200.000 tons per year
- Moisture: max. 4 %,

Delivered construction waste consits of:

Soils from excavation: is divided into two parts. The first part consists in splitting the wet soils from the rest of the received waste, in order to evacuate them to the inert waste landfill. This part represents about 12,000 tons per year (12% of the incoming CD waste). Thus, dry soils correspond to the remaining 88%. This waste is stored in the construction waste storage area and is used for:

- internal use at new landfills
- sales / storage

Waste generated during demolition: this waste is treated at the CDW plant. Mentioned waste is sorted first on the floor, in order to separate inert waste (70%) from non-inert waste (30%). The non-inert waste is transported by trucks to the landfill. The inert waste goes through the treatmant process to be crushed and screened, and then transported to the right size storage unit. The stored products (fractions) are used for external off-take (sales).

Pre-sorting at the CDW platform occurs with the wheel excavator to remove waste that should not be put into the crushers, but gets transported by trucks to the landfill for surplus construction waste. There is 30% of the incoming waste which is expected to be not suitable for entering the process and will be evacuated toward the landfill.

Construction waste suitable for treatment at the CDW plant is stored in an additional storage area, on the gravel area of the CDW platform. Platform for additional storage has the capacity to accommodate 385 t of waste per day.

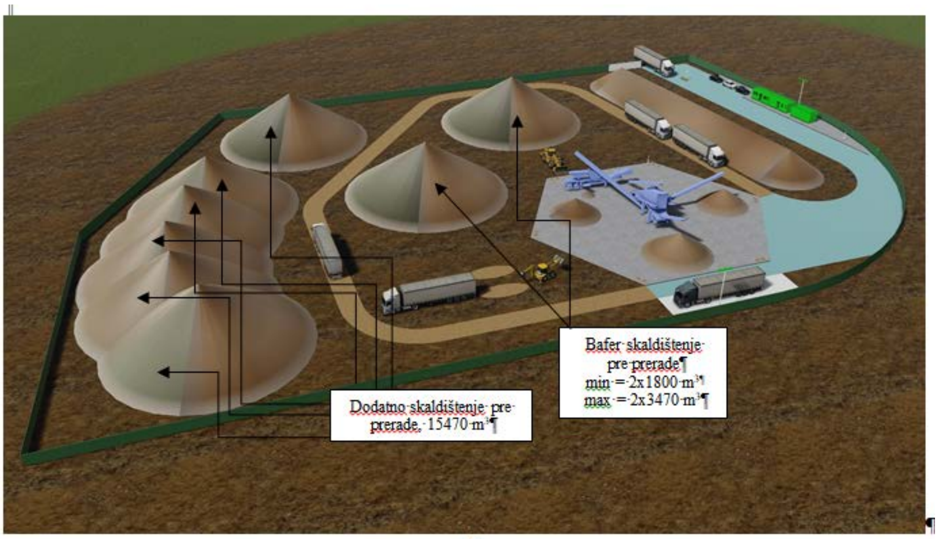


Figure 35 Skladištenje građevinskog otpada pre tretman (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019)

CDW plant has a capacity of 200,000t/year (300 t/h with an input material density of 2.6 t/m^3).

The estimated flow of construction waste through the CDW plant is shown in the figure:

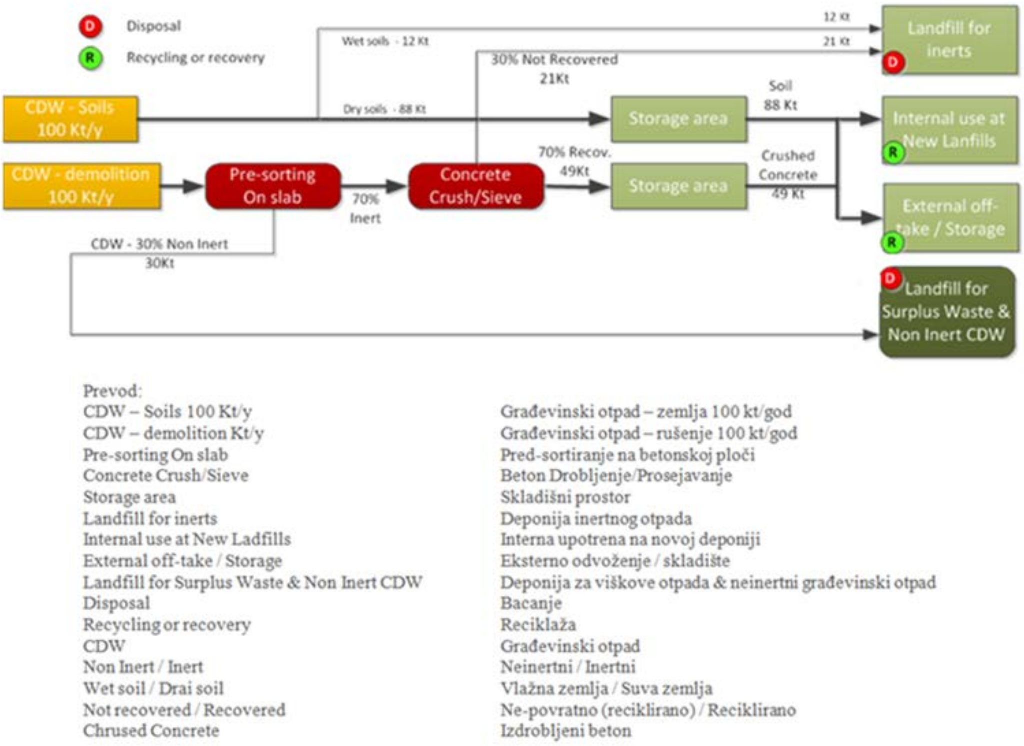


Figure 36 Estimated flow of materials through the CDW plant (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019)

CDW treatment plant is portable and consists from:

- Portable crushing plant (250 kW power)
- Portable screening plant (22 kW power)
- Set of 4 belt conveyors (37,2 kW power)

Expected production at the plant is:

- 67% fraction of 0/32 mm
- 33% fraction of 32/80 mm

CDW plant consists of 4 segments:

- feed hopper of a vibrating grizzly feeder
- impact crusher
- magnetic separator
- belt conveyors system

Figure 37 Illustration of the portable CDW tratment plant

An example of the technological scheme of the crushing process is given in the following scheme

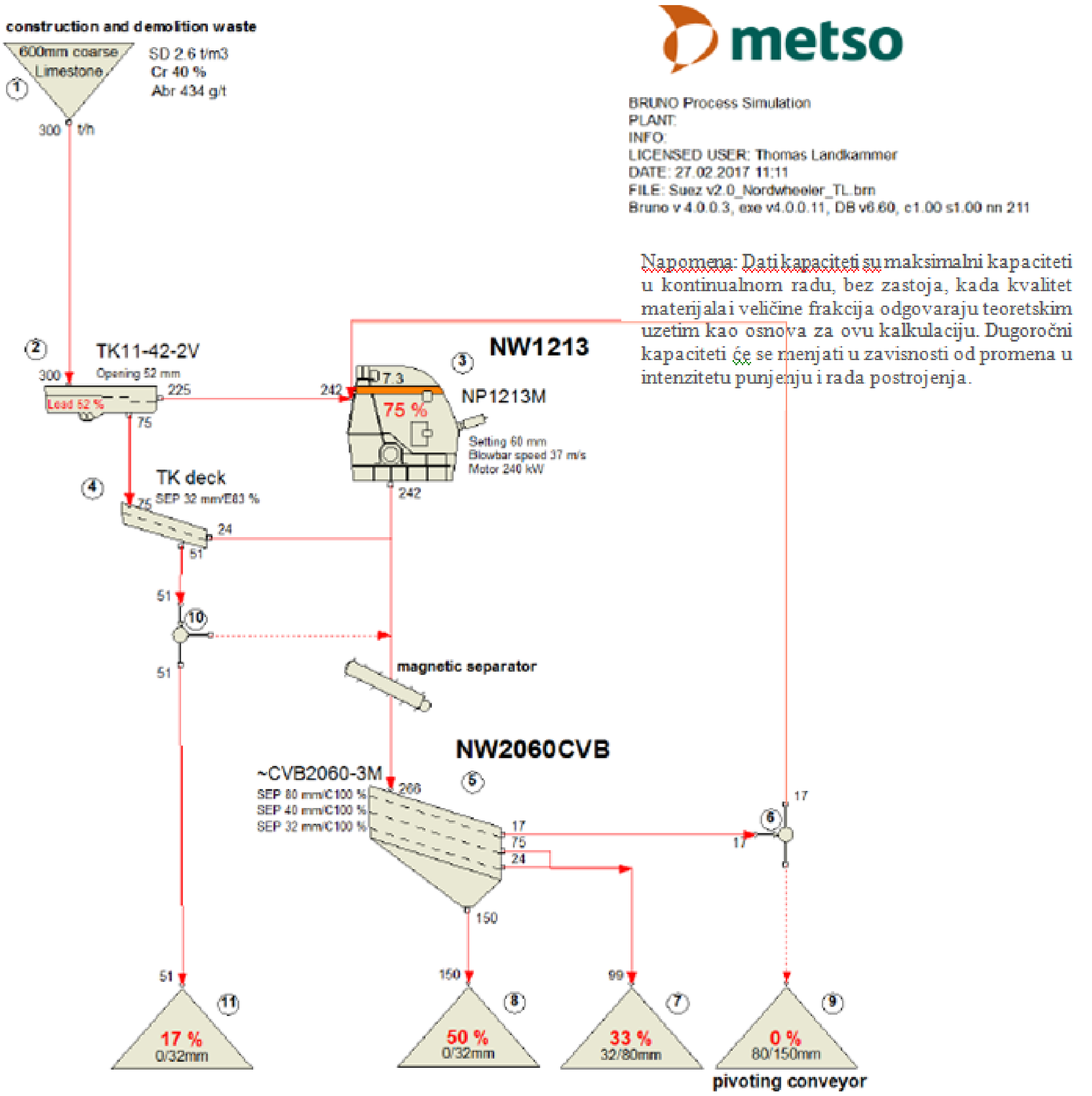


Figure 38 Process Flow Diagram of CDW treatment at thr CDW plant (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019)

The following is a description of the crushing plant process according to market currents with respect to the inflow and fractions demand of a particular granulation.

The process concept of a CDW plant can, with the time of exploitation, be adapted to current market requirements, either in relation to the construction waste inflow or in terms of changing the demand of a particular fraction in terms of quality and / or quantity. The evolution of the process in that context would be realized by modifying the crushing and sifting equipment, according to new requirements with respect to the granulation of individual fractions and / or the redistribution of the reserved volumes for receiving and storing sorted material.

The loading of materials is performed by wheel loader from the zone of temporary storage areas into the feed hopper of a vibrating grizzly feeder, gradually loading construction waste

From the vibrating grizzly feeder, the material goes to the system of vibrating screens which are designed to separate the input material into several fractions, according to their size. At the output of the feed hopper, the waste is calibrated according to the defined sizes. The grizzly spacing of the bars makes it possible to enable this sorting. The opening is 52 mm, so all waste finer than 52 mm goes through and the rest is discharged directly into the crusher. The grizzly spacing is 52mm / 38mm.

Waste from the grizzly feeder below 52mm is again sorted in a vibrating screen with a 32mm mesh. Waste less than 32mm is transported by a belt conveyor into a storage area.

The vibrating screen separates waste into 3 different sizes (0/32mm; 32/80mm; 80/150mm) which are sent to a dedicated storage area. Size 80/150mm can be returned back to crusher by means of pivoting belt conveyor.

The crusher consists of rotors equipped with knives. The crusher is design to treat up to 100 t/hour, (385 tones/day) of construction waste.

Material larger than 52 mm leaving the feeder is transported by a belt conveyor into the crusher. The waste is then crushed to a size of about 50 mm.

Waste between 52mm and 32mm is discharged by another belt conveyor to the magnetic separator to remove ferrous waste.

A magnetic separator is used to extract ferrous metal from a waste stream.

Belt conveyors are used to carry materials to the treatment machines and/or to transport sorted/crushed CDW.

The materials sorted by the machine are evacuated from the CDW by belt conveyors to the designated places for storing obtained fractions, with the following capacities:

- 250 m^3 for the 0-32 mm fraction
- 150 m^3 for the 32-80 mm fraction
- 150 m^3 for the 80 -150 mm fraction

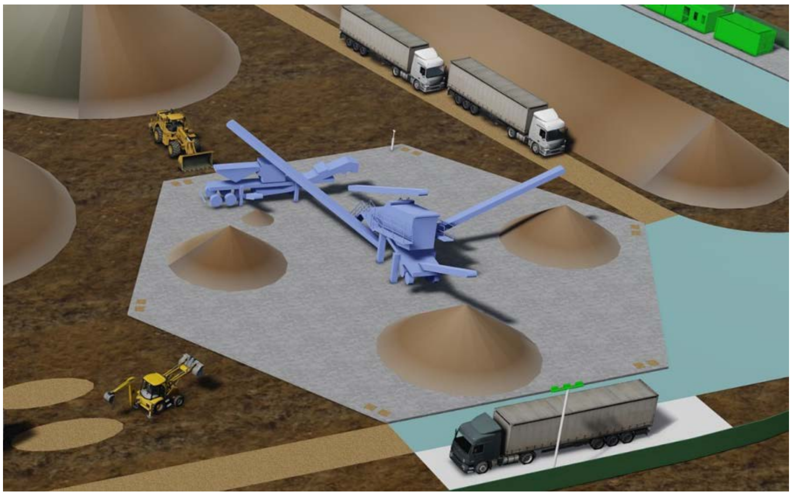


Figure 39 Temporary storage of treated material by obtained fractions (Source: IDP Book 7/3 Technological design, Energoprojekt Hidroinženjering, May, 2019)

In addition to these temporary storage sites, a buffer storage space with a capacity of 3,000 m3 of sorted material is foreseen, for 20 days of storage, within the CDW plateau.

Figure 40 Storage area for the treated construction waste

If during the landfill management period there were market changes in the pattern of inflow and demand of fractions of a certain granulation, the concept of the crushing plant would be adjusted in terms of adequate selection of new and replacement of existing crushing and sifting equipment. As a consequence, there may be a redistribution of the reserved volumes for receiving and storing sorted material to meet the needs of the evolved process.

For manipulation of construction demolition waste on CDW platform, excavator and wheel loader of the following characteristics will be used:

Hydraulic excavator

- Type: MH 3026 or similar
- Additional equipment:
  - Multi-functional crusher;
  - Demolition and sorting grapple;
  - Hydraulic hammer;

Wheel loader

- Type: CAT 966 or similar
- Hours of use: 150 h/month (1 shift, 5 days/week)
- Bucket capacity: 5 tons
- Maximum speed: 39 km/h

Figure 41 Excavator and wheel loader

Hydrotechnical installations at the CDW platform

The following hydrotechnical installations and facilities are envisaged within the CDW platform *(Source: IDP Book 3/7 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019)*:

- Outdoor sanitary water supply network
- Outdoor industrial water network with the connection for the dust reductions system during the crushing
- Outdoor hydrant firefighting network
- Outdoor foul water sewerage network
- Technological sewer for water drainage after dedusting with the settling tank.
- Oily water street gutters and oily rain water sewerage network with the settling tank and light fluids separator

The water supply and sewerage system of the CDW platform is connected to the outdoor water supply and sewerage system of the entire Landfill complex, which is located in the immediate vicinity of the platform. The total designated water consuption for sanitary needs is 0,47 l/s.

Industrial (process) water network is connected to the outdoor industrial water distribution network of the complex, which is supplied from the landfill leachate water treatment plant. It is estimated that 0.2 l/s of industrial water is needed for the CDW plant, in order to reduce dust emission.

Foul water sewage network from the facilities on the CDW plateau, whose expected volume is 0.56 l / s, is connected to the outdoor foul water sewage network of the Vinča complex.

After dedusting, waste waters are collected from the concrete plateau via canals with grates, which are directly routed to the settler tank. These waters are from the settling tank are directed to the oil waters separator. These channels collect and drain the rain water from the plateau.

The expected amount of waste water generated by firefighting is 0.2 l / s, but for the dimensioning of the system for the intake of these wastewaters, the amount of atmospheric water that flows into it has been adopted as relevant. The expected amount of oily rain water is 63.8 l / s.

Oily surface waters from the plateau are collected and directed to the oily waters separator with the settling tank. The separator's flow rate is 150 l/s. Upon the treatment, these waters are drained into to the perimeter rain waters channels.

The fire water network is connected to the outdoor hydrant fire network of the complex, which is supplied from the fire water tank, with a capacity 75 m3, located in the immediate vicinity of the complex entrance, and which is filled from the city water supply network. The total estimated water consumption for the hydrant fire fighting network is 10 l/s.

Electrical supply for the CDW platform

Electrical supply of consumers at the platform is provided from the new transformer station TS1, 630kVA, 10kV / 0,4kV, which is located in the construction plot K3 (*(Source: IDP Book 4/4 Power Supply Design, Energoprojekt Industrija, May, 2019)*).

Laying of 1kV cable lines from the TS1, 10kV / 0,4kV NN plant to the main distribution box will be carried out underground. From the TS1 to the CDW plant platform, three power cables are foreseen, one for the technological consumers of the CDW plant, the other for the CDW crusher, and the third for other consumers at the platform: a business container, a sanitary container, a storage container, a platform lighting and power supply for the camcorder.

Ground and lightning rod installations

The CDW platform lightning installation will consist of an internal and external lightning rod installation, which are galvanically interconnected and provide effective protection against atmospheric discharges. The facility's external lightning rod system installation will consist of:

- the receiving system,
- down conductors to the grounding facility and
- grounding facility.

The protection against atmospheric discharge of the container will be performed by a classic lightning rod installation in the form of a Faraday cage. The down conductors will be made of steel/galvanized Fe/Zn 20 mm x 3 mm strip. They will be placed on the facade of the building, on appropriate supports or in concrete pillars.

The protection against indirect contact of metal parts, which are not energized under normal operating conditions, but can be in the event of a malfunction, will be achieved by automatically switching off the power supply. The applied power system in this case is the TN-S system.

Lighting installating

Within the CDW platform, the following lighting installations are foreseen:

- General indoor lighting installation is done with energy efficient lamps with LED light source (or fluo lamps).
- Anti-panic lighting is performed with lamps with LED light source, equipped with ac battery and 1 hour operation autonomy. These lamps provide safe movement and evacuation in case of power failure. Anti-panic lighting locations must comply with the requirements of lighting according to SRPS EN 1838. Anti-panic lighting is automatically switched on after a power outage from the network.
- General outdoor lighting installation of roads and buildings is performed with energy efficient lamps with natural light source, which are mounted on 10 meters high steel poles.

Electricity consumption

The basic technological equipment on the CDW platform, supplied by "Metso", has a power of 334,2 kW. Installed power of other consumers is approx. 37,1 kW. The total installed power on the plateau is about 371,3 kW. Estimated electricity consumption is about 700 MWh per year.

Telecommunication, signalling and video installations

Telecommunication and signal installations are foreseen in the office container. The pillars on the platform will be equipped with 4 fixed video surveillance cameras and the fifth on the office container. They will be, via network commutator, connected to the video surveillance server and work station in the doorman booth. *(Source: IDP Book 5/3 Telecommunication and Signalling Installations Design, Energoprojekt Industrija, May, 2019)*.

In the office, each of two work places will be provided with two connectors RJ45 category 6a, one for IP phone and one for work station.

The voice & data system in the office container shall be connected to the integrated voice & data system of the entire complex. The office container shall be equipped with one network commutator with 16 gigabit connections and 2 optical fiber 10- gigabit connections toward the network backbone. With the help of this commutator, all the work stations and IP phones shall be connected to the main commutator in the doorman booth.

Traffic solution

A traffic solution on the CDW platform consists of an entrance part, entrance/exit road for traffic from the platform. There are containers for staff accommodation and 3 longitudinal parking spaces next to it. *(Source: IDP Book 2/7 Road design, Energoprojekt Industrija, May, 2019)*.

The crushed stone road, which goes through the platform, is formed in the extension of the asphalt road. Full trucks bring the construction waste and unload it at areas dedicated for this type of material. The unloaded trucks circle around the platform and exit it. The empty trucks that entered the site for collection of the granulates, stop next to the granulates area, are loaded and exit the complex.

The drainage, according to the grading solution, directs the atmospheric water towards the entrance/exit from the platform, from where it is further taken to the separator.

The pavement structure at the part of the entrance road's paved part consists of the following courses:

- 5 cm asphalt concrete wearing course AB 11
- 8 cm top bituminous sub base course BNS 22
- 15 cm mechanically stabilized crushed stone course (0-31)
- 30 cm mechanically stabilized gravel-sand course (0-63)

Total thickness of the pavement structure is D = 58 cm.

Structure of the crushed-stone road surface (JUS U.S4.050) consists of the following courses:

- 15 cm surface of vibrated crushed stone (0-31)
- 30cm mechanically stabilized gravel-sand sub base course (0-63)

Total thickness of the pavement structure is D = 45 cm.

Truck traffic is designed to avoid any crossings and not interfere with moving equipment for manipulating construction waste.

3. New landfill

The construction area of the new landfill belongs to the spatial-functional unit K3 and K5 (construction plot KP6-7), according to the current Detailed Regulation Plan *(Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019).*

Construction of the new landfill is planned west to the existing landfill and will be formed from several cells. The cells will be successively formed and opened, according to plan and needs. The construction of cells should provide permanent, controlled, organized and safe disposal of waste.

On the construction site KP6-7, within the New Landfill, it is planned to deposit the following types of waste:

- Temporary sanitary landfill for municipal waste,
- Sanitary landfill for untreated waste,
- Landfill for residues resulting from the waste processing at EfW plant and
- Inert waste landfill (north of the existing landfill

3a. Temporary sanitary landfill for municipal waste, sanitary landfill for untreated waste and landfill for residues from EfW plant

The area where the waste disposal is planned is prepared by removing the material, in order to extend the bottom of the landfill. The removed material can be used to build the embankment until an adequate inclination is achieved.

The municipal waste sanitary landfill will contain protection systems whose role is to prevent expansion of pollution from the landfill body to the natural terrain and to isolate the waste from external effects. The most relevant protection systems of the municipal waste landfill are:

- lining systems in the base and on the flanks formed from multi-layer barriers which are typically constructed from compacted clay, geosynthetic clay layers and/or a combination of them, geosynthetic geomembranes and drainage layers;
- covering finishing systems, which restrict the flow of atmospheric water to the landfill body and prevent the infiltration of atmospheric water into the landfill body after its closure;

A system for the collection and evacuation of leachate water and a system for the collection of landfill gas, which are formed inside the landfill body, is planned at the municipal waste landfill.

The Landfill Design proposes that new quantities of waste are disposed starting from the lowest places of the new interim landfill in cells, of average dimensions 74,0 x 57,0 m. The interim landfill of municipal waste is separated from the landfills for untreated waste and residues from EfW plant. Waste at the landfill is disposed on a previously prepared surface.

Waste disposal

Disposal of waste on the landfill is done on the surface, on a prepared base and with installed wells (biogas and leachate water, 1 well per cell).

A garbage truck arrives along the designed transport route to a designated work area on the landfill body and unloads the waste.

Waste leveling and compaction

Upon delivery to the landfill, waste is systematically disposed and leveled in layers of 0,5 m thickness and compacted to a specified density by a compactor. Onto every compacted layer the next thin layer of waste is spread, which is also compacted by a compactor. This operation is repeated throughout the waste disposal period, until the total height of the daily waste layer (about 2 m) is reached and then covered with a layer of inert material.This forms one working cell, i.e. a working level of total length of 2,30 m onto which the daily amount of waste is disposed. The degree of compaction is an extremely important parameter that determines the lifespan of a landfill and therefore it is necessary to use a compactor - resulting in a high density of disposed waste (more than 0.9 t / m3), which also saves space and reduces the risk of fire.

The best compact density is achieved for layers whose thickness does not exceed 0.60 m, so the most efficient compactness is over a large number of thin layers. Optimal density is achieved with 3 - 5 crossings of the compactor.

Leveling and compaction are better if the waste is moist, but thus the decomposition of organic matter is accelerated, leading to increased gas separation.

The entire daily amount of waste that is disposed and compacted at the end of the day must be covered with inert material to reduce the spread of waste and the risk of fire, as well as the spread of unpleasant odors. The thickness of the inert blanket will be about 10 cm, thus creating a working cell.

At the landfill in question and with this method of sanitary waste disposal, the maximum height of the landfill will be about 77 m, plus a final layer for covering / recultivation of thickness from 1.20 to 1.30 m.

As an inert material for covering freshly deposited waste, the following materials can serve:

- earth material from excavation originating from the site of the landfill itself and/or the whole complex, but also from other sites in the city area,
- prepared construction debris, i.e. construction waste that can no longer be used,
- near-surface sediments represented by loess, lesoid clay and silty sand, from local and distant borrow sites.

An inert material cover prevents insects, reduces penetration of water into the deposited waste layers, prevents adverse effects (smells and visual effects), prevents dispersal of individual components in the waste (paper, nylon bags, plastic...), contact of birds, rodents, insects, etc. with the waste, thus preventing spreading of infectious diseases.

The finishing cover layer at the landfill (the recultivation layer) is envisaged from material from the new landfill excavation, 120 cm thick and top-soil material 10 cm thick, which provides the total thickness of the finishing cover of 1.3 m.

The total capacity of the free space for disposal of the new landfill will be approximately 6.525.000 m3, on about 29 ha of surface. The realization of the landfill is foreseen to take place in phases, with the next phase of deposition starting after full capacity has been deposited for the previous phase. The construction of a new landfill at the Vinča site is planned in three phases, with respect to the waste material disposal, the planning of the phases itself will be enviable in relation to the future operational circumstances at that moment.

The landfill for temporary disposal of municipal waste will be in operation for about 1.5 years.

After that period, phase II starts for a period of 3 years, when the operation of the EfW plant begins. By the end of phase II, waste that does not go to the EfW plant will be disposed in the area envisaged for the Untreated Waste Landfill ("Untreated Waste I"). With the operation of the EfW plant, residues (ash and bottom ash) are generated after stabilization in the plant itself (the subject of the EfW plant construction project). These remains will be deposited during the phase II period in the area envisaged for the Landfill of residues resulting from waste treatment at the EfW plant ("Residues I").

After the phase II, phase III of the new landfill construction will be realized, which will last 22 years. During this period, the disposal of waste that does not go to the EfW plant ("Untreated Waste II") and residues from the EfW plant ("Residues II") will be carried out.

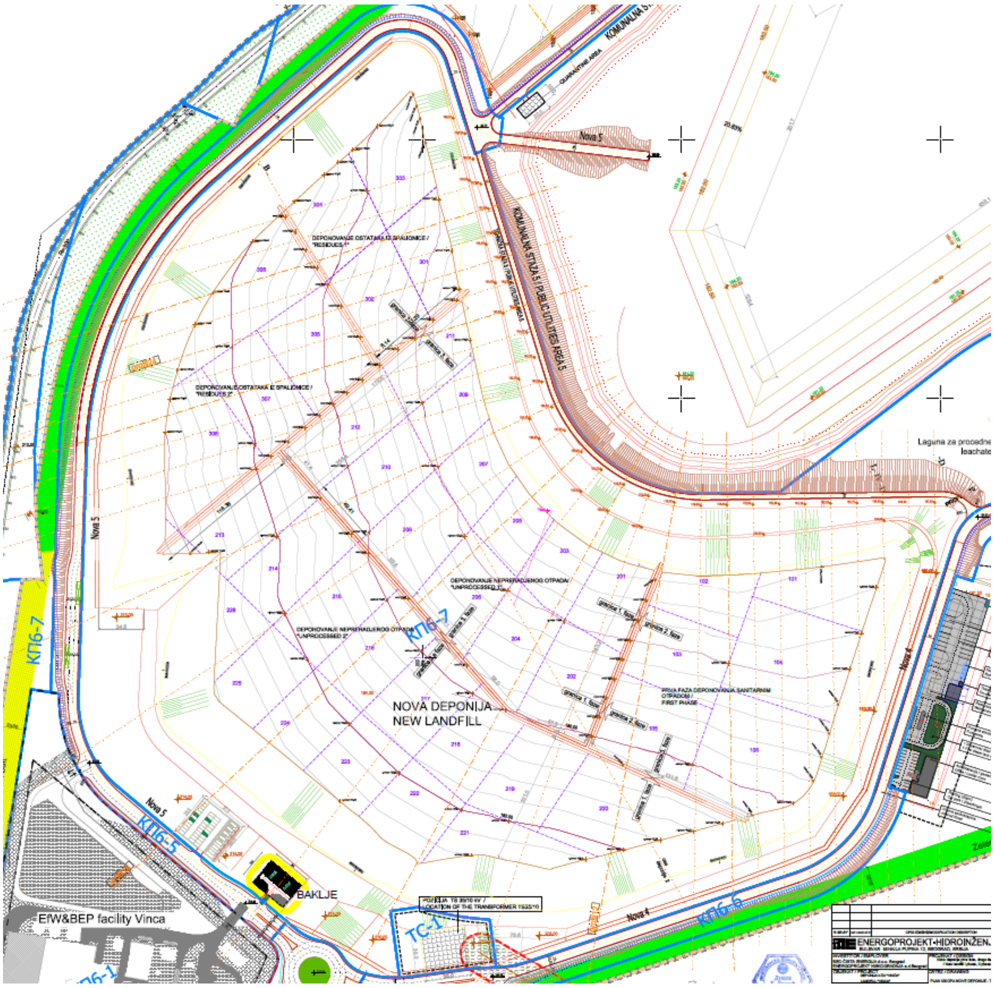


Figure 42 Plan for the formation of the new landfill by phases (Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

Estimated quantity of the excavated earth material (to be confirmed in the Main Design)
- for the phase I: quantity of excavation: 280.000 m3, quantity of waste filling 980.000 m3
- for the phase II: quantity of excavation: 111.500 m3, quantity of waste filling 900.000m3

The temporary disposal of excavation material is foreseen in the area reserved for Phase III of the project from 2021. to 2046. The excavation / loading balance indicates that all excavation material will be used for filling during the construction of the new landfill.

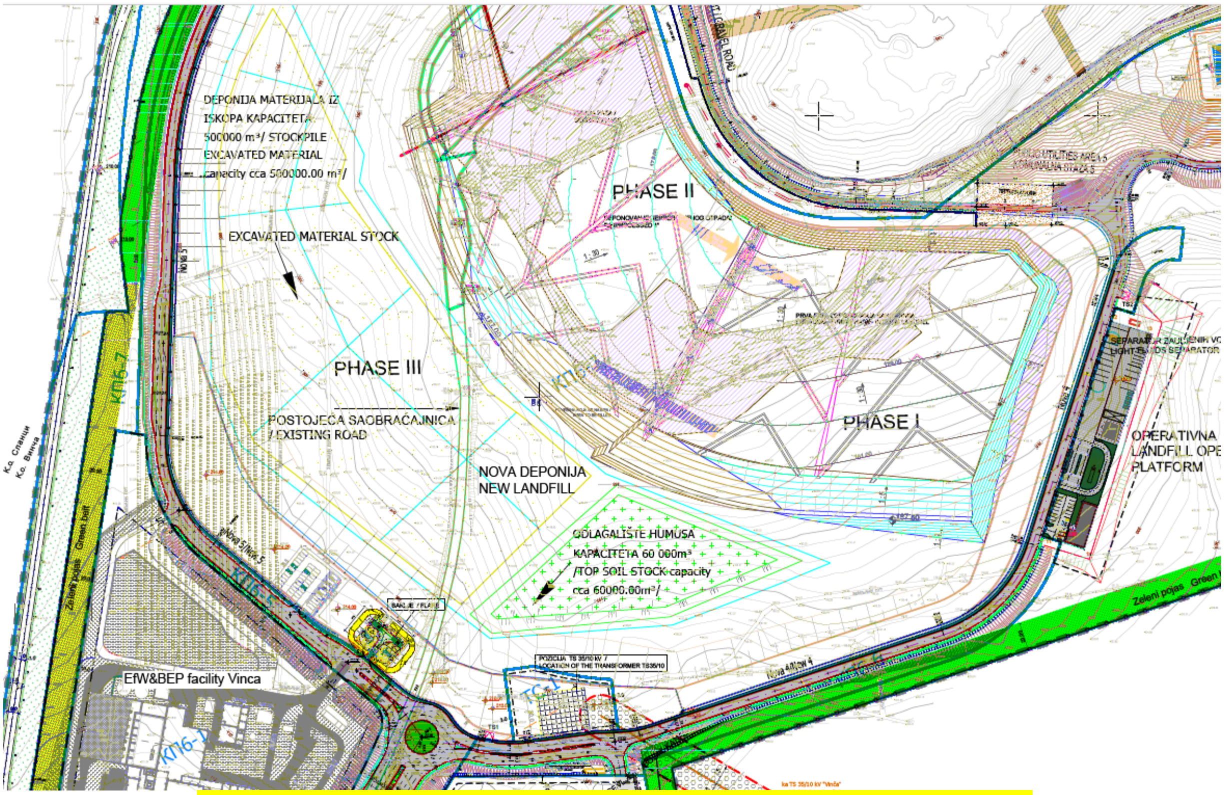


Figure 43 Temporary disposal of humus and excavation material

The total amount of land for waste filling in the first and second phase is 1.203.000 m3.

Depositing capacity

The new landfill is designed in accordance with the following waste disposal programme:

For Phase I, in duration of 1.5 years, the following amount of waste is foreseen:

Waste disposal on the interim municipal waste landfill (lasting 1,5 years)	
Year	Amount of waste (t)
1.0	510,000
0.5	255,000

From the given table, the total amount of waste is derived:

$$m_{uk} = m1 + m2 = 510.000\ t + 255.000\ t = 765.000\ t,$$

after compaction of waste by compactor, waste density is ρ=1,06 t/m^3, which makes the total required net volume:

$$V_{uk} = \frac{m_{uk}}{\rho} = \frac{765.000t}{1{,}06\,t/m^3} = 722.000m^3$$

For Phase II, in duration of 3 years, the following amount of waste is foreseen:

Waste disposal at the new landfill (cells for “Untreated waste I”)	
Year	Amount of waste (t)
1	170,000
2	170,000
3	170.000

From the given table, the total amount of waste is derived:

m_{uk} = m1 + m2 + m3 = 170.000 t + 170.000 t + 170.000 t = 510.000 t

after compaction of waste by compactor, waste density is ρ=1,06 t/m^3, which makes the total required net volume:

$$V_{uk} = \frac{m_{uk}}{\rho} = \frac{510.000t}{1,06 t/m^3} = 481.100 m^3$$

Estimated amounts of residues from the EfW plant, for Phase II in duration of 3 years, are presented in the table:

Waste disposal on the new landfill (cells for "Residues I")	
Year	Amount of waste (t)
1.	88.200
2.	88.200
3.	88.200

From the given table, the total amount of waste is derived:

m_{uk} = m1 + m2 + m3 = 88.200 t + 88.200 t + 88.200 t = 264.600 t

for average residues density of ρ=1,5 t/m^3, which makes the total required net volume:

$$V_{uk} = \frac{m_{uk}}{\rho} = \frac{264.600t}{1,5 t/m^3} = 176.400 m^3$$

For Phase III, in duration of 22 years, the following amount of waste is foreseen:

Waste disposal on the new landfill (cells for "Untreated waste II")	
Year	Amount of waste (t)
from 1. to 22.	170.000 per year

From the given table, the total amount of waste is derived:

m_{uk} =m1 + m2 +…+ m22 = 170.000 t +170.000 t+…+170.000 t = 3.740.000 t

after compaction of waste by compactor, waste density is ρ=1,06 t/m^3, which makes the total required net volume:

$$V_{uk} = \frac{m_{uk}}{\rho} = \frac{3.740.000t}{1,06 t/m^3} = 3.528.300 m^3$$

Estimated amounts of residues from the EfW plant, for Phase II in duration of 22 years, are presented in the table:

Waste disposal on the new landfill (cells for "Residues II")	
Year	Amount of waste (t)
from 1. to 22.	88.200 per year

From the given table, the total amount of waste is derived:

m_{uk} =m1 + m2 +…+ m22 =88.200 t +88.200 t +…+88.200 t = 1.940.400 t

for average residues density of ρ=1,5 t/m^3, which makes the total required net volume:

$$V_{uk} = \frac{m_{uk}}{\rho} = \frac{1.940.400t}{1{,}5t/m^3} = 1.293.600m^3$$

Morphological composition of municipal waste

Average composition of municipal waste and percentage of certain fractions were analysed in the Environmental and Social Scoping Study for the Belgrade WtE project in Serbia for the 2012-2014 period. This analysis provided results shown in the table.

Table 10 Composition of waste on solid municipal waste landfill (Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

Component	**Percentage of raw waste, %**
Food waste	25,6%
Paper	11,1%
Cardboard	13,8%
Plastic	13,8%
Textile	3,8%
Diapers	3,9%
Leather	1,0%
Garden green waste	6,6%
Tree	1,6%
Glass	5,2%
Metals	2,3%
Inert waste	10,9%
Hazardous waste	0,4%
TOTAL	100,0%

Within the composition of domestic waste, the usual value is about 0.4% of hazardous waste. A method of managing hazardous waste, originating from the household, is its primary selection and extraction, before the collection and disposal of municipal waste.

For the purpose of temporary storage of hazardous waste, a quarantine area is foreseen. The quarantine area is an area with a fence and isolated infrastructure. If hazardous waste is detected in the incoming waste, it will be stored in the quarantine area until it is handed over to the operators to treat a specific type of hazardous waste.

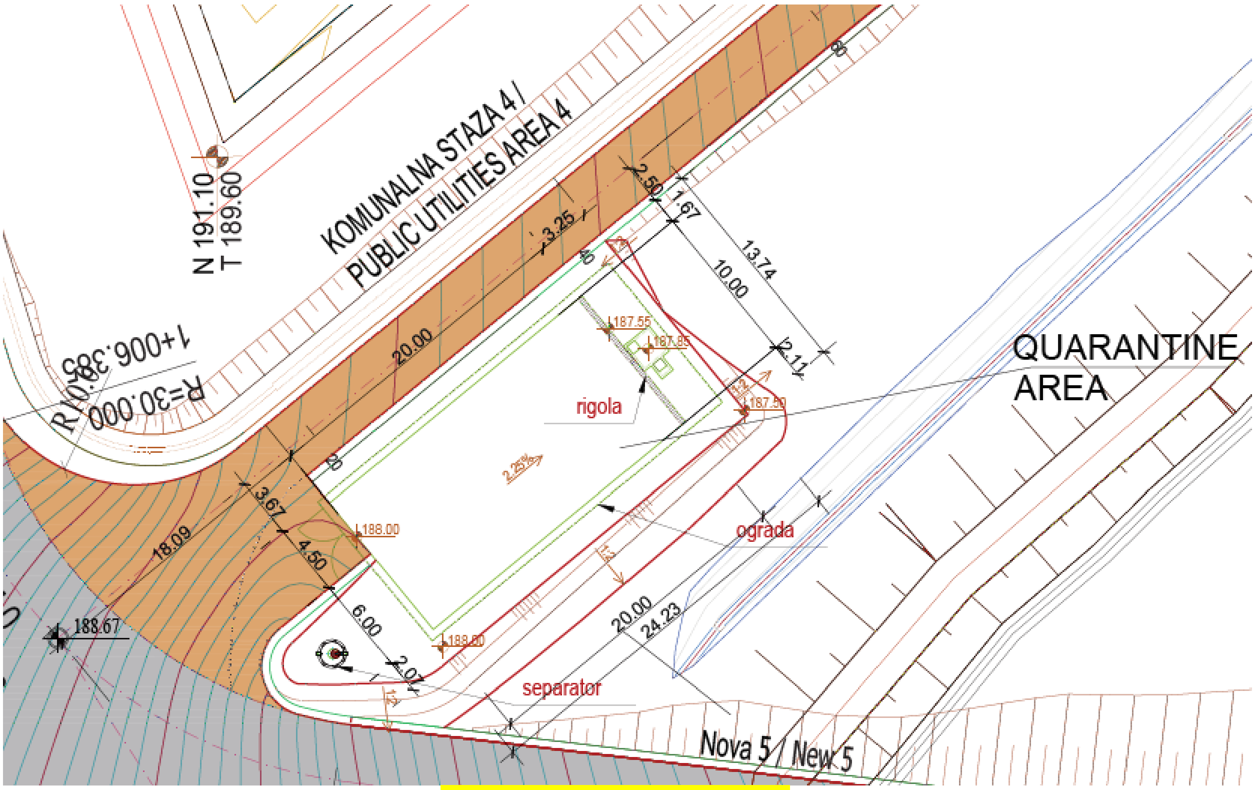


Figure 44 Quarantine area

Landfill gas

Landfill gas is produced at municipal landfills due to degradation of degradable waste. Landfill gas is a mixture of gases formed by anaerobic decomposition of organic components of disposed waste. The gas composition depends primarily on the type and amount of waste, as well as the microbiological processes that take place in the body of the landfill. The basic gases that are generated by degradation are: methane (CH_4) and carbon dioxide (CO_2). Methane and carbon dioxide are represented in the landfill gas in a large percentage, and other gases occupy a smaller share in the total volume.

Methane (CH4) gas is colorless and odorless and is a flammable gas. At concentrations in the range of 5 -15% by volume and in contact with oxygen, methane is self-igniting, and these two values represent the lower and upper limits of methane flammability. This is a gas that has a lower density than air.

Carbon dioxide (CO2) is also a colorless and odorless gas. Unlike methane, it does not belong to explosive gases. Its density is 1.5 times greater than air density.

Under normal conditions, the landfill gas, by molecular diffusion, goes into the atmosphere. In the case of an active landfill, due to the pressure difference, there is also a convective transfer. Methane, in addition to being largely discharged into the atmosphere, also shows the ability to migrate horizontally. Because it is heavier than air, carbon dioxide remains in high concentrations in the lower layers of the landfill so it can remain there for many years after the landfill closes.

The formation of landfill gas

The formation of landfill gases can be divided into five more or less consecutive phases. The speed of each individual process varies, and therefore the duration of each phase. The duration of the phases depends on the conditions which are established in the landfill body and enable the previous phase to fully unfold.

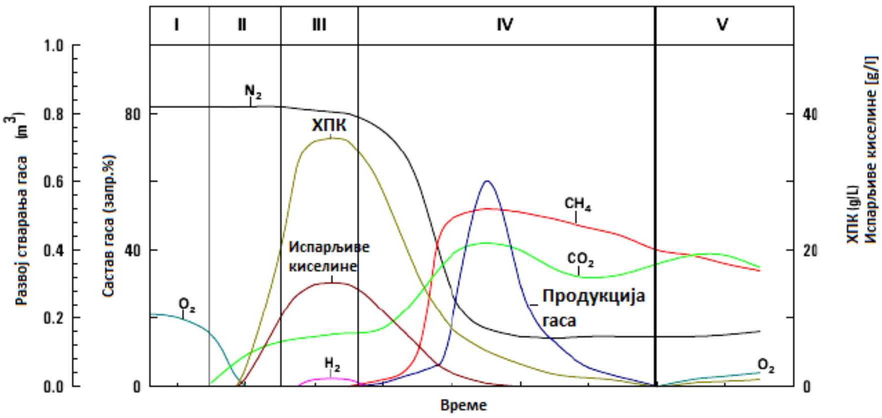


Figure 45 Phases of landfill gas formation
(Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May 2019)

Phase I is aerobic, initial stage of organic waste decomposition. The process of microbial degradation in the presence of oxygen from the air begins in this stage.

In the aerobic phase, a chemical hydrolysis reaction takes place to produce simple sugar - glucose ($C_6H_{12}O_6$) from cellulose ($C_6H_{10}O_5$):

$$C_6H_{10}O_5 + H_2O \xrightarrow{microorganisms} C_6H_{12}O_6$$

Upon completion of the first phase, the oxygen content in the landfill decreases significantly. Then begins Phase II, which is a transition phase from aerobic to anaerobic conditions. Upon transition to anaerobic conditions, the present nitrates and sulfates are reduced and already start to form nitrogen gas and hydrogen sulfide.

Phase III may be presented as an acidic stage of the process, as microbiological activity, that started in phase II, intensifies, resulting in higher amounts of organic acids and lower amounts of hydrogen. Acidogenic microorganisms are responsible for the formation of acids. This phase includes the processes of enzymatic transformations and microbial conversion.

The basic gas that is produced is carbon dioxide. In the process of acidogenesis, with the effect of micro-organisms, from glucose ($C_6H_{12}O_6$) are obtained: methane (HCOOH), ethane (CH_3COOH), propane (CH_3CH_2COOH) acid and separates carbon dioxide (CO_2).

$$C_6H_{12}O_6 \xleftrightarrow{acidogenic\ microorganisms} 2CH_3CH_2OH + 2CO_2$$
$$C_6H_{12}O_6 + 2H_2 \xleftrightarrow{acidogenic\ microorganisms} 2CH_3CH_2COOH + 2H_2O$$
$$C_6H_{12}O_6 \xleftrightarrow{acidogenic\ microorganisms} 3CH_3COOH$$

Methane fermentation stage represents the IV phase of the process. At this stage, methanogenic microorganisms that are anaerobic play a dominant role. The formation of methane and organic acids takes place at the same time, as the rate of acid formation decreases. The resulting acids and hydrogen are converted to methane (CH_4) and carbon dioxide (CO_2).

$$CO_2 + 4H_2 \xrightarrow{methanogenic\ microorganisms} CH_4 + 2H_2O$$
$$2C_2H_5OH + CO_2 \xrightarrow{methanogenic\ microorganisms} CH_4 + 2CH_3COOH$$
$$CH_3COOH \xrightarrow{methanogenic\ microorganisms} CH_4 + CO_2$$

The last is phase V, and it can be expressed as the phase of maturation. In the phase V, biodegradable organic matters are converted into methane and carbon dioxide, and moisture that migrates through the waste helps converting the residual biodegradable material. The rate of gas formation now drops significantly, due to lack nutrients that left the landfill body with leachate, or the lack of biodegradable waste. At this stage, methane gas and carbon dioxide are produced.

The duration of each phase depends on several factors: conditions at the landfill, moisture content of the waste, availability of nutrients, characteristics and compactness of the waste. The structure of waste determines its characteristics.

Waste with a higher proportion of readily biodegradable components, will be able to generate higher concentrations of landfill gas, because certain types of organic waste contain large amounts of nutrients for bacteria involved in the process. In this way the higher activity of the mentioned bacteria is achieved, which results in a faster production of landfill gas.

The compactness of disposed waste is important, because less compacted waste leaves more space for oxygen to penetrate the landfill body, so aerobic digestion takes longer. However, if the waste is compact, it will be more difficult for air to enter the landfill body, therefore the methane generation phase will start earlier.

Atmospheric pressure affects the penetration of oxygen into the landfill body, primarily into the shallower layers, resulting in aerobic degradation in these layers.

Water and moisture content affect the movement of nutrients to bacteria and their growth condition. In the more compact landfills, moisture migration is lower

Temperature is a factor that affects the multiplication of bacteria. This influence is strongest in landfills with less depth. As the temperature rises, bacterial activity increases and so does gas production. A decrease in temperature adversely affects the formation of landfill gas. Temperatures below 10^{o}C significantly reduce the activity of bacteria.

Landfill gas production at the landfill for untreated waste

Before designing the sanitary landfill, mathematical modeling of landfill gas production was performed. The model is developed on the basis of input data, relating primarily to the surface and volume of the landfill and the waste composition.

A preliminary mathematical model of production and biogas collection opportunities has been developed for the new Vinča landfill. The performed SIMTEC simulation is based on a combination of two theoretical models: SWANA (Solid Waste Association of North America) and the American Environmental Protection Agency (EPA). It is estimated that there will be around 170,000 tonnes of waste deposited annually at the new landfill, starting in 2021. The results obtained by simulation are shown in the following diagram.

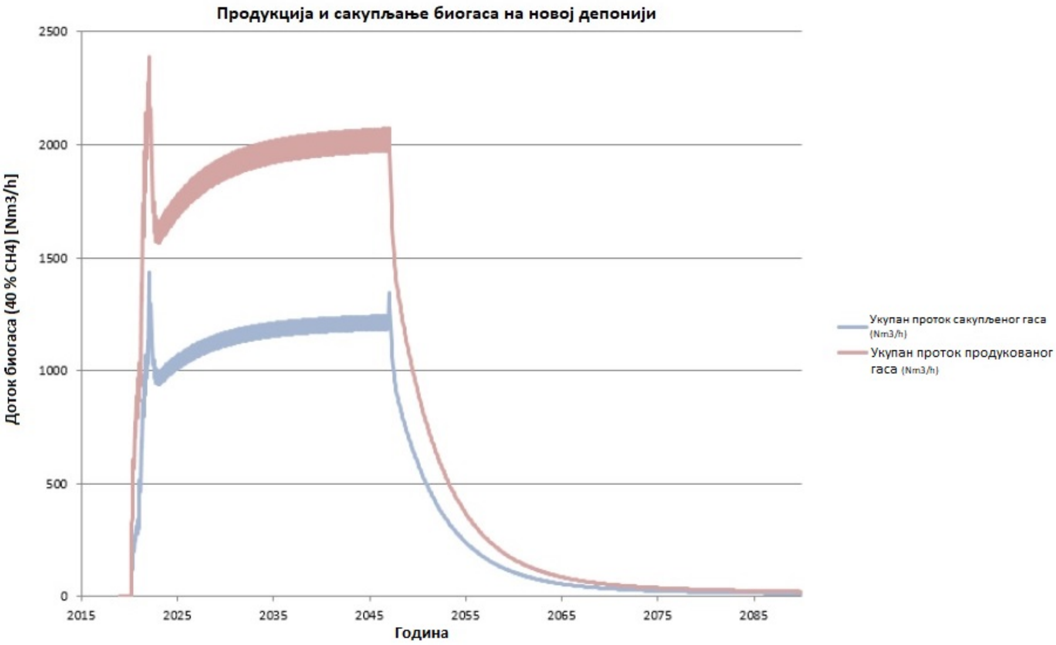


Diagram 1 Biogas production model
(Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

At the very beginning of 2022, a sudden jump in landfill gas production occurs with a maximum peak of 2,390 m^3/h. After that, there is a sharp decline in production to stabilize production around 2025, with steady growth until 2050, when it will amount to 2,070 m^3/h. After this period, a logarithmic decline is expected by 2056, when production is expected to be 300 m^3/h, and in 2090 production is reduced to a minimum of zero.

The flow of collected landfill gas is less than the theoretical production. It is predicted that in the 2020-2053. period, the flow of collected landfill gas ranges from 300-1400 m^3/h, with an average value of about 1,000 m^3/h.

Based on the above, it is possible to calculate the average gas collection rate (AGCR) by form: AGCR = (W x 0,35 + X x 0,65 + Y x 0,85 + Z x 0,9)/(V + W + X + Y + Z), in accordance with the table:

Table 11 Dependence of gas collection rate on surface characteristics
(Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

Type of surface	**Collection rate, (%)**	**Area, (m^2)**
Operating zone is disconnected	0	V
Operating zone connected to a biogas combustion unit	35	W

Semi-waterproof (transition layer with a low permeability) zone connected to a biogas combustion unit	65	X
Waterproof (1 m thickness layer of covering material with permeability <109 m/s) zone connected to a biogas combustion unit	85	Y
Liner covered zone connected to a biogas combustion unit	90	Z

The typical composition of landfill gas is given in the table:

Components	Unit	Typical values (interval)
CH_4	%	35 - 50
N_2	%	33 - 23
CO_2	%	27 - 29
O_2	%	0 - 3
VOC	mg/m^3N	800 - 900
VOSiC	mg/m^3N	5 - 20
Relative humidity	%	100
H_2S	mg/m^3N	900 - 1200
Lower heat power	kWh/m^3N	3.49 - 4.99
Density	kg/m^3N	1.28 - 1.18

Degassing of the untreated waste landfill

In terms of degassing, active and passive systems are distinguished. Passive and active systems are based on the installation of degassing wells - biotrns. Biotrn is a degasser that is formed by drilling a hole in the landfill body into which a perforated tube is placed at 50-90% of the waste depth, most preferably being set at about 75% of the waste depth.

An active degassing system performs forced landfill gas drainage. The landfill gas is extracted under vacuum conditions from the landfill body through biotrns, by means of a compressor station, and taken by a pipeline network system to a system for the transformation of biogas into energy (BEP plant, which is not the subject of this study).

The proposed number of biotrns per hectare of the new landfill body is in the upper limit (more secure system) of the value range prescribed by ADEME (the French Agency for the Environment and Energy Management Environmental Agency).

An active degassing system is planned in parts of the landfill for the treatment of untreated municipal waste.

Biotrns are perforated HDPE (high-density polyethylene) tubes that are placed in a borehole with a diameter of Ø600. They consist of body and head.

The body of the biotrain consists of a perforated PE pipe Ø110, the last 3 m are without perforation, while in the case of drainage biotrn, pipe is Ø315. The length of the biotrns is up to a maximum of 17 m, which is the maximum length of biotrns in the middle of the landfill, while the maximum length of biotrns placed on slopes is 13 m. The pipes that make the biotrns are SDR 17 and 315 mm and 110 mm in diameter, depending on their purpose. The impact zone of a well is 15 meters radius.

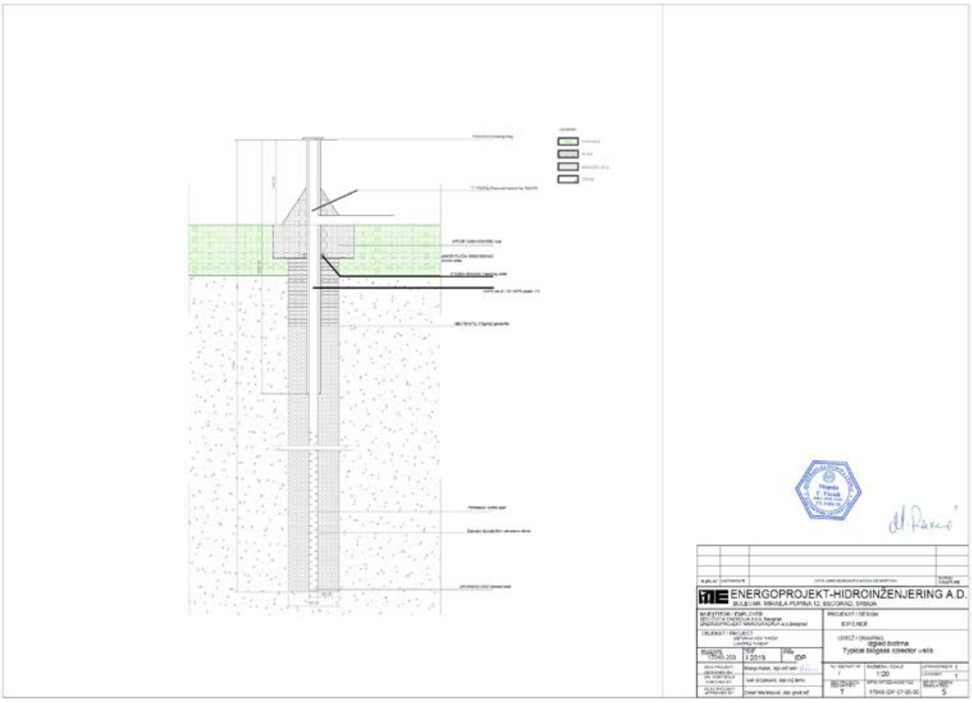


Figure 46 Schematic display of a Biotrn (Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

Each cell of the landfill for untreated waste will be equipped with one well from the bottom of the landfill, which, in addition to collecting biogas, will also be used for drainage and collection of leachate water. In the case of drainage biotrns with leachate water pipes, submersible pumps are planned to pump the leachate water from the biotrn.

There are two ways of appointing these types of wells

The first is based on the placement of concrete rings, which are perforated. Such wells are most effective if placed in the drainage layer at the bottom of a cell. The first concrete ring is placed at the level of the drainage layer. When the waste reaches the height of the first ring, the next concrete ring is placed on and thus every next one. The space between the concrete ring and the biotrn's inner tube is filled with a drainage layer of gravel.

Another way of installing wells going from the bottom of the landfill is by using a metal cylindrical mold, 800 mm in diameter and about 4 m long, which is positioned on the drainage layer of the bottom of the cell.

The head of the biotrn is partly installed underground and partly above ground and forms the final part of the biotrn. The biotrn's head is made of solid pipe (without perforations). The biotrn's head consists of:

- 3 m long pipe, 160 mm diameter.
- Anchor plate is placed around the well's head as a support for the biotrn.
- A tertiary network is connected to the biotrn's head via T pieces.
- Top of the biotrn's head is equipped with a sealing connection for gas sampling.

An active degasser system will be installed over the surfaces for the disposal of untreated waste. The biogas network from the landfill body to the BEP plant consists of:

- Pipe biogas network;
- Elements for condensate collection and draining.

The wells will not be installed on the parts of the landfill used for the disposal of stabilized incineration residues, because the waste that is disposed here is not biodegradable and will not even generate landfill gas.

Biogas network (landfill gas collection and extraction network), active degassing system, *(Source: IDP Book 2/5 Construction design, Energoprojekt Hidroinženjering, January 2019.)*,consists of: a primary, secondary and tertiary network that connects biotrns with the system for the transformation of biogas into energy (BEP plant). For the production of biogas network, HDPE pipes are used with a diameter: primary network D = 315 mm, secondary network D = 160 - 250 mm and tertiary network D = 110 mm.

The primary network is laid above the ground. Tertiary and secondary networks can be laid above ground over the landfill and then rested over adjustable metal supports or underground, by laying the pipes in the ground. Biogas Network Configuration:

- The radius of influence of each biotrn is 15 m,
- 9 to 15 biotrns are connected to the secondary collector Ø 160 mm,
- 1 manual valve between the secondary and the main collector,
- 1 barometric drainage at the end/beginning of each secondary collector to avoid collecting too much condensate in the main collectors,
- Minimum one waterproof drainage on each main collector.

The collected condensate from the biogas network is pumped and piped to the system for the evacuation of leachate water from the landfill and further to the lagoon for leachate waters, ie treatment at the LTP plant. The quantity of produced condensate created in the collection system depends on how much gas is extracted, as well as the pressure or biogas vacuum and the temperature change value. The amount of condensate varies throughout the year. During the winter, the most condensate is generated.

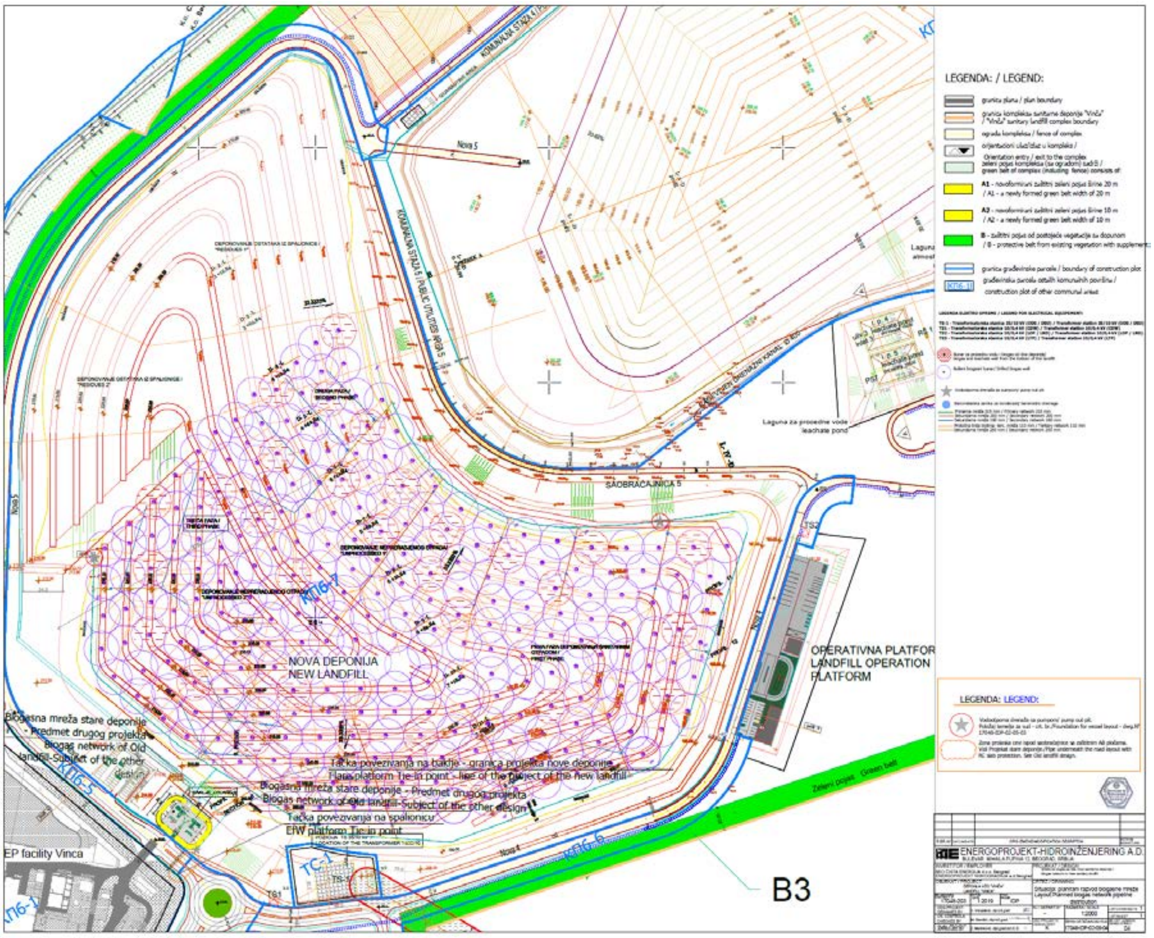


Figure 47 Biotrns with biogas network (active system)
(Source: IDP Book 2/5 Construction design, Energoprojekt Hidroinženjering, May, 2019)

3b. Inert material landfill

Inert material landfill is planned to be located in the north part of the complex, on plot KP6-7 above the old landfill body.

It is planned to prepare the bottom of the natural terrain on an area of approximately 95.825 m^2 with removal of the surface layer of soil with an average depth of about 2.5 m, whereby all excavated material would be used for overlay on the new and old landfill (closing and recultivaiton).

At the planned area for the landfill of inert material, it is planned to dispose material that is not hazardous and which would be brought from external construction sites and has the characteristics of non-hazardous/inert material and can serve for daily coverings on the new landfill and a final cover at the old landfill.

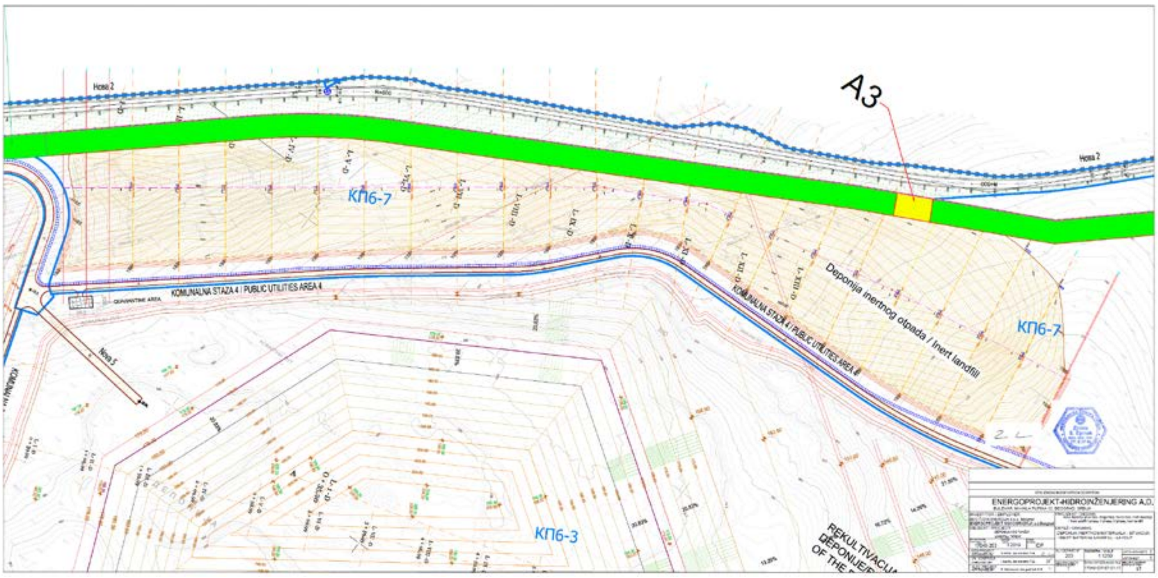


Figure 48 Inert material landfill
(Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

Layers for lining the bottom and slopes of new landfills

The following layers for lining the landfill bottom (viewed from the top to bottom) are envisaged:

- Waste,
- 50 cm thick layer of gravel for drainage,
- Geotexstile: 1000 g/m^2 .

Active barrier:

High Density Polyethylene Lining - 2 mm thick HDPE;

Passive barrier:

The geosynthetic clay liner GCL low permeability and compacted clay layer of 50cm of clay material, the water permeability coefficient of this layer is total $k_x \leq 1 \times 10^{-9}$ m/s. (This solution is equivalent to a 100cm thick layer of clay lining with a water permeability coefficient $k_x \leq 1 \times 10^{-9}$ m/s. This solution will only be applied if the natural soil does not meet the required water permeability coefficients (100cm with a water permeability coefficient $k_x \leq 1 \times 10^{-9}$ m/s). During the construction works, we will conduct testing to determine the watertightness of the natural soil at the bottom of the landfill.

Natural soil:

A compact layer of clay lining covers the entire base of the bottom of the landfill, and is performed up to 2 m on slopes, as shown in the drawing below.

The geosynthetic layer (geosynthetic clay layer + geomembrane + geotextile) covers the entire base and slopes of the bottom of the landfill. They are anchored on a slope curve to prevent the geomembrane from sliding down the slopes, and to prevent the lifting of the geomembrane under the influence of wind, which is not anchored.

The drainage layer covers only the flat part of the base of the landfill bottom.

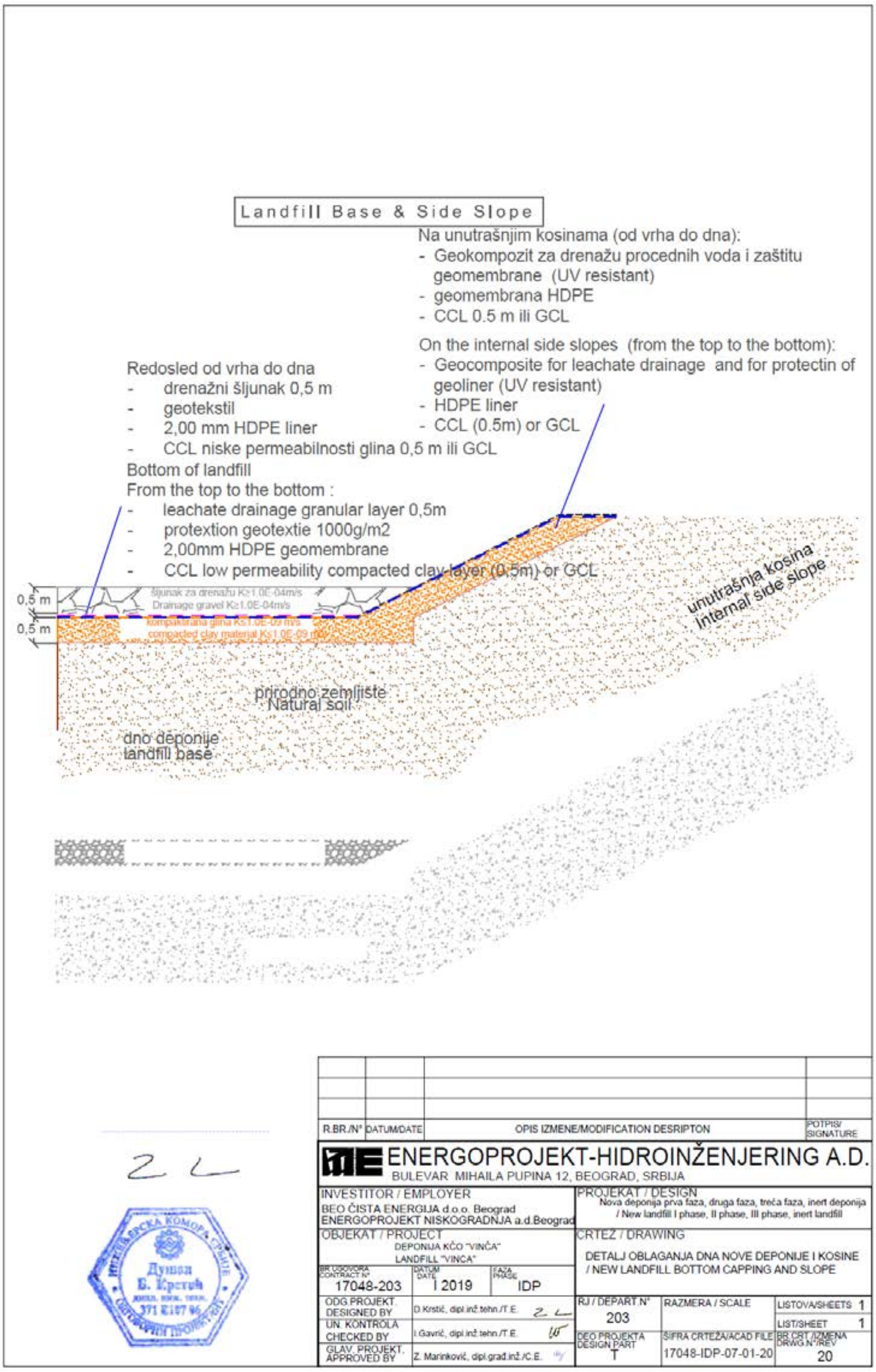


Figure 49 Landfill bottom and slopes lining (Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

New landfill recultivation (closing) layer

The final covering layer for the deposited waste is made of material that was generated during excavation for the formation of a new landfill.

According to design requirements, i.e. design solution, the maximum slope inclination of the landfill cover is 33% (1V/3H). Apart from this, considering primary and secondary compaction of waste in new landfills, it can be considered that the slope inclination of landfill cover will decrease below the value of 33.3%. The total thickness of cover layers is 1.30 m.

Designing the layer for final covering of the landfill (i.e. landfill cover) is performed in the following way, starting from the top of the landfill to its bottom:

- Cover layer – soil 50 cm (10 cm humus + 40 cm excavation material);
- Layer for atmospheric water drainage – geocomposite drainage layer;
- Layer of low permeability soil, 50 cm thickness – excavation material;
- Layer for gas drainage, 20-30 cm layer thickness, which is also a protective layer;
- Waste.

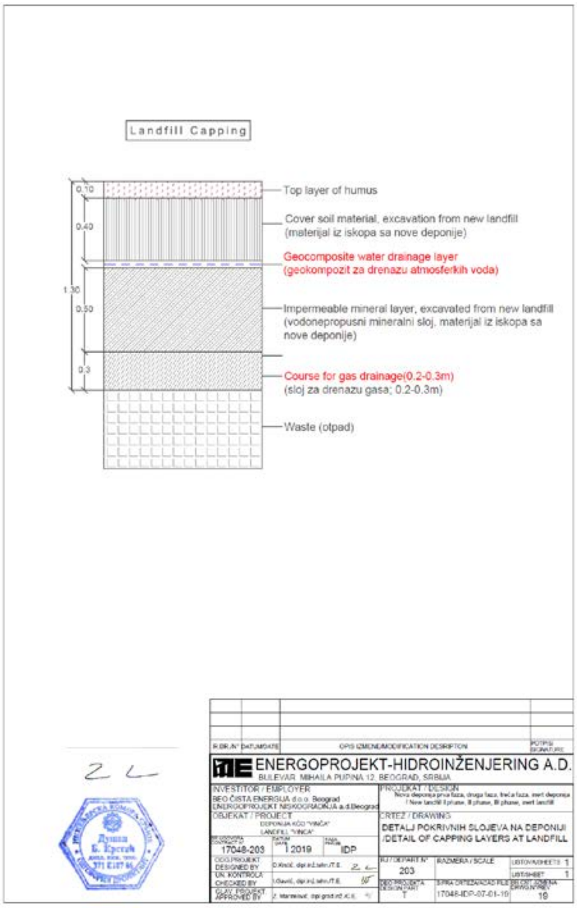


Figure 50 Covering layers at the landfill (Source: IDP Book 7/1 Technological Design, Energoprojekt Hidroinženjering, May, 2019)

Drainage system and leachate water discharge

Leachate from the New landfill *(Source: IDP Book 3/3 Hydrotechnical installations design, Energoprojekt Hidroinženjering, January, 2019)* is all the water that passes through the landfill body, i.e. through the disposed waste and infiltrates towards the most downstream part of the landfill. Having in mind such degree of leachate pollution, their collection, discharge and treatment is foreseen.

According to the relevant literature and the empirical data, the balance of water that falls on the landfill amounts to:

For the landfills located on the "inclined" terrain

- evaporates due to thermal heating within the landfill body	70%
- chemically bonds during the waste disintegration process	15-25%
- infiltrates towards the bottom in the form of a filtrate	5-15%

For the landfills located on the "horizontal" - flat terrain

- evaporates due to thermal heating within the landfill body	70%
- chemically bonds during the waste disintegration process	20-29%
- infiltrates towards the bottom in the form of a filtrate	1-10%

Concept of the leachate drainage system was developed based on the topography of the terrain and the required transport of these waters to the lagoons located on the Upper platform.

Active surface for the waste disposal is divided in three parts: a part for temporary disposal of municipal waste, a part for disposal of untreated waste and a part for disposal of the EfW plant residues. According to the type of waste that is disposed, the leachate water system is divided into two parts:

- System for collection of leachate from the interim municipal waste landfill and from the landfill for the disposal of untreated waste;
- System for collection of leachate from the part of the landfill where the stabilized residues are deposited after waste treatment at an EfW plant.

Leachate collected from both these parts is drained into the leachate lagoons, located at the elevation of 160,00 m.a.s.l. (Upper platform) and further gravitationally to the lagoons on the Lower platform at the elevation of 90,00 m.a.s.l, and from there to the leachate treatment plant (LTP).

Leachate water is intended to be collected from each cell by a drainage pipes system of appropriate diameter. Drainage pipes from individual cell are collected through secondary drainage pipes of smaller diameter, which are then connected to a system of primary drainage pipes of larger diameter.

The primary drainage pipes direct the collected leachate water to the northeastern perimeter embankment, where the lowest points are formed by the slope of the landfill bottom. After passing through the embankment, the leachate waters are cascaded into the control shafts, which are installed along the main collector pipes tracks, which bring leachate water into the lagoons for the leachate water on the Upper Platform.

The main collector pipes differ in the origin of leachate water to:

- The leachate water collector pipe from the temporary municipal waste landfill and the untreated waste landfill, which leads the mentioned leachate water to the appropriate lagoon and
- The leachate water collector pipe from the part of the landfill where the stabilized residues are deposited after waste treatment at the EfW plant, which leads the mentioned leachate water to the appropriate lagoon.

Waters from cells that have been prepared for waste disposal, but the waste disposal on them has not started, are considered to be rainwater and as such are evacuated from the landfill body by a drainage pipeline system, whereby the valve system, instead into the main collector pipes for the collection and evacuation of leachate water into the lagoons on the Upper Platform, directs them to the perimeter channels for rainwater collection and further to the rainwater collection lagoon on the Upper Platform.

Calculation of leachate quantities

The maximum daily quantity of the leachate from the landfill body was determined according to the formula obtained experimentally by the Russian researchers, which reads:

Qf = k x (P + Q)/365, where:

Q_f - Leachate water daily quantity (m^3/day)
k - Coefficient which characterises ability of moisture and evaporation absorption;
k = 0,15, for the landfills located on the inclined terrain;
P - Total annual precipitation quantity (m^3/year);
Q - Total annual quantity of other water that is distributed over the landfill (m^3/year)

Based on the given formula, Q_f = 0,99 l/s ≈ 1.0 l/s is given.

The cells that have been prepared for waste disposal, but where the disposal has not yet begun, are actually collecting and draining atmospheric water. In that sense, the drainage pipes are dimensioned to the relevant atmospheric water, which is Q = 20.14 l / s.

For defining the dimensions of lagoons (on the Upper platform) that accept only the leachate of the New Landfill, for a maximum quantity of 1,0 l/s, respecting the PE "Srbijavode" condition, it is necessary to provide retention for 20 consecutive calendar days for the continuous rain duration t = 24 hours return period T = 25 years, the total lagoon volume of V = 1.728 m3 is obtained. Two basins of 2 x 2.000 m3 capacity are being adopted. One is foreseen for leachate water from a temporary landfill and a landfill for untreated waste, and the other for residues after waste treatment at an EfW plant.

Stormwater Drainage System

For the discharge of stormwater from the landfill body after construction *(Source: IDP Book 3/3 Hydrotechnical installations design, Energoprojekt Hidroinženjering, May, 2019)*, main peripheral channels which will run around the newly-designed landfill and secondary concrete channels are foreseen.

The main peripheral channels are also used for the drainage of the stormwater that might flow in from the external drainage areas into the active phase of the landfill, during the excavation phase and the landfill operation phase.

The main peripheral channels start from the highest elevation and run to the left and right side. They lead the stormwater into the lagoon intended for collection of stormwater located on the Upper Platform, at the elevation of 160 mm. The main peripheral channels are earth channels, wit a trapezoidal cross section, with side slopes of 1:1.

The secondary concrete channels collect stormwater from the covered landfill surface and lead them to the main peripheral channels.

For the reception of rain water with an estimated inflow of 177.67 l/s, a stormwater lagoon (on the Upper Platform) of the adopted volume of 4,000 m^3 is foreseen.

When carrying out excavations for each planned construction, temporary peripheral canals are foreseen around the excavation to prevent the flow of external water into the active area of the excavation.

3c. Torch System

The location of the planned torch system as part of the system for utilization of landfill gas at the BEP plant (not the subject of this study) is located on the cadastral plot KP6-7 *(Source: IDR Book 6/3 Torch system, Delta Inženjering, 2019.)*.

The torch system with the planned access road is positioned on the border of the New Landfill design and EfW plant (southwest part of the complex).

The torch system is fully connected to the Landfill gas utilization plant (BEP).

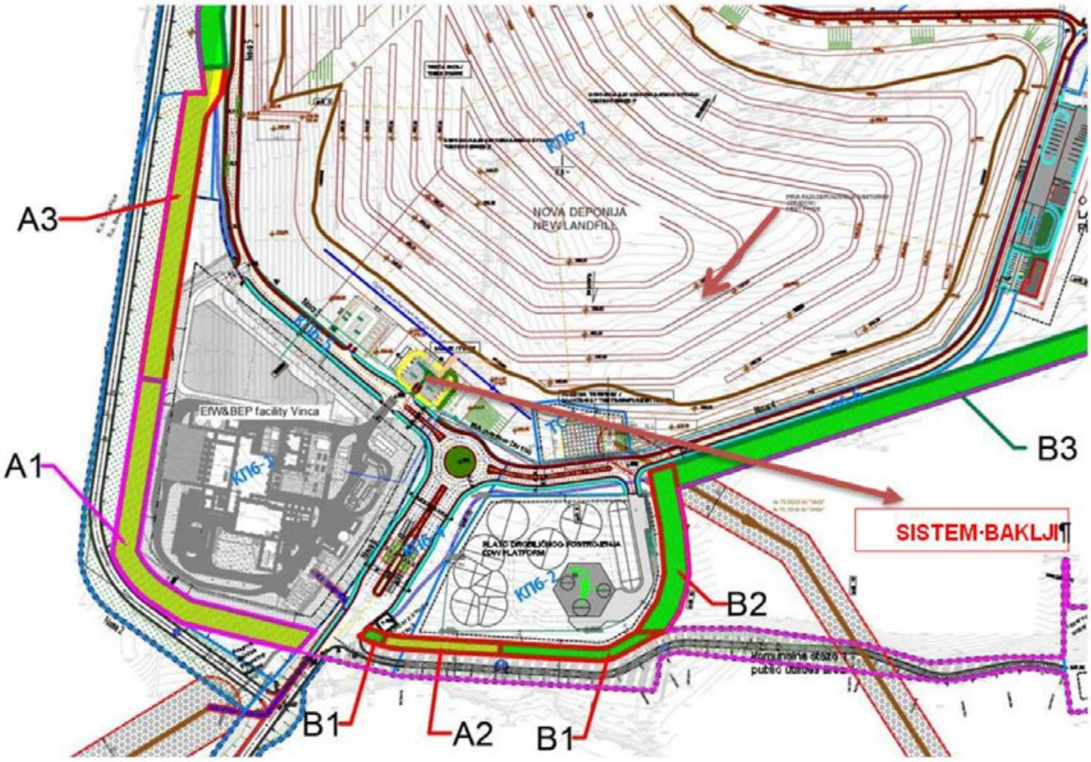


Figure 51 Position of the torch system (Source: IDR Book 6/3 Torch system, Delta Inženjering, 2019.)

The planned torch system will occupy an area of 660 m^2. The plateau on which it will be accommodated is a 30 m long, 22 m wide rectangular shape. The operational part of the plot is covered with oval gravel and covers an area of 420 m^2, surrounded by a fence and has a 4-meter wide vehicle entrance.

The asphalt road that passes through the vehicle entrance to the plateau for the Torch System is in the form of the letter "T" and is connected to the road that surrounds the southwest side of the New Landfill.

On the plateau of the Torch System there are three concrete plateaus on which the equipment is located: plateau of control equipment (8,0 m^2) and two plateaus for the accommodation of equipment for two torches (rectangular shape length 7,8 m, width 3,4 m, surface 26,5 m^2 for each torch).

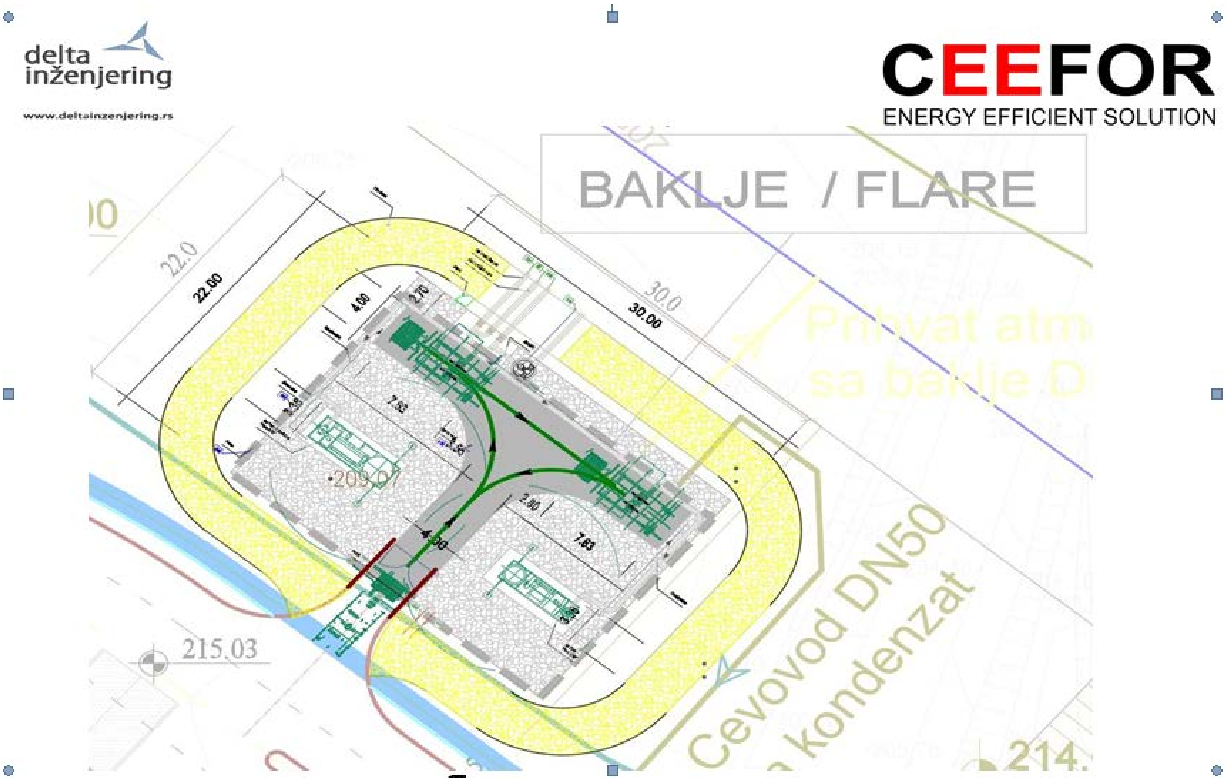


Figure 52 Disposition of the contents on the plateau of the torch system (Source: IDR Book 6/3 Torch system, Delta Inženjering, 2019.)

The torch system consists of the following segments:

- Inlet platform of landfill gas;
- "U" tube for the inlet of the landfill gas;
- The system of second torch;
- The system of the first torch;
- The pipeline for the supply of landfill gas to the torches;
- The pipeline for the transport of landfill gas to the BEP plant;
- Internal "T" shape road;
- Condensate tube;
- Fence.

Two plateaus with torches and associated equipment were positioned symmetrically with an internal asphalt road within the gravel covered area.

The main pipes for conducting the landfill gas from the "old" and the New landfill enter the middle of the plateau of the Torch System, opposite of the gate and the entrance of the internal road.

The pipelines from both landfills are connected to the inlet platform and collector the landfill gas is fed by a single pipe from the to the inlet "U" pipe. From the "U" pipe, the landfill gas is either conducted towards a cogeneration plant (BEP) or to the Torch System.

Condensation occurs because the landfill gas is saturated with moisture,. The condensate from the inlet collector of the landfill gas and from the torches is returned to the U-tube by condensate tubes, and from there it is transported by a pump to the pipeline for collecting wastewater that is outside the location of the Torch System and further into the lagoon for the leachate water.

The torch system starts when:

- if the gas flow is greater than the specified value, or the pressure value is greater than the set value,
- if the gas engines on the cogeneration plant (BEP) are out of operation, where the BEP control system includes the operation of torches.

When one or both torches start, the torch control system further regulates the landfill gas flow to maintain the set value of the gas subpressure.

Torch burners are designed so that they can work with different gas flows and different flame temperatures. The combustion air flow is regulated by means of valves located at the bottom of the combustion chamber. The combustion chamber is equipped with a UV probe and corresponding relays that are connected to the control cabinet. The temperature measuring sensors and the emission measurement connection points are located at the top of the torch. The coils are designed to provide:

- gas retention time of more than 3 s,
- a flame temperature exceeding 900 ^{o}C

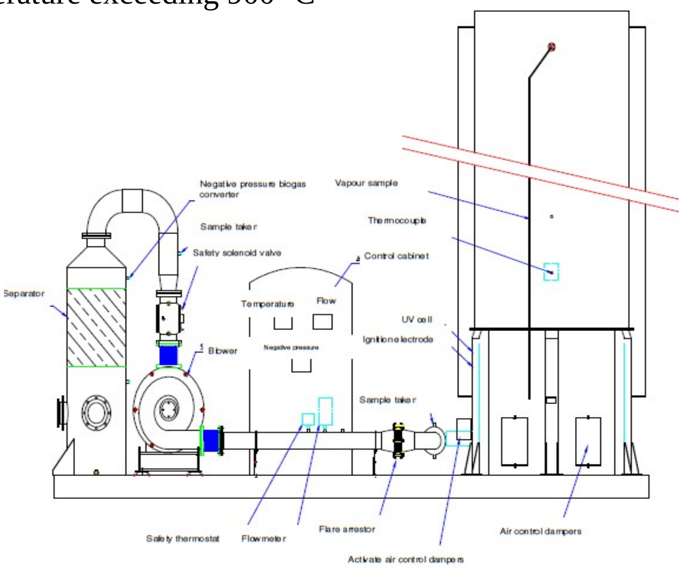


Figure 53 Schematic display of the equipment on the torch frame (Source: IDR Book 6/3 Torch system, Delta Inženjering, 2019.)

The first torch has a capacity of 550-2300 Nm^3/h, while the second torch has a capacity of 300-1200 Nm^3/h. The total expected gas flow together for the "old" and the New landfill is about 2560 Nm^3/h with 50% CH_4.

Table 1 Characteristics of the torches for landfill gas

Type	Gas flow, Nm^3/h, 50% CH_4	Maximum heat power, kW	Combustion temperature, °C	Retention time, s
BG 2000	550-2300	16000	1000	>3
BG 1000	300-1200	6000	1000	>3

The frames of the torches are of the following dimensions: for the first torch 7,0 x 2,3 m, for the second torch 5,1 x 1,7 m, and the heights are: for the first torch 8,6 m, and for the second torch 7,0 m . The diameter of the torches (d_s/d_u) is: for the first torch 2,20/1,74 m, and for the second torch 1,756/1,4 m.

The torch system is envisaged for occasional operation, in case of short unexpected stops or during the maintenance of gas engines on the BEP plant, that is, no continuous/long-term operation of this system is planned.

4. Operative Platform (technical maintenance)

The landfill operative platform is located in the south-east part of the landfill, on a building plot KP6-7. The platform occupies an area of about 5,000 m^2 *(Source: IDP Sveska 1/2 Architectural design, Energoprojekt Industrija, May 2019.).*

The platform consists of:

- Administration building
- Workshop with a vehicel washing area
- Hazardous matter storage
- Diesel fuel pump station
- Containers for hazardous waste (4 pieces)
- Machinery parking (with 3 parking places)
- Delivery veichels parking (with 5 parking places)
- Truck parking (with 8 parking places)
- Car parking (with 20 parking places and 1 parking place for disabled person

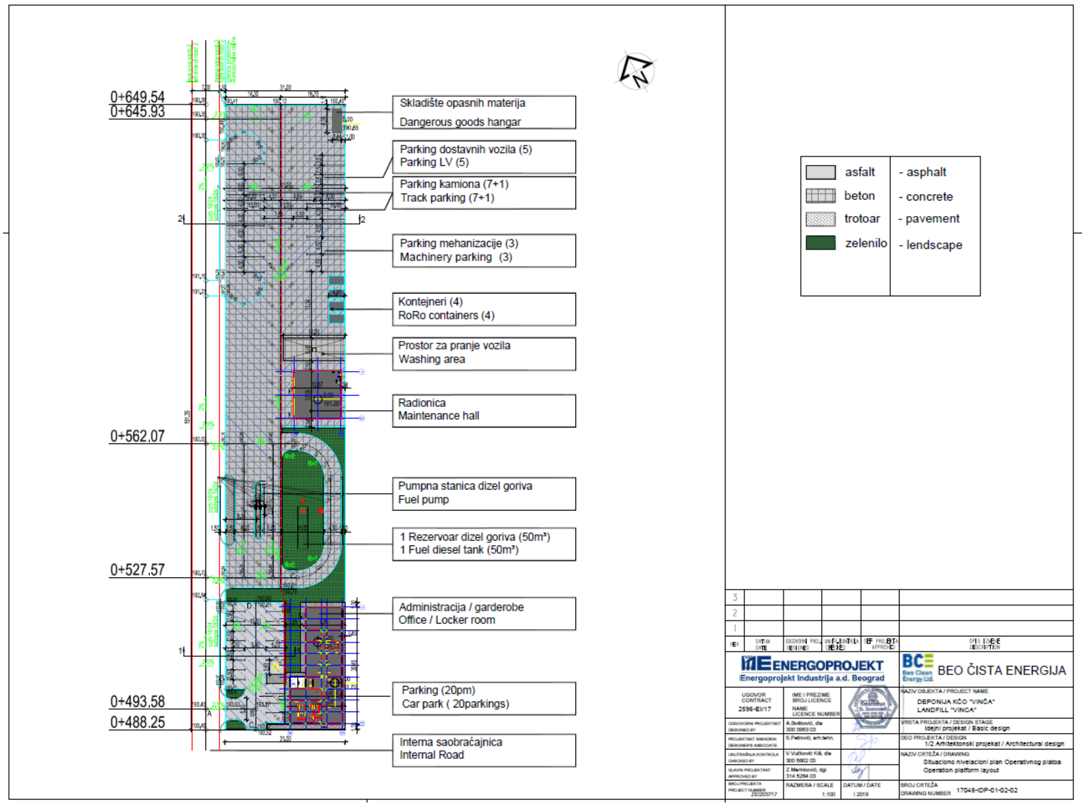


Figure 54 *Situation plan - Operative platform* (Source: IDP Book 1/2 Architectural design, Energoprojekt Industrija, May, 2019)

Administration Building

Administrative one-storey building contains a canteen and locker room for employees, is built with brick blocks with a thickness of 25 cm, while the construction is combined from brick walls (t=25 cm), reinforced concrete slabs, beams and columns and steel elements. The building basis is the shape of the letter "L" axis dimensions 10x3.00 = 30.00m with 2x4.00 + 1.50 = 9.50m + 3x3.00 = 9.00m by 4.00 m The roof is two-sloped over reinforced concrete slab t=12cm and the roof structure is steel box beam.

The roof cover is steel panels. The floor slab is reinforced concrete slab with a thickness of d=15cm, waterproofed, over rammed concrete and rammed gravel slab-on-grades. Floor finishing is non-slip ceramic tiles in all premises with the exception of the administration part, where laminate floor is specified in offices and conference rooms.

The interior wall will be finished with plastering, finish painted with semi-dispersion paint, the toilets and a part of the rest room shall have ceramic wall tiles.

The structure is built on reinforced concrete strip foundation with cross section of reverse "T", width 80 cm height 115 cm. A rammed concrete layer is placed below the foundation.

The administration building consists of the following premises:

- Office
- Locker rooms
- Sanitary facilities with showers
- Canteen for 20 persons
- Conference rooms, 12 m^2+30 m^2
- Communication hall.

The heating system of the administration building will be carried out with wall-mounted electric convectors. The electric convectors shall be controlled by the integrated thermostat.

The air-conditioning of the offices, conference rooms and the rest room will be carried out with wall-mounted split-system air-conditioners. The external units shall be placed on the building's facade. The split system control is integrated in the units themselves.

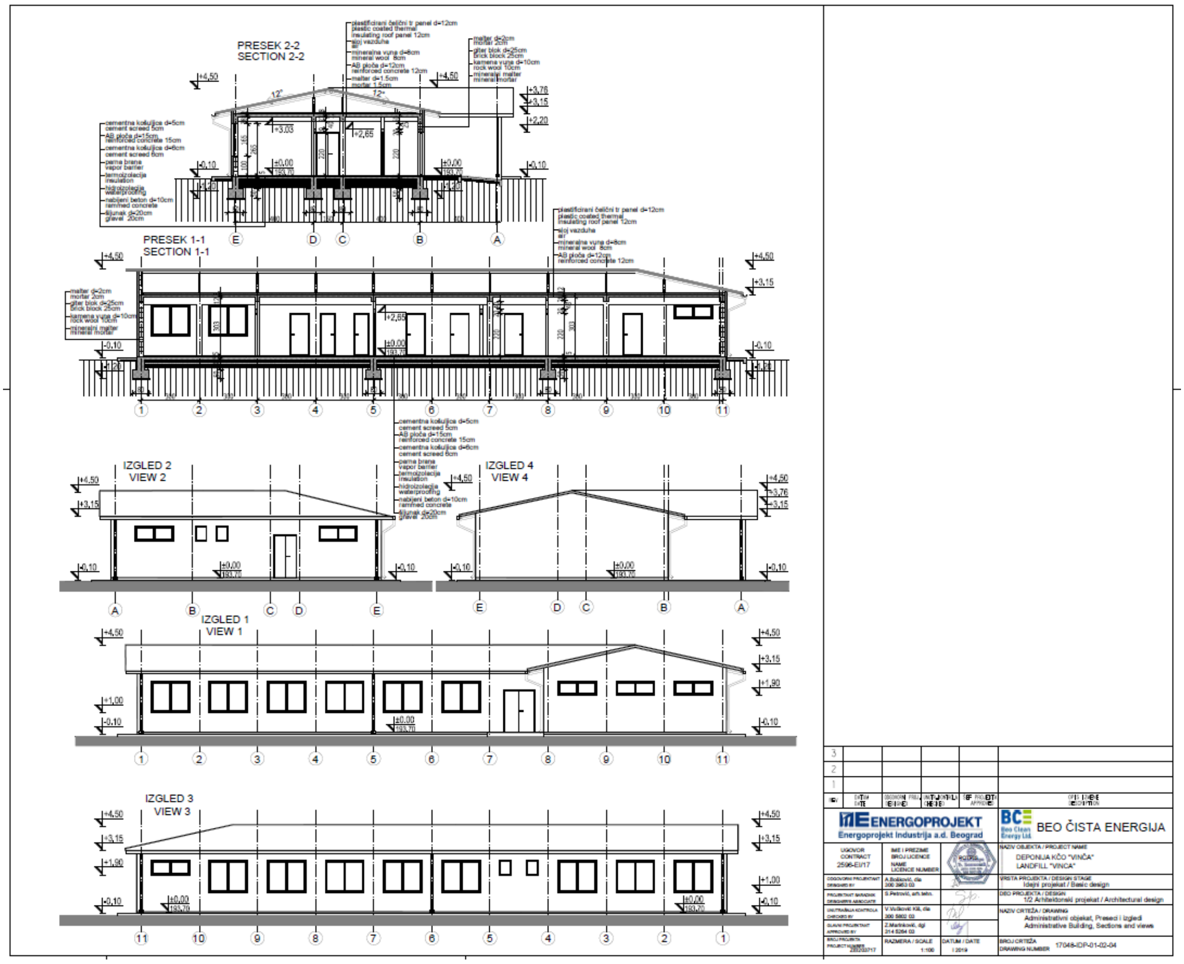


Figure 55 Administration building (Source: IDP Book 1/2 Architectural design, Energoprojekt Industrija, May, 2019)

Workshop with a Vehicle Washing Area

The workshop dimensions are 12 x 12 m and a height = 8 m, of steel structure on a reinforced concrete slab. The walls are of prefabricated plasticized steel trapezoidal panels with a thickness = 10 cm.

Two segment doors doors 4.5 x 4.5 m, with a pedestrian door each, 90 x 220 cm, opening around vertical axle. The windows are of steel locksmith and they are being open using opening mechanism.

Floor finish coating is epoxy coating. The roof covering is of prefabricated plasticized steel trapezoidal panel with a thickness of 12 cm. Toilet is in the corner, height 2.8 m.
The building shall be erected on the perimeter strip foundation of the width 1.0 m at the depth of 1.20 m against the building floor, with rammed concrete layer below the foundation. The floor slab is reinforced concrete and waterproofed, cast over rammed concrete and rammed gravel slab-on-grades.

A mobile 4 kW compressor, complete with tank, dryer, filters and a connection hose is planned to be placed in the workshop.

A truck exhaust gases extraction system which is comprised of flexible hose on a reel with adapter for connection to exhaust pipe, Spiro ducts and and an exhaust fan with the capacity of 1000 m^3/h is also planned to be installed in the workshop.

The heating system within the maintenance hall shall be carried out with wall-mounted electric unit heaters. The electric unit heaters shall be controlled by the supplied thermostats.

The workshop ventilation in the summer period will be natural by occasional opening of doors and windows. As for the winter period, two, hand-operated, wall-mounted exhaust fans with the capacity of 550 m^3/h each, are planned.

Hazardous Matter Storage

The hazardous matter storage is container-type building of dimensions 2.44x6.06m, h=2.59m, t=12cm, steel structure on the reinforced concrete slab d=10cm. One container is planned.

Roof cover and wall coating: prefabricated plasticized steel trapezoidal panels over a 120 min. fire rated box beam sub-structure. The floor shall be carried out as a double floor, with galvanized grating, mesh size 30x30 m, below which a bundwall made of welded sheet protected with a coating resistant to acids and similar matters shall be installed. The doors shall be panel, double doors, sliding along the entire width of the container.

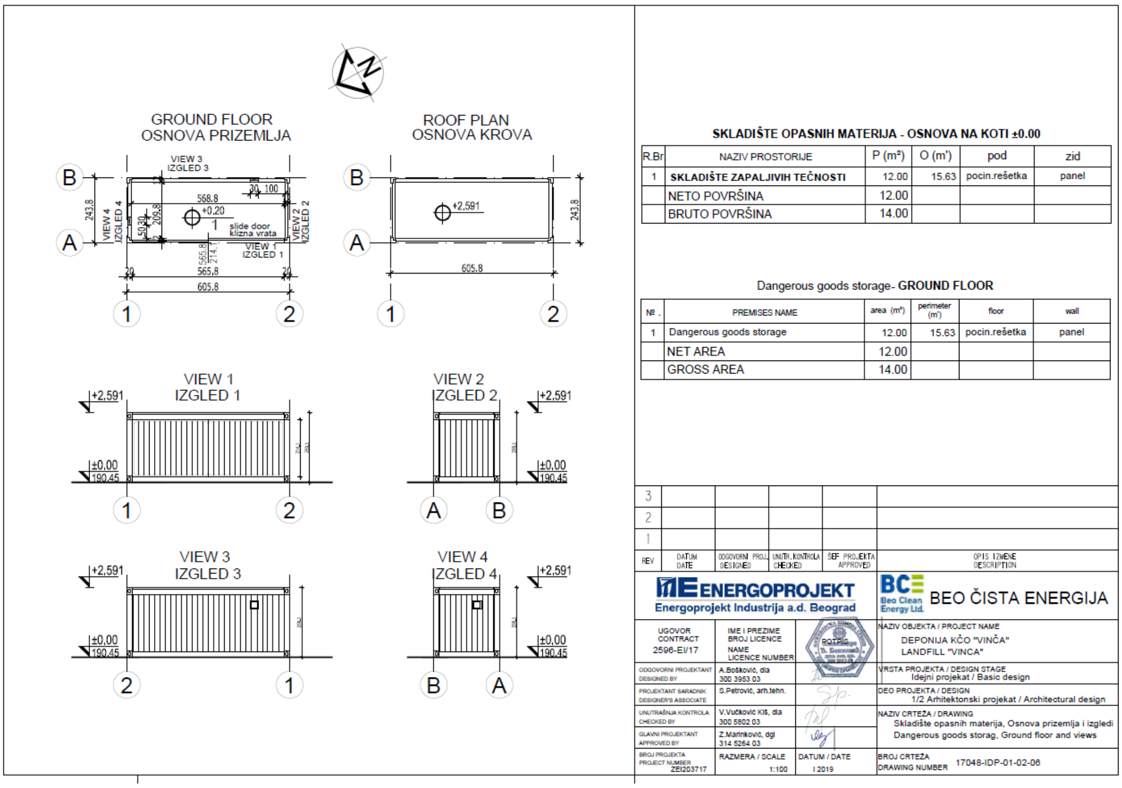


Figure 56 Hazardous matter storage (Source: IDP Book 1/2 Architectural design, Energoprojekt Industrija, May 2019)

Diesel Fuel Pump Station

The pump station is internal-type for fuel supply to the machinery and trucks. *(Source: IDP Book 6/6 Mechanical Installation Design, Energoprojekt Industrija, May, 2019)*

It is located between the internal road and the green belt on one side and between the administration building and the workshop with the vehicle washing area on the other.

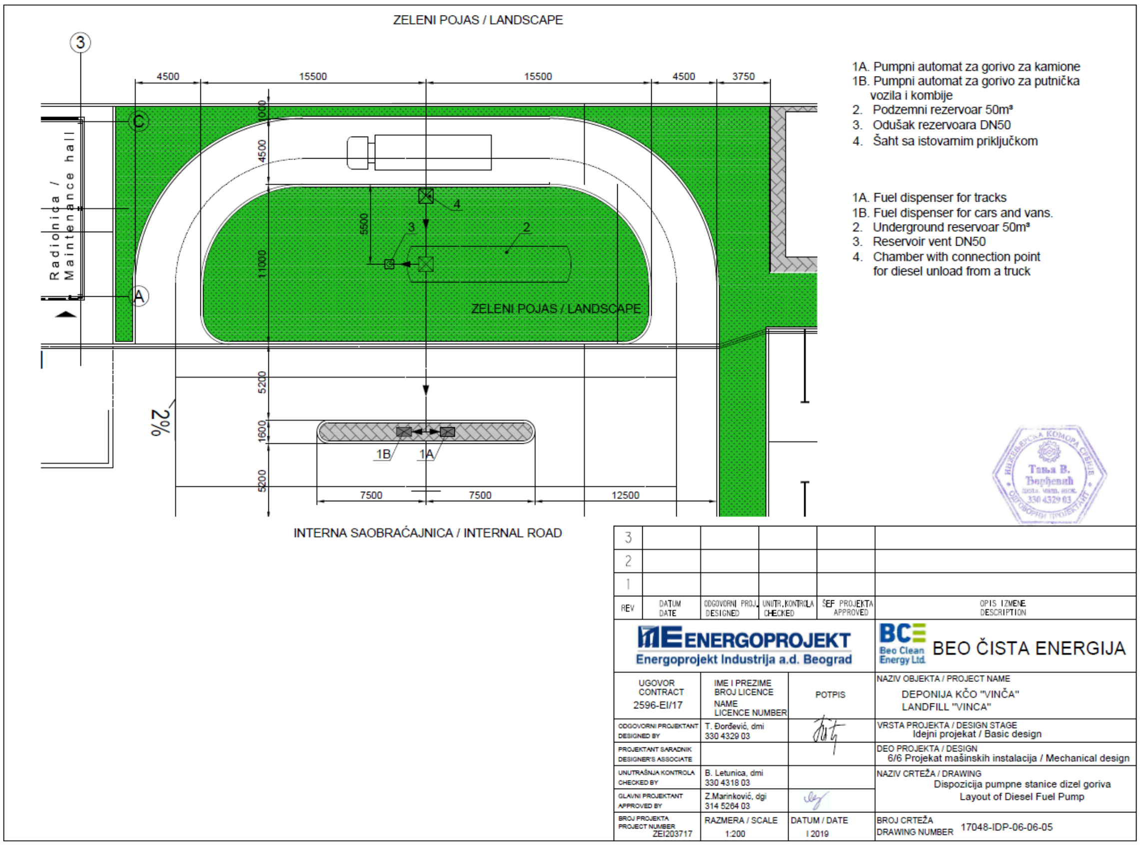


*Figure 57 Internal diesel fuel pump station (*Source: IDP Book 1/2 Mechanical Installations Design, Energoprojekt Industrija, May 2019*)*

The fuel storage shall be carried out in underground double-shell tanks with the capacity of 50m³, in the green surface area.

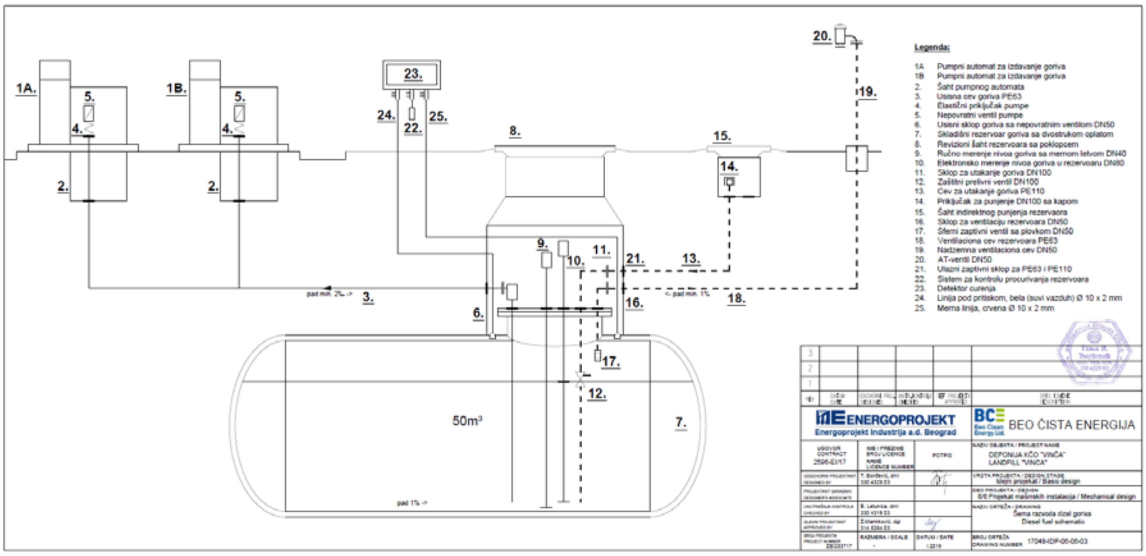


Figure 58 Hazardous matter storage (Source: IDP Book 1/2 Mechanical Installations Design, Energoprojekt Industrija, May 2019)

The fuel delivery is with fuel tank trucks by a special one-way road, which is closed during the unloading of fuel. The unloading connection shall be located in a manhole within the green belt, with the cover secured by a lock..

The pipelines shall be installed underground from the unloading connection to the tank and in a concrete channel from the tank to the fuel dispensers. The relief pipe shall be elevated at cca. 2.2 m in the green area. The tank shall be provided with all the required connections and all the metering and control equipment as required the regulations. The fuel status and fuel consumption control, as well as the control of status in the double shell of the tank will be carried out from the room within the administration building.

Hydrotechnical installation

The Operative Platform and the buildings on it shall have the following hydro-technical installations and systems: *(Source: IDP Book 3/8 Hydrotechnical Installations Design, Energoprojekt Hidroinženjering, May, 2019)*:

- outdoor and indoor sanitary water supply network
- outdoor water supply network with the connection for the car washing equipment
- outdoor and indoor hydrant network
- outdoor and indoor fecal sewerage network
- process water from vehicles washing with the settling tank
- oily water street gutters and oily storm water sewerage with the settling tank and light fluids separator
- fecal water treatment for buildings from BEP, CDW and Operative Platform

The hydraulic installations of the Operative Platform are planned to be connected to the external hydraulic installations of the entire landfill complex, located in the immediate vicinity of the platform.

Sanitary water networks shall be connected to the internal sanitary water network system that is further connected to the municipal water supply network.

Firewater network shall be connected to the outdoor hydrant water network of the complex which shall be supplied from the firewater tank, with the capacity 75 m^3, located in the immediate vicinity of the complex entrance, which is refilled from the municipal water supply network.

Industrial water distribution lines shall be connected to the outdoor sanitary water distribution lines. The water supply network shall be carried out with polyethylene water pipes.

Fecal water sewerage of the Vinca complex, as well as of the buildings from the Operative Platform (about 200 employees), shall run into the fecal waters treatment (WWT) package unit which located within the Operative Platform . The WWT unt capacity is 100 ES. The purified waters shall outflow to the perimeter storm waters channel and out of the boundaries of the complex.

The fecal sewage system of the Vinča - Municipal Waste Water Complex flows into the package sewage treatment unit located within the operational platform. The device is generic, prefabricated, with a capacity of 100ES and works on the principle of biodegradation using the Floating Bed technology. The projected daily flow rate of the device is 1500 l/day and the organic load is 6000 gBPK5/day.

The flow of water through the device is gravitational, without the use of pumps, so that the return flow of the water to the system in the event of a power failure is prevented. The stages of treatment are as follows:

- The waste water from the network enters the first part of the plant where the preliminary deposition and separation of large waste takes place which prevents its passage into further stages of purification.
- The second stage of purification is the biological degradation of organic matter, by the deep aeration system. It is intensified by the floating bed system of floating biofilm carriers.
- The next phase is aerobic stabilization and deposition of mineralized sludge. The activated sludge from this phase mixes with the precipitated material from the preliminary deposition phase and prevents the occurrence of odor.
- Finally, such purified and cleared water flows into the last chamber with the overflow, where the two final stages of treatment take place - filtration adsorption and disinfection.

Such purified water is of high quality and can be discharged into an open watercourse. The purified water is discharged into a channel near the operating platform.

The device is compact in design. It is made from high density polyethylene (HDPE). It is manufactured by spiral coil technology, which ensures maximum shape stability during burial. This material has the following advantages:

- It is chemically resistant to most chemically aggressive substances
- Resistant to abrasion, corrosion and electrolytically stable
- thermally resistant (-30 ° C to + 80 ° C)
- Lasting - long exposure to atmospheric influences does not affect the stability and functionality of the device (lifetime up to 50 years)
- It does not pollute the environment or the contents inside the device, preventing the development of algae and bacteria
- UV stable

The device is automatic, so it does not need constant monitoring. Occasional checking of its operation compliant to the manufacturer's instructions is required.

The investor is obliged to enter into a contract with a registered organization for maintenance of the device and possible removal of waste during the cleaning of the device.

The quality of the treated water discharged from the device after treatment meets the requirements of the Regulation on Emission Limit Values for Pollutants in Waters and the Deadlines for their Reaching ("Official Gazette of the RS", Nos.67 / 11 and 48/12) for discharging the water into Category II watercourses.

Relatively clean storm waters from the buildings' roofs freely discharge in the environment around the building.

Oily storm waters from the Operative Platform (parkings, car washing, filling stations) is collected and run to the oily waters separator with the settling tank. The oily waters separator flow rate is 70 l/s. Upon the treatment these waters also run into to the perimeter storm waters channel.

All the ground sewerage pipes are made of plastic, of adequate bearing capacity to be installed in the ground below the roads and paved surfaces.

Water Balance - Operative Platform

- Planned consumption for sanitary purposes is 1.10 l/s.
- Planned consumption for vehicles washing is 1.10 l/s.
- Planned consumption for the firewater hydrant network is 10 l/s.
- Expected fecal waters flow is 1.1 l/s.
- Expected flow of process waters from vehicles washing is 1.10 l/s.
- Expected oily storm waters flow is 68.8 l/s.

Electrical Installations on the Platform

Power supply of consumers in the newly designed facility is envisaged from the newly-constructed transformer station TS-2, 630kVA, 10kV/0,4kV *(Source: IDP Book 4/5 Electrical Installations Design, Energoprojekt Industrija, januar 2019.).*

Lighting installation will be carried out as overhead, recessed and reflector LED lighting, with adequate power and protection.

In the hallway of the administration building and the staircase, anti-panic lamps with accumulator batteries with 1h autonomy, are provided with an appropriate inscription or arrows indicating the direction of movement in case of evacuation.

Switching on and off of the lighting installation will be manual by an appropriate number of wall mounted switches. In all premises of the administrative building, the corresponding number of monophase and triphase connectors for general and special purposes is planned.

External and Internal Lightning Protection

The Operating Platform lightning installation consist of an internal and external lightning protection installation that is galvanically interconnected and provides effective protection against atmospheric discharges.

The system's external lightning protection installation consists of:
- the air termination system,
- the down conductor system conducting to the earthing conductors and
- the earth termination system.

The down conductors will be made from a galvanized steel strip, Fe/Zn 20mm x 3mm. They will be placed on the facade of the building, on appropriate supports or in concrete pillars.

The earthing conductor of the administrative building will be executed as a foundation earthing. From the earthing conductor, an appropriate number of terminals will be placed to connect all earthing conductors of adjacent buildings, the equipotential bond rails, the down conductors, the vertical gutters, etc.

The protection against indirect contact of metal parts, which are not under live voltage in normal operating conditions, but may be in the event of a malfunction, will be achieved by automatically switching off the power supply. The power supply system in this case is the TN-C-S system.

Telecommunications and Signal Installations

The telecommunications and signaling installations are forseen in the Administration Building and in the Workshop. Near the diesel fuel pump station one PTZ video surveilance camera will be installed. The camera will be connected via network switch, to the video server and the working station in the gate house. *(Source: IDP Book 5/4 Telecommunications and Signalling Installations Design, Energoprojekt Industrija, May, 2019).*

Fire Alarm System

The fire alarm system will be installed in the Administration Building. This system in Administration Building and the Workshop will consist of:

- fire alarm control panel
- automatic smoke detectors
- manual fire alarm notification devices
- sirens and
- power supply.

Fire alarm control panel will be installed in the entrance corridor, and shall have one adressable loop for the alarms. This fire alarm control panel will be connected by an optical cable to the main fire alarm control panel in the gate house, where there will be a fire watcher 24/7.

Automatic smoke detectors will be installed in each room exept in the toilets. Manual fire alarm notification devices will be installed at building exits. Alarming people in the building will be by sirens. Detectors and sirens will be connected to the fire alarm control panel that ensures transmission of the signals and of power at least 30 minutes in flame.

Two outlets will be installed in the Workshop, one for the IP telephone set and the other for the computer working station. Those outlets will be connected to the panel in the Administration Building.

Traffic Solution – Operative Platform

Access to the Operative Platform shall be carried out by the internal road of the complex. The internal road width in the Operative Platform zone is 7m. *(Source: IDP Book 2/8 Road Design, Energoprojekt Industrija, May, 2019).*

The traffic solution concept on the Operational landfill platform is based on the creation of three zones. The first, independent, zone is the Administration Building with the parking lot. The second zone is the diesel fuel pump station, with a road connection to the third zone. The third zone includes the Workshop with the car wash area, hazardous matter containers, truck, supply vehicles and machinery parking lot.

Parking is provided for the parking of employees' and visitors' vehicles. Twenty parking places are foreseen in this area, and one is reserved for persons with disabilities. Trucks and machinery parking is located in the depth of the complex. Parking lot dimensions are 4.0x10m, i.e. 4.5x10m. In this zone there are 5 more parking places for delivery vehicles or employees' vehicles with dimension of 2.50x5.00m.

The diesel fuel pump station operates independently with regard to the roads. The vehicles drive in to the station for tanking, at two tanking points and if there is no need to remain on the platform, they leave.

For vehicles requiring repair, washing or parking, an appropriate traffic connection is provided. The movement of vehicles along the Operational landfill platform shall be carried out as the two-way.

Roads will be carried out as a rigid (concrete) road structure on the adequate base course. Total thickness of road construction is t = 67 cm.

All the facilities on the platform will be functionally separated, they will have concrete curbing with an elevation of 12cm or marked by horizontal traffic signs.

5. The Upper Platform

The Upper Platform is planned on the construction plot KP6-7 and it is intended for the collection and evacuation of:

- Atmospheric water
- Leachate water

On the Upper Platform, with an approximate surface area f 16,500 m^2, the following ponds will be built:

- One atmospheric water collection pond,
- Two leachate water collection ponds.

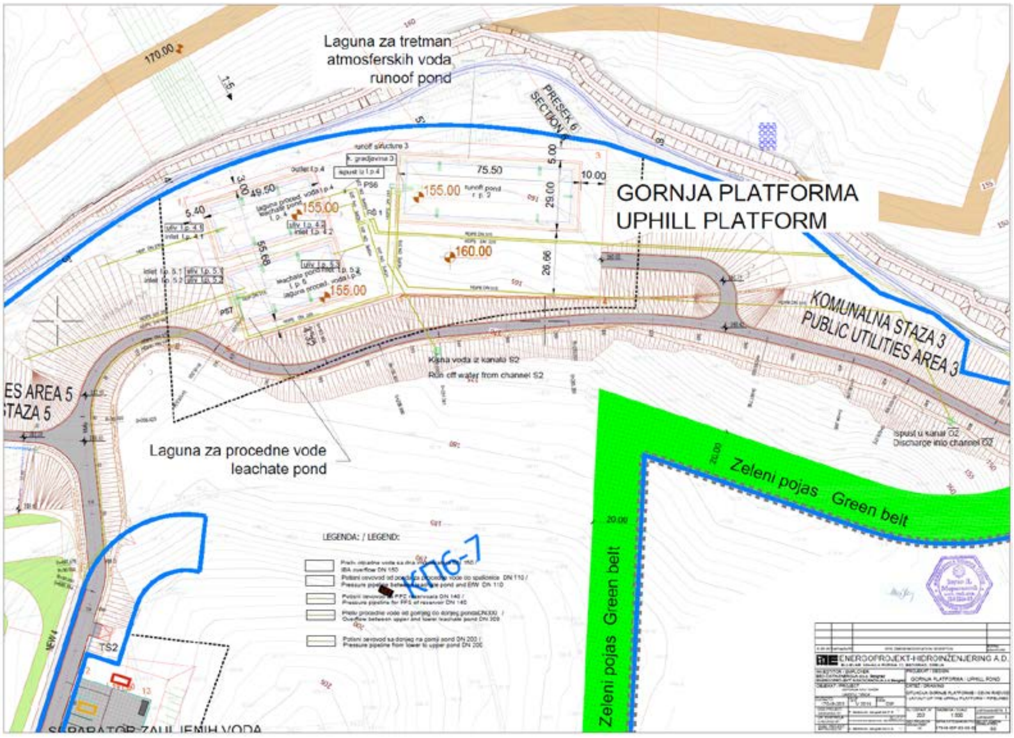


Figure 59 *The position of structures on the Upper Platform*
(Source: IDP Book 3/5 Hydrotechnical installation design, Energoprojekt Hidroinženjering, May, 2019)

Evacuation of Atmospheric Water

Atmospheric waters collected in the ponds on the Upper Platform, terrain level 160.00 (mnm) are waters from the left and the right perimeter canal around the new landfill and the canal that transport the water from the operating platform. (*Source: IDP Book 3/5 Hydrotechnical installation design, Energoprojekt Hidroinženjering, May, 2019*)

The designed capacity of the atmospheric water collection pond is accepted in the case of a 25 year rainfall of 24 hour duration (condition of PE “Srbijavode”).

For the adopted criterion, the amount of rain water which reaches the pond on the Upper Platform is 177.67 l/s with accepted volume of 4,000 m^3 with the criterion of 6h of retaining water in the pond. This volume is sufficient for multi hour retaining without discharge of water from the pond. The pond is of trapezoid shape, base dimensions: 54.5 m x 8 m, depth of water 4.5 m, slope grade 1:1.5.

The atmospheric water collection pond is designed as follows (observed from top to bottom):

- HDPE coating;
- Geotextile;
- Coating for gas evacuation that prevents the forming of gas “pockets” underneath the HDPE coating;

- Underground pipe for water drainage (in the perimeter canal filled with drain gravel at the bottom of the pond).

It is planned to transfer the pump and the pipeline to evacuate the atmospheric water from this lagoon, to the tank chamber for the purposes of fire protection of the facilities at the landfill as well as for washing the wheels of vehicles in the control zone. Any excess water will be transported to the right arm of the main perimeter canal.

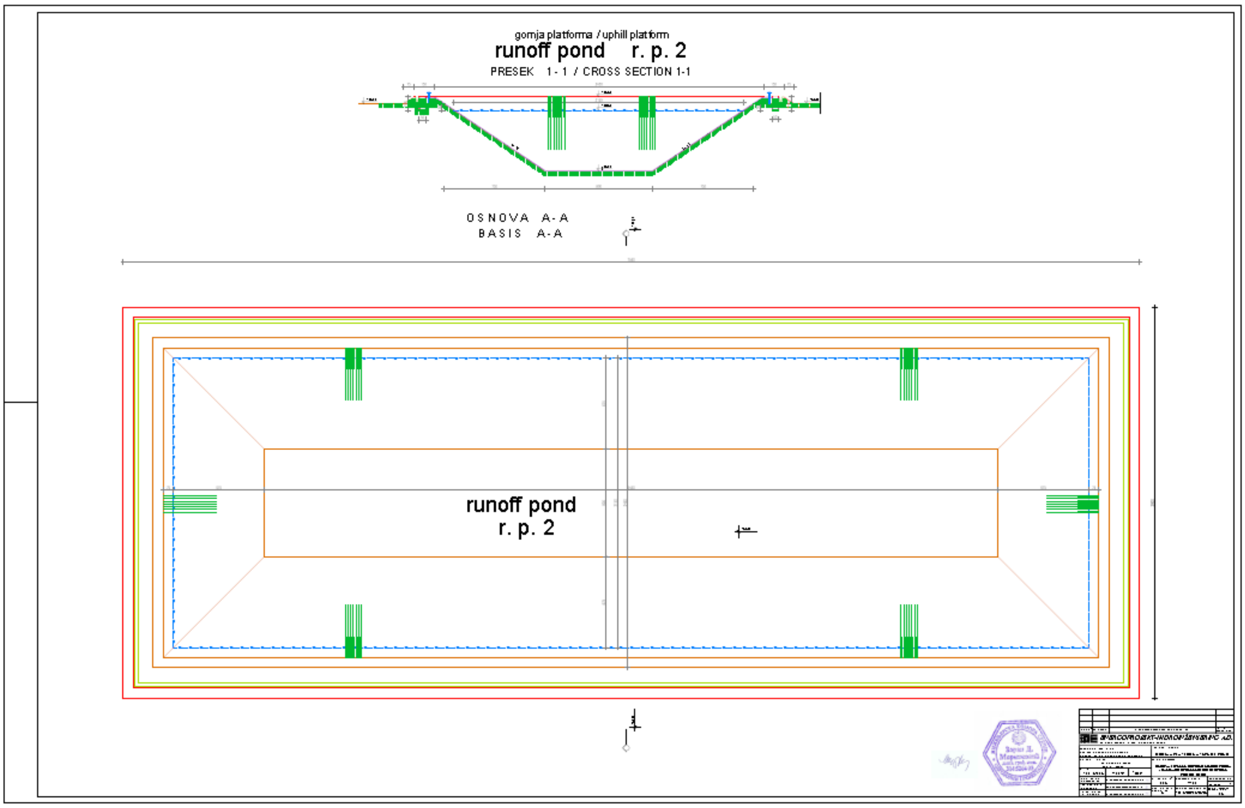


Figure 60 Atmospheric water pond on the Upper Platform (Source: IDP Book 3/5 Hydrotechnical installation design, Energoprojekt Hidroinženjering, May, 2019)

Evacuation of Leachate Water

The system for the drainage of leachate water from the new landfill is separated into two parts, according to the types of waste:

- System for the collection of leachate water from the interim communal waste landfill and a part for the Unprocessed Waste Landfill (unprocessed waste I and II)
- System for collection of leachate from the landfill for residue generated after waste processing in the EfW plant (residues I and II).

Therefore, the collected leachate water from both parts of the new landfill is drained into leachate ponds at the level of 160.00mnm.

Two ponds, 2,000 m^3 each (total capacity 4,000 m^3) are designed on the Upper Platform. The ponds are of trapezoid shape, bottom base dimensions: 28.5 m x 6 m, depth of water 4.5 m, slope grade 1:1.5.

The leachate waters collection ponds are designed as follows (observed from top to bottom):

- HDPE lining;
- Geotextile;
- Coating for gas evacuation (connected with biothorns) that prevents the forming of gas "pockets" underneath the HDPE coating;

Underground pipe for the evacuation of water from the pond.

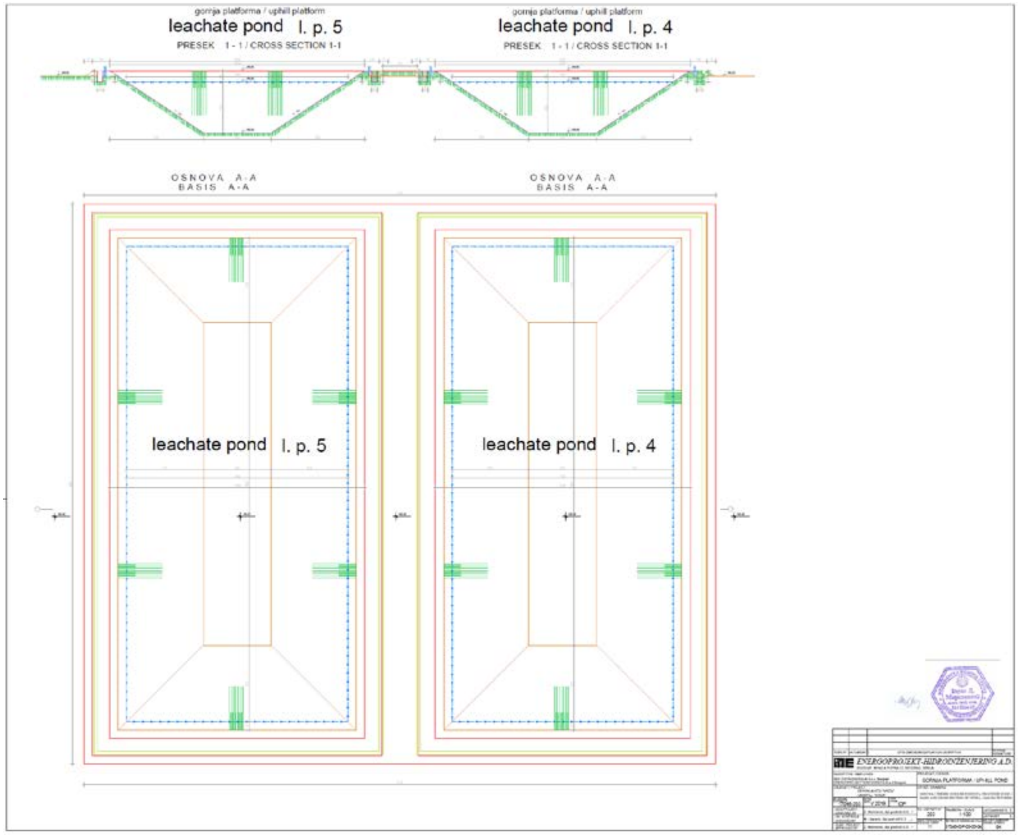


Figure 61 Leachate Water Pond on the Upper Platform (Source: IDP Book 3/5 Hydrotechnical installation design, Energoprojekt Hidroinženjering, May, 2019)

The leachate pond for the collection of leachate water from the part of the landfill where unprocessed leachate is landfilled (unprocessed waste I and II), receives the leachate water from the IBA zone (part of the EfW plant which is not the subject of this study).

, A pump station for the delivery and return of that water to the EfW plant (maximum recirculation, depending of technological needs of the plant), by a delivery pipeline is planned for the water from this pond.

The leachate water is evacuated by gravity from the separation manhole of upper leachate pond by a Ø 315 pipeline to the second leachate pond on the Lower Platform (where Leachate Treatment Plant is planned).

6. The Lower Platform

On the Lower Platform *(Source: IDP Book 3/6* Hydrotechnical installation design, *Energoprojekt Hidroinženjering, May, 2019)* located north-east from the existing ("old") landfill body that will be shut down and remediated, on the construction plot KP6-7, the following will be collected:

- Leachate water from the old landfill,
- Leachate water from the new landfill
- Atmospheric water from:
  - The "old" landfill,
  - The downhill access road.

On the Lower Platform, with a surface area of 38,680 m², the following are placed:

- Atmospheric water pond, surface area cca 1,900 m²
- Leachate pond, surface area 2 x cca 2,900 m² and cca 2,300 m²
- Leachate treatment plant (LTP Unit), 1,050 m²

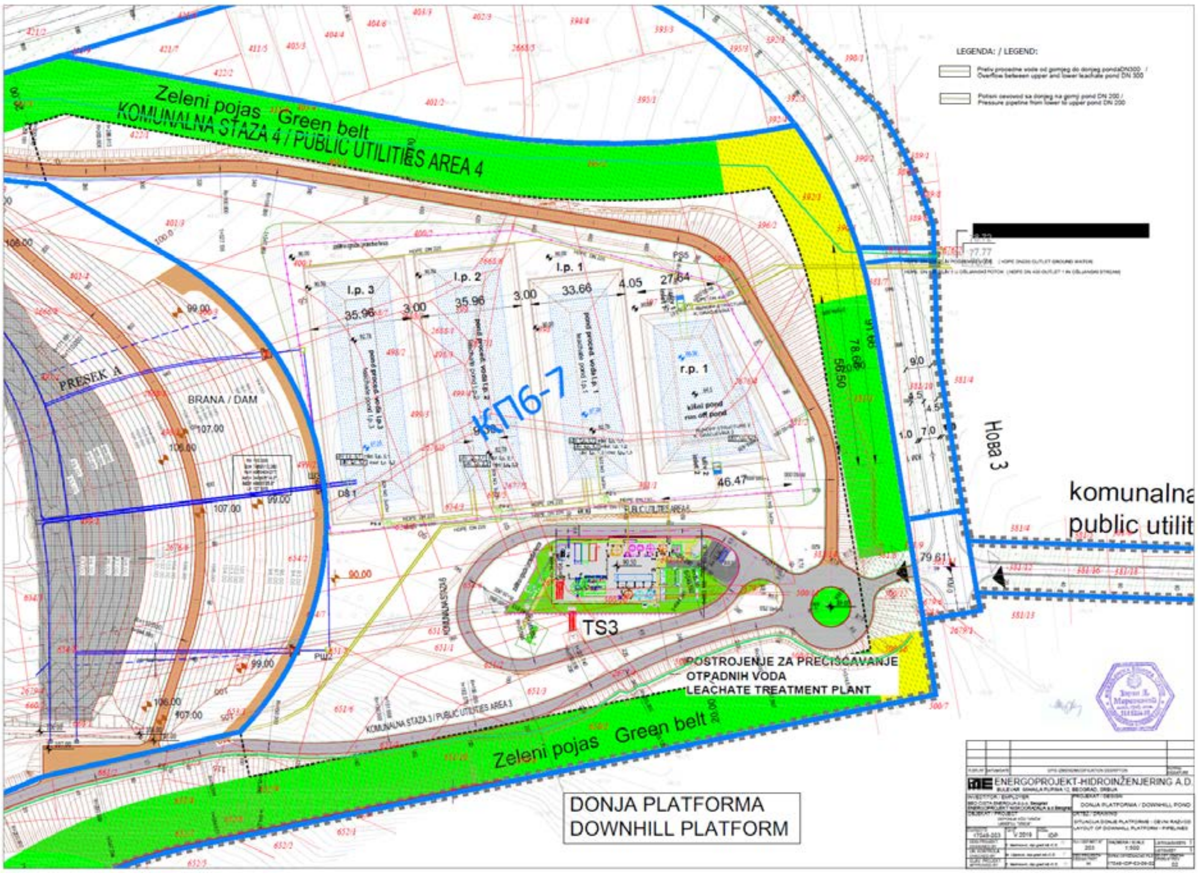


Figure 62 The position of structures on the Lower Platform (Source: IDP Book 3/6 Hydrotechnical installation design, Energoprojekt Hidroinženjering, May, 2019)

The Collection and Evacuation of Atmospheric Water

The perimeter canals for the collection and evacuation of atmospheric water are marked around the landfill body, starting from the highest elevation and directed to the left and the right side. The left and the right perimeter canals discharge into the lower stormwater pond on the Lower Platform, terrain elevation 90.00 (mnm). *(Source: IDP Book 3/6* Hydrotechnical installation design, *Energoprojekt Hidroinženjering, January 2019.)*

The designed capacity of the atmospheric water collection pond is adopted in the case of a 25 year rainfall of 24 hour duration (the condition of the PE "Srbijavode").

For the adopted criterion, the amount of stormwater which reaches the pond on the Lower Platform is 171.47 l/s with the adopted volume of 3,700 m^3 with the criterion of 6h of water retension in the pond, in accordance with the best practice in the industry. This volume is sufficient for multi hour retention, without discharge of the water from the pond.

In normal conditions, which do not imply rain of an intensity higher than the adopted, the discharge of water will be controlled with a maximum flow of 10% in relation to the inflow.

From the lagoon, the collected atmospheric water is discharged by gravity through a pipeline (diameter DN 400, length L = 100 m) into the Ošljan stream. On this pipeline, it is planned to install a measuring device for the discharged water, which is connected to a probe for automatic monitoring of water levels in the lagoon.

The atmospheric water collection pond is designed as follows (observed from top to to bottom):

- HDPE coating;
- Geotextile;
- Coating for gas evacuation that prevents the forming of gas "pockets" under the HDPE coating;
- Clay material 0.5 m thick (permeability < 1 x 10^{-9} m/s)
- Underground pipe for water drainage (in the perimeter canal filled with drain gravel at the bottom of the pond).

The pond is of trapezoid cross section of dimensions: 10 m and 22 m in the bases, length 36 m, maximum water depth 4.0 m. The grade of the pond sides is 1:1.5.

At the canal inlets into the pond, inlet structures are designed for the hydraulic surge relief.

Level of ground water under the stormwater pond (and each leachate pond) are reduced by two drain pipes DN 150 that are designed under and around the pond. The drain pipes flow into the outlet drainage pipeline DN 225 and from it into the Ošljan stream they are discharged by gravity to the Ošljan stram. The length of the drainage pipeline to the discharge into the Ošljan stream is L= 220 m.

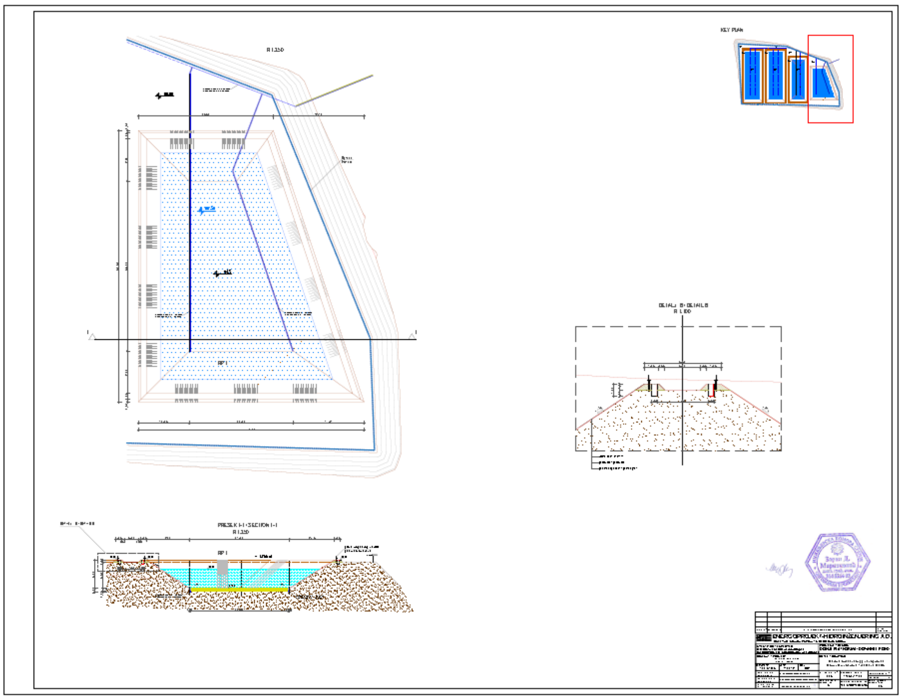


Figure 63. Cross section of the atmospheric water lagoon on the Lower Platform (Source: IDP Book 3/6 Hydrotechnical installation design, Energoprojekt Hidroinženjering, May, 2019)

Collection and Evacuation of Leachate Waters

The new landfill drainage system drains the leachate water from the ponds on the Upper Platform to the Lower Platform ponds. The leachate water is evacuated from the Upper Platform ponds by gravity to the leachate waters ponds on the Lower Platform.

Leachate waters from the existing ("old") landfill that will be closed and recultivated (not the subject of this project) flow to the leachate water ponds on the Lower Platform.

Three ponds/lagoons, with a total capacity of 13,800 m^3, have been designed for the reception of leachate waters on the lower platform (two ponds with a capacity of 2 x 5,100 m^3 and one pond with a capacity of 3,600 m^3) .

The leachate water collection ponds are designed as follows (observed from top to bottom):

- HDPE coating;
- Geotextile;
- Coating for gas evacuation that prevents the forming of gas “pockets” under the HDPE coating;
- Two underground pipes DN 150 for drainage of water (in the perimeter canal filled with drain gravel at the bottom of the pond).

The ponds have dimensions: (volume 5,100m^3) 9.30 m x 65 m in the bases, length 61 m, (volume 3,600m^3) dimensions 7.0 x 52m, depth of water maximum 4.5 m. The grade of pond sides is 1:1.5.

The pond with the capacity of 3,600 m^3 will be used for mixing the water from the other two ponds

One pond with the capacity of 5,100m^3 collects the leachate waters from the "old" landfill, and the other pond with the capacity of 5,100m^3 collects the leachate waters from the leachate waters pond on the Upper platform (leachate from the new landfill).

After the old landfill is shut down and recultivated, and after the leaching of leachate from the old landfill, the leachate will be pumped into a pond on th Upper Platform.

For the purpose of leachate water pumping to the LTP plant, a pump with following characteristrics is selected: Q = 5 l/s, H = 15 m. The pumping system will consist of one working and one spare pump.

After treatment, the treated leachate waters are lead outside the landfill complex, to a recipient.

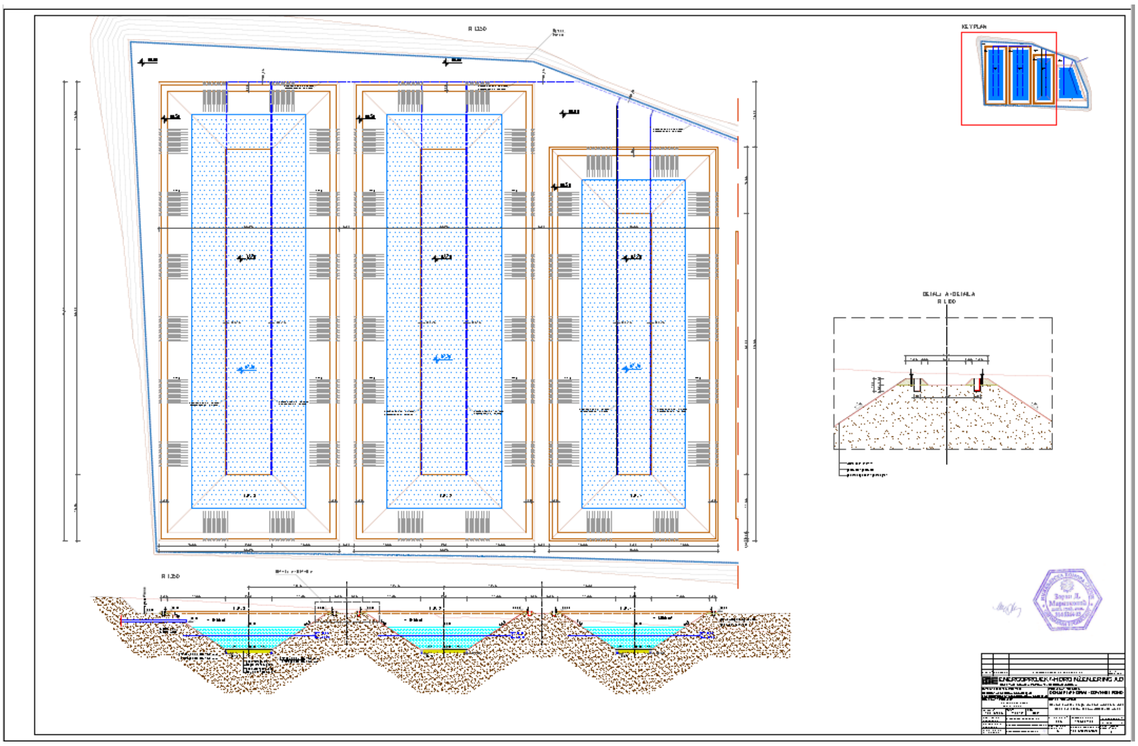


Figure 64 Cross-section of the leachate water pond on the Lower platform (Source: IDP Book 3/6 Hydrotechnical installations design, Energoprojekt Hidroinženjering, May, 2019)

6a. Leachate Water Treatment Zone (LTP Unit)

The leachate treatment plant (LTP) is on Lower platform, construction plot KP6-7, *(Source: IDP Technology design, Delta Inženjering, 2018.).*

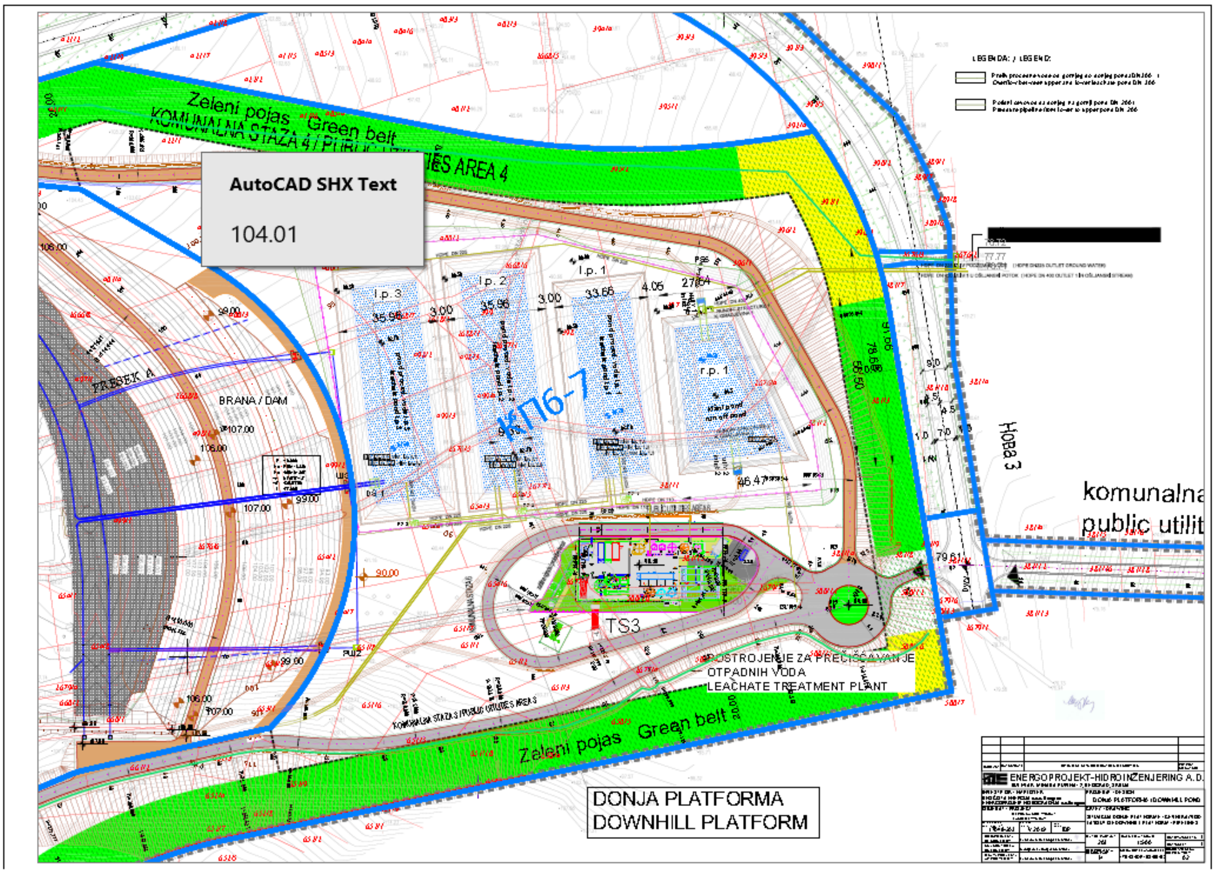


Figure 65 Figure 8 Location of the zone for the LTP (Source: IDP Technology design, Delta Inženjering, 2019)

Leachate Water Generation

Leachate water occurs as a result of atmospheric waters leaching through the body of the landfill and/or as a result of the process of biochemical degradation of organic matter.

An extremely important process at each landfill is the process of degradation of organic waste materials and inorganic substances and their elution from the bottom of the landfill to the surrounding environment. The degradation processes at the landfill can in principle be regarded as biodegradable processes that take place in the presence of living organisms (bacteria, algae, mushrooms, etc.) and processes of chemical degradation of organic and inorganic substances.

The essence of biodegradable processes is the biodegradation of complex carbohydrates, proteins, fats, biopolymers and artificial organic products susceptible to degradation to simple organic acids, carbon dioxide and methane. The examining of the processes that take place in the body of the landfill has established that the process of biological decomposition of organic waste takes place in several stages. The processes in phases are variable and their intensity and speed depend on the environment conditions.

In the initial stage, the leachate waters in the body of the landfill are formed by aerobic decomposition of waste, forming a complex solution of approximately neutral pH value. This process usually lasts for several days or weeks and does not have a significant impact on the quality of the leachate waters. However, the process of aerobic degradation releases a large amount of heat so that the temperature of the filtrate can reach a value of up to 80 - 90°C, which later contributes to the intensifying the degradation process.

By further development of the decomposition process, oxygen trapped in the pores disappears and anaerobic conditions are created. In an early anaerobic stage, the filtrate contains high concentrations of soluble organic substances and has a low pH value, around 5. It is an "acid phase" or an acetogenesis phase. Ammonia concentrations are raised, and the landfill filtrate is enriched by many inorganic ions, such as calcium, manganese, iron, copper, zinc, chromium and others, and anions such as sulphate, chloride, nitrate nitrate, nitrite, phosphate and other in landfill filtrate. Fatty acids break down to acetic acid.

The methanogenesis phase can occur after several months or even years. The leachate water becomes neutral or slightly alkaline and contains significant amounts of different compounds. The change occurs due to the rapid development of a special group of microorganisms that convert acetic acid and hydrogen into methane and carbon dioxide. The amount of acid produced decreases due to the production of methane.

The last phase of biodegradation in the body of the landfill, the so-called "maturation" phase, is characterized by the possibility of re-establishing the aerobic environment, by the completion of the conversion of organic matter into methane and carbon dioxide, and consequently a sudden decrease in the amount of generated landfill gas because a large amount of nutrients is washed from the landfill body while the remaining part is poorly biodegradable.

Most of the inorganic material in the landfill, especially heavy metals and other toxic elements, is in a solid phase. When such material is deposited as waste at the landfill, the process of its chemical degradation begins. In doing so, a series of inorganic compounds such as heavy metal cations and other inorganic and organic substances are released.

The basic factors that define the degradation capacity of soluble matter in the leachate waters are:

- Ions types and concentrations in solution,
- Acidity of thesolution,
- Redox potential of the solution,
- Temperature.

The basic chemically degradable processes of inorganic matter are: hydrolysis, hydration, oxidation, and others. The velocity of chemical degradation depends on the conditions of the environment and on the strength of the chemical bond between different elements.

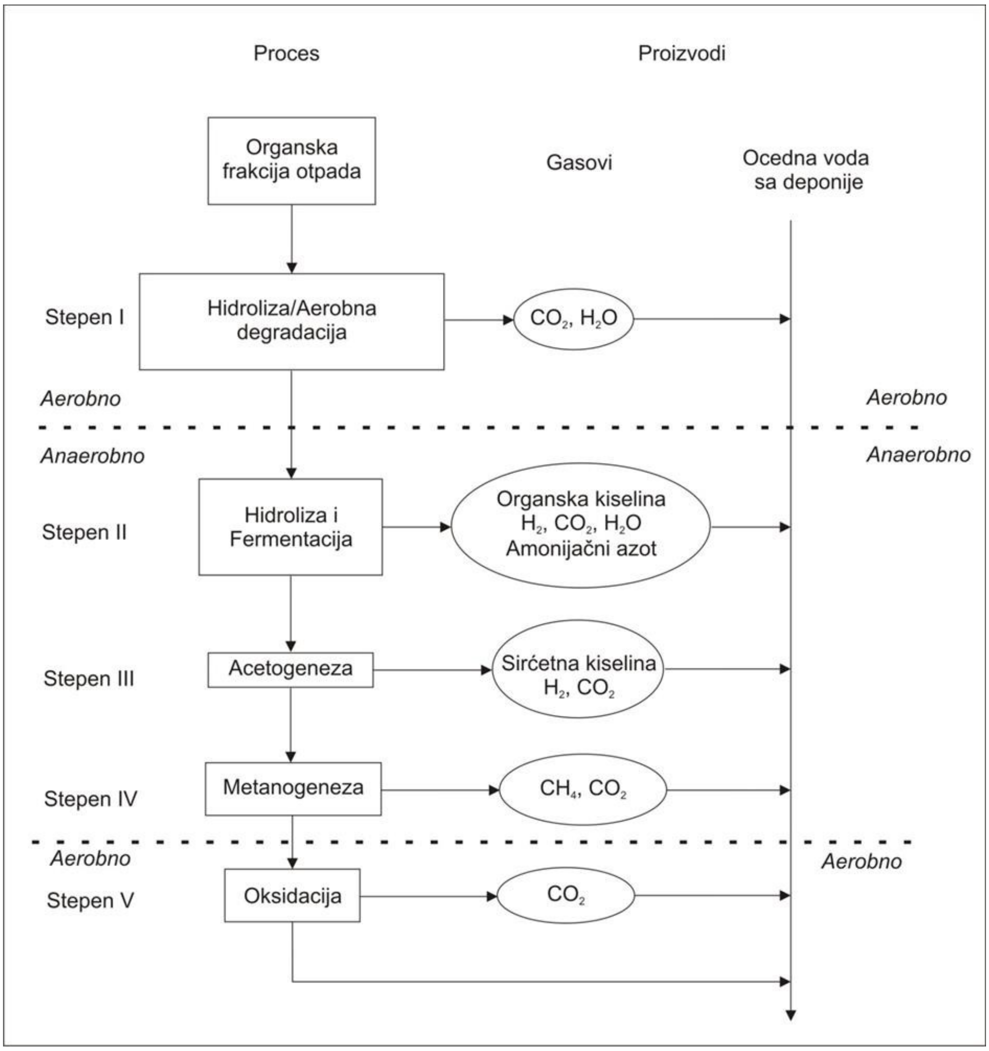


Figure 66 Phases of biodegradation waste at the landfill (EPA, 2000)

Characteristics of Leachate Waters from the Landfill

The leachate water is a complex, heterogeneous mixture of a variable composition, and consists of various organic and inorganic compounds and microorganisms. The general characteristics of the leachate waters from the landfill are a strong odor and specific dark color, high concentrations of different compounds, as well as the high values of the indicators of organic and inorganic pollution (BOD_5 and COD).

The composition of the leachate landfill water depends on many factors such as climate conditions, waste composition, landfill age, waste handling processes at the landfill, hydro-geological conditions, liquid diffusion rate through waste, temperature in the landfill body, moisture content, pH value, chemical and (micro) biological activity within the landfill body and the impact of weather conditions, depending on the seasons (McArdle et al., 1988; Westlake, 1997). Leachate water contains a wide variety of inorganic and organic pollutants, viruses, bacteria, parasites...

According to the literature data, (Renou et al., 2008), a general division of landfills according to age was carried out to young landfills, medium landfills and old landfills. Concentrations of organic components in leachate waters for young and old landfills, compared to their concentrations in municipal leachate waters and groundwater, are shown in the following tables (Ngo et al.).

	Mlada deponija	Deponija srednje starosti	Stara deponija
Starost (godine)	<5	5-10	>10
pH	6,5	6,5-7,5	>7,5
HPK (mg/l)	>10.000	4.000-10.000	<4.000
BPK_5/HPK	>0,3	0,1-0,3	<0,1
Organska jedinjenja	80% isparljive zasićene kiseline	5-30% isparljive zasićene kiseline + huminske i fulvo kiseline	huminske i fulvo kiseline
Teški metali	Niska do srednja koncentracija	Niska koncentracija	Niska koncentracija
Biodegradibilnost	U velikoj meri	U srednjoj meri	U maloj meri

Parametar	Koncentracija u procednoj vodi mlade deponije (mg/l)	Koncentracija u procednoj vodi stare deponije (mg/l)	Koncentracija u komunalnoj otpadnoj vodi (mg/l)	Koncentracija u podzemnoj vodi (mg/l)
HPK	20.000-40.000	500-3.000	350	20
BPK_5	10.000-20.000	50-100	250	0
TOC	9.000-15.000	100-1.000	100	5
Isparljive masne kiseline (kao sirćetna kiselina)	9.000-25.000	50-100	50	0

Based on the literature data and the results of the analyses of the leachate waters from municipal waste landfills, a characteristic composition of the leachate waters was given in the following table *(Source: Technology design, Delta Inženjering, 2018):*

Parameter, mg/l	Value
pH value	4.5 – 9.0
Conductivity (*µS/cm*)	2500 – 35000
Dry residue	2000 – 60000
Organic compounds	
Total organic carbon (*TOC*)	30 – 29000
Biological oxygen demand (BOD_5)	20 – 57000
Chemical oxygen demand (COD)	140 – 152000
BOD_5/COD (ratio)	0.02 – 0.80
Organic nitrogen	14 – 2500
Inorganic macro components	
Total phosphorus	0.1 – 23
Chlorides	150 – 4500
Sulfates	8 – 7750
Hydrogen bicarbonate	610 – 7320
Sodium	70 – 7700
Potassium	50 – 3700
Ammonium nitrogen (NH3-N)	50 – 2200
Calcium	10 – 7200
Magnesium	30 – 15000
Iron	3 – 5500

Manganese	0.03 – 1400
Silicon dioxide	4 – 70
Heavy metals	
Arsenic	0.01 – 1
Cadmium	0.0001 – 0.4
Chromium	0.02 – 1.5
Cobalt	0.005 – 1.5
Copper	0.005 – 10
Lead	0.001 - 5
Mercury	0.00005 – 0.16
Nickel	0.015 – 13
Zinc	0.03 - 1000

Leachate Water Treatment

The purification method of landfill leachate waters is conditioned by its variable inflow and high organic load, as well as by the presence of other inorganic pollutants such as heavy metals. As organic pollution is dominant, biological methods are most often used for leachate purification. They are based on microbiological degradation of biodegradable organic matter dispersed in the leachate water. Organic matter is partly transformed into biomass, and partly into harmless oxidation products, which provides the energy for the metabolism of bacteria.

For the needs of the design of the leachate water treatment plant (LTP plant), the testing of the quality of the treatment water at the Vinča landfill was carried out. Test results are given in the table.

Table 13 The adopted quality of the leachate water for the plant design
(Source: IDP Technology Design, Delta Inženjering, 2018)

Parameter	Unit	Sample1	Sample 2	Average value
Air temperature	°C	32.0	32.0	32
Water temperature	°C	23.6	23.2	23.4
Odor		present	present	present
Visible waste		present	present	present
pH value		8.1	7.8	7.95
Conductivity	µS/cm	41400	41900	41650
Hydrocarbon index	mg/l	<0.1	0.01	0.055
Chemical oxygen demand (COD)	mgO_2/l	16000	16000	16000
Biochemical oxygen demand (BOD_5)	mgO_2/l	4000	4000	4000
AOX (adsorbable organic halides)	mg/l	<0.05	<0.05	0.05
Total nitrogen (TN)	mg/l	2000*	2000*	2000
Ammonium	mgN/l	1000	1000	1000
Nitrates	mg/l	32	34	33
Nitrits	mg/l	<0.03	<0.03	0.03
Sulphates	mg/l	1242	1248	1245
Chlorides	mg/l	5350	5350	5350
Fluorides	mg/l	0.58	0.51	0.545
Sodium	mg/l	2124	2189	2156.5
Iron	mg/l	35.4	36.1	35.75

Manganese	mg/l	0.86	1.99	1.425
Total Organic Carbon (TOC)	mg/l	2723	2253	2488
Chromium	mg/l	<0.5	<0.5	0.5
Lead	mg/l	<1	<1	1
Cadmium	mg/l	245	255	250
Mercury	mg/l	0.0039	0.0178	0.0108
Arsenic. mg/l	mg/l	0.12	0.17	0.145
Total cyanide, mg/l	mg/l	12.2	5.5	8.85
Phenolic index, mg/l	mg/l	0.027	0.047	0.037

Thr Required Quality of Purified Lachate Water

As Ošljanski potok is the recipient of purified leachate water from the Vinča landfill, the pollutants concentration in the effluent must be within the limited emission values defined by the Regulation on emission limit values of pollutants in waters and deadlines for their achievement ("Official Gazette of RS No. 67/11, 48/12 and 1/16), part II – Other wastewater, no. 2 – Emission values limits for pollutants in wastewater that originate from surface waste disposal, Table 2.1. Emission values limits at discharging point in surface water and Table 2.2. Emission values limits before mixing with other process wastwaters.

The required water quality is shown in the following Table.

Table 14 Emission values limits on discharging point in surface water (Source: IDP Technology Design, Delta Inženjering, 2018.)

Parameter	**Unit**	**Limit value**
Water temperature	°C	30
pH value		6.5 - 9
Suspended substances	mg/l	35
Chemical Oxygen Demand (COD)	mgO_2/l	200
Biological Oxygen Demand (BOD_5)	mgO_2/l	20
Total inorganic nitrogen	mgN/l	70
Total phosphorus	mgP/l	3
Hydrocarbon index	mg/l	10
Nitrite-nitrogen (NO2-N)	mg/l	2
Toxicity to Fish (TF)		2
Adsorbable Organic Halides (AOX)	mg/l	0.5
Total chrome	mg/l	0.5
Chrome VI	mg/l	0.1
Lead	mg/l	0.5
Copper	mg/l	0.5
Nickel	mg/l	1
Zinc	mg/l	2
Mercury	mg/l	0.05
Cadmium	mg/l	0.1
Arsenic	mg/l	0.1
Total cyanides	mg/l	0.2
Sulfides	mg/l	1

Based on the above tables, the LTP is designed with guaranteed output values of purified water, which are given in the tables.

Table 15 Guaranteed output parameters for the provided treatment plant for leachate water treatment *(Source: IDP Technology Design, Delta Inženjering, 2018)*

Parameter	**Unit**	**Limit value**
Water temperature	°C	30
pH value		6.5 - 9
Suspended substances	mg/l	35
Chemical Oxygen Demand (COD)	mgO_2/l	200 (for COD <4000 mg/l, in other cases, 95% of the input concentration)
Biological Oxygen Demand (BOD_5)	mgO_2/l	20
Adsorbable Organic Halides (AOX)	mg/l	0,5
Total inorganic nitrogen	mgN/l	70
Total phosphorus	mgP/l	3
Hydrocarbon index	mg/l	10
Nitrite-nitrogen (NO_2-N)	mg/l	2
Toxicity to Fish (TF)	-	2
Total chrome	mg/l	0.5
Chrome VI	mg/l	0.1
Lead	mg/l	0.5
Copper	mg/l	0.5
Nickel	mg/l	1
Zinc	mg/l	2
Mercury	mg/l	0.05
Cadmium	mg/l	0.1
Arsenic	mg/l	0.1
Total cyanides	mg/l	0.2
Sulfides	mg/l	1

The plant is dimensioned to operate at temperatures between -5°C and 25°C. If the temperature is out of this range, there is a possibility that the guaranteed emission standards will not be achieved. In this case, Article 4, paragraph 2, of the Regulation on emission limit values of pollutants in waters and deadlines for their achievement ("Official Gazette of RS" No. 67/11, 48/12 and 1/16) shall apply: " In case the emission limit value can not be reached, it is necessary to achieve the appropriate efficiency of the wastewater treatment process.

These temperatures represent limit values for optimal continuous automatic operation. If the temperature is outside this range, then the Operator must intervene to adjust operating parameters and maintain guaranteed discharge levels. (For example, additional recirculation of the leachate water).

The efficiency of the treatment process is expressed as the percentage of the reduction of a given pollution parameter or as the amount of pollutant released per unit of the obtained product or per unit of consumed raw material from Annex 2 of the said Regulation. It is calculated based on the pollutant load of wastewater and treated wastewater."

The Quantity of Generated Leachate Water

The quantity of leachate water from the landfill has been estimated based on hydrological, morphological, geological and hydrogeological bases, as well as on the conditions at the complex. In the dimensioning of the leachate retention pools and other facilities, the continuous rainfall of 20 days for a return period of 25 years was used.

The quantities of leachate waters to be accepted and treated are given in the Table.

Table 16 *Quantity of generated leachate water* (Source: IDP Technology Design, Delta Inženjering, 2018)

Year	2020	2021	2022	2023	2024	2025	2026	2027
Collected leachate water (m^3/year)	96,000	91,900	92,000	82,500	41,800	8,600	3,300	2,400
Leachate water for EfW plant (m^3/year)	0	6,000	12,000	12,000	12,000	8,600	3,300	2,400
Leachate water to be treated (m^3/year)	90,000	90,000	81,900	70,500	29,800	0	0	0

The quantity of leachate waters shown in Table 16 represents the sum of the leachate waters generated at the existing and the new landfill. Quantification of the quantities of leachate waters for the EfV represents the annual effluent consumption of leachate waters for the APCr process (instead of raw water/city water, the leachate water is used to stabilize the APCr). Therefore, the LTP plant processes the excess leachate waters that will not be reused in the APCr curing process.

From Table 16 it can be seen that:

- in the first year and a half, all collected leachate waters must be treated on LTP and the surplus (exceeding LTP capacity) must be stored in lagoons with a capacity of 13,800 m^3 - this while EfW is still under construction;
- when the EfV starts operating, it will have an annual leachate water consumption of 12,000 m^3, so only excess leachate water will be treated at LTP;
- as EfV leachate water consumption exceeds the flushing production, it will be possible to eliminate LTP (forecast after 5 years).

In accordance with the production of leachate water and its needs for biogas production in the EfW plant, the wastewater treatment plant is dimensioned to process 90,000 m^3/year with a reserve of about 20%, that is, the capacity of the plant is 13 m^3/h.

The leachate treatment plant will only operate for five years, after which all leachate water will be transported to the EfW plant (not subject to this project).

Concept of the LTP

For the needs of evacuation the water from the landfill body , a drainage system that drains all leachate waters to the lagoon and from it to the LTP plant is planned. After the treatment, this water can be taken to the Ošljanski potok and further into the Danube. The leachate water flow chart is shown in the figure.

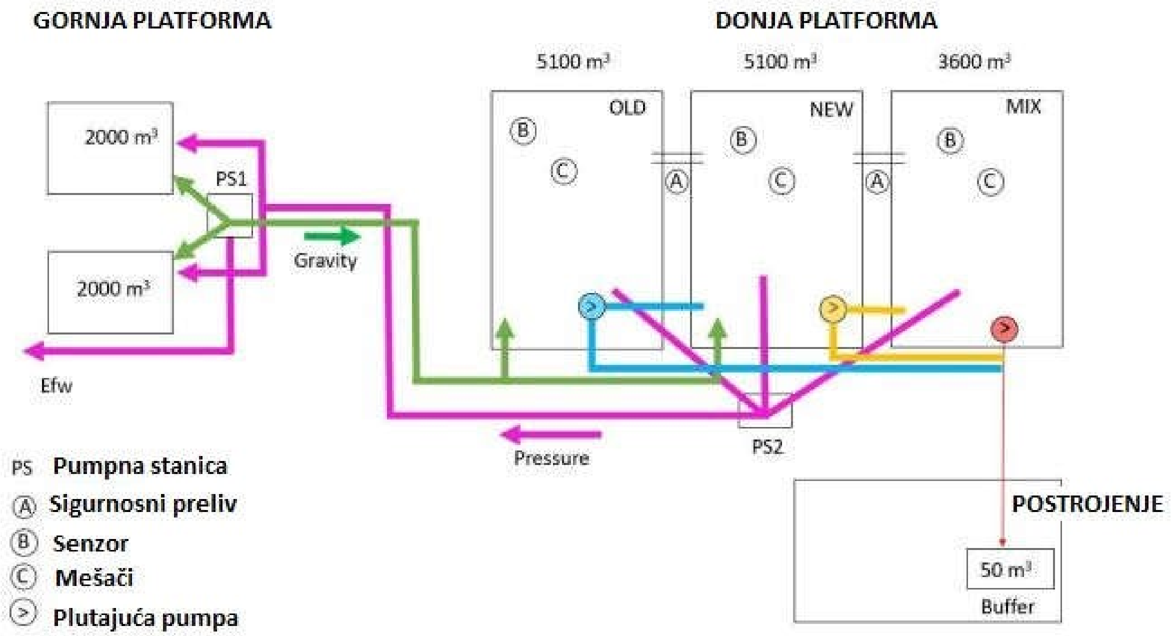


Figure 67 Leachate water flow chart (Source: IDP Technology Design, Delta Inženjering, 2018)

Drainage channels along the periphery of the landfill collect the leachate water and take it to the lagoons - the upper one that collects leachate water from the "old" landfill, and the lower lagoon that collects the leachate water from the new landfill.

The pumping station at the lower lagoon is expected to transport the collected water flows to the EfW plant after the LTP is shut down.

The Leachate treatment plant is dimensioned to satisfy:
- the required degree of treatment
- guaranteed performance of the plant
- conditions for discharge into the recipient

The Vinča landfill Leachate Treatment Plant consists of the following phases:
1. Pretreatment
2. Acidification (pH value adjustment)
3. Reverse osmosis (RO)
4. Evaporation of the concentrate from reverse osmosis,
5. Finishing reverse osmosis (FRO).

In order for the process to run smoothly, the required heat is provided by combustion of a part of biogas in a biogas boiler or in a boiler with an electric heater.

Pre-treatment

The pre-treatment on the LTP plant involves mechanical treatment on roto-sieves and sand filters. Each filter is a multilayer filter (sand + anthracite). In the pre-treatment, sand, sludge and other inert particles from the flowing water are removed.

On the inlet pipeline to the roto-sieve, there is a device that captures impurities larger than 2 mm, in order to protect the equipment in the further treatment process. The pre-treatment comprises of:

- Roto-sieves, with the sieve size of 0.5 mm
- Sand filters, intended for the elimination of particles larger than 30 µm, within the RO stage

The sand filter is used for mechanical filtration of the water solution, which is used to remove rough mechanical suspended particles from the raw water. The sand filter is filled with quartz grit and sand of particular granulation. The filtration takes place through the flow of water in a downward direction (gravity). After the filter fill is saturated, a counter-flow flushing is provided.

The quantity of water required for flushing is 500-600 l/min per m^2 of the filter surface, and 1.0-1.5 m^3 of compressed air per minute and of m^2 of filter surface. Filter cleaning takes 15 to 20 minutes, and the flushing frequency depends on the degree of the filter fill saturation.

After counter-flow flushing, the filter fillings is flushed in gravitational direction in order to stabilize the filtration layer and prepare the mass for regular operation.

Acidification

It is necessary to eliminate ammonia, which is one of the leachate components. Free ammonia can pass through the membrane of the RO system and end up in the permeate (treated leachate). Therefore, the filtered leachate is acidified using sulfuric acid, in order to convert ammonia into ammonium sulfate, which remains in the concentrate during treatment at the RO membrane.

Reverse osmosis

Reverse osmosis is based on the use of semipermeable membranes, a selective barrier that allow the passage of certain components, while retaining other components of the solution (the criterion is the size of the molecules/ions of the dissolved substances). The flow of matter through the membrane is kinetically defined by applying pressure, vapor pressure, hydrostatic pressure, electrical potential, and temperature.

Concentrated impurities are retained on the side of the membrane that is under pressure, and the purified water is passed to the other side of the membrane.

Depending on the leachate quality (mostly disolved salts and organic matter), the percentage of the generated permeate will be about 50% to 70% of the water inflow.

The permeate goes to the clean water pool, from where it is transported to the recipient, with a previous flow measurement, and the concentrate from the RO membranes is transported further to the treatment on the vacuum evaporator.

A two-stage RO will be used at the LTP plant..

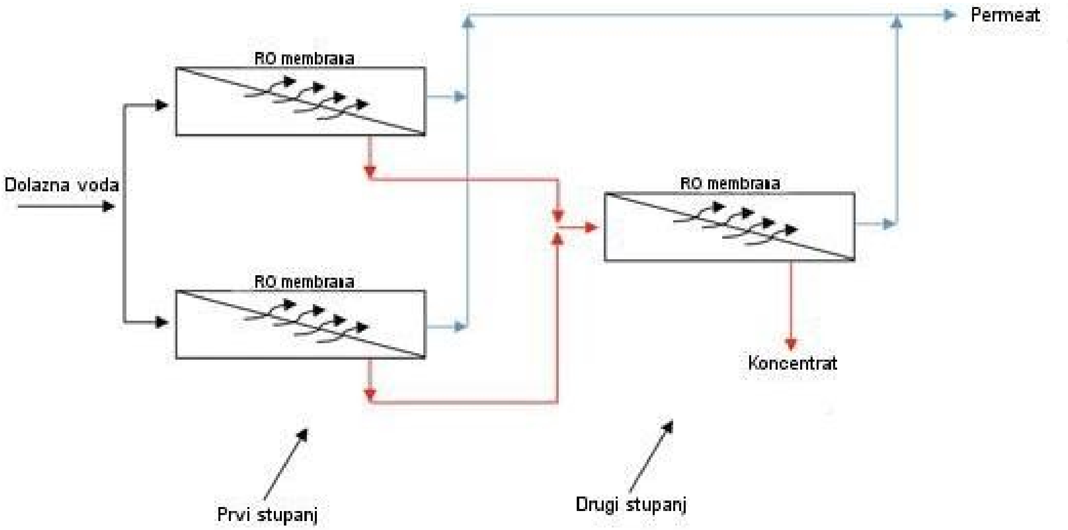


Figure 68 Schematic diagram of two-stage RO (Puretec Industrial Water, 2012 – 2015)

The efficiency of certain components removing by two-step reverse osmosis is given in the following Table.

Component	Removal rate
Monovalent ion	> 99.5%
Polyvalent ion	> 99.9%
Ammonium ion at pH 6.5	> 99.5%
Organic components	> 99.9%

Evaporation - Vacuum Evaporator

In the evaporator, the concentrate from the first degree RO is thermally treated. Heating is achieved by circulating the heat through the mass of the solution. The evaporator operates under vacuum, which allows lowering the boiling point of the water and separating the water vapor from the salt at lower temperatures.

Nitric compounds - the ammonium in the leachate must be previously treated. Otherwise, ammonium would remain as steam instead of as liquid. As previously mentioned, for the purposes of this process, the pre-treatment of ammonium will be carried out by acidification process.

The evaporation takes place in two phases. The first phase allows the evaporation of water from the leachate under vacuum. In the second phase, the energy needed for evaporation is created by mechanical compression with steam.

The condensate generated in the first stage mostly does not contain dissolved salts and organic compounds, and it remains within the limits allowed for release into the natural recipient.

In the second phase, after the evaporation of the water contained in the concentrated leachate from the first phase, a superconcentrate with a dry matter concentration of about 30% (between 20-30%) and it contains concentrated dissolved salts, nitrogen components, organic matter and metals from leachate. The resulting superconcentrate is deposited at the landfill.

The condensate generated in the second phase is free from most of the dissolved salts and organic compounds and is further transported to the reverse osmosis finishing system.

Reverse Osmosis Finishing

The reverse osmosis finishing system is installed after the vacuum evaporators, in order to treat the condensate from the evaporator. The RO finishing system will remove possible residual ammonia, salts and heavy metals traces and ensure that the parameters values are below the allowed limits for a natural recipient. The percentage of the permeate generated from the RO condensate treatment system is 85-90%.

The concentrate from the reverse osmosis finishing will be recirculated into the leachate pre-treatment tank (before the reverse osmosis membrane at the water line), whereas the permeate from the second stage reverse osmosis shall go into the treated (clean) water pond, wherefrom, together with the permeate from the first stage reverse osmosis system, it will be transported into the manhole and further to the recipient, with previous measurement of the flow.

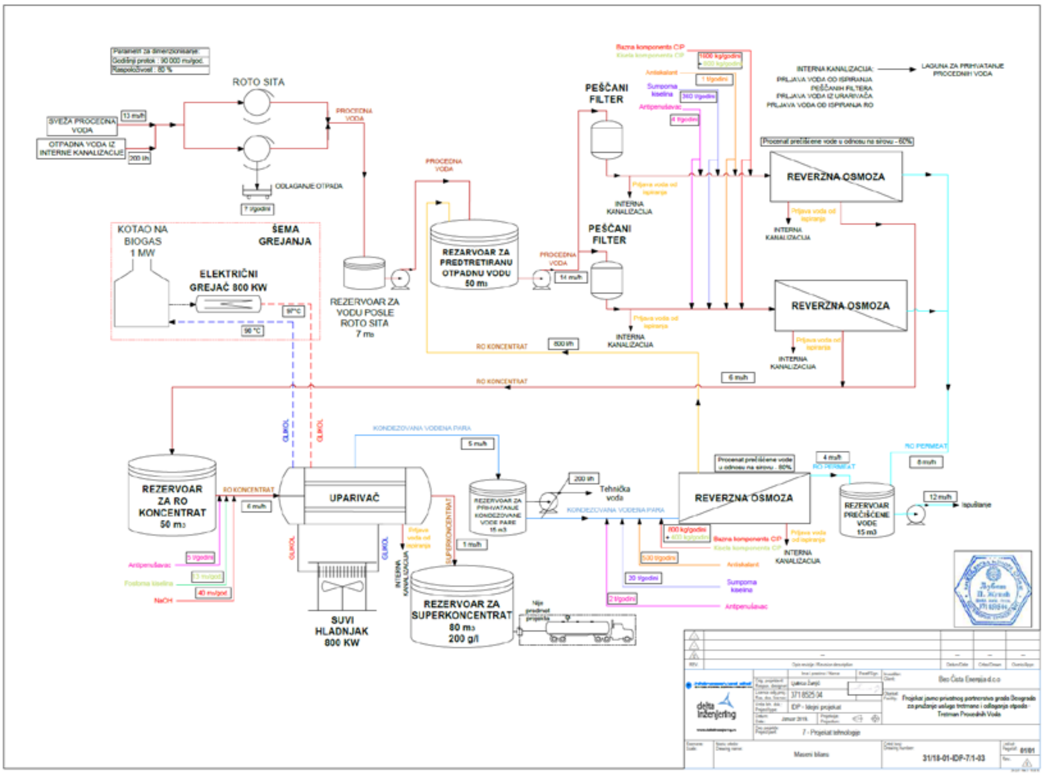


Figure 69 Schematic diagram of LTP
(Source: IDP Technology Design, Delta Inženjering, 2018)

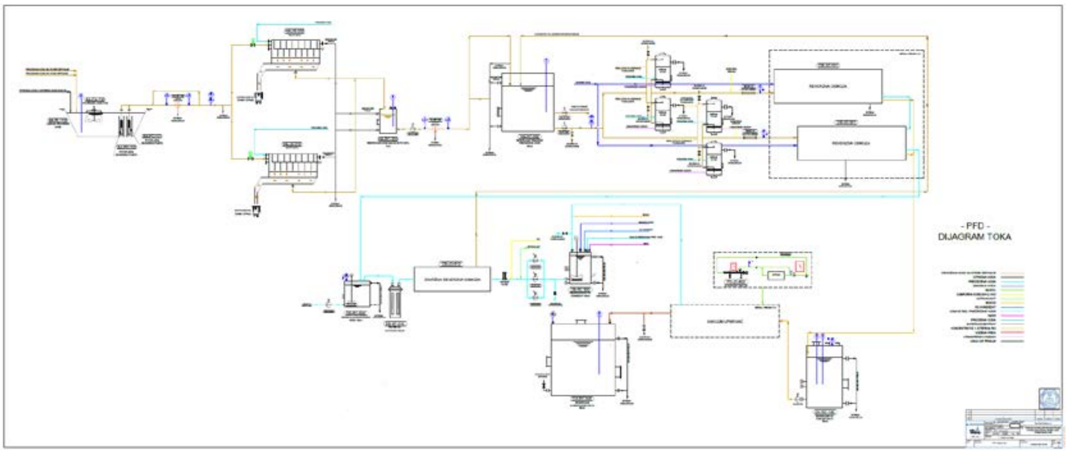


Figure 70. Flow diagram of LTP process
(Source: IDP Technology Design, Delta Inženjering, 2018)

The membranes in the reverse osmosis system must be periodically cleaned from the accumulated organic and inorganic matter, in the CIP system that is located in the facility. To the CIP tank, there are inlet pipelines for sodium hydroxide from a 15 m^3 storage tank, for hydrochloric acid from the IBC containers, located in the RO facility, then clean water from the city water supply and return water from the first stage RO system.

Technical characteristics of the LTP equipment

Based on the project documentation, (Source: IDP Project of Machine Installations and Equipment, Delta Inženjering, 2019), the basic technical characteristics of LTP equipment are shown bellow.

Roto-sieve

Pre-treatment involves the leachate purification through the sieve, with following characteristics:

Parameter	**Unit**	**Value**
Units number	-	2
Annual water quantity	m^3	90,000
Removal rate	%	80
Water flow per unit	m^3/h	7
Sieve hole size	mm	0.5
Power	kW	0.37
Voltage	V	3x400

Sand filters

Each reverse osmosis unit will have 2 sand filters with automatic counter-flow flushing (while one is in operation, the other is flushing). For the calculation of the filter fill, the following is adopted:

- Capacity Q = 2 x 7,0 m^3/h
- The total height of the filter fill is 1000 mm.
- Effective surface: P = 1.4 m^2
- Filter diameter: D = 1.3 m
- The treatment of raw water in this device removes all floating particles larger than 30 □m.
- Filtration speed, when both filters are in operation: v = 4.6 m/h
- Filtration speed, when one filter is in the flushing phase: v = 9.3 m/h,
- Air quantity required for filter flushing: Qvaz = ~50 $m^3/h/m^2$
- Water flow required for filter flushing: Qvod= 35 $m^3/h/m^2$
- Water quantity required for one filter flushing (30 minutes): 17.5 m^3

Reverse osmosis

The following table shows the reverse osmosis system characteristics:

Parameter	**Unit**	**Value**
Units number	-	2
Maximal water amount per unit	m^3/d	200
Flow rate per unit	m^3/h	5.7
Number of membrane phases	-	2

Membrane characteristics are shown in the following table:

Parameter	Unit	Value
Membrane type	-	Organic, tubular and spiral
First phase		
Membrane surface area	m^2	≈ 1,321
Number of membranes	-	36
Specific designed permeate flow	$l/m^2/h$	4.1
Second phase		
Membrane surface area	m^2	≈ 450
Number of membranes	-	12
Specific designed permeate flow	$l/m^2/h$	11

Consumption of chemicals is shown in the following table:

Parameter	Unit	Value
Sulfuric acid 96%	t/y	360
Antiscalant	t/y	1
Base reagent 1%	kg/y	1,600
Acid reagent1%	kg/y	800
Antifoam (93 to 96%)	t/y	4

Vacuum evaporator

Vacuum ecaporator characteristics are shown in the following table:

Parameter	Unit	Value
Average evaporator capacity	m^3/h	6
Maximum evaporator capacity	m^3/h	7.5
RO concentrate temperature	°C	20
Required heat power	kW	800

Required chemicals amount are shown in following table:

Parameter	Unit	Value
Antifoam	t/y	5
Caustic soda (30%)	m^3/y	40
Phosphoric acid /75%)	m^3/y	13

Reverse Osmosis Finishing

The reverse osmosis finishing dimensioning is based on the following data:

Parameter	Unit	Value
Number of units	-	1
Maximal water amount per unit	m^3/d	6.5
RO degree	-	1
Utilization rate	%	80-90

Membrane characteristics are shown in following table:

Parameter	Unit	Value
Membrane type	-	Organic, tubular and spiral
Membrane surface area	m^2	≈ 560
Number of membrane	-	15
Specific designed permeate flow	$l/m^2/h$	4
Permeate flow	m^3/h	5.5
Concentrate flow	m^3/h	1

Consumption of chemicals is shown in following table:

Parameter	Unit	Value
Sulfuric acid 96%	t/y	360
Antiscalant 5%	t/y	1
Base reagent 1%	kg/y	1,600
Acid reagent 1%	kg/y	800
Antifoam (93 do 96%)	t/y	4
Biocide	t/y	2.9

Characteristics of chemicals used in reverse osmosis

The following chemicals are used in the leachate water treatment, (Source: IDP Technology Project, Delta Inženjering, 2018), in the reverse osmosis system:

- sulfuric acid
- antiscalants
- acidic and basic component in CIP flushing equipment
- sodium hydroxide
- phosphoric acid
- antifoam

Sulfuric acid

Concentration	96 %
pH	<1
Viscosity at 20°C	26.9
Density at 15°C	1.40 -1.841 kg/l
Freezing point	-15 °C
Baumé degree at 15°C	66 °Bé
Annual consuption	380 t/y

Storage tank volume	15 m^3
Storage refilling frequency	every 20 days

Antiscalant

pH	11.1 (5%)
Density at 15°C	1.3 kg/l
Freezing point	-21 °C
Boiling point	100°C
Storage volume	1.5 t/y
Supply	48 containers of 25 kg/y

CIP system, acidic component

Concentration	1 %
pH	2.3 (1%)
Density at 20°C	1.07 kg/l
Annual consumption	1.2 t/y
Supply	48 containers of 25 kg/y

CIP system, base component

Concentration	1 %
pH	12.2 (1%)
Density at 15°C	1-17 kg/l
Annual consumption	2.4 t/y
Supply	32 containers of 25kg/year

Sodium hydroxide

NaOH concentration	30.5 %
Viscosity at 25°C	14
Density at 20°C	1.22 kg/l (20%)
Boiling point	110°C
Crystallization temperature	-27°C (20%)
Annual consumption	40 m^3/y
Storage volume	5 m^3
Storage refilling frequency	45 days

Phosphoric acid

Concentration	75 %
Density at 25 °C	1.17 g/cm^3 (30%)
Crystallization temperature	21 °C (85%)
Annual consumption	13 m^3/y
Storage volume	5 m^3

Storage refilling frequency	every 4 months

Antifoam

Density (20°C)	0.970 g/cm^3
Concentration	93 do 96 %
Dynamic viscosity at 20°C	90 – 145
Boiling point	235 °C
Crystallization temperature	-25 °C/-5 °C
Annual consumption	11 t/y
Storage volume	1 m^3
Storage refilling frequency	monthly

Total chemical consumption in LTP, t/year

Chemical	Amount	Chemical	Amount
Sulfuric acid, 96%	380	Antifoam, (93-96%)	11
Antiscalant, 5%	1.5	Sodium hydroxide, 30%	40
CIP – base reagent, 1%	0.0024	phosphoric acid, 75%	13
CIP - acidic reagent, 1%	0.0012	Biocide	2.9

7. Protective dam of the old landfill body (support structure)

The support structure is planned on the construction plot KP6-7. It is located in the northeastern part of the Vinča landfill complex, below the body of the existing - "old" landfill.

In order for the works on the construction of the supporting structure to be carried out efficiently, it is necessary to carry out appropriate preparation works on the site before the commencement of the works. Preparation works include the following group of works *(Source: PZI for rehabilitation of landfill landslide and stabilization of part of the Vinča landfill, Book 10 - Preparation works design, Hidrozavod DTD, 2018):*

- Securing the front part of the landfill in the construction site zone
- Excavation of a peripheral channel
- Construction of access roads

The front of the landfill in the construction site is planned to be secured by Larssen sheet piles type 605, length 6.0 m. Piling is carried out with a pneumatic hammer, up to a depth of 4.0 m. Piled sheets will be 2.0 m above the ground level. Sheets will not be removed after the completion of the works.

The excavation of the peripheral channel is planned along the periphery of the existing landfill, in order to accept all the leachate waters that are currently freely spilled over the surrounding areas.

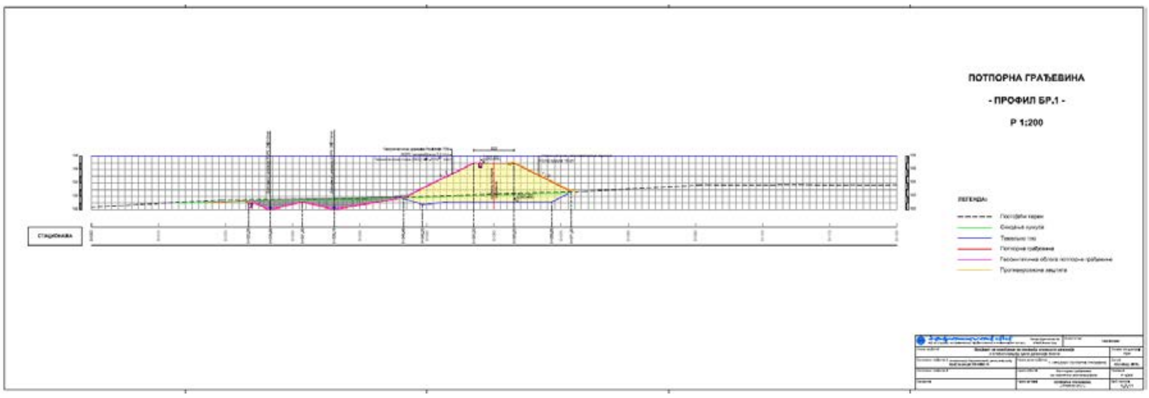
The peripheral channel has a trapezoidal cross section, the width of the bottom is 0.8 m and the inclination of the slopes is 1:1. The total length of the channel is 446.10 m.

In order to transport the material from the borrow pit to the place of installation in the support structure, an access road in the form of two roads is planned. The lengths of the planned roads is 371.2 m and 421.30 m. During the execution of the works, a one way traffic of heavy vehicles is envisaged, and for each road, different directions are used for the maximum acceleration of the construction time and for the reduction of accidents in transport. The width of the access road was adopted at 3.5 m. A road with a cover of crushed stone is foreseen. The thickness of the road layer is 25 cm, and it is planned to install two layers, the lower layer with 31.5-63 mm granulation and 15 cm thick, and the upper layer with 0-31.5 mm granulation and 15 cm thick.

Construction of the support structure

The construction of the support structure is planned on the lowest part of the drainage area of the "old" landfill, right next to the landfill. The support structure is located on the construction plot KP6-7, at the northeastern part *(Source: PZI for the rehabilitation of the landfill landslide and stabilization of part of the Vinča landfill, Book 1 – Support structure design, Hidrozavod DTD, 2018).*

The supporting structure has a trapezoidal cross-section, elevation point of the crown is 107 mnm. Due to the length of the slope, berms are provided on the inner and outer sides of the supporting structure, at an elevation point of 99.0 mnm. The width of the supporting structure crown is 6, 0 m. Berms are 4.0 m wide. The inclination of the slopes of the supporting structure are 1: 2, except for the slopes from the internal berm to the drainage trench, which is provided with the inclination of 1: 3.



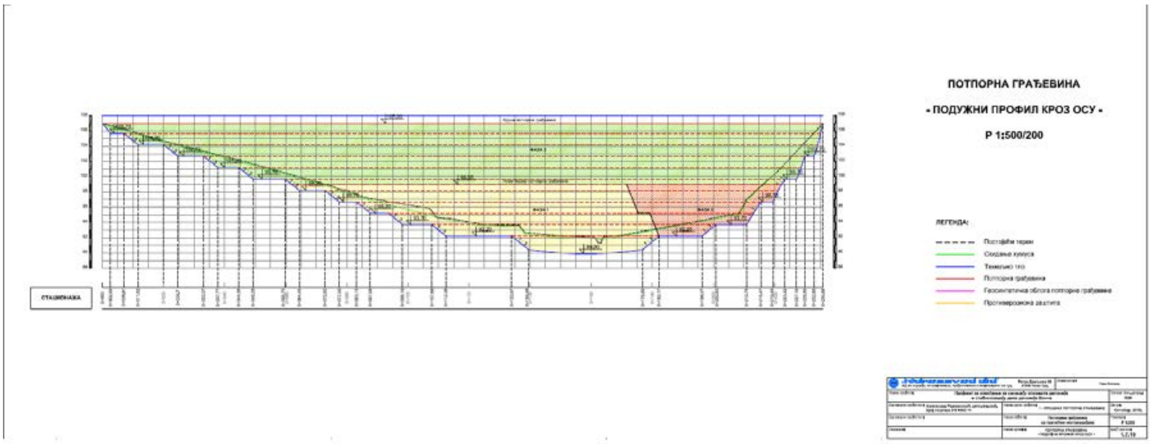


Figure 71 Cross-section and longitudinal cross-section of the support structure (Source: PZI for rehabilitation of the landfill landslide and stabilization of part of the Vinča landfill, Book 1 – Hidrozavod DTD, 2018)

Due to the continuous leachate flow emerging from two places from the waste mass, a phased construction of the support structure is planned. The design documentation defines the following stages of construction of the support structure:

- *Phase 1*: Construction of a supporting structure from the northern slope of the hill to the boundary of the peripheral channel that regulates the leachate flow during the execution of works in Phase 1. In this phase, the support structure will be built up to the elevation of 99.0 mnm, which represents the level of berms of the support structure. For continuation of the support structure, cascade cutting at the point of continuation will be executed;
- *Phase 2*: After the construction of the support structure and the drainage trench in Phase 1, the leachate from the peripheral channel is directed to a built drainage collector that will drain the leachate water through the supporting structure. In this phase, it is necessary to build a part of the supporting structure from the executed Phase 1 until it leans on the hill on the south side. The final elevation of the supporting structure in this phase is 99.0 mnm;
- *Phase 3*: This stage envisages the construction of a support structure along the entire length from the level of berms – 99.0 mnm to the elevation of the support structure crown of 107 mnm.

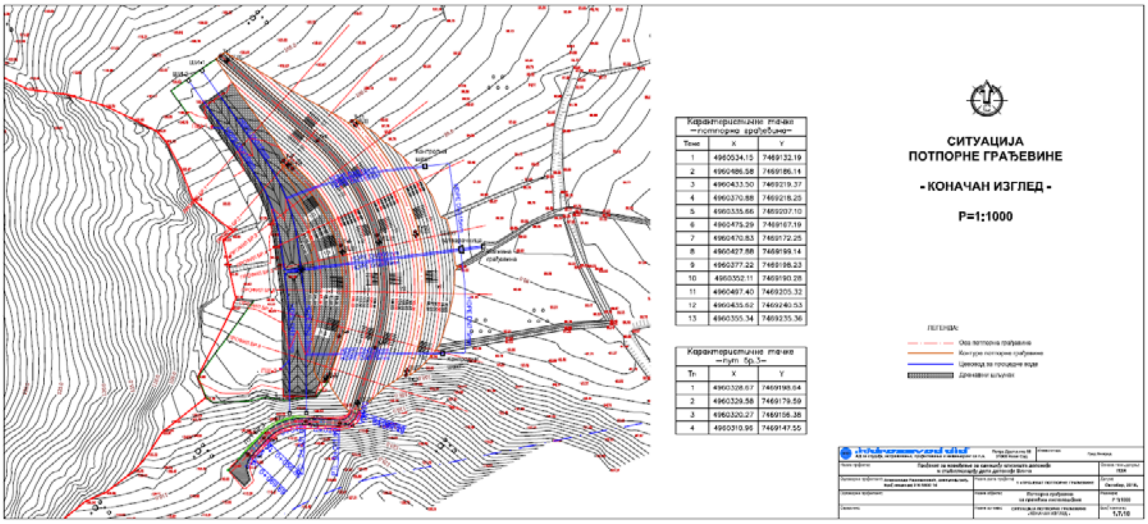


Figure 72 Support structure
(Source: PZI for rehabilitation of landfill landslide and stabilization of part of the Vinča landfill, Book 1 – Hidrozavod DTD, 2018)

Given the fact that the width of the support structure is 80 m at its base, design documentation provides for the cascading formation of the foundation ground. The foundation ground is performed in phases, following the phases of the construction of the support structure.

The support structure is made from coherent material (silty clay) excavated from the earth material borrow pit. The borrow pit is located within the boundaries of the landfill complex in Vinča, on the northern slopes area near the support structure.

The excavation of the material on the borrow pit begins with the removal of the 30 cm humus layer. After the completion of excavation works, this material is returned and distributed over the surface. Excavation on the borrow pit is planned at a depth of up to 2.5 m.

Humus or soil with poor bearing capacity and other materials that could in time change their mechanical and physical properties due to biochemical processes may not be placed on the embankment.

Covering of the Support Structure

As the insulation of the inner surfaces of the support structure and drainage trench, the project envisages insulating in accordance with the rules for sanitary landfills. As a layer of hydrogeological barrier, the use of the geosynthetic clay liners (GCL) is planned so as to improve the existing soil (2.3 × 10-8 m/s) and the compacted material of the embankment (1.3 × 10-10 m/s) in order to achieve the required layer of 50 cm water permeability coefficient c <1 × 10-9 m/s.
The geosynthetic clay liners should have the following minimum characteristics:

- Water permeability coefficient: c ≤ 1,2 × 10-11 m/s (ASTM D 5887-04)
- Layer thickness at pressures of 2 KPa: 6.5 mm (EN ISO 9863-1)
- Penetrating force: 1.8 KN (ISO 12236)

As the second layer of insulation, a high density polyethylene (HDPE) geomembrane of 2.0 mm thickness is planned.

The characteristics of the HDPE geomembrane required by this design are:
- Density: 0.94 g/cm3 (ISO 1183, ASTM D 1505)
- Strength at break: 30 N/mm2 (EN ISO 527-3)
- Elongation at break: 800% (EN ISO 527-3)
- Penetration resistance: 5.5 KN (EN ISO 12 236)
- Water absorption: <0.04% (ISO 1269)

The geomembrane is placed on a prepared layer with a 200 g/m2 polypropylene (PP) geotextile surface mass placed for easier installation of the the geomembrane.

On the outer slope of the supporting structure, the use of anti-erosion geosynthetic material EROSMAT TYPE 3/20Z500M is planned. This material is placed exclusively on the slopes, over a layer of humus and it is anchored in anchor trenches at the top and the bottom of the slope.

Hydrotechnical Installations

Hydrotechnical installations in the support structure zone at the Vinča landfill have the function to provide drainage of the leachate waters through the support structure and their evacuation to the leachate treatment plant (LTP).

The design documentation envisages the construction of a collector network for the collection of leachate waters and of facilities for the installation of equipment and for the maintenance of the pipeline (Source: PZI for rehabilitation of landfill landslide and stabilization of part of the Vinča landfill, Book 3 – Design of hydrotechnical installations Hidrozavod DTD, 2018).

Leachate Waters Collector Network

The collector network for the leachate waters collection is distributed in the drainage trench at the bottom of the inner part of the foot of the barrier. The function of the collector is to discharge leachate from the landfill mass to the LTP plant.

The collector network consists of the following elements:
- Drainage trench on the inside of the support structure;
- Discharge pipelines;
- Discharge structure.

Drainage Trench

The drainage trench function is to collect the leachate waters from the back of the supporting structure and to direct them towards the discharge pipelines. Two lateral pipelines are planned within the drainage trench - a 199.28 m drainage pipeline and a 205.04 m long drainage pipeline. For the lateral drainage pipelines, the design foresees a perforated HDPE pipe DN315mm SDR11.

The drainage trench is filled with granulated pebbles, with granulation of 16-32 mm, which is installed through the pipeline and the geosynthetic layer on the bottom.

In the zone of the inner slope of the supporting structure, a geosynthetic material POZIDRAIN 735, which enables efficient surface drainage, is envisaged as a drainage material.

Discharge Pipelines

The design envisages the construction of the main discharge pipelines and lateral discharge pipelines. The main drainage pipelines are provided in the lowest part of the drainage trench and consist of two HDPE pipes DN500mm SDR11. These two pipes have sufficient capacity to allow the evacuation of the drainage water outside the support structure. The slope of the main drainage pipeline is 3.5%.

The lateral drainage pipes have a function to allow local overflow of leachate waters. The design foresees a lateral pipeline on the north side, with an inclination of 3.1% and a lateral pipeline on the south side, with an inclination of 2.5%. The lateral pipelines are connected to the main pipelines in the gate chamber shaft.

Discharge Structure

The discharge structure is located next to the existing bed of the Ošljan stream and the leachate waters flow through into the bed until the leachate treatment plant is built. The untreated leachate waters will be discharged into the Ošljanski potok until the completion of construction of the lagoons for the leachate waters on the Lower Platform (6 to 8 months), after which a trial test of the leachate water treatment plant will start. Ošljanki potok is also a recipient of treated wastewater.

The discharge structure is monolithic reinforced concrete buried construction, with dimensions in the base of 2.4×1.65 m. The foundation slab is 25 cm thick. The walls of the discharge structure are 1.20 m in height and 25 cm thick.

The discharge structure is based on a 5 cm thick layer of lean concrete, and a 10 cm thick buffer layer of gravel with natural granulation.

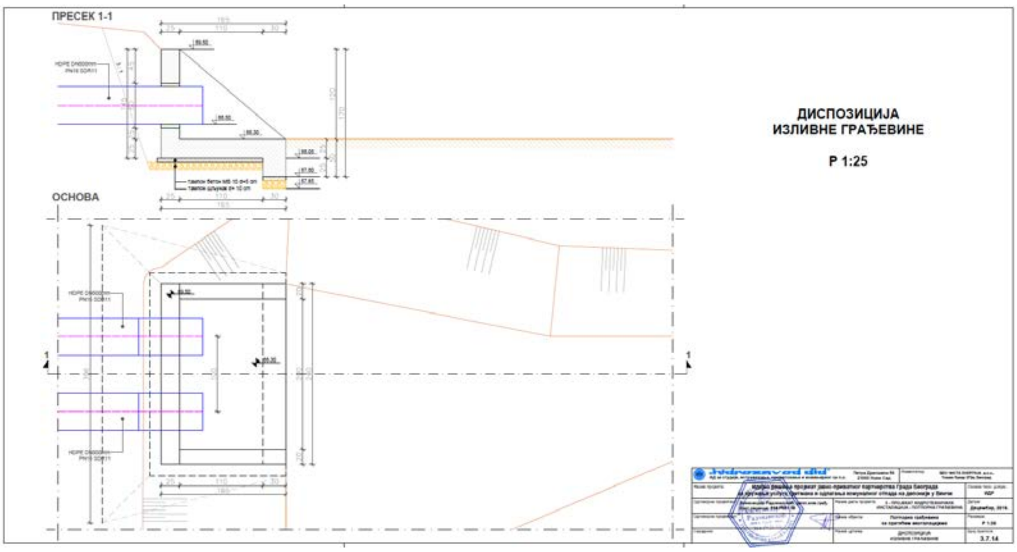


Figure 73 Discharge structure
(Source: PZI for rehabilitation of landfill landslide and stabilization of part of the Vinča landfill, Book 3 Hidrozavod DTD, 2018)

Structures at the collector network

Gate chamber shaft

Within the gate chamber shaft, the connection of the lateral pipelines to the main collector is carried out and the flow regulation equipment is installed.

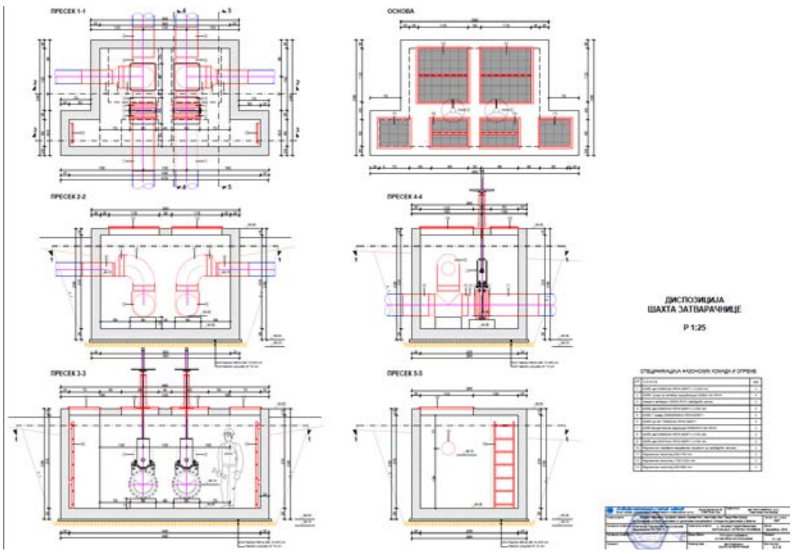


Figure 74 Gate chamber shaft

Control Shaft

The control shaft has the function of both the flow regulator and the maintenance of the pipeline. For the needs of the flushing of the pipeline, on each discharge pipeline, the access was made in the form of a blind flange, and hondling space is provided.

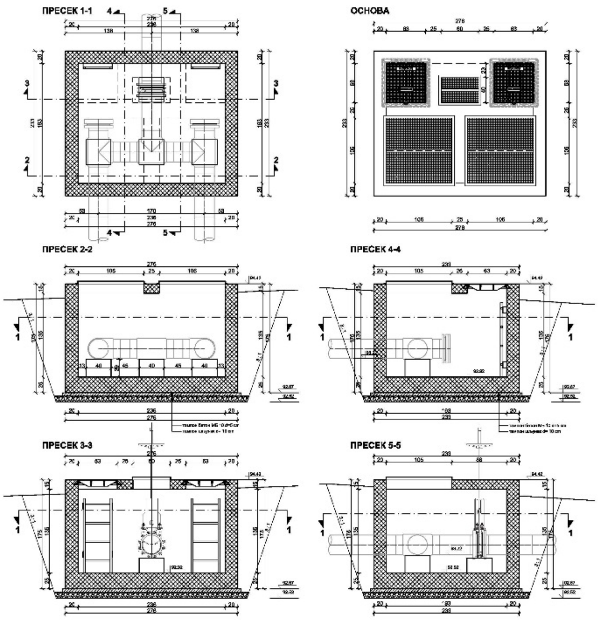


Figure 75 Control shaft

Pipelines Flushing Shaft

The pipelines flushing shaft is provided with access points for the flushing of pipelines at the ends of the pipeline in the form of a blind flange.

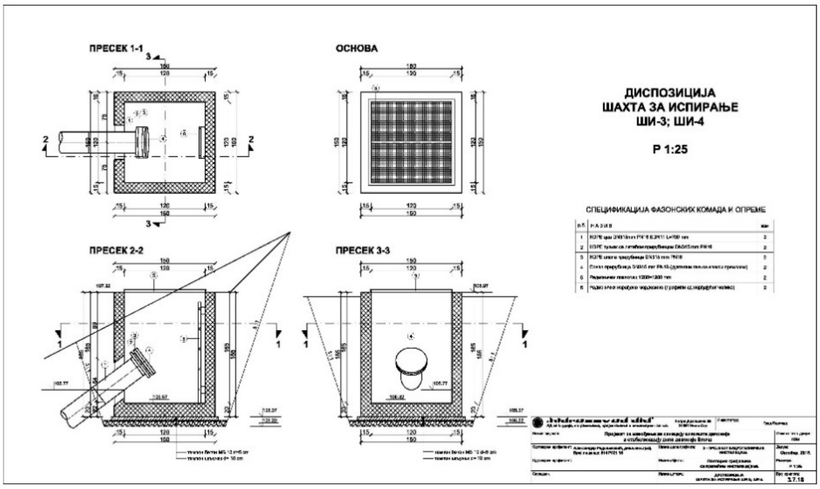


Figure 76 Pipelines Flushing Shaft

Connection Shaft

The function of the connection shaft is to connect the future pipeline for lateral drainage of the leachate waters from the landfill. The connection is provided in the form of a blind flange on a pipe of 315 mm in diameter. The shaft is defined in the design documentation as made from HDPE material because it is located on the inside of the supporting structure. The shaft is cylindrical in shape, 120 cm in diameter and 170 cm high.

Directing Atmospheric Waters

The collection of atmospheric waters falling to the outer slopes of the support structure is carried out over a channel network from concrete prefabricated channels with trapezoidal cross-section. One line of concrete channels is installed on the outer berm of the support structure and the other in the outer foot of the supporting structure. The total length of the channel is 328.0 m.

The width of the bottom of the concrete channels is 26 cm and the depth is 20 cm. The thickness of the wall is 5 cm. The channels are placed on a gravel base.

On the external berm, it is necessary to achieve minimal inclinations of the bottom of the channel of 0.4% to the sides. The channel network gravitates to the lowest points of the valley, towards the bed of the Ošljanski potok.

Service Road

For the purpose of inspection and access to the facilities within the drainage system, it is envisaged to build a service road through the crown of a supporting structure. The service road width is 3.5 m. A traffic road with a surface of crushed stone is foreseen. The thickness of the surface is 25 cm, and two layers are foreseen, the lower layer with granulation of 31.5-63 mm is 15 cm thick, and the upper layer with granulation of 0-31.5 mm is 15 cm thick.

The service road consists of a road through the crown of the supporting structure and the planned road, which is actually an extension of the road through a supporting structure in order to access the shafts for the flushing of the pipeline.

The length of the road over the crown of the supporting structure is 235.9 m and the planned road is 69.70 m.

3.1.1. Calculation of slope stability of new, old and inert landfill under static and dynamic conditions

The calculation of the stability of the landfill slopes (Source: 17048-PGD-02-01.1 Energoprojekt Niskogradnja) comes to determining the safety factor as the ratio between the shear strength of the soil and the average shear stress along the assumed sliding surfaces.

The conditions that give the minimum factors for the safety of slopes of the landfill are relevant for the calculation. The calculated minimum safety factors must be greater than the permitted safety factors which according to the JUS Regulation. U.C5.020, 1980 is as follows:

- in static conditions for constant loads:

  - for embankments up to 15 m high, Fs, dop ≥ 1.30;
  - for embankments over 15 m high, Fs, dop ≥1.50;
- in static conditions for occasional loads:
  - for embankments up to 15 m high, Fs, dop ≥ 1.20;
  - for embankments over 15 m high, Fs, dop ≥1.30;

For the impact of an earthquake, the criterion is adopted that the minimum safety factors for critical sliding surfaces must be greater than or equal to:

- permissible safety factor Fs, dop = 1.10 for EC-8 earthquake (return period 475 years),
- permissible safety factor Fs, dop = 1.00 for earthquake Z2 (return period 1000 years

According to the Rulebook, the minimum required Fs is allowed to be lower than 1.0 if the maximum movement is within acceptable limits and does not affect the stability and functionality of the landfill.

Calculation methods

The stability calculation was performed using the GeoStudio 2007 software package, i.e. its SLOPE/W tool, which is based on border balance conditions. The calculations in SLOPE/W were performed using the Morgenstern - Price method for arbitrary sliding surfaces. This software automatically searches for a critical sliding circle with a minimum safety factor. The determination of critical sliding surfaces was carried out by the Entry and Exit procedure, defining two lines representing the areas of inlet and outlet of critical sliding surfaces on the slope of the landfill. Within the boundaries of these lines, several possible sliding surfaces are specified, while the graphic annexes show optimized sliding surfaces corresponding to the minimum safety factors.

The effect of the earthquake on the slope stability was tested by a pseudo-static analysis, in which the earthquake is represented by the acceleration that produces inertial forces. These forces act in the horizontal and vertical directions at the center of each lamella. In SLOPE/W, pseudo-static acceleration is entered by the coefficient c, which represents the ratio of pseudo-static acceleration and gravitational acceleration. Pseudostatic acceleration was calculated as cx = 2/3cmax.

The pore pressures in the landfill foundation and in the materials during the construction phase of the landfill were introduced into the program through the coefficients of pore pressure, which represents the ratio of the weight of the water column and the weight of the soil in the dry state at a certain point.

Results of the slope stability calculation for the new landfill

Selection of material characteristics

The adopted parameters of the shear strength of the material to be incorporated into the body of the new landfill as well as of the materials in the landfill foundation are shown in the following table and in the following figures.

Table 18 Characteristics of the materials for the landfill and the foundations-New landfill

Mark	MATERIAL	γ [kN/m³]	c' [kN/m²]	ϕ' [°]
1	ENVIRONMENT GT2	19	15	21
2	ENVIRONMENT GT4	20	20	20
3	ROCK	21	50	28
4	LANDFILL- Phase III	8.5	0	25
5	LANDFILL-buffer zone	8.5	0	25
6	EMBANKMENT	17	10	20

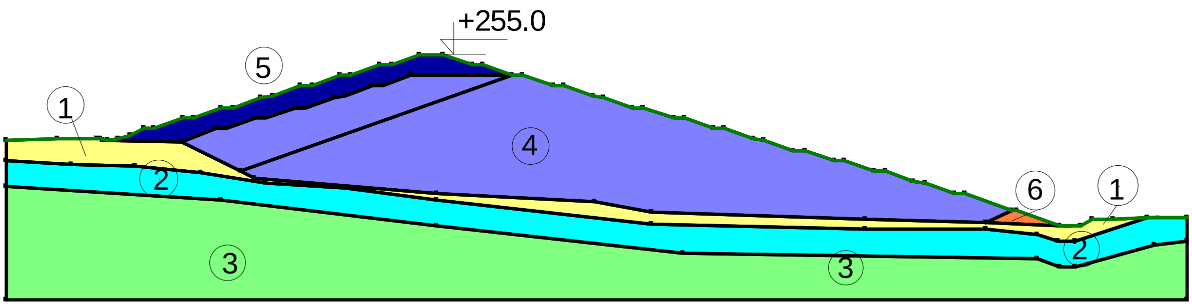


Figure 77 Model of the new landfill – the final construction phase (Phase IV)

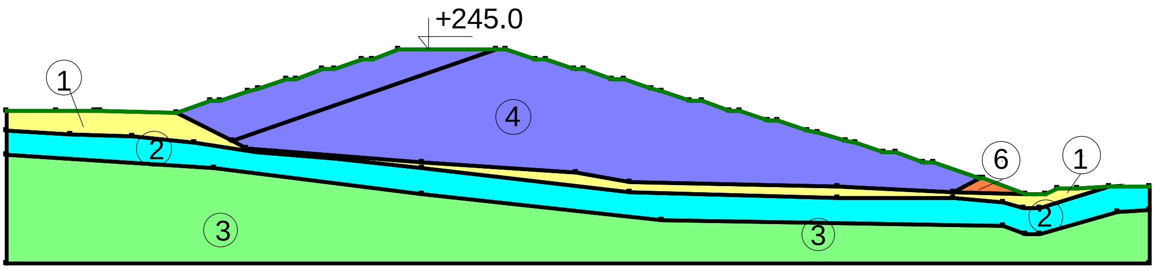


Figure 78. Model of the new landfill – Phase III of the construction

For the materials from which the embankment was built, as well as for the materials in the landfill foundation, the shear strength parameters were adopted according to the linear Mohr-Coulomb fracture law based on laboratory and field tests performed for the purpose of designing all stages of remediation of the old and the construction of the new landfill, presented in detail in the Geotechnical Study. The parameters for the waste material at the landfill were adopted based on experience in the design of similar facilities and the literature data.

Adopted Design Criteria

The stability of the slopes of the new landfill (the left and right slope) was tested for several different sliding surfaces. At the end of this chapter, only the characteristic sliding surfaces for which minimum safety factors are obtained are presented.

For sliding surfaces for which minimal safety factors are obtained under static conditions, a stability analysis in seismic conditions was performed using a quasi-static method.

In dynamic conditions, earthquakes according to EC-8 as well as earthquake Z2 of the return period of 1000 years were adopted as the relevant conditions.

Table 19 Maximum and pseudostatic accelerations from the earthquake –the new landfill

	Tr(year)	Tso(s)	Maximum acceleration		Pseudostatic acceleration	
			ah(g)	av(g)	ah(g)	av(g)
EC-08	475	0.25	0.125	0.031	0.083	0.021
Z2	1000	0.43	0.147	0.035	0.098	0.023

The calculation of the slope stability of the new landfill was carried out for the final phase of the landfill construction as well as for phases I, II and III of the landfill construction.

Calculation results - final phase of landfill construction

The stability calculations for the final phase of the landfill were made at the characteristic cross-section 22.

The following tables present the results of the stability calculations for the last phase of construction of the landfill for section 22, while graphics are given at the end of this chapter.

Table 20. Section 4 - Safety factors for the final phase of construction of the new landfill

Cross section 4 – Final construction phase	SAFETY FACTORS		Fs,dop
	Left slope	Right lope	
Static condistions – situation before the recultivation	1.347	1.565	1.30
Static condistions – situation after the recultivation	1.716	1.756	1.50
Pseudostatic conditions (EC-08)	1.298	1.318	1.10
Pseudostatic conditions (Z2)	1.242	1.260	1.00

Final phase of construction of the new landfill

This chapter presents graphics for the calculation of the slope stability of the new landfill for the final phase of the landfill construction, for two options: before recultivation and after recultivation.

Table 21 Material characteristics of the new landfill and foundation up to the final elevation

Mark	MATERIAL	γ [kN/m^3]	c' [kN/m^2]	ϕ' [°]	ru*/ru** [-]
1	ENVIRONMENT GT2	19	15	21	0.15/0.15
3	ENVIRONMENT GT4	20	20	20	0.10/0.10
4	ROCK	21	50	28	0.0/0.0

5	LANDFILL- Phase III	8.5	0	25	0.10/0.0
6	LANDFILL-buffer zone	8.5	0	25	0.20/0.0
7	EMBANKMENT	17	10	20	0.10/0.0

ru* and ru** - the pore pressure coefficient before recultivation and after recultivation

The calculations of the slope stability of the new landfill to the final stage before recultivation are shown in the following figures.

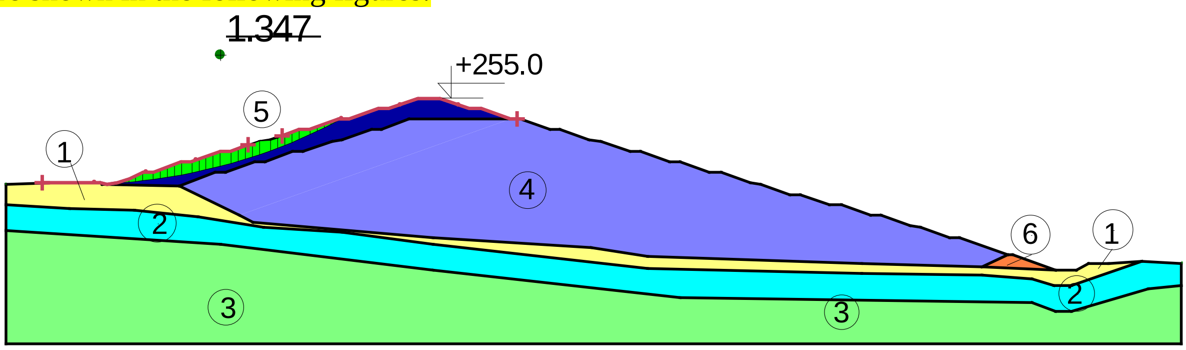


Figure 79 Section 4 - Final phase of landfill construction, situation before the recultivation, static conditions, left slope, Fs=1.347

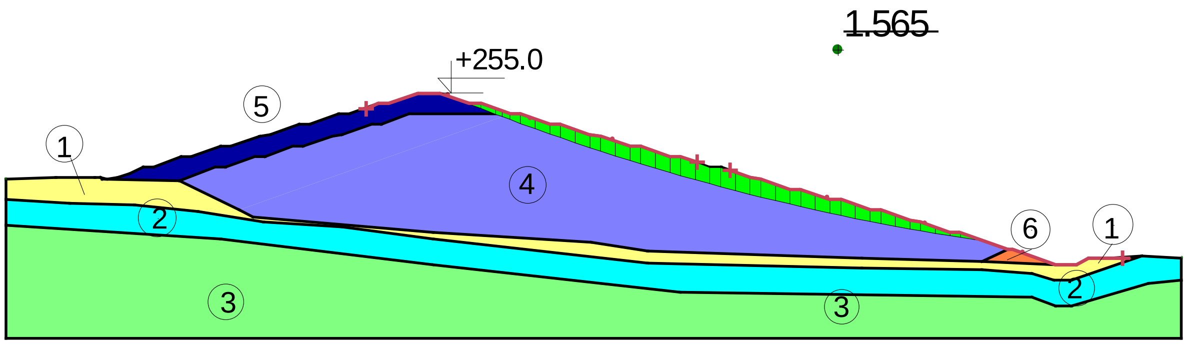


Figure 80 Section 4 - Final phase of landfill construction, situation before the recultivation, static conditions, right slope, Fs=1.565

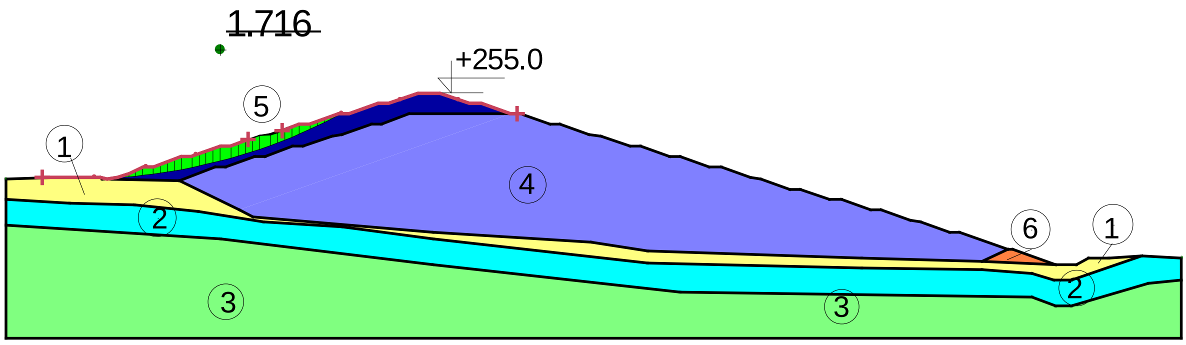


Figure 81 Section 4 - Final phase of landfill construction, situation after the recultivation, static conditions, left slope, Fs=1.716

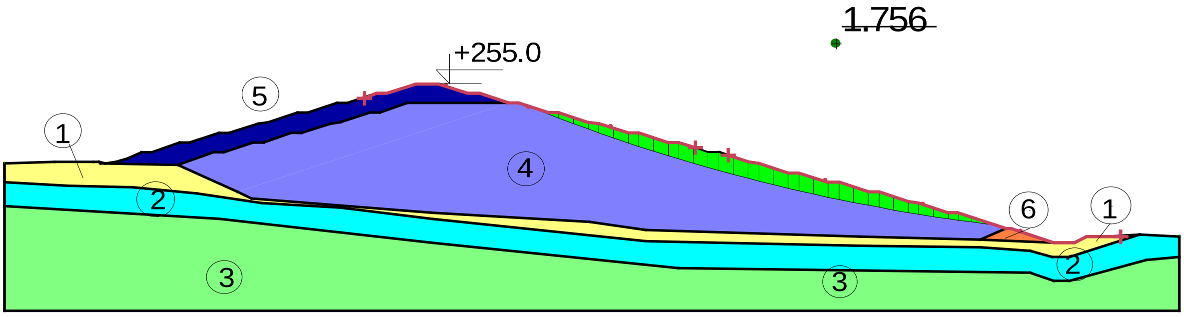


Figure 82 Section 4 - Final phase of landfill construction, situation after the recultivation, static conditions, right slope, Fs=1.756

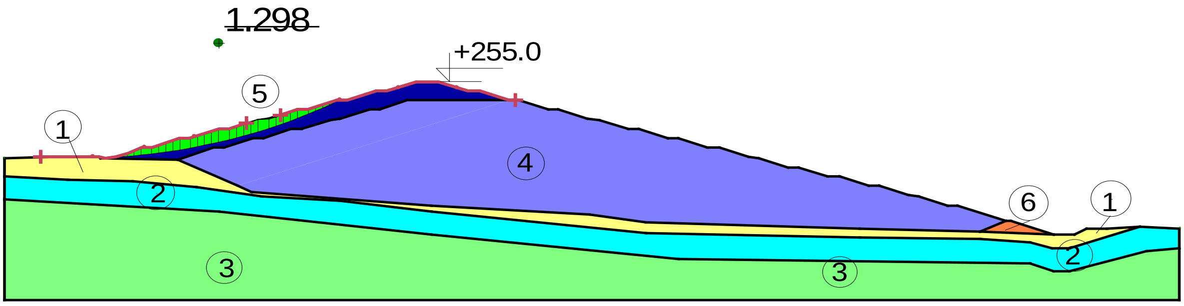


Figure 83 Section 4 - Final phase of landfill construction, situation after the recultivation, pseudo static conditions(Z1), left slope, Fs=1.298

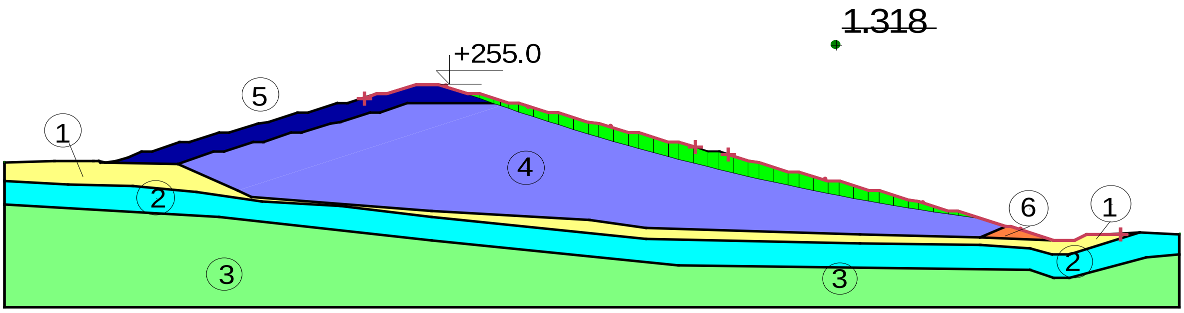


Figure 84. Section 4 - Final phase of landfill construction, situation after the recultivation, pseudo static conditions(Z1), right slope, Fs=1.318

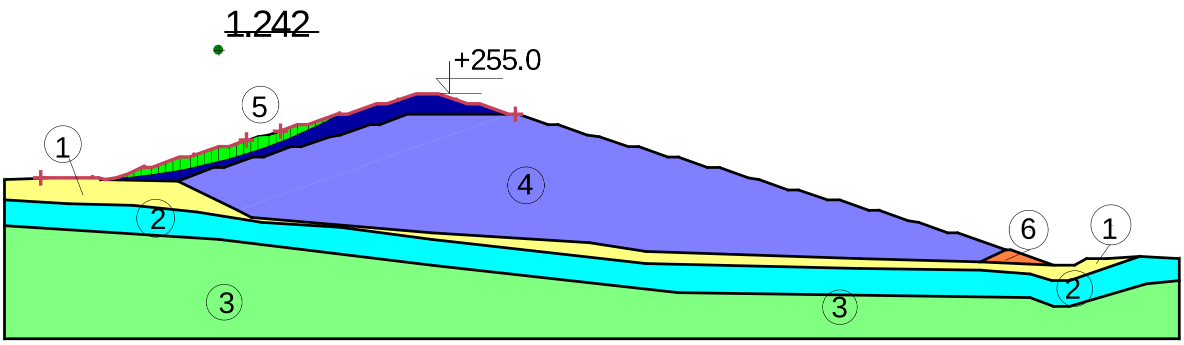


Figure 85. Section 4 - Final phase of landfill construction, situation after the recultivation, pseudo static conditions(Z2), left slope, Fs=1.242

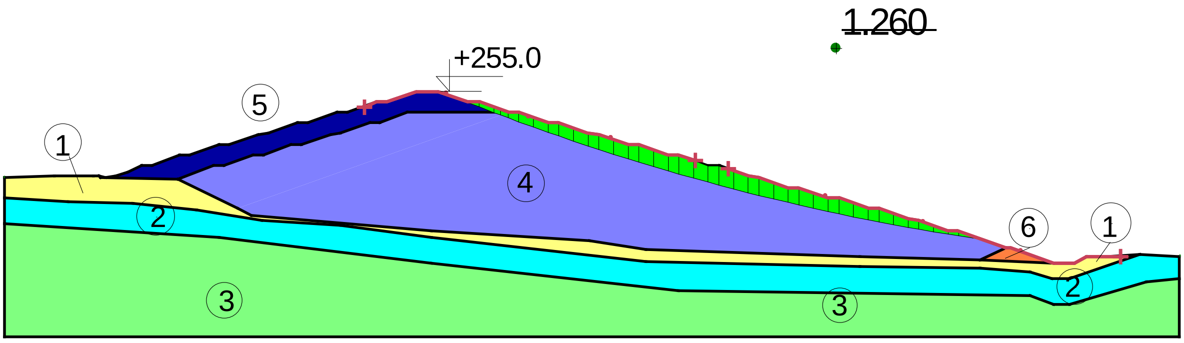


Figure 86 Section 4 - Final phase of landfill construction, situation after the recultivation, pseudo static conditions(Z2), right slope, Fs=1.260

Conclusion

Based on the conducted analysis, it can be concluded that the slopes of the new Vinča landfill in the final phase of the landfill construction are stable for all static and seismic loads, i.e. that the minimum safety factors obtained are greater than the permitted safety factors. Based on the foregoing, it can be concluded that the stability and functionality of the new Vinča Landfill have not been compromised.

Results of the Phase III Budget Calculation

The adopted parameters for the shear strength of the material to be incorporated into the Phase III landfill body as well as the materials in the landfill foundation are shown in the following table and in the following figure.

Table 22 Characteristics of landfill and foundation materials

Mark	MATERIAL	γ [kN/m^3]	c’ [kN/m^2]	ϕ’ [°]	ru*/ ru** [-]
1	ENVIRONMENT GT2	19	15	21	0.15/0.15
2	ENVIRONMENT GT4	20	20	20	0.10/0.10
3	ROCK	21	50	28	0.0/0.0
4	LANDFILL- Phase III	8.5	0	25	0.20/0.10
6	EMBANKMENT	17	10	20	0.10/0.05

* Note: ru * - pore pressures after construction, and before recultivation, ru ** - values of pore pressures after partial recultivation of phase III of the landfill construction, i.e. after covering the temporary slopes of the landfill with a clay layer 0.5m thick.

The following table shows the results of the stability calculation for the Phase III of the landfill construction at cross-section 22, while graphics are given in the figures at the end of this chapter.

Table 23. Results of the stability calculation- New landfill Phase III of construction

Final phase of the landfill	SAFETY FACTORS		Fs,dop
	Left slope	Right slope	
Static conditions-before the partial recultivation	1.356	1.380	1.3
Static conditions-after the partial recultivation	1.598	1.568	1.5
Pseudostatici conditions (EC-08) Z1	1.166	1.174	1.0

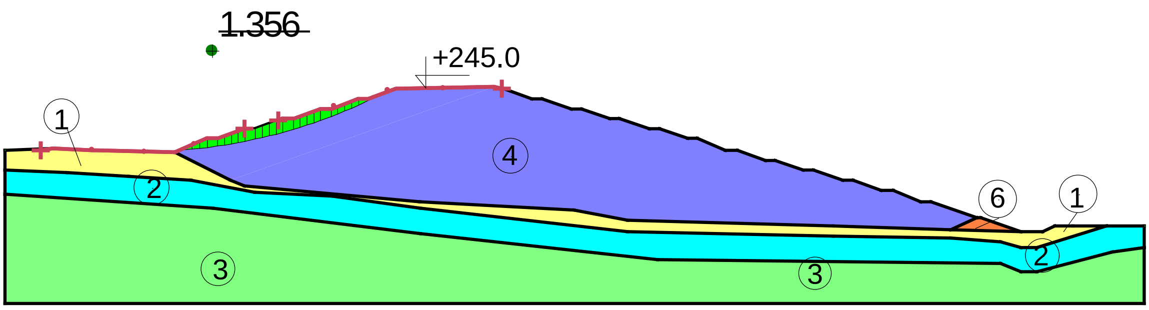


Figure 87 Phase III of construction - Static conditions-before recultivation, left slope, Fs=1.356

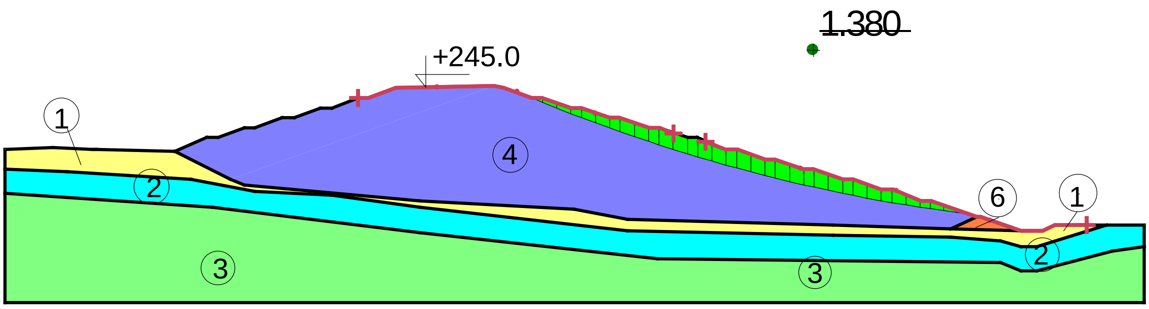


Figure 88 Phase III of construction - Static conditions-before recultivation, right slope, Fs=1.380

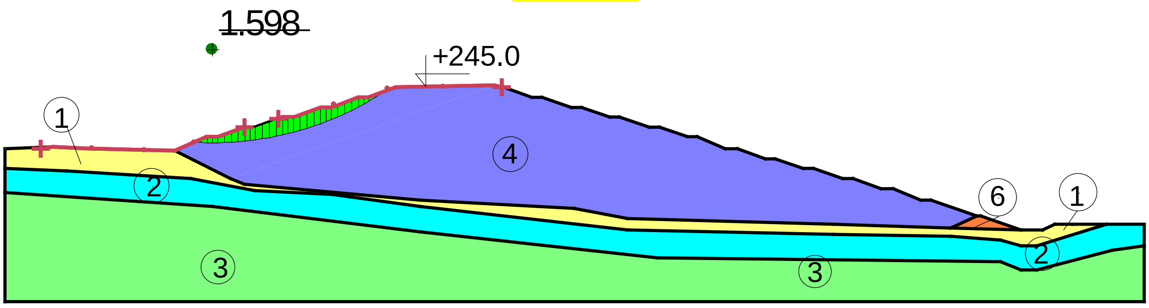


Figure 89 Phase III of construction - Static conditions-before partial recultivation, left slope, Fs=1.598

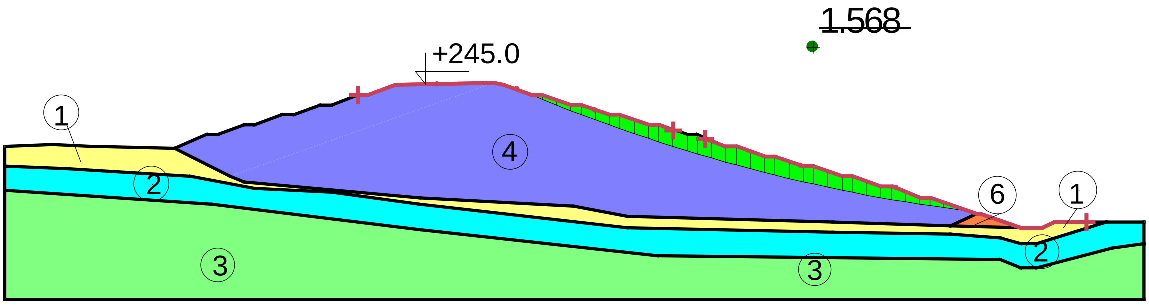


Figure 90. Phase III of construction - Static conditions-before partial recultivation, right slope, Fs=1.568

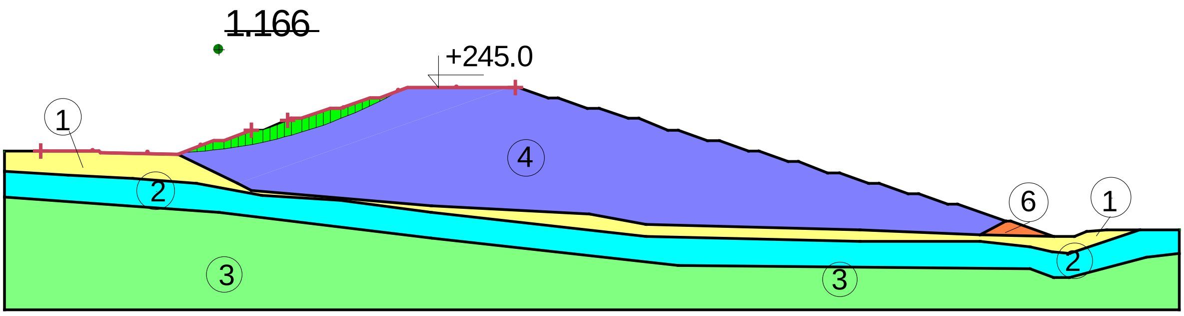


Figure 91. Phase III of construction – Pseudo-static conditions (EC-08), left slope, Fs=1.166

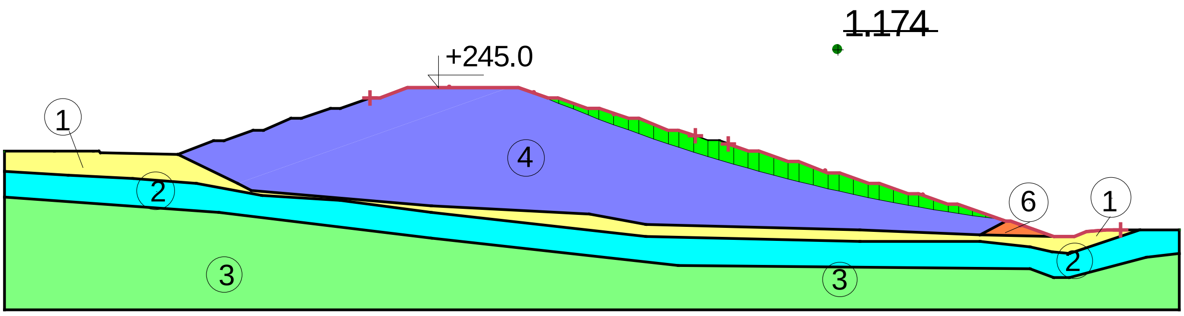


Figure 92. Phase III of construction – Pseudo-static conditions (EC-08), right slope , Fs=1.174

Conclusion

Based on the conducted analyzes, it can be concluded that the slope of phase III of construction of the new Vinča landfill is stable for all static loads as well as for seismic loads Z1, i.e. that the minimum safety factors obtained are higher than the permitted safety factors. Based on the above, it can be concluded that the stability and functionality of Phase III of the construction of the new Vinča Landfill have not been compromised.

Results of Calculation for Phase I and Phase II of the New Landfill Construction

Temporary slopes at 1:2.7 in the Phase I and Phase II of landfill construction were calculated at cross sections VP8 and 22, respectively. The adopted shear strength parameters of the material are shown in the following table and figure.

Table 24. Characteristics of landfill materials and foundations for Phase I and Phase II of landfill construction

Mark	MATERIAL	γ [kN/m³]	c' [kN/m²]	ϕ' [°]	ru*
1	ENVIRONMENT GT2	19	15	21	0.15/0.15
2	ENVIRONMENT GT4	20	20	20	0.10
3	ROCK	21	50	28	0.0
4	LANDFILL- Phase I	8.5	5**	25	0.20
6	EMBANKMENT	17	10	20	0.10

Note: * ru - pore pressure coefficient after construction Phase I and Phase II of a new landfill
** In Table 26, Characteristics of the foundation material, higher shear strength parameters for unprocessed waste have been adopted, as it will not completely degrade and reduce its mechanical properties during these phases.

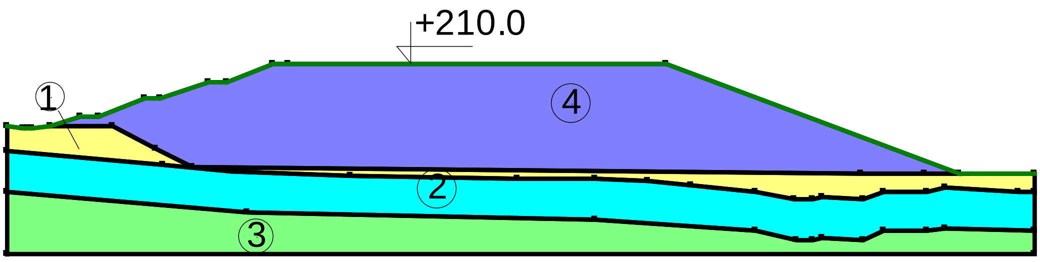


Figure 93 Section VP8: Model – landfill construction Phase I

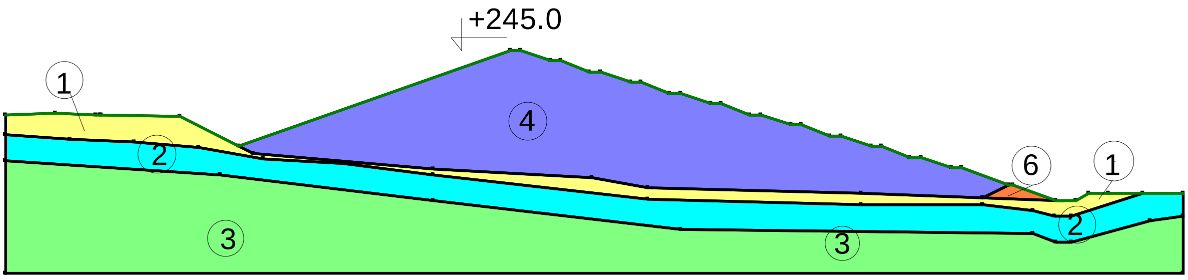


Figure 94 Section 22: Model – landfill construction Phase II

The following table shows the results of the stability calculations for Phase I and Phase II of the landfill construction, while graphs are given in the figures at the end of this chapter.

Table 25. Stability calculation results - New landfill Phase I and Phase II of construction

Final landfill phase	SAFETY FACTORS Temporary slope	Fs,dop
Phase I - Static conditions-before recultivation	1.416	1.3
Phase II - Static conditions- after recultivation	1.365	1.3

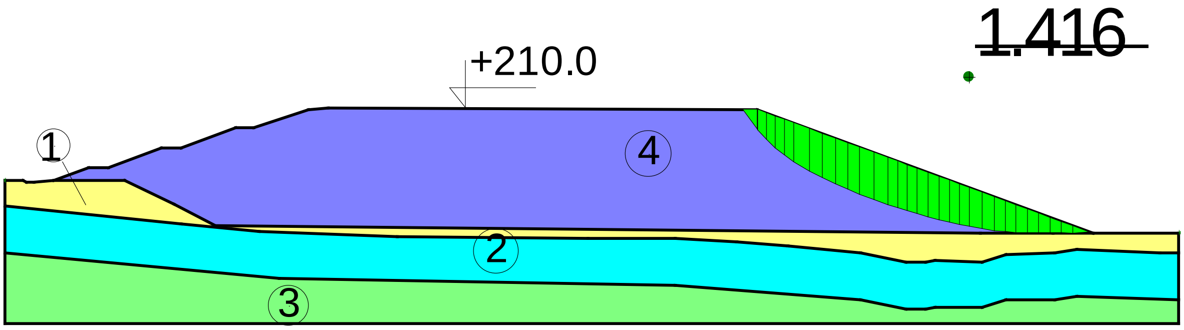


Figure 95 Phase I of the landfill construction - Static conditions, before recultivation, right slope, sFs=1.416

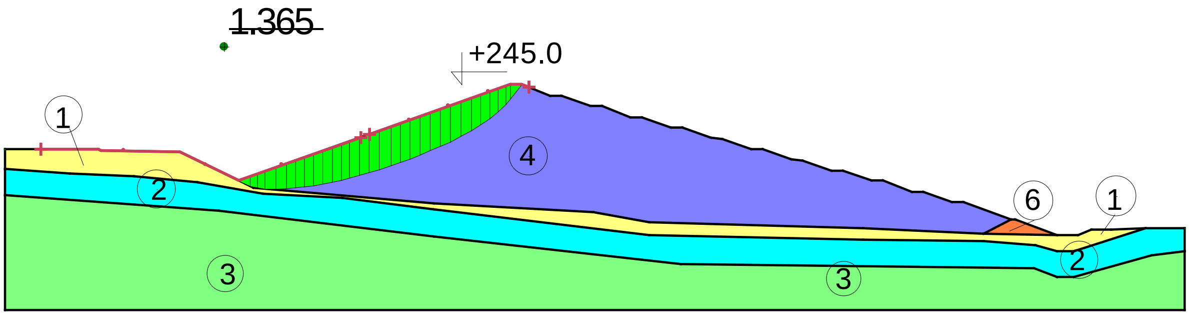


Figure 96 Phase II of the landfill construction - Static conditions, before recultivation, right slope, Fs=1.365

Conclusion

Based on the analysis, it can be concluded that the slopes of Phase I and Phase II of the new Vinča Landfill are stable for all static loads, ie that the minimum safety factors obtained are higher than the permitted safety factors. Based on the foregoing, it can be concluded that the stability and functionality of Phase I and II of the construction of the new Vinča Landfill have not been compromised.

Results of the excavation calculation for the new landfill

The excavation stability calculation was performed at cross-section 22. The adopted shear strength parameters of the material are shown in the following table and figure.

Table 26. Characteristics of foundation materials

Mark	MATERIAL	γ [kN/m^3]	c' [kN/m^2]	ϕ' [°]	ru [-]
1	ENVIRONMENT GT2	19	15	21	0.15
3	ENVIRONMENT GT4	20	20	20	0.10

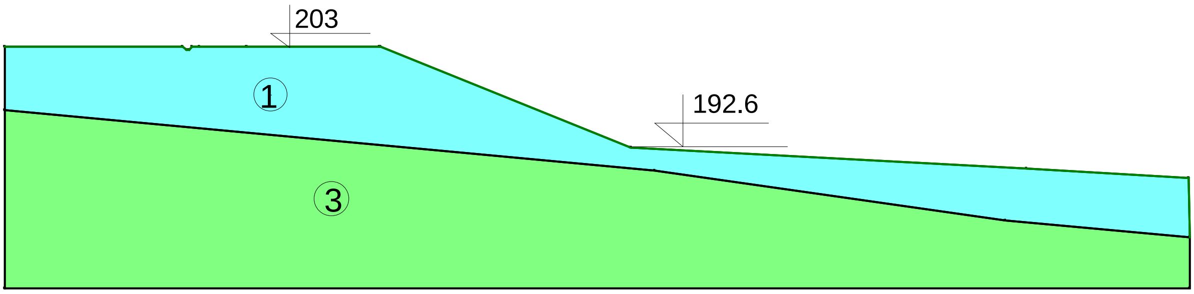


Figure 97. Model – New landfill excavation

The following table shows the results of the excavation stability calculation for a new landfill at section 22, while graphics are given in the following figures.

Table 27. Results of the stability calculation - New landfill excavation

Final phase of the landfill	SAFETY FACTORS	Fs,dop
Static conditions of the partial recultivation	1.469	1.3
Pseudostatic conditions (EC-08) Z1	1.185	1.0

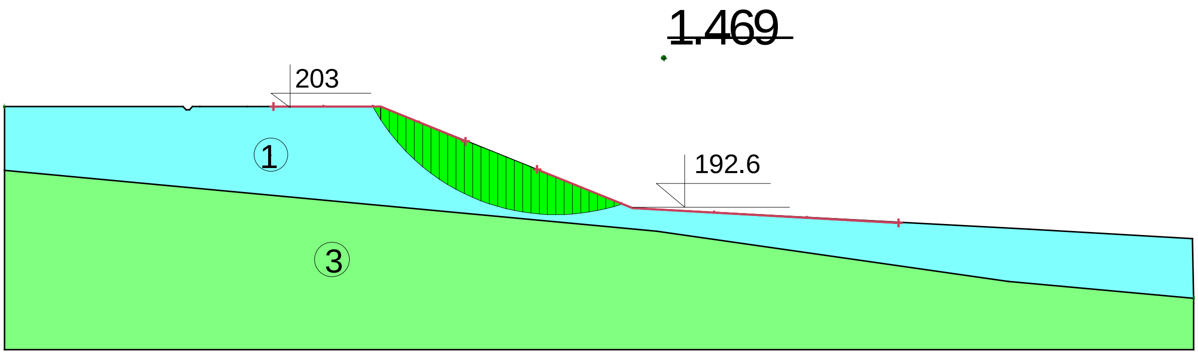


Figure 98 New landfill excavation – Section 22, Static conditions, Fs=1.469

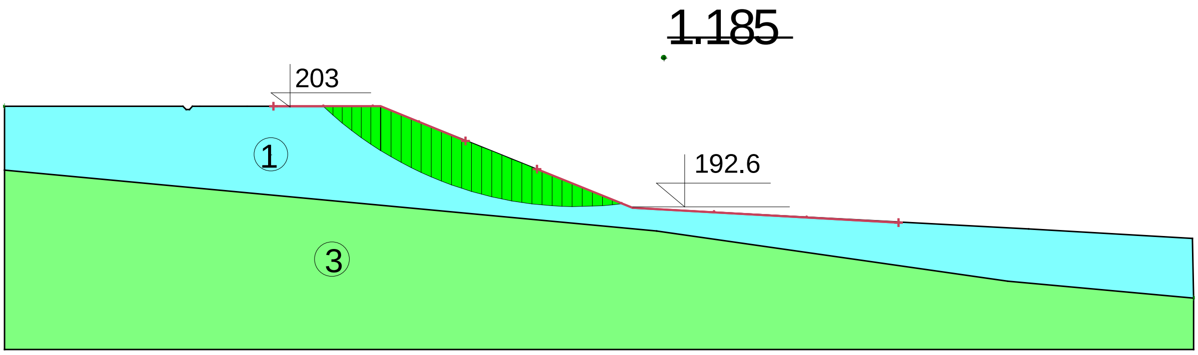


Figure 99 New landfill excavation – Section 22, Pseudostatic conditions (EC-08), Fs=1.185

Results of inert landfill slope stability calculations

The inert landfill slope stability calculation was carried out at the intersection of the maximum height.

The adopted shear strength parameters of the material to be incorporated into the landfill body as well as the material in the landfill foundation are shown in the following table and figure.

Table 28. Material characteristics of INERT landfill and foundation

	MATERIAL	γ [kN/m³]	c' [kN/m²]	ϕ' [°]	ru [-]
1	ENVIRONMENT GT2	19	15	21	0.15
2	ENVIRONMENT GT4	20	20	20	0.10
3	ROCK	21	50	28	-
4	CONSTRUCTION WASTE	19.5	0	30	0
5	EMBANKMENT	17	10	20	0.1

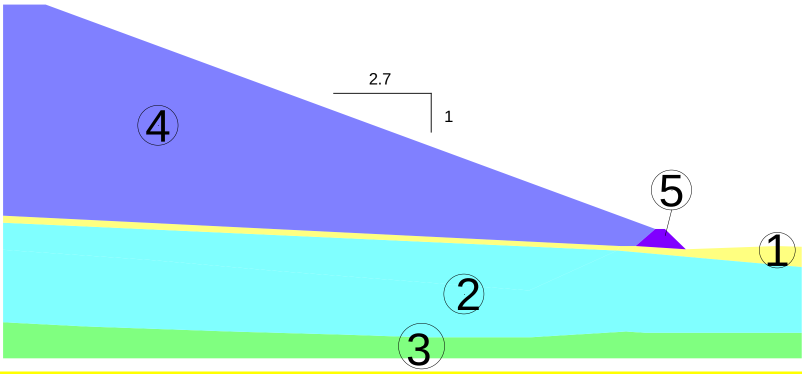


Figure 100. Model of the inert landfill – final phase (critical section with maximum height)

For the materials used for the construction of the body of the landfill , as well as for the materials in the landfill foundation, the shear strength parameters were adopted according to the linear Mohr-Coulomb fracture law based on laboratory and field tests carried out for the purpose of designing all stages of remediation of the old and the construction of the new landfill are presented in detail in the Geotechnical study.

The adopted design criteria

The stability of the slopes of the landfill (left and right slopes) was tested for several different sliding surfaces. At the end of this chapter, only the characteristic sliding surfaces for which minimum safety factors are obtained are presented.

For sliding surfaces for which minimal safety factors are obtained under static conditions, a stability analysis in seismic conditions was performed using a quasi-static method.

Under dynamic conditions, earthquakes according to EC-8 as well as earthquake Z2 of the return period of 1000 years were adopted as the relevant conditions.

Table 29. Maximum and pseudo static accelerations from earthquakes - Inert landfill.

	Tr(year)	Tso(s)	Maximum acceleration		Pseudo static acceleration	
			ah(g)	av(g)	ah(g)	av(g)
EC-08	475	0.25	0.125	0.031	0.083	0.021
Z2	1000	0.43	0.147	0.035	0.098	0.023

The following tables present the results of calculations for stability of the inert landfill in the cross section of the maximum height, and graphics are given at the end of this chapter.

Table 30. Safety factors for inert landfills

Burden conditions	SAFETY FACTORS	Fs,dop
Static conditions	1.511	1.50
Pseudo static conditions (EC-08)	1.201	1.10
Pseudo static conditions (Z2)	1.156	1.00

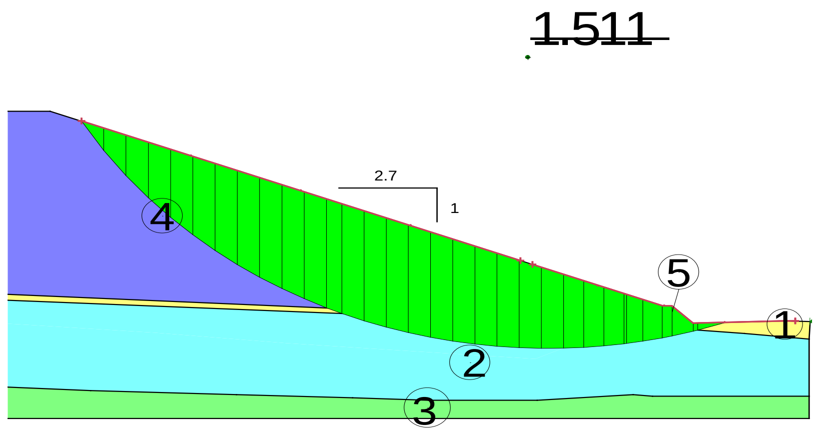


Figure 101 Safety factor in static conditions, Fs=1.511

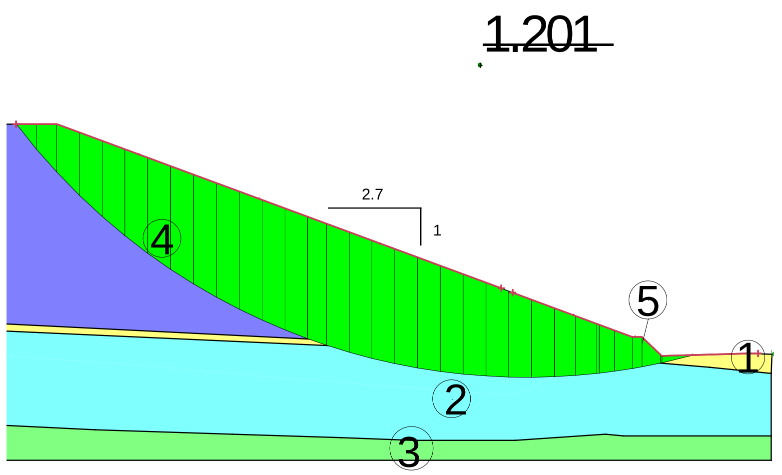


Figure 102 Safety factor in pseudo static conditions (Z1), Fs=1.201

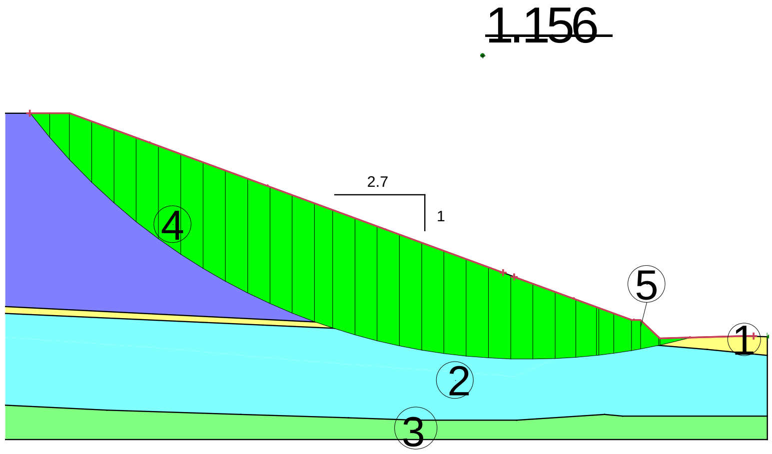


Figure 103 Safety factor in pseudo static conditions (Z2), Fs=1.156

Conclusion

Based on the analysis, it can be concluded that the slopes of the Inert landfill at the Vinča landfill are stable for all static and seismic loads, i.e. that the minimum safety factors obtained are higher than the permitted safety factors. Based on the above, it can be concluded that the stability and functionality of the Inert landfill at the Vinča landfill is not compromised.

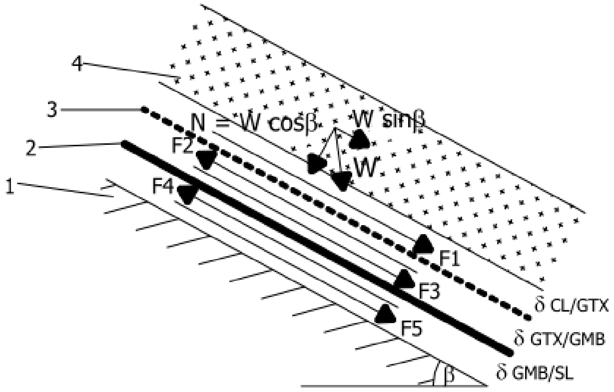
Calculation of stability of landfill cover layers

The following is a calculation of the stability of the landfill cover layers with the design parameters:

- max. slope 1: 2.7,
- max. slope length 60 m,
- the internal friction angle of the earth cover layer 26°,
- internal friction angle of the covering layer (clay mineral or geosynthetic) 25°,

The parameters used to calculate the tensile forces in various GSS geosynthetics are the shear angles at the material contacts.

The calculation of the cover layers was made for the steepest slopes of the landfill (V: H = 1: 2.7)



1. Support layer
2. Geomembrane
3. Geotextile
4. Cover layer

Figure 104. Force analysis in the cover layer of slopes - GSS Sealing System (Koerner)

The shear angles between the two materials allow the calculation of the shear stresses along the considered contacts:

$$\tau = (\sigma - u) \tan \delta$$

u - contact pore pressure, (u = 0)

The forces considered in the GSC represent the following:
- The force parallel to the slope is Wsinβ, where W represents the weight of the cover layer and β is the slope.
- The forces that can cause tensile forces in geosynthetics are as follows:
- F1-F2 = tensile force in geocomposite drainage layer
where
- F1 = Ntan δps / Gkomp
- F2 = Ntan δps / Gkomp
- δps / Gcomp - internal friction angle along the contact of the layer over the geocomposite and the geocomposite
- δGkom / GM - internal friction angle along the contact of geocomposite and low permeability clay mineral layer

If F1> F2 is equivalent to δps / Gkomp> δGkom / GM and corresponds to the case of lower contact resistance above the geocomposite, no tension within this layer will occur.

If the angle does not provide stability of the cover layers, anchors and / or supports should be used.

The preliminary calculation for the adopted internal friction angles at the material contacts is shown in the following tables:

Table 31. Tensile forces in geocomposite

Geotextile			
	mark	dim.	value
height of the overlayer	h	m	0.5
length of slope	l	m	60
width in the longitudinal direction		m	1
weight	W	kN	600
slope 1: 2.7	tan β		0.371
slope 1: 2.7	β	°	18.433
tangential force	T	kN	189.717
normal force	N	kN	569.216
friction angle of overlayer and geocomposite	δps/Gkomp	°	26
friction angle geocomposite/clay layer	δGkom/GM	°	25
friction of the overlayer -geocomposite	F1	kN	292.64
friction geocomposite-protective layer	F2	kN	279.785
slide safety -geocomposite coefficient	F1/T		1.5425
tension in geocomposite	F1-F2	kN	12.855

For the assumed geosynthetic layer and material parameters, a safety factor >1.30 (required minimum) was obtained.

It is necessary to prove the stability of geosynthetic products on the slopes of the landfill before performing the works.

The manufacturer of geosynthetics should demonstrate that the minimum safety factor for internal plane stability is satisfied, as this may cause the slope to fall for a particular geosynthetic product and particular materials that cover the geosynthetic material or in their base.
Fs,dop ≥1.3.

3.1.2. Regulating and Landscaping

Landscaping

The Vinča communal waste landfill area and its immediate surroundings is an area of damaged and almost completely destroyed autochthonous and anthropogenic (agricultural) spatial units.

The land where forming the protective green belt is envisaged is for the most part covered with autochthonous vegetation, while only one part is used for agriculture. In the northern and north-east part of the complex nearer to the Danube bank, the land is influenced by high ground waters and on the eastern side the area is covered by forest.

By the landscape design (Source: IDP Book 9, Landscape Design – Protective Green Belt, Landscaping, Fence, Energoprojekt Hidroinženjering, May, 2019), it is foreseen to form a protective green belt from various shrubs and tree species along the fence of the complex, on the inner side in the width of 20m, except to the right from the entrance in the length of 630m, in the width of 10m due to technical conditions.

The belt will consist of good quality shrub and woody species which are naturally already located in the area where the green belt will be formed. In other areas and as an addition, deciduous and coniferous species will be planted, species that are resilient and fulfill the requirements of green belt efficiency throughout the year.

Provided by the design solution, the protective belt will fulfill the sanitary, hygienic and decorative function and upon the forming of thick vegetation it will prevent further endangering of the environment (wider area) by gasses, dust and potential light landfill waste dispersing.

In addition, this type of greenery will be incorporated into the system of newly formed green landfill areas and surrounding forests and as such it will affect its entity, functionality and aesthetics.

Within the KP6-4 construction unit, on the entrance-control platform, the forming of a green area by free shaping is envisaged, with the use of trees, shrubs and grass covers.

According to this design solution, the biological recultivation of the new landfill envisages grassing of areas which in the process of technical recultivation, in accordance with the dynamics of the use of the provided area.

The Protective Green Belt

This area includes natural habitats with woody and shrub vegetation, with mosaic distributon of grass areas.

A list of plant species (bioecological basis) that are located in the green belt area was made (list of species is displayed in detail in the subject Landscape design).

The existing groups of shrub vegetation are mainly kept, by selection of the best quality specimens, except in parts where the percentage of Indigo bush amorpha and Old Man's Beard is high and such areas need to be cleared in order to prevent the expansion of invasive species.

Tree groups along the planned green belt route are of satisfactory vitality and decorative character and will be kept. An exception are forests in the eastern part of the complex where there are great damages (uncontrolled cutting down of trees, damage from wind and snow) and heavy attacks of insects and diseases, so their removal is recommended. "Trees with this state of health cannot perform the intended functions of a buffer zone and cannot prevent the spread of infection and disease, it is recommended that all vegetation in the eastern part be removed." (*Source: IDP Book 9, Landscape Design – Protective Green Belt, Landscaping, Fence, Energoprojekt Hidroinženjering, May, 2019*).

The positive effect of the green belt will be obvious at the distance of 20-30 heights of the planned greenery. The alignment of trees and shrubs in the green belt is formed so as to integrate into the natural environment in the best possible way.

Apart from its basic functions for protection and integration into the surrounding landscape which the green belt (Type A) needs to fulfill, on certain sections the green belt (Type B) should also fulfill the function of a vegetative barrier in order to prevent the spreading of and reduce pollution from dust near particular emitters. In the south-west part, green belt (Type C), besides serving as a vegetative barrier for dust, also has the function of protecting the space from dispersing plastic bags and similar waste.

Type A green belt envisages the forming of a 20 m wide belt which has a protective function and serves as a visual barrier that will help the vegetation integrate into the surrounding landscape. This type of belt is formed from a double tree strip in the middle and shrub strips on each side by planting seedlings in an alignment which imitates the natural environment at the mutual distance between the trees of 4m and the mutual distance between the shrubs of 1.5m. The number of woody species envisaged on one Are of surface is 7 pieces, and of shrub species it is 25 pieces. In order for the belt to function throughout the year, 30% of plants forming the green belt are envisaged to be evergreen.

The Type B green belt envisages the forming of a 20 m wide belt which serves to reduce dust pollution. At places where the area does not allow a 20 m wide belt (in the southern part by the

CDW platform) forming of a 10 m wide belt is envisaged. This type of belt implies thick planting of coniferous and deciduous tree species and the belt is formed from a triple tree strip in the middle and shrub strips on each side by planting seedlings in an alignment which imitates the natural environment at the mutual distance between trees of 3 m and the mutual distance between shrubs of 1.2m.

Forming of 20m wide Type C green belt is envisaged in the same way. Beside other things, its function is also to protect from dispersing plastic bags and similar waste, therefore the design should envisage placing of a net along the belt which would serve as an additional barrier for the dispersing of mentioned waste. The number of trees envisaged on one acre is 11, and the number of shrubs per acre is 35.

In order for the belt to function throughout the year, 30% of plants forming the green belt are envisaged to be evergreen.

All types of belts have a conical cross section because that shape best mitigates the wind currents. Coniferous trees and evergreen shrub seedlings should have an uninterrupted continuity along the full length of the belt in order to form a barrier during winter months when other species have lost their leaves and have reduced protective function.

For forming of the green belt, apart from the seedlings on the green belt route and the plants that will be kept, planting of new seedlings will be carried out to the required number of seedlings for achieving the envisaged thickness of the belt. Deciduous tree seedlings of minimum height of 2-3m will be used, depending on the type and coniferous trees of minimum height of 1m. Shrub species which will be planted should have well developed and branched foliage with multiple shoots. In addition to the autochthonous tree species, planting of allochthonous species is also planned. Considering there are no autochthonous evergreen species in the Belgrade area, evergreen and some introduced deciduous species are selected that correspond to the requirements that the green belt has to fulfil and to the conditions of the habitat and anthropogenic influence.

Alternating tree and shrub species along the belt provides more diverse colouring and surpasses the monotonous appearance of the entire green belt.

The coniferous and deciduous tree species and evergreen and deciduous shrubs are planned for forming of the green belt, according to the table:

Table 32 Specification of planting material predicted for planting in the green belt (Source: Excerpt from Table 7, Landscape Design - Energoprojekt Hidroinženjering, May, 2019)

No.	Species	Number of plants
	TREES, coniferous species	
1	*Pinus nigra* Arn.	2644
	Total coniferous trees	*2644*
	TREES, deciduous species	

2	*Tilia cordata* Mill.	1427
3	*Quercus cerris* L.	1427
4	*Quercus frainetto* Ten.	1427
5	*Fraxinus excelsior* L.	855
6	*Acer campestre* L.	570
7	*Salix alba* L.	77
8	*Alnus glutinosa* (L.) Gaertn	77
	Total deciduous trees	*5860*
	SHRUBS, coniferous species	
9	*Mahonia aquifolium* (Pursh) Nutt.	3177
10	*Prunus laurocerasus* L.	2887
11	*Pyracantha coccinea* M. Roem.	2887
	Total coniferous shrubs	*8951*
	SHRUBS, deciduous species	
12	*Spiraea* x *vanhouttei* (Briot.) Zbl	2580
13	*Forsythia* x *intermedia* Zab.	2580
14	*Symphoricarpos albus* (L.) S. F. Blake	2000
15	*Corylus avellana* L	2000
16	*Sambucus nigra* L.	759
17	*Crataegus monogyna* (Jacq.)	620
18	*Crataegus laevigata* (Poiret) DC.	620
19	*Cornus sanguinea* L.	620
20	*Rosa rugosa* Thunb.	620
	Total deciduous shrubs	*12399*

A 1-2 m wide space will be formed between the fence of the complex and the plants in the protection zone, which will be grassed to allow access to the fence from the space of the complex.

Landscaping of the Entrance-Control Zone

The entrance-control zone is a space consisting of five green spaces, with a total area of 4,237.0 m2 (T1 - 505.0 m^2; T2 - 374.0 m^2; T3 - 410.0 m^2; T4 - 452.0 m^2 and T5 - 2,496.0 m^2).

Plants on the plots intended for the formation of greenery and lawns have been selected and designed to play the aesthetic and sanitary function at the entrance area with their habitus, color and layout throughout the year. In addition to that, care was taken to ensure that the greenery does not interfere with visibility in the busiest traffic area, as well as to separate the entrance area from the surrounding functional facilities on the complex. The grass surface is intended to be formed by sowing a seed mixture of grass species resistant to the climatic conditions, which are at the same time resistant to walking. The sowing standard is 35 g/m^2.

Table 33. Varieties of grasses and their percentage share in the mix

Grass variety	**Participation in the mix (%)**
Festuca rubra L.	50

Poa pratensis L.	30
Lolium perenne L.	15
Agrostis alba Roth.	5

Biological recultivation of new landfills

Landfill recultivation is a complex process of engineering, land reclamation, agro-technical and other works aimed at the same goal - restoring the reproductive capacity of damaged land and creating organized "cultural" landscapes. The most delicate, from the stages of restoration of damaged land, is biological recultivation. This process of recultivation of new landfills involves the establishment of lawns with the application of appropriate technological procedures, after the end of their exploitation life. The biological recultivation process envisages the forming of meadow-type lawns on a total area of 286,784.0 m^2.

A mixture of grass seeds and legumes is used to grow meadow-type lawns, which will suit the purpose of the green area, but also the general climatic conditions and maintenance intensity, which are characterized by tolerance to relatively unfavorable microclimate and edaphic conditions. The sowing standard is 30g/m^2.

Tabela 34. Varieties of grasses and their percentage share in the mix

Grass variety	**Participation in the mix (%)**
Lolium perenne L. - English ryegrass	20
Festuca arundinacea Schreb. - Tall fescue	50
Poa pratensis L. - Kentucky Bluegrass	10
Lotus corniculatus L. - Birdsfoot trefoil	20

The given mix is resilient to high summer temperatures, dry conditions and low winter temperatures.

The Complex Protective Fence

The entire Vinča landfill complex is surrounded by a 2.20 m high fence. The total length of the fence is 6,416.0 m. Concrete columns and fence with galvanized wire mesh with Ø2/40 eyelets are envisaged. In this way, the complex is protected from the uncontrolled entrance of vehicles, people, large animals, etc.

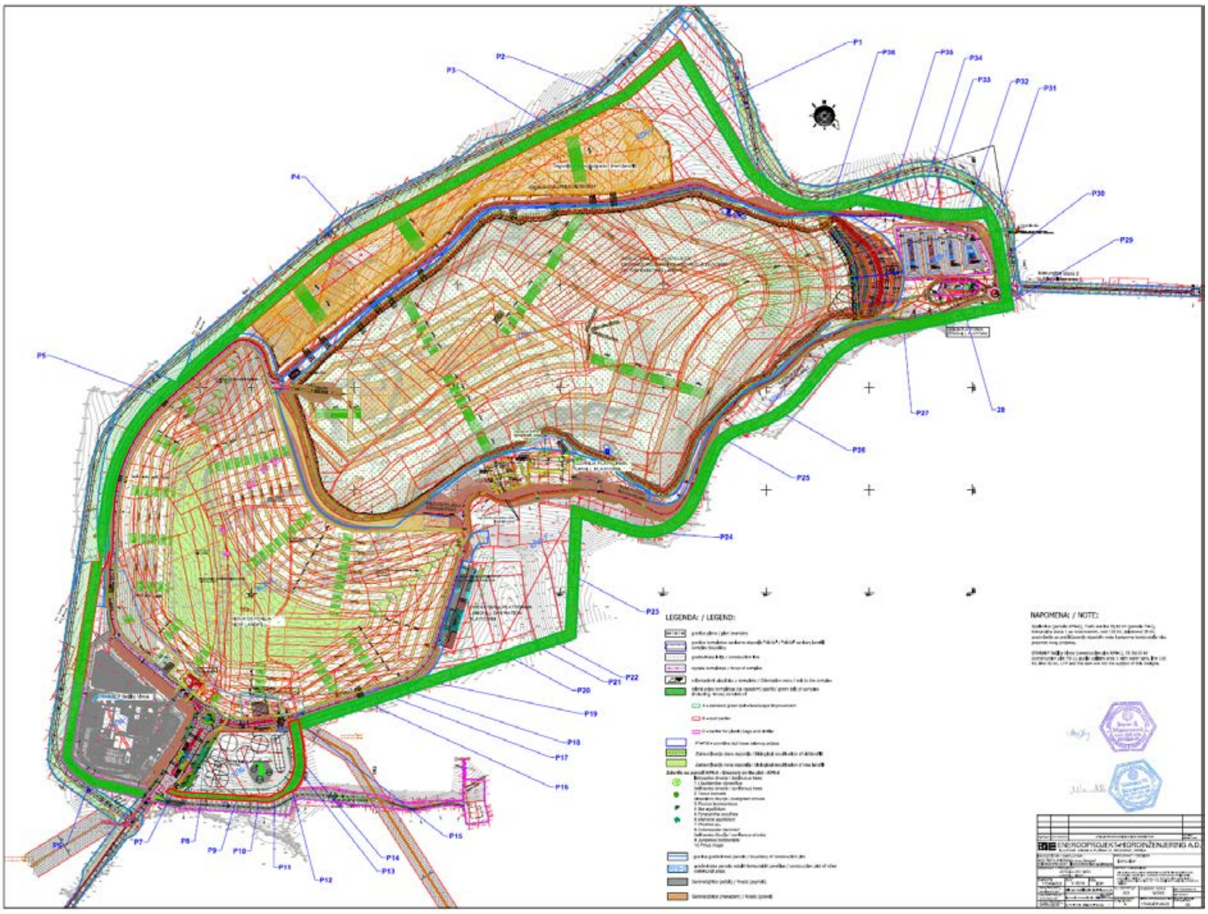


Figure 105. *Layout of the landcaping*
(Source: IDP Book 9. Landscape Design – Protective Green Belt, Landscaping, Fence, Energoprojekt Hidroinženjering, May, 2019)

3.1.3. OVERVIEW OF THE REQUIRED TYPES AND QUANTITIES OF ENERGY AND ENERGY SOURCES, WATER AND RAW MATERIALS

Electric Power

Based on the technical terms and conditions, issued by EPS Distribucija (No. 350-1971/17) dated May 15, 2018, on the needs of making a detailed Regulation Plan for the sanitary landfill in Vinča, the municipality of Grocka, for the needs of supplying technological consumers within the framework of the Vinča landfill complex, it is necessary to build a new substation TS 35/10 kV, transformer power of 8 MVA.

The temporary connection of the new (connected) TS 35/10 kV within the landfill Vinča will be to the free 35 kV cell in the existing TS 35/10 kV "Vinča". The permanent connection of the new TS 35/10 kV within the landfill Vinča will be in the future TS 110/35 kV "Grocka", after its construction and integration into the 35 kV network. For technological units at the landfill complex, the supply of the following consumers is planned at the 10 kV voltage level:

- Construction and demolition waste (CDW) platform, $P_{ins}t/P_{jed}$=0.65/0.52 MW
- Operative platform, New landfill, $P_{ins}t/P_{jed}$ =0.7/0.45 MW
- Leachate treatment plant (LTP), $P_{ins}t/P_{jed}$ =2.2/1.9 MW

Power supply of technological units of the CDW platform, Operating platforms, New landfill and the LTP plant, as well as other consumers covered by this Conceptual Design is foreseen from the planned transformer stations TS1, TS2 and TS3 of the transmission ratio 10/0.4 kV, respectively. For the supply of TS1, TS2 and TS3 transformer stations, two 10 kV lines are foreseen, one for TS1 and another for TS2 and TS3.

Water supply

The amount of water that PUC Belgrade Water Supply and Sewage can provide for the municipal waste landfill complex in Vinča is 24 l/s (refilling at nights, 10:00 PM – 06:00 AM). A supply pipeline PEHD Ø200mm is planned. In front of the entrance to the landfill, a new water supply shaft is planned.

At the entrance to the complex, a water-meter shaft with a combined industrial water meter for measuring the flow of FP and sanitary water is envisaged. This water-meter measures total water consumption for the needs of the EfW Plant and the New Landfill.

The water supply network on the CDW platform is connected to the water supply and sewage system of the landfill complex, located in the immediate vicinity of the platform. The total estimated water consumption for sanitary purposes is 0.47 l/s.

The network of industrial (technological) water is connected to the external distribution of the industrial water of the complex. The estimate is that 0.2l/s of industrial water for the CDW plant is needed. The water consumption for sanitary needs at the LTP plant is 5 m^3/h.

3.1.4. Review on the types and quantities of released gases, water, and other liquid and gaseous waste materials, observed by technological units and the technology of their treatment

1. Entrance-Control Zone

The vehicle washing water in the complex entrance zone is supplied by the DN100 mm pipeline from the atmospheric water lagoon located on the Upper platform. Washing water is discharged to a separator located on the CDW platform.

The newly designed system for atmospheric water discharge from the landfill complex entrance implies linear grates and pipes that specifically collect clean atmospheric water and oily atmospheric water. All water collected at the entrance zone are led in a channel to a separator on the CDW platform. This channel also collects surface water from the slopes to the CDW platform.

Oil separator with precipitator that is located on the CDW crusher unit has the capacity of 130 l/s.

The atmospheric water collected in the part from the channel for washing vehicle wheels to the roundabout, together with the water from the roundabout enters the perimeter channel along the New 4 and 5.

The oily atmospheric water comes from washing truck wheels. Washing channels are located before the weightbridge at the exit from the landfill complex.

All collected oily atmospheric waters are taken to the oil separator with a precipitator located on the CDW plant platform. The separator capacity is 150 l/s.

A sewer network made of PVC sewage pipes DN 160 and DN 200 for collectors that collect fecal waste water from these platforms and facilities is planned.

Fecal sewage from the inlets of the landfill entrance enters the axis of the New 1 road and continues to collect wastewater from the EfW plant platform and the construction site along the New 5 road over the roundabout. Then the fecal sewage passes the edge of the New 4 road where it collects the fecal sewage from the CDW platform. After passing the CDW platform, the fecal sewage system continues along the route along the New 4 road to the Operating Platform where all fecal sewage is collected. The total amount of fecal water from the complex is 4.82 l/s.

After collecting of all fecal waters, they are taken to the wastewater treatment plant (WWTP), or to the package unit - Fecal Wastewater Treatment Plant located within the Operative Platform. The device has a capacity of 100 PE. The effluent of purified water is carried out in the peripheral rain channel, which leads these waters to the lagoon on the Lower platform.

2. The CDW Plant Platform

The fecal sewerage network from the facilities on the CDW platform, with the expected amount of 0.56 l/s, is connected to the external fecal sewerage network of the Vinča complex.

After dedusting, waste water is collected from the concrete plateau into channels with grates that flow directly into the precipitator. From the precipitators, wastewater is directed to an oily water separator. These channels collect and lead the rainwater that falls on the plateau.

The expected amount of technological wastewater from the dredger system is 0.2 l/s, but for the dimensioning of the system for the collection of these wastewaters, the amount of atmospheric water that flows into it has been adopted. The expected amount of oily stormwater is 63.8 l/s.

The oily surface waters from the plateau are collected and led to the oil separator with the precipitator. The flow through the separator is 150 l/s. After the separator, the processed water is drawn to the periferal stormwater channels.

3. New Landfill

At the very beginning of 2022, there will be a sudden leap in the production of landfill gas with a maximum peak of 2,390 m^3/h. After that, there is a sharp dip in production, so that around 2025, the production will stabilize with constant growth until 2050, when it will be 2,070 m^3/h. After this period, a logarithmic dip is expected by 2056, when the production is expected to be 300 m^3/h, when in 2090, the production will be reduced to a minimum gravitating to zero.

The collected landfill gas flow is lower than the theoretical production. It is expected that in the period 2020-2053, the flow of collected landfill gas will range from 300-1,400 m^3/h, with an average value of about 1,000 m^3/h.

The Biogas Collection and Evacuation System collects the landfill gas and leads it to the facility for the use of landfill gas - BEP. In the event of a standstill or overhaul of the BEP plant, the landfill gas is directed to the Torch System (two torches are planned).

The first torch has a capacity of 550-2,300 Nm^3/h, while the other torch has a capacity of 300-1,200 Nm^3/h. The total expected gas flow together for the "old" and the new landfill is about 2,560 Nm^3/h with 50% CH_4.

Table 2 Characteristics of landfill gas torches

Type	Gas flow, Nm^3/h, 50% CH_4	Maximum heat power, kW	Combustion temperature, °C	Time, s
BG 2000	550-2300	16000	1000	>3
BG 1000	300-1200	6000	1000	>3

The leachate waters from the New Landfill are all those waters that pass through the body of the landfill i.e., through the deposited waste to the most downstream part of the landfill. Due to high level of pollution, their collection, removal and purification at the LTP plant is envisaged.

Maximal daily leachate water flow is $Q_f = 0.99$ l/s ≈ 1.0 l/s.

For the surface, completely "open" first phase, without waste, the amount of atmospheric water that will reach the drainage system is Q = 20.14 l/s, which was adopted as the baseline amount of water for dimensioning the drainage systems - drainage pipes.

The volume of the lagoons (on the Upper Platform), which only accepts the leachate waters from the New Landfill, for a maximum quantity of 1.0 l/s, respecting the condition of the PE “Srbijavode” that it is necessary to provide retention for 20 consecutive calendar days for rain of continuous duration t = 24 hours of return period T = 25 years, a total lagoon volume of V = 1.728 m^3 is obtained. Two pools of 2 x 2,000 m^3 capacity are adopted. One is foreseen for leachate waters from the temporary landfill and the landfill for untreated waste and the other is for the residues after waste treatment at an EfW plant.

Main peripheral canals traced around the newly designed landfill and secondary concrete ducts are foreseen for the evacuation of atmospheric water from the body of the landfill after construction,.

The main peripheral channels also serve for the atmospheric water discharge that can flow from the outer slopes into the active phase of the landfill in the excavation and exploitation phase of the landfill.

Secondary concrete channels collect atmospheric water from the covered landfill surface and lead them to the main peripheral channels.

The lagoon for atmospheric waters (on the Upper Platform) with a volume of 4,000 m^3 is envisaged for the reception of rain water with addition of 177.67 l/s,.

4. Operative Platform

It is envisaged that the hydraulic installations of the Operative Platform are connected to the external hydraulic installations of the entire landfill complex, located in the immediate vicinity of the platform itself.

The fecal sewerage from the complex, as well as from the facilities on the Operative Platform (around 200 employees), is pumped into a fecal wastewater treatment plant (WWTP), which is part of the Operative Platform. WWTP has a capacity of 100 PE. The purified water is dischared into a peripheral stormwater channel which drain them away from the boundaries of the complex.

Conditionally clean stormwater from the roofs of the buildings freely flows into the field and greenery around the buildings.

Oily stormwater from the Operative Platform (parking lots, vehicle washing, fuel pump station) are collected and taken to the oily water separator with precipitator. The separator capacity is 70 l/s. After treatment, this water is also discharged into the peripheral rain channel.

Water balance on the Operative platform:

- Total estimated water consumption for sanitary purposes is 1.10 l/s.
- Total forecast water consumption for vehicle washing is 1.10 l/s.
- Total forecast water consumption for fire hydrant network is 10 l/s.
- Expected quantity of fecal wastewater is 1.1 l/s.
- Expected quantity of technical waste water from vehicle washing is 1.10 l/s.
- Expected quantity of oily stormwater is 68.8 l/s.

5. Upper Platform

The quantity of atmospheric waters that come in the lagoon on the Upper Platform is 177.67 l/s with the adopted volume of 4,000 m^3. This volume is sufficient in the case of multiple hours retention without draining the water from the pool. The pool is of trapezoidal shape in with dimensions in the base of 54.5 m x 8 m, water depth 4.5 m, slope inclination 1: 1.5. From this lagoon, it is planned to transfer the atmospheric water by a Ø 140 pressure pipeline and pump into the tank chamber for the purpose of fire protection of the facilities at the landfill as well as for washing the wheels of vehicles in the control zone.

The system for draining the leachate from the new landfill is according to the type of waste that is being disposed, divided into two parts:

- The system for collecting the leachate from the temporary landfill of municipal waste and part for the Untreated Waste Landfill (Untreated Waste I and II)
- The system for collecting the leachate from the Landfill for residues from waste treatment at the EfW plant (Residues I and II)

Two pools are designed on the Upper Platform for the intake of leachate, with a capacity of 2,000 m^3 (total capacity 4,000 m^3.). The pools are trapezoidal in dimension in the lower base 28.5 x 6 m, water depth 4,5 m, slope inclination 1: 1.5.

The leachate is evacuated from the distribution shaft for leachate waters at the Upper Platform, by gravitation with a pipeline to the leachate waters lagoon on the Lower platform (where the leachate treatment plant - LTP is planned).

6. Lower Platform

The amount of atmospheric waters that flow in the lagoon on the Lower platform is 171.47 l/s with the accepted volume of the lagoon of 3.700 m^3. This volume is sufficient in the case of multiple hours retention without draining the water from the pool. From the lagoon, the collected atmospheric water flows into the Ošljanski potok by gravitation with a pipeline. A meter for measuring the quantity of discharged water is planned on this pipeline, and the meter is to be connected to a probe for automatic monitoring of the water level in the lagoon.

Three pools/lagoons, with a total capacity of 13,800 m3, are designed to receive the leachate waters on the Lower Platform (two pools with a capacity of 2 x 5,100 m^3 and one pool with a capacity of 3,600 m^3).

The pools (5,100m^3 in volume) have dimensions: 9.30 x 65 m in the bases, 61m long, the pool (3,600m^3 in volume) has dimensions: 7.0 x 52m, water depth max. 4.5 m. The slope of the sides of the pool is 1: 1.5.

A pool with the capacity of 3,600 m^3 will serve to mix water from the other two pools (capacity 5,100 m^3). From this pool, through the pumps, the leachate water will be delivered to the leachate water treatment plant (LTP). One pool with the capacity of 5,100 m^3, accepts the leachate water from the “old” landfill, and the other pool with the capacity of 5,100 m^3, accepts the leachate water from the leachate waters lagoon on the Upper Platform (leachate water from the New landfill).

After the end of the operation of the “old” landfill and its recultivation and after the filtration of the leachate water through the “old” landfill, the leachate water will be re-pumped into the lagoon on the Upper Platform.

Leachate Treatment Zone (LTP Plant)

The quantities of leachate waters to be collected and treated are given in the table.

Table 36 Amount of leachate waters generated at the landfill

Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Collected leachate water (m^3/year)	96,000	91,900	92,000	82,500	41,800	8,600	3,300	2,400
Lachate water for the EfW, (m^3/ year)	0	6,000	12,000	12,000	12,000	8,600	3,300	2,400
Treated leachate water (m^3/ year)	90,000	90,000	81,900	70,500	29,800	0	0	0

In accordance with the production of leachate waters and its production needs for biogas in the EfW plant, the leachate treatment plant is dimensioned to 90,000 m^3/year with a reserve of about 20%, that is, the capacity of the plant is 13 m^3/h.

The amount of leachate waters shown in the table represents the sum of the process water produced at the existing and new landfill. The quantification of leachate quantities for EfW represents the annual leachate waters consumption for the APCR process (instead of raw water/city water, the leachate water is used to stabilize the APCR). Therefore, the LTP plant processes excess leachate water that will not be reused in the APCR curing process.

The leachate water treatment plant will only operate for five years, after which all the process water will be transported to the EfW plant (not a subject of this project).

Overview of atmospheric and wastewater quantities

Atmospheric waters

The relevant rainfall intensity is determined from the calculation of the short duration rainfall intensity (ITP curve) for the Belgrade Meteorological Station, which is attached below.

"According to the conditions of PE Srbijavode No. 325-05-00418/2019-07, Belgrade, April 3, 2019, for the sizing of atmospheric channels, the value of rain intensity for a return period of T=25 years, for a period of 24 hours, was adopted and it is 0.056 mm/min or 9.33 l/s/ha.

The total surface from which atmospheric water is collected is approximately 230 ha.

The flow is then **Q = Ψ*I*P**, where:

For return period T=25 years and rain duration tk=24 h:
- Rain intensity I = 0.056 mm/min = 9.33 l/s/ha
- Ψ, runoff coefficient of 0.1 (green areas) to 0.9 (concrete)
- P, Water catchment area"

Meteorološka opservatorija Beograd

STATISTIČKI PARAMETRI SERIJA KIŠA TRAJANjA Tk
OCENjENI METODOM MOMENATA

Tk (min)	H_{sr}	C_v	C_s	H_{srl}	C_{vl}	C_{sl}
10	12.08	0.43	1.34	1.05	0.16	0.51
20	16.33	0.41	1.20	1.18	0.14	0.20
30	19.27	0.40	0.86	1.25	0.13	0.03
60	22.65	0.39	0.73	1.32	0.13	-0.12
120	26.26	0.40	0.56	1.38	0.13	-0.31
180	28.63	0.39	0.55	1.42	0.12	-0.28
360	32.17	0.38	0.92	1.48	0.11	0.08
720	36.59	0.38	1.30	1.54	0.10	0.25
1440	42.64	0.39	0.86	1.60	0.10	0.06

ORDINATE RASPODELE VEROVATNOĆA SLOJA KIŠA H(mm)
TRAJANjA Tk (min) I VEROVATNOĆE P(%), GUMBEL

Tk (min)	P(%)								
	0.1	1	2	4	5	10	20	50	80
10	40.7	30.3	27.2	24	23	19.7	16.4	11.3	7.49
20	53.6	40.1	36	31.8	30.5	26.3	21.9	15.3	10.3
30	61.5	46.2	41.5	36.8	35.3	30.6	25.6	18.1	12.5
60	72	54.1	48.7	43.3	41.4	35.9	30	21.3	14.7
120	84.1	63.1	56.8	50.2	48.3	41.8	34.9	24.6	17
180	89.9	67.7	60.9	54.2	52	45	37.8	26.9	18.8
360	99.5	75.1	67.7	60.1	57.8	50.2	42.3	30.3	21.4
720	113.9	85.8	77.4	60.8	66	57.3	48.2	34.4	24.2
1440	135.1	101.6	91.4	81.3	77.9	67.4	56.5	40	27.8

ORDINATE RASPODELE VEROVATNOĆA INTENZITETA KIŠA I(mm/min)
TRAJANjA Tk (min) I VEROVATNOĆE P(%), GUMBEL

Tk (min)	P(%)								
	0.1	1	2	4	5	10	20	50	80
10	4.066	3.029	2.716	2.400	2.297	1.974	1.637	1.128	0.749
20	2.682	2.005	1.801	1.590	1.527	1.316	1.096	0.764	0.516
30	2.049	1.539	1.384	1.227	1.178	1.019	0.853	0.603	0.417
60	1.2	0.901	0.811	0.722	0.691	0.598	0.501	0.354	0.245
120	0.701	0.526	0.473	0.418	0.403	0.348	0.291	0.205	0.141
180	0.499	0.376	0.339	0.301	0.289	0.25	0.21	0.149	0.104
360	0.276	0.209	0.188	0.167	0.161	0.139	0.117	0.084	0.059
720	0.158	0.119	0.107	0.084	0.092	0.08	0.067	0.048	0.034
1440	0.094	0.071	0.063	0.056	0.054	0.047	0.039	0.028	0.019

Figure 106. ITP curves for the Meteorological Station Belgrade

Wastewater

Atmospheric water is collected by an atmospheric sewer system.

Newly designed channels can be divided into the peripheral channels of the landfill complex that collect water from catchment areas outside the landfill complex, as well as atmospheric water from the catchment areas around the perimeter of the complex (but not from the landfill body) and the peripheral channels around the body of old and new landfills that collect the atmospheric water from the landfill body.

On those areas where atmospheric water pollution may occur, it is anticipated that it will be collected and discharged to oil separators before discharging into channels (water from roads, as well as atmospheric water from platforms (EfW, CDW and LOP)).

Atmospheric water collected by the peripheral channels around the body of the old and new landfill is discharged into lagoons for atmospheric (clean) water. The project envisages two lagoons for atmospheric water. The first, with volume of 4,000 m^3, is located on the Upper Platform at an elevation of 160.00 m, while the second lagoon is on the Lower Platform, downstream of the old landfill at an elevation of 90.00 m and has a volume of 3,700 m^3.

Atmospheric water coming from the catchment areas outside the landfill complex is discharged directly into the recipient - Ošljanski potok, and further into the Danube.

OZNAKA KANALA	DUŽINA DEON. (m)	PRIPADAJUĆA SLIVNA POVRŠINA (ha)
O1	2373.5	75,93
O2	2355.5	57,02
Desni obodni-stara deponija	1155.5	18,12
Levi obodni-stara deponija	1478.72	18,91
Desni obodni-nova deponija	1107.3	16,19
Levi obodni-nova deponija	1114.9	13,42
S1	256.9	0,45
S2	533.4	1,83
S3	1288.3	11,37
S4	300.2	6,05
S5	693.9	8,78
Nova 4-separator S1	527.6	0,45
Nova 5-separator S2	1007.7	1,15

The total quantities of the atmospheric sewage are given in the Table below:

Type of atmospheric sewage	Channels for atmospheric sewage	Quantity dischareged to Osljanski potok
External (riparian wastewater)	O1, O2	247 l/s
Internal wastewater	Right and left peripheral channel around the new landfill, right and left peripheral channel around the old landfill, channels S1 to S5, New 4 - Separator S1, New 5 - Separator S2.	350 l/s

3.2. **OVERVIEW OF THE COMPLIANCE OF THE PLANNED AND DESIGNED SOLUTIONS WITH THE REFERENCE BAT DOCUMENT**

The European Commission has not produced a BREF reference document for the best available techniques for landfills, but the Landfill Directive (COUNCIL DIRECTIVE 1999/31 / EC of 26 April 1999) has established certain technical standards for landfills.

Where the Landfill Directive does not provide relevant technical requirements, the general principles of the IPPC Directive, including BAT, must be applied.

BAT is not applicable for activities such as landfill design, as best practice is applied during the construction of a new phase or a cell. BAT will be applied to landfill activities that are continuous and where continuous progress can be achieved over time. This includes the operation of the plant, which is not only related to the landfill body, but to activities such as e.g. landfill gas and leachate water management.

The Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010) was used for analysis, as well as the document Guidance for the Landfill Sector / Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02); UK Environment Agency, which defines measures to meet the relevant legal and technical requirements for the IPPC landfills. The Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 was also used.

Tehnološki proces

Podaci o BAT zahtevima utvrđenim referentnim i drugim relevantnim dokumentima za proces rada sanitarne deponije u Vinči i usaglašenosti procesa sa ovim zahtevima prikazani su u narednoj tabeli:

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
General requirements				
1	**Ensuring adequate financial security for environmental protection obligations (both foreseen and unforeseen), including closure and post-closure control**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.2 Primary requirements/5.3 Environmental Liabilities)	Yes	In the procedure for obtaining the Waste Management Permit from the competent ministry, within the Waste Disposal Facility Operation Plan, it is the responsibility of the project developer to submit a Contract and an insurance policy for damage caused to third parties and to the environment, in accordance with the Law on Waste Management (Official Gazette of RS, No. 14/2016).
2	**Landfill design in accordance with the Landfill Directive and the Landfill Regulation:** 2.1 control of water flows - leachate from the landfill, process wastewater and precipitation water must be separately collected and discharged separately to the wastewater treatment plant or the appropriate recipient 2.2 leachate water management - Sufficient number of shafts (stable and ground-based) must be built to maintain and	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5.2 Primary requirements) Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), Article 6; Annex 2, Item 1. 1), 2) and 3) (conditions for the	Yes	2.1 Separate leachate water collection from landfill, process wastewater and stormwater has been designed and will be constructed in accordance with the design. All waters will be led in a controlled way to a wastewater treatment plant or recipient, in accordance with the conditions of the competent authority, legislation and BAT recommendations. 2.2 The project envisages an adequate number of shafts and other parts of the system for controlled leachate waters

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	inspect the leachate water collecting drainage pipes. - a temporary collection shaft (resistant to chemical influences, secured against explosion and odors) must be installed for temporary retention of the leachate water collected from the landfill body 2.3 adequate system of protective layers 2.4 adequate overlay 2.5 adequate measures for the prevention and management of landfill gas	landfill body) Rulebook on Methodology for Designing Remediation Projects (Official Gazette of RS, No. 74/2015)		disposal. 2.3 The design of the protective layer system was carried out in accordance with the requirements defined in the Regulation. 2.4 The design envisages the construction of an overlay system in accordance with the Regulation. 2.5 The project envisages controlled collection, removal and treatment of landfill gas.
3	**Establishment and implementation of an Environmental Management System (EMS)**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (3.1 Management techniques) Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5.2 Primary requirements)	Yes	The EMS system will be established as a management system throughout the Vinča project complex (landfills, EfW and BEP facilities with associated facilities) and will contain, inter alia, the following elements: - management and reporting structure - a plan of general and specific environmental objectives - Annual Environmental Report - Landfill environmental management program - documentation management system - Procedures for implementing corrective measures - training and awareness program - internal and external communication program

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
4				- waste acceptance procedure - a waste management system that includes all incoming waste and waste on the site
4	**Quantities of biodegradable waste that can be landfilled:** 1) in the period from 2012 to 2016 - at least 25% of the total amount (by weight) of biodegradable municipal waste 2) in the period from 2017 to 2019 - at least 50% of the total amount (by weight) of biodegradable municipal waste 3) in the period from 2020 to 2026 - at least 65% of the total amount (by weight) of biodegradable municipal waste	Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), Article 10	Yes, partly	The plan for reducing the amount of biodegradable waste that is landfilled is an obligation of the City of Belgrade and it is part of a special project implemented in cooperation with PE Zelenilo.
5	**Application of the Waste Acceptance Criteria (WAC) and Waste Acceptance Procedures (WAP) for receiving waste in accordance with Annex II of the Landfill Directive and Council Decision 2003/33 / EC**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (1.7 Key Issues for the Landfill Sector) Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), Articles 11-22 Law on Waste Management (Official Gazette of RS, Nos.	Yes	Applying the appropriate measures is necessary to ensure that only waste is disposed of in landfills that is in accordance with the national and the EU regulations / recommendations, the design parameters and conditions prescribed by the relevant waste management permits and to ensure the following: - implementation of defined measures for documenting waste coming to the site - clear criteria for receiving waste: - the waste to be received must have a proper description, coding and

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
		36/2009, 88/2010, 14/2016 i 95/2018), articles 29, 30, 43, 75, 76 - on reporting		classification - the received waste has undergone appropriate treatment (if necessary) - there are certain limits for the types and composition of waste that is acceptable - clear measures for the treatment of waste that cannot be received on site. - The acceptance of landfill waste will be defined by the plant's Operation Plan and guidance on criteria and procedures for accepting or not accepting landfill waste in accordance with Annex II of the Waste Directive 2003/33/EC.
6	**Implementation of basic security measures to prevent unauthorized entry and conditions for the handling service platforms**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (3. Management/ 3.5 security) Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), Article 6; Annex 2, item 2. (conditions for the handling service platform)	Yes	The entire sanitary landfill complex will be surrounded by a wire fence to prevent the spread of waste, as well as to prevent the unauthorized and uncontrolled entry of humans and animals into the site. At the entrance to the landfill complex, a gate with a ramp is planned. Within the control zone there is a supervision station (three prefabricated houses, two connected and one separate), which includes a doorman, control panels, vehicle control system and video surveillance controls, office space, kitchenette and toilets and communal areas for drivers .

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				A radioactivity detection system with alarm and appropriate software will be installed at the entrance to the incoming truck weighbridge.
7	**Conditions for roads and necessary infrastructure** 7.1 width of access road 6m, maximum slope 14% 7.2 sufficient quantity of drinking water and process water to wash the container vehicles, etc. 7.3 facilities and installations for consumer electric power supply, for external lighting, lightning protection, fire and explosion alarm installation, TT and internet networks	Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), Article 6; Annex 2, item 5. (conditions for roads and the required infrastructure)	Yes	7.1 Yes 7.2 Yes 7.3 Yes
8	**Procedure for closing down a landfill and maintaining and controlling a closed landfill**	Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), articles 24-25	Yes	A landfill closure plan and the maintenance and control of a closed landfill will be developed. The project defines the technical solution and the cover layers, in accordance with the Regulation.
9	**Application of the waste management hierarchy as a priority in waste prevention and management:** - prevention, - preparation for reuse, recycling, - other reuse operations (re-utilization for the purpose of obtaining energy,	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.1.1 Overview of Waste Landfill Activity)	Yes	<u>Prevention</u> of generating waste in the City of Belgrade is carried out through activities defined at the national level and is reflected, first of all, through the implementation of the principles of cleaner production, circular economy, defining by-products and termination of

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	etc.), - waste disposal	Law on Waste Management (Official Gazette of RS, Nos. 36/2009, 88/2010, 14/2016 i 95/2018)		waste status, and more. Effort has been put in raising the awareness of the population about the importance of prevention for over 10 years. Preparation for reuse and recycling begins with a relatively well organized primary selection system operating in the city of Belgrade. Primary selected secondary raw materials that are collected through a wide network of provided and placed collection containers in the city of Belgrade. The primary selected secondary raw materials are taken to the existing municipal waste collection centers where secondary separation is carried out on the separation line (Ada Huja, New Belgrade). By Decision of the Mayor of Belgrade no. 501-4180/16-G from 06/17/2016, the locations for establishing new waste collection centers - recycling centers and transfer stations - were determined. The City of Belgrade budget for 2019 envisages the procurement of equipment and equipping of two more recycling centers with a separation line and other necessary equipment. Recycling centers also collect special types of waste in accordance with the Law. The budget for 2019 also envisages the

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				procurement of additional containers for the separate municipal waste collection system (paper, plastic, metal, glass, mixed municipal waste), additional underground containers, numerous machinery and vehicles for waste collection and collection of sorted secondary raw materials, abrol containers, baling presses with a capacity of 100 t, with the aim of upgrading the existing system and expanding the coverage of the territory with a waste collection service. Supply contracts are signed by the suppliers and PUC "Čistoća". The project for construction of a new landfill and other facilities envisages the installation of a construction waste treatment line. <u>Other re-utilization operations (re-utilization for energy purposes, etc.).</u> The landfill in question is being constructed at a site where an existing landfill is already located, where the entire amount of mixed collected municipal waste is deposited. Instead of such a solution, this project includes a modern plant for the utilization of energy from waste, as well as a plant for the utilization of landfill gas from the body of the existing and new mixed

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				municipal waste landfill. Disposal of mixed municipal waste in the City of Belgrade in the future will only be carried out for the amount remaining after primary and secondary waste selection, reuse and treatment at construction waste treatment plants, energy waste utilization and landfill gas utilization, as well as after separation of green waste from the maintenance of green areas and the felling of trees performed by PE Zelenilo in special locations.
Use of resources/energy consumption and applied technology				
9	**Energy Efficiency** 9.1 monitoring energy consumption and keeping records 9.2 implementation of energy efficiency measures during plant operation and maintenance 9.3 annual energy analysis to identify opportunities for identifying the opportunities fir optimizing energy supply (use of generated landfill gas to produce heat / electricity) and optimizing/reducing energy consumption	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (3.4 Energy) Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.3.2 Techniques for Prevention and Minimisation of Resource Consupmtion/ 4.3.2.1 Use of Energy)	Yes	Energy consumption is represented in the following activities: - heating, lighting and electricity supply of plant facilities - supply of electricity for vehicle washing equipment, scales, pumps, video surveillance, signaling, etc. - fuel to power the vehicle - operation of lagoon pumps - operation of degassing system - operation of the wastewater treatment system - operation of the construction waste treatment system 9.1 Yes

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				9.2 Yes 9.3 Yes
10	**Energy usage**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, /Environmental Protection Agency, Ireland; December 2011 (4.3.2 Techniques for Prevention and Minimisation of Resource Consupmtion /4.3.2.1 Use of Energy) Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010), Article 6; Annex 2, item 1. 4) (conditions for the landfill body)	Yes	In accordance with the requirements of the Waste Directive and the Waste Disposal Regulation, the project for the construction of a new landfill envisages the installation of a biothorn network, the separation and energy utilization of landfill gas from the body of both the new and the existing municipal landfill.
11	**Use of waste as raw material**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, /Environmental Protection Agency, Ireland; December 2011 (4.3.2 Techniques for Prevention and Minimisation of Resource Consupmtion/ 4.3.3.1 Waste as the Raw Material)	Yes	Only non-recyclable waste will be disposed on the landfill (secondary raw materials) in primary and secondary selection processes (when disposed of in containers in the city and after separation of raw materials on separation lines at several locations in the city), reused for other purposes or that did not go for recycling treatment or treatment at the EfW facility. Green biodegradable waste from public areas of the City of Belgrade is removed

	BAT documents defined by reference documents	Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				and treated at another location. Construction materials from demolition will be treated in a construction waste treatment system and used to cover the terrain. Excavation land will be used to build other parts of the complex's terrain as needed. Landfill gas released in the landfill body will be used to generate energy.
12	**Use of waste as alternative fuel**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, /Environmental Protection Agency, Ireland; December 2011 (4.3.2 Techniques for Prevention and Minimisation of Resource Consupmtion/ 4.3.3.1 Waste as the Raw Material)	Yes	The use of waste as an alternative fuel is part of the Vinča project and only non-EfW waste will be disposed of at the landfill.
Air emissions				
13	**Preventing emissions from waste decomposition by applying best landfill gas management practices and appropriate control techniques:** 13.1 reducing the possibility of landfill gas generation by appropriate pre-treatment of waste prior to admission to the landfill 13.2 collection and removal of landfill gas by gas well system and pipeline network	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.5 Emissions to Air/Techniques for Prevention and Minimisation of	Yes	13.1 Yes, partly. Prior to the admission of a large amount of green waste generated in the process of maintaining green areas and pruning trees in the city of Belgrade to the landfill, the waste is separated and treated at a specially designated location of JP Zelenilo. 13.2 Yes. The project envisages a complete system for the disposal and

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	13.3 managing condensate from landfill gas in the gas network 13.4 regular monitoring and regulation of gas wells	Emissions/4.4.5 Management of Landfill Gas) Regulation on the waste landfilling (Official Gazette of RS, No. 92/2010)		treatment of landfill gas, as described in the text of this study. 13.3 Yes. The project envisages a complete system for the disposal and treatment of landfill gas, as described in the text of this study. 13.4 Yes.
14	**Recommended landfill gas emission limits (diffuse air emissions): methane - 1% v / v or 20% of the lower explosive limit; VOC (surface emissions):** **≥50 ppmv on average above the surface with a final overlay** **≥100 ppmv direct reading in open areas within the landfill area** **≥500 ppmv in surrounding facilities;** **carbon dioxide (CO2) - 1.5 v / v;** **total sediment matter 240 - 350 mg / m^2/day**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (6.3 BAT Emission Levels for Air Emissions/6.3.1 Fugitive Air Emissions)	Not applicable currently	The recommended limit values will be taken into account in the monitoring process and the limit values defined by the legislation of the Republic of Serbia will be applied.
15	**Burning of landfill gas on a torch with a minimum temperature of 1000 °C and a retention time of 0.3 seconds, if it is not possible to use landfill gas for energy production**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, /Environmental Protection Agency, Ireland; December 2011 (4.3.2 Techniques for Prevention and Minimisation of Resource Consupmtion /4.3.2.1 Use of Energy) Regulation on the waste landfilling	Yes	The use of landfill gas for the production of energy under defined conditions is foreseen. The operation of the torch system is also planned, which starts in the event of: - if the gas flow is higher than the set value, or the pressure value is higher than the set value, - if the gas engines at the cogeneration plant (BEP) are out of operation, with the BEP plant control system

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
		(Official Gazette of RS, No. 92/2010) Article 6; Annex 2, item 1. 4) (conditions for the landfill body)		including torch operation. The project envisages the burning of landfill gas on a torch with a minimum temperature of 1000 °C and a retention time of 0.3 seconds.
16	***Recommended NOX emission limit values:*** ***16.1 from the gas-burning torch are 150 mg/m^3*** ***16.2 from the gas extraction plant is 500 mg/m^3.***	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.5 Emissions to Air/Techniques for Prevention and Minimisation of Emissions/4.4.5 Management of Landfill Gas)	Yes	The recommended emission limit values have been taken into account in the monitoring procedure and the limit values defined by the legislation of the Republic of Serbia will be applied.
17	**Dust and fine particulate matter reduction using the following control techniques:** 17.1 Waste emitting dust must be pre-treated with water or a "wetting agent", or such waste may only be accepted in sacs 17.2 All waste containing asbestos must be treated as "hazardous waste" and disposed of in a separate cell in limited quantities. 17.3 compacting waste immediately after unloading from a delivery vehicle and covering it with appropriate material (natural or artificial cover)	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.6.1 Dust/Fine Particulates (PM_{10} and $PM_{2,5}$) Regulation on the waste landfilling (Official Gazette of	Yes, partly	17.1 Yes, foreseen by the project 17.2 Not defined by the project, but it will be defined by the Plant Operational Plan. 17.3 Yes, foreseen by the project 17.4 Yes, foreseen by the project 17.5 Yes, foreseen by the project 17.6 Yes, foreseen by the project

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	17.4 regular dusting of roads on site (cleaning and spraying) 17.5 avoiding disposal of waste in adverse weather conditions 17.6 formation of vegetation buffer zone 17.7 Covering vehicles / containers the enter and leave the site	RS, No. 92/2010), Annex 2, item 1. 6) (ocnditions for the landfill body) and item 6. (conditions for the protective ventilation belt)		17.7 Yes, foreseen by the project
18	**Ensure that odours do not affect the significant deterioration of facilities and the environment beyond the boundaries of the site, using the following management and control techniques:** 18.1 define and implement an odour management plan 18.2 pre-treat waste that produces odours 18.3 apply appropriate procedures for receiving waste 18.4 reduction of open areas for the roll-over of waste (max 25 h 25m, slope 1:3) 18.5 compaction and covering of waste immediately after unloading 18.6 proper landfill gas management 18.7 aeration of lagoons for accepting leachate	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.6.2 Odour)	Yes, partially	There are no facilities in the immediate vicinity of the site that could be significantly affected by odours from the site of the new landfill. The nearest residential buildings are more than 1 km away. 18.1 Yes, it is foreseen by the project, primarily through activities of regular compacting of saturated waste on a daily basis, covering of waste with inert material, systematic collection of leachate and its treatment at the wastewater treatment plant, as well as collection of landfill gas and its further treatment at the BEP plant. 18.2 The project does not foresee the pre-treatment of waste deposited at the landfill site. 18.3 Yes, it is foreseen by the project and defined in detail by the legislation of the Republic of Serbia.

BAT documents defined by reference documents		**Reference document (title)**	**Compliance with Directive / BAT requirement (Yes/No)**	**Comment**
				18.4 The recommended slope is envisaged by the project but the size of the waste disposal cells is larger and is 74.0 x 57.0 m. Rollover surfaces are not foreseen by the project. 18.5 Yes, provided by the landfill project and the landfill operation plan. 18.6 Yes, landfill gas collection and further treatment at the BEP plant is foreseen. 18.7 Aeration in lagoons is not foreseen since water goes for purification to the LTP plant (mechanical pre-treatment on rotary sieves and sand filters, acidification, reverse osmosis, thickening /evaporation of concentrate from reverse osmosis, final reverse osmosis) and in lagoons no processes of purification are performed, they only serve as equalization pools and temporary acceptance where water is not retained much. The leachate collection basin will have an adequate capacity to receive an average amount of leachate over 20 consecutive calendar days (request by PC Srbijavode) (IDP, Volume 3.5. Hydrotechnical Installation Design - Upper Platform and Volume 3.6. Hydrotechnical Installation Design -

	BAT documents defined by reference documents	Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				Lower Platform).
19	**Reduction of emissions from vehicles on site using the following management and control techniques:** **19.1 defined procedures for the maintenance and efficient operation of vehicles** **19.2 defined procedures for checking the use of fuel for all vehicles on site (energy efficiency)** **19.3 regular vehicle servicing and maintenance** **19.4 engine shutdown when the vehicle is not in use** **19.5 reducing the movement of vehicles on location**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.7.3 Vehicle Emissions)	Yes	19.1 It is envisaged by the project and will be defined in detail and used in the operating stage of the plant. 19.2 It is envisaged by the project and will be defined in detail and used in the operating stage of the plant. 19.3 Provided for in the project and by environmental measures within this Study. 19.4 Provided for in the project and by environmental measures under this Study. 19.5 Yes. Restriction of vehicle speed on and off the complex is predicted by this Study.
Water emissions				
20	**Placing temporary coverings on non-working surfaces and overlay upon completion of each cell as soon as practicable in order to reduce infiltration**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2 Landfill Engineering) Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4	Yes	The landfill project and operation plan envisage compacting of the spilled waste and covering it with inert material immediately after disposal, at least once a day.

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
		Techniques for Prevention and Minimisation of Emissions / 4.4.4 Minimisation of (Potentially Contaminated) Storm Water Emissions / 5.4.1 BAT for Discharges to Surface Water)		
21	**Controlled collection and control of water discharged into surface water**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.4.1 Discharges to Surface Water)	Yes	The active landfill surface is divided into three parts: the municipal waste landfill, the untreated waste landfill and the part for disposing of residues from the EfW plant. The leachate water system is divided into two parts according to the type of waste being deposited: - A system for collecting leachate from a temporary landfill and part for the disposal of untreated waste in a later period; - A system for collecting leachate from the part of the landfill where pre-stabilized residues are deposited after treatment at the EfW plant. The collected leachate from both parts is discharged into the leachate lagoons at the level of 160.00 m.a.s.l. (Upper platform) and then gravitationally to the lagoons at the Lower platform at the level of 90 m.a.s.l. and from there to the leachate treatment plant (LTP). After treatment, this water can be flowed into the Ošljanski stream and further into the

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				Danube. For evacuation of atmospheric water from the body of the landfill after construction, perimeter canals are planned, routed around the newly designed landfill. The perimeter canals also serve to drain atmospheric water that can flow from the outer catchment areas to the active landfill phase during the landfill excavation and exploitation phase. Oily rainwater from the operational plateau (parking lots, vehicle washing, fuel station pump) is collected and discharged to an oily water separator with a settling basin. After treatment, this water also flows into the perimeter rain canal. The project and this study envisage the installation of flow meters (flow meters) at the places of discharge of water from the complex into surface waters - the recipient.
22	**The recommended emission values for the quality of wastewater discharged into surface water are:** **pH 6 – 9, toxicity 10 TU, BOD5 25 mg/l, suspended solids 25-35 mg/l, total ammonia 10 mg/l, total nitrogen (sum of Kjeldahl nitrogen, nitrates and nitrites) 15 mg/l, total phosphorus 2mg/l (depending**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (6. BAT Associated Emission Levels/6.1 Emission Levels for Discharges to Surface Water)	Yes	Wastewater quality monitoring will be defined in detail in the Monitoring Plan, in accordance with legal regulations.

	BAT documents defined by reference documents	Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	on the recipient sensitivity)			
23	**BAT for the discharge of wastewater into public sewage implies the quality of effluent in accordance with the prescribed standards by the competent authority**	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.4.2 Discharges to Sewer)	not applicable	The project does not envisage the discharge of wastewater into the public sewer network.
24	**The BAT for the discharge of wastewater into groundwater includes:** 24.1 ban on the direct discharge into the groundwater of effluents containing certain dangerous substances (List I) and the application of strict controls to prevent indirect emissions of substances from List II of the Groundwater Directive 24.2 eliminating the risk of groundwater emissions by applying appropriate control measures (bundwalls, solid substrates, etc.) 24.3 Groundwater monitoring for the early detection of groundwater pollution	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.4.3 Discharges to Groundwater)	Yes	24.1 The project does not foresee the discharge of wastewater into groundwater 24.2 The risks of wastewater discharges into groundwater are minimal as the project envisages controlled collection, implementation and treatment from the entire landfill complex. The bottom of the landfill body and the lateral embankments are covered with protective watertight layers in accordance with legislation and good practice, to prevent wastewater from leaking into the soil and further into groundwater. Concrete and controlled drainage of water from drainage areas to grease and oil separators is planned in all manipulation and parking spaces, in accordance with the project. Separators/settling basins must be regularly maintained/emptied by authorized organizations.

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
				Due to the occasional large daily rainfall, it is necessary to control and regularly maintain the perimeter canals. - The buried diesel fuel tank must be double sheathed and in the bundwall made of watertight reinforced concrete. The bundwall must be of sufficient volume to accommodate the total amount of fuel stored. All buried facilities, as well as parts of buried facilities, must be made of waterproof concrete. According to geological studies, the soil at the site is treated as waterproof, with a filtration coefficient of Kf = $10^{-6} \div 10^{-9}$ cm/s. 24.3 Groundwater quality monitoring will be in accordance with the Monitoring Plan, in accordance with the legal regulations.
25	**Leachate control by the application of recommended techniques for the reduction of generation/discharge of leachate:** 25.1 maintaining the minimum active cell area (maximum 25x25 m) and slope 1:3 25.2 compaction and daily cover to reduce	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.6 Leachate Management)	Yes	25.1 The recommended slope is foreseen by the project but the size of the waste disposal cells is much larger and is 74.0 x 57.0 m. Based on these dimensions, lagoons have been designed for receiving leachate, of adequate capacity. 25.2 Yes, provided by the landfill project

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	infiltration and thus the quantity/quality of leachate 25.3 implementation of appropriate procedures to prevent damage to the final covering layer 25.4 recirculation of leachate with the application of the following measures/conditions: - existence of an efficient system for collecting and draining leachate from the respective landfill cells (where sprinkling irrigation is carried out) - monitoring of the level and quality leachate in the appropriate cells - existence of a system for collection, removal and treatment of landfill gas from the appropriate cells - the composition of leachate does not disturb the processes of landfill stabilization	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.4.4 Leachate Effluent)		and the landfill operation plan. 25.3 Waste disposal at the landfill is done on a surface, on a previously prepared base (bottom to top layers): 1. Natural soil. 2. Compact low-permeability GCL clay lining 50 cm thick or geo-synthetic GCL clay lining made of clay-like material. The required value of the water permeability coefficient of this layer is $k_x \leq 1 \times 10^{-9}$ ms^{-1}; 3. High density polyethylene coating - HDPE 2 mm thick; 4. Geotextiles: 1000 g/m^2; 5. 50 cm thick layer of gravel for drainage; 6. Waste; 25.4 Leachate from the upper lagoon collected by the gravity pipeline shall be carried to the lower lagoon. From the lower lagoon, after mixing the leachate from the old and the new landfill, the leachate is transported by floating pumps are to the leachate treatment plant. The pumping station near the lower lagoon is intended to transport collected leachate to the TE-TO Vinča (EfW) plant for the energy utilization of municipal waste, after the closure of the leachate treatment plant (LTP).

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
26	**Design, construction and operation of lagoons for storage and treatment of leachate in a manner that minimizes the risk of leakage. Monitoring system is installed to ensure no leakage occurs.**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.6 Leachate Management)	Yes	Fully envisaged by the project, as explained in item 24.2, 25.3 and other. A detailed monitoring plan will be elaborated in the Monitoring Plan.
Soil and groundwater				
	Defined under Water Emissions and Waste Management sections			
Waste management				
27	**Each shipment of waste must undergo a visual inspection by employees trained to identify waste that may not be acceptable and act in accordance with defined procedures.**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)	Yes	Reception of landfill waste will be defined by the operation plan of the plant and guidance on criteria and procedures for accepting or not accepting landfill waste in accordance with Annex II of the Waste Directive 2003/33/EC.
28	**The work surface must be designed to meet the measures of protection against infiltration of atmospheric precipitation, stability and settlement measures, interference suppression measures, as well as operational logistics and security.**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)	Yes	Fully envisaged in the project.
29	**Distribute and compact waste immediately after unloading onto the work surface.**	Environment Agency, Guidance for the Landfill Sector - Technical	Yes	Fully envisaged in the project.

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
		Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)		
30	**The recommended waste density after initial compaction is about 0.8 t/m3, which is the optimum for biodegradation processes.**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)	Yes	Envisaged by the project.
31	**The daily cover has the effect of preventing the material from blowing up by the wind, as well as deterring waste collectors, birds and rodents. The operator must ensure that waste is covered as soon as practicable.**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)	yes	The landfill project and operation plan envisage compacting of the spilled waste and covering it with inert material immediately after disposal, at least once a day.
32	**Risk analysis should identify any waste with characteristics that require a specific site handling that does not comply with daily procedures, such as:** **- fine particles;** **- empty containers;** **- very large objects;** **- sludges;** **- waste of intense odour.** **Pre-treatment options need to be**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)	yes	The procedure for obtaining the Waste Management Permit by the competent ministry, within the Operation Plan of the Waste Disposal Facility, defines the types of waste to be disposed of and the conditions under which these activities will be performed.

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	considered.			
33	**Waste that cannot be received at a landfill must be temporarily stored in an isolated area unless immediately removed by a delivery vehicle.**	Environment Agency, Guidance for the Landfill Sector - Technical Requirements of the Landfill Directive and Integrated Pollution Prevention and Control (IPPC S5.02), April 2007 (4.2.13 Waste handling and treatment)	yes	Waste that cannot be received at the landfill is not retained at the complex and is returned to the waste supplier.
Noise and other interference				
34	**Noise reduction by applying the following control techniques:** 34.1 raising the buffer zone between the site and the surrounding area 34.2. where necessary, installing noise dampers on equipment that produces high noise 34.3 limiting activities that potentially produce noise for a specified period during the day 34.4 regular maintenance of vehicles and roads	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.7.2 Vechicle Emissions) EPA Guidance Note for Noise in Relation to Scheduled Activities, 2nd Edition, 2006 Regulation on the disposal of waste on landfills (Official Gazette of RS, no. 92/2010), Article 6;	yes	34.1 The project envisages putting up a green belt. 34.2 Provided by the design and standards. 34.3 Envisaged by the project. The CDW plant only operates in day mode. The entrance gate to the CDW Plateau is scheduled to be open during the plateau operation time (8 h/day, 5 days/week) (IDP Volume 7/3 Technology Project - crushing plant Plateau). 34.4 Envisaged by the project.

	BAT documents defined by reference documents	Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
		Annex 2, Item 1. 5) (conditions for the landfill body)		
35	**Implementation of techniques for preventing the generation and control of bulk waste by location:** 35.1 pre-treatment and separation of light recyclable waste fractions before disposal 35.2 waste baling 35.3 use of an appropriate covering 35.4 maintaining the minimum surface of the working face (max 25 m x 25 m), slope 1:3 35.5 guard rail to prevent waste from spreading 35.6 daily waste disposal inspection	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.7.1 Litter) Regulation on the disposal of waste on landfills (Official Gazette of RS, no. 92/2010), Article 6; Annex 2, Item 1. 5) (conditions for the landfill body)	yes	35.1 Not provided for in the project. 35.2 Not provided for in the project. 35.3 An adequate cover will be used to cover the waste on a daily basis. 35.4 The recommended slope and size of the working face are provided for in the project. 35.5 Yes. The entire landfill complex will be fenced off to prevent the spread of waste, as well as to prevent the unauthorized and uncontrolled entry of humans and animals into the site. 35.6 Yes
36	**Application of bird control techniques:** 36.1 pre-treatment of organic/biodegradable waste 36.2 effective waste covering 36.3 installation of fixed or mobile bird scarecrows	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.7.4 Birds) Regulation on the disposal of waste on landfills (Official Gazette of RS, no. 92/2010), Article 6; Annex 2, Item 1. 5) (conditions for the landfill body)	Yes, partially	36.1 Not provided for in the project. 36.2 An adequate cover will be used to cover the waste on a daily basis. 36.3 Not foreseen by the project but foreseen by protective measures.
37	**Application of pest and insect control**	Final Draft BAT Guidance Note on	Yes, partially	37.1 Not provided for in the project.

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
	techniques: 37.1 pre-treatment of organic/biodegradable waste 37.2 compaction and covering of waste immediately after unloading into a defined cell 37.3 treat affected/exposed areas with insecticides	Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.7.5 Vermin & Insects) Regulation on the disposal of waste on landfills (Official Gazette of RS, no. 92/2010), Article 6; Annex 2, Item 1. 5) (conditions for the landfill body)		37.2 An adequate cover will be used to cover the waste on a daily basis. 37.3 Not applicable
38	**Implementation of techniques for controlling the spread of mud on roads at the location:** 38.1 regular dusting of access roads 38.2 regular maintenance of access roads 38.3 regular inspection of internal and external roads 38.4 use of efficient equipment for wheel cleaning and vehicle washing	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (4.4.6 Techniques for Prevention and Minimisation of Air Emissions/4.4.7.6 Mud)	yes	38.1 Yes 38.2 Yes 38.3 Yes 38.4 Yes
	Vibration emission limit values are not applicable to landfill activities	Final Draft BAT Guidance Note on Best Available Techniques for the Waste Sector: Landfill Activities, Environmental Protection Agency, Ireland; December 2011 (5. BAT for Landfill Activities/5.5.5	-	/

BAT documents defined by reference documents		Reference document (title)	Compliance with Directive / BAT requirement (Yes/No)	Comment
		Vibration)		
	There are no established BAT requirements for accident assessment issues.	Law on Disaster Risk Reduction and Emergency Management ("Official Gazette of RS", No. 87/2018), Methodology for the development of assessment of threat from natural disasters and other disasters and emergency plans and rescue plans ("Official Gazette of RS", No. 18/2017) and Regulation on the content and method of preparation of emergency plans and rescue plans ("Official Gazette of RS", No. 8/11).	-	The assessment of the risk of an accident will be examined through the aforementioned legal acts.

4.0. OVERVIEW OF MAIN ALTERNATIVES CONSIDERED BY THE PROJECT LEADER

This chapter presents a summary of the assessment of alternative solutions considered in the process of the Competitive Dialogue with Bidders and explains the reasons for excluding them from further consideration.

The tender documentation for the first round of Competitive Dialogue offered two potential locations for the EfW plant:

- Vinča location, which would offer space for new landfills, EfW and BEP plant and
- Location of Cerak, where an EfW plant could be built alternatively.

Three possible Concepts of the Design were considered, each with the aim of treating 100% of municipal waste from the territory of the City of Belgrade, taking into account the above two locations:

- Option 1:
  - Construction of a plant for mechanical-biological treatment at the Vinča site, where fuel from waste would be produced;
  - Transport of waste prepared for incineration to the Cerak site, near the residential area;
  - Construction of a new combined heat and power plant (CHP) at the Cerak site, near the existing heating plant that would use waste for its operation;
  - Transport of combustion residues to the Vinča site where new landfills would be built.
- Option 2:
  - Transport of untreated remains from the site in Vinča to the Cerak site;
  - Transport of combustion residues to the Vinča site where new landfills would be built.
- Option 3:
  - Incineration of unprepared municipal waste at the site in Vinča, at the EfW plant that would be built there;

- Disposal of combustion residues at the new landfill that would be built at the Vinča site.

In addition to each of the options, the Bidders were allowed to bid equipment for the disposal of recyclable or organic materials (sorting, composting, digestion) to further reduce the amount of municipal waste that would be finally treated at treatment facilities within the said options.

In addition, treatment, recycling, storage and disposal of construction waste are contained in each of the options listed.
The following project parts were considered:

- Part 1: Management of the existing landfill by PUC "Gradska čistoća" Belgrade:

  - Operation of the existing Vinča landfill in the transitional period of the project of 3 years (2016 - end of 2018).

- Part 2: Measures from the project implemented by the Bidder:

  - Remediation and closure of the existing Vinča landfill, including landfill gas treatment plant, energy generation and leachate treatment plant

- Part 3: Construction of a new landfill at the Vinča site, comprising:

  - Temporary landfill

  - Landfill for combustion of treatment residues, including a facility for the maturation or solidification of these residues

  - Construction waste recycling plant and inert waste landfill

- Part 4: Construction Phase and Routine Phase for the above three options of the considered Concept of the Design and, Option 3, as preliminary the most favourable concept.

The key impacts and risks of the three alternative solutions of the Design and the "no project" situations on the physical, biological and environmental impacts during the construction and operational phases of the project were assessed. The basis for comparison lies in the effectiveness of the option considered in terms of avoiding and minimizing the environmental and social impacts of project sites. The analysis and evaluation of the options considered showed that:

- Options 1 and 2 have similar disadvantages,

- Option 3 has the most advantages,

- The "no project" option has the most disadvantages.

The Cerak location is disadvantageous due to the many disadvantages, considered Options 1 and 2. The location is close to (about 120 m) residential areas which:

- makes potential noise, odours and imissions significant,
- causes a greater visual impact on the environment,
- carries a greater risk of public complaint.

Additionally, Option 1 requires significantly more transportation effort between the Cerak site and the Vinča site than other options.

Option 3 shows the most advantages over the other two options. This is mainly due to the fact that:

- the facilities are located relatively far from the volatile/residential facilities, in an area where visual effects are minimal,
- the facilities will be located in the immediate vicinity of the existing waste disposal site.

The "no project" option is unsustainable in the current state. At the Vinča site, there is currently a typical unsanitary landfill that has been formed over more than 40 years of municipal waste disposal. The consequence of the operation of this landfill is the pollution of the water of the Ošljanski stream and Ošljanska pond, the pollution of the surrounding agricultural land, groundwater and air. The landfill is not equipped with technical control systems. No lower impermeable layer (natural or artificial) was used which resulted in uncontrolled migration of leachate to the underground. There is no collection and treatment of leachate, so leachate is discharged to the nearest surface recipient. No sewer system was built at the site.

Currently, septic tanks are also disposed of at the landfill. Landfill gas accumulation is not technically controlled and utilized, leading to its complete migration and release into the air. The presence of many birds, rodents, waste-feeding insects is evident, as is their role in the potential transmission of infectious diseases beyond the boundaries of the complex. The landfill is partially fenced, but does not have an adequate and complete vegetation barrier. Waste dispersion and dispersion of particles into the air are also not controlled. Adequate supply of fire protection water is not available.

As part of the Competitive Dialogue process, Bidders evaluated different project options. The results of the dialogue are as follows:

Dialogue result	Effect
None of the Bidders selected the Cerak site as part of the project	Options 1 and 2 are no longer the subject of interest due to the proximity of the residential area and the potential impacts of the planned project on the closest environment.
Pre-treatment and production of recyclable	Prior primary separation of all recyclable components from waste is done prior to disposal of municipal waste into containers (primary selection). In the further

products were not of interest to most Bidders	development of the project, the option based on direct incineration of waste, Option 3, should be considered.
An estimate of finances and costs resulted in the City's decision to reduce the project	Option 3 will be modified. This means reducing the planned capacity of the EfW plant to around 65% to build a new landfill for untreated waste.

Source: "Environmental and Social Scoping Study for the Belgrade EfW Project in Serbia, Amendment to the E&S Scoping Report" Fichtner, April 2017)

In short, the project opted for the location of the existing municipal waste landfill in Vinča with the concept of direct incineration of municipal waste and landfill gas with the utilization of heat and electricity, as well as the construction of a new landfill for untreated waste, landfill for inert waste, landfill for EfW residues and rehabilitation of the body of the existing landfill and its final closure, with the application of modern technological solutions and equipment, and in accordance with the legislation of the Republic of Serbia, EU directives and guidelines of BAT reference documents.

Based on the aforementioned, alternatives from the point of view of a suitable location were considered by the Project Leader.

Alternative technological solutions and planned equipment have been considered, primarily in terms of meeting the requirements set out in the legislation and guidelines of the EU Directive on landfill waste disposal.

From the aspect of environmental protection, the project concerned reduces the greenhouse gas gases, decreases the distribution of waste from the landfill body, reduces the occurrence of birds, rodents and other animals on the active surface of the landfill body, reduces the risk of infectious diseases, allows the exploitation of landfill gas for energy purposes, enables the utilization of non-hazardous construction waste, etc.

From the aspect of safety and health of the population, the project in question has the effect of reducing the occurrence of infectious diseases originating from the municipal waste landfill, controlling the flow of leachate through the body of the landfill and preventing their entry into the groundwater and surface waters and their microbiological and chemical contamination.

Dust reduction systems from the landfill, wastewater treatment and landfill gas utilization are foreseen at the plant.

The Leachate Treatment Plant (LTP) as a biological treatment of water was considered as a possible alternative during the development of the project. This solution was not accepted for several reasons:

- the required layout (bases) of the necessary infrastructure was not compatible with the available space on the site (especially given the limited space below the supporting structure)

- the commissioning period required to put the biological treatment into operation is much longer

- this anticipated type of process would require more experienced professionals for the process monitoring and more intensive operation monitoring

- fluctuation of certain parameters in the quality of the leachate would require modifications and adjustments to the design during the working period

- the equipment could not be so easily put out of operation once the production of treated water has declined significantly (as expected after the supply of leachate from the existing landfill is treated)

The main benefits of the project are the temporary sanitary disposal of municipal waste until the construction of a facility for its energy utilization, the prevention of water and land contamination with wastewater from the landfill body, the reduction of greenhouse gas, the utilization of construction waste, etc.

5.0. OVERVIEW OF THE ENVIRONMENTAL STATUS OF THE LOCATION AND THE SURROUNDING AREA

5.1. POPULATION

Around the site of the Vinča landfill there are Belgrade settlements Veliko selo in the north, Slanci and Mirijevo in the northwest, Kaluđerica in the west and Vinča in the south. The closest settled households in individual settlements are at a distance of about 1700 m. The landfill complex is not directly visible from the aforementioned settlements and the nearest inhabited households. To the east is the Danube River.

Due to the implementation of a comprehensive project for landfill site management in Vinča, residents of this informal settlement will be physically displaced to free up space for the construction of newly designed facilities at the Vinča landfill complex.

The City of Belgrade is aware of the importance of physical and economic relocation, as well as the expected effects resulting from the implementation of the project.

The City of Belgrade has signed a Public Private Partnership Agreement for municipal waste treatment and disposal services in Vinča, which includes rehabilitation and remediation of the Vinča landfill, construction of a waste treatment plant and launching of a new waste management system in Vinča. In accordance with the Public Private Partnership Agreement, it is the obligation of the City of Belgrade to hand over to the public-private partner a site freed from all persons and things for the purpose of bringing the site (land) to the intended purpose established by the said planning acts.

Based on the Plan of Resettlement of Households living in the informal settlement at the Vinča landfill site as well as the re-establishment of the secondary raw materials collector revenue source at the Vinča Landfill ("Official Gazette of the City of Belgrade", No. 86/2018), it is the obligation of the City of Belgrade to draw up and implement a plan for the resettlement of households living in an informal settlement at the Vinča landfill site and on the land planned for the construction of public utility infrastructure facilities, as well as a plan to restore the source of revenue of secondary raw material collectors at the landfill. The goal of the resettlement plan is to minimize the adverse effects of the project and re-establish and improve the standard of living of those affected by the project.
The Action Plan stated:

- That members of the working group from the Secretariat for Social Welfare, the Secretariat for Environmental Protection and the Center for Social Work repeatedly went to the field and visited the site of the Vinča landfill. On 03.12.2014, 15 (fifteen) families were listed, while on 16.01.2015 14 (fourteen) families were listed at the site of the Vinča landfill;

- On 08.06.2016, the third listing was conducted on the site of the informal settlement at the site and a survey was conducted on the socio-economic status of households living in the informal settlement at the said location by an expert team comprising representatives of the Secretariat for Social Welfare and the Center for Social Work.

- The City Center for Social Work (Department of Planning and Development) conducted an analysis of the social status of families at the site and verified that they were on the records of the city Center for Social Work and prepared the Report filed under No. 551-879/7 of 1 August 2016;

As part of the latest survey (8 June 2016), there were 17 families (85 people) whose members were present in their homes between 2014 and 8 June 2016. Of the total number of respondents, a total of 41 were registered: 41 men, 44 women, 38 minors (under 18), 47 adults and 6 (six) persons without documentation on the basis of which their age would be determined.

Families mostly have four and five members, which makes 50% of the total number of families. Five families have six or more members.

All households claim to have permanent residence in the settlement. Out of the total number of respondents, 9 (nine) persons were listed as "head of household-family" have their last registered place of residence in the City of Belgrade, while 8 (eight) of them do not have a registered place of residence in the City of Belgrade.

Of 17 (seventeen) families enumerated in the last listing: 12 (twelve) families were found in the settlement during all three censuses (listings), 3 (three) families were found in two censuses, 2 (two) families were found only in the last census.

In the meantime, two persons left their households and formed 2 (two) separate households in separate barracks.

The length of residence of families in the settlement is shown in the table:

LENGTH OF RESIDENCE IN THE SETTLEMENT				
Number of years of residence	Up to 3 years	10-20 years	20-30 years	Over 30 years
No. of families	4	5	6	3

Families were asked to estimate the monthly income of each family member. In addition, they were asked to indicate the primary and secondary sources of income and the amounts generated from these sources. Individual amounts were summed and taken as an estimate of the entire family's income on a monthly basis.
Information on the amount of income is given in the table:

	INCOME AMOUNT, in dinars			
Income	up to 10,000	10,000 - 15,000	Over 15,000	It has not been stated
Number of families	5	4	3	5

The main sources of family income are: contract with landfill - 25 (twenty-five) tenants, the right to financial social assistance in Belgrade is exercised by 5 (five) tenants, while the right to social assistance in the municipality of Šabac is exercised by 4 (four) tenants.

All families live in illegally built barracks without electricity and water. After checking the property status and income on a different basis, it was determined that 2 (two) tenants are indebted with the property tax of the taxpayer.

Thirty-one (31) persons have incomplete elementary education, 6 (six) persons have completed primary education, 2 (two) persons have completed secondary education, 1 (one) has completed post-secondary education, and 3 (three) are illiterate. Five (5) tenants are still attending school.

The Working Group noted that a total of 9 families (with a total of 37 persons - household members) having the last reported claim on the territory of the City of Belgrade are entitled to resettlement with appropriate housing support in accordance with the Action Plan and the provisions of the Law on Housing and the Maintenance of Residential Buildings.

In addition to the right to resettlement with the appropriate housing support defined in the Action Plan, all families covered by the project will be entitled to the following forms of assistance whose implementation will be the responsibility of the City of Belgrade, or the competent City Administration bodies of the City of Belgrade:

- Assistance in obtaining personal documents
- Assistance when enrolling children in school
- Assistance in exercising the right to health care
- Assistance in employment and re-establishing sources of income
- Assistance in exercising the right to social assistance

The Action Plan states that there are currently seven companies present at the landfill, under contracts with PUC "Gradska čistoća". These companies employ collectors from informal settlements, (on average 10-15 per company), who extract recyclable waste from the imported municipal waste in order to reduce the amount of waste to be deposited and to increase recycling rates.

PUC "Gradska čistoća" undertakes not to increase the number of companies operating in the landfill in the meantime, as well as the number of employees in the existing companies with which it cooperates, and to terminate contracts with the said existing companies 6 months before taking over the landfill operations by the said private partner, and in cooperation with the City, to adopt a plan for monitoring and restoring the living conditions of the employees of these companies.

The Secretariat for the Environment commits itself to informing PUC "Gradska čistoća" of the adoption of the Action Plan on the obligations set out in the Action Plan. Following the adoption of the Action Plan, the City of Belgrade, through the competent secretariats, will continue to regularly inform and consult the families involved in the project about the following activities:

- Plan for the placement of families in apartments;
- Individual discussions with property owners and agreement on activities that will be undertaken to assist them;
- Presentation and signing of contracts;
- Consultative meetings with local communities in which families move;
- Date of commencement of the resettlement and planned transportation of families and their belongings (families will be notified of the exact date of resettlement at least one week before that date).

In the period from 15 June 2018 to 25 June 2018, representatives of the Secretariat for Social Work and PUC "Gradska čistoća" held meetings with companies for the collection of secondary raw materials and informed them of a possible interruption of the collection of raw materials by 2019. Subsequent discussions with the public private partner and review of the implementation plan for the various components of the project identified that these activities could continue for two more years. This was presented to recycling companies at a meeting held on 13 July 2018.

Neither company owns the facility at the Vinča landfill, so companies use hangars belonging to PUC "Gradska čistoća". Two companies have mobile equipment for baling collected waste at the landfill, and one company has a special waste collection vehicle. The Secretariat confirmed that the companies have the right to transport the equipment to another location, but the companies refuse this option. The companies said they had no plans for further work after the landfill closed and that their revenue would be jeopardized. One of the larger companies at the meeting, estimated that its workload would be reduced by app. 20%.

As stated in the study above, the City of Belgrade is responsible for the resettlement of Roma families in order to free up space for the construction of planned facilities, as well as for providing information and assistance to affected households. The City Assembly formally adopted the Resettlement Action Plan (RAP), which commits the City to meet all legal requirements, as well as the International Financial Institutions (IFIs) that will participate in the financing of the Project.

According to the latest information obtained by the City, the resettlement status is as follows:

All families that meet the requirements of the Law on Housing and Building Maintenance and adequate housing support was provided and are housed in already constructed apartments of the City of Belgrade in accordance with the Plan of Resettlement of households living in the informal settlement at the landfill site as well as re-establishing the sources of income of the collectors of secondary raw materials at the Vinča landfill.

The City of Belgrade provided assistance to individuals who do not have IDs to obtain them. Persons over the age of 16 have been assisted in obtaining ID cards. Parents were helped to obtain birth certificates for children under 16 years of age.

Prior to the resettlement itself, all children under the age of 14 were enrolled in a preparatory pre-school program and primary school, in accordance with compulsory pre-school and primary education defined by positive RS regulations. Class attendance is monitored on a regular basis in collaboration with school principals, teachers and the Secretariat for Education.

After the resettlement, all the medical records of the persons covered by the project were transferred to the health centers in the new locations. Those who do not have medical records are helped to apply for and obtain medical records at health centers.

Families are employed by the Vinča landfill as collectors, paying housing costs out of their own income. Prior to the resettlement, families were informed of the costs of using the apartments, i.e. households were told that they would have an obligation to pay the rent (if they did not go to their apartment, i.e. house) and utility costs, but also that the City would use subsidies to help them cover these costs, and that the City would also help them with drafting personal documents, enrolling children in school, health care, social protection and finding a job.

The City of Belgrade, the City of Šabac and the Municipality of Vladimirci will assist the persons involved in the project to re-establish and improve their sources of income through the following measures:

- offering seasonal jobs;
- offering jobs in city utility companies;
- offering jobs through public works programs;
- offering jobs in collaboration with the NES (development and implementation of individual employment plans, job search training as well as adult training and retraining courses, job opportunities available, employment mediation, entrepreneurship incentive and development services, special programs for individuals who are at risk; harder-to-employ groups);
- offering employment and self-employment assistance within available programs and projects of NGOs and other organizations (e.g. EU IPA 2016 EU Support Program for Roma Inclusion - Empowering Local Communities for Roma Inclusion, funded by the European Union and implemented by the Permanent Conference of Cities and Municipalities, in cooperation with local governments across Serbia);
- offering adult education and craft training courses;
- offering jobs during the construction phase of the project, at the Vinča landfill and later during the operational phase of the new landfill;
- offering collection and sorting jobs for secondary raw materials at other locations where PUC Gradska čistoća operates (e.g. at locations of future recycling centers).

Since the families were resettled from the informal settlement to the Vinča landfill in September 2018, the Working Group has been monitoring the implementation of the Resettlement Plan for at least two years after resettlement in collaboration with all other organizational units involved in the implementation of the Resettlement Plan.

5.2. AIR

Air is one of the major environmental factors, whose quality determines the quality of life of people by directly affecting health, but also indirectly affecting all other environmental factors. Numerous studies have confirmed the rise in mortality and morbidity caused by contaminated air. Quantifying the impact of polluted air on human health has become one of the key components (arguments) in stakeholder decision making.

The control of air quality in the territory of Belgrade is performed through a monitoring system established by the national and local network of measuring stations (Source: Belgrade

Environmental Quality for 2016, City Administration, Secretariat for Environmental Protection, 2017).

The Air Pollution Measurement Program in Belgrade ensures the achievement of several goals:

- monitoring air pollution levels in relation to the limit value (GV), tolerance value (TV), maximum allowable values (MDV) and target values (CV),
- taking preventive measures to protect the air from pollution,
- informing the public and making recommendations for behavior in increased air pollution events,
- monitoring of concentration trends by zones of the urban territory,
- population exposure assessment,
- identification of sources of pollution or risk,
- evaluation of long-term trends,
- considering the impact of the measures taken on the degree of air pollution.

Previously available data

<u>Regular national and local air quality monitoring</u>

With the Regulation on Zone and Agglomeration Designation ("Official Gazette of RS", No. 58/2011 and 98/2012), the territory of Serbia is divided into three zones and eight agglomerations, for the control, maintenance of conditions and/or improvement of air quality. The entire territory of Belgrade belongs to the "Belgrade" agglomeration.

Air quality monitoring requirements, including criteria for determining the minimum number of measurement and sampling points in the case of fixed and indicative measurements, methodologies for measuring and assessing air quality, data requirements and methods for providing air quality assessment data, as well as volume and content information on air quality assessment is set out in the Regulation on monitoring conditions and air quality requirements ("Official Gazette of RS", No. 11/2010, 75/2010 and 63/13).
In accordance with the Law on Air Protection, the Environmental Protection Agency was proclaimed the responsible contractor for the establishment and management of an automatic air quality monitoring system within the national monitoring network, while the Belgrade City Environmental Secretariat is in charge of controlling the air quality in the local Belgrade city network.

Belgrade's local network includes 18 measuring stations established to achieve: continuous fixed measurement of pollutants from stationary sources of air pollution in populated areas (18 measuring stations), continuous fixed measurement of pollutants from stationary sources of air pollution in industrial areas (3 measuring points) and indicative measurements of pollutant levels from mobile sources of air pollution (15 measuring stations).

The spatial distribution of automatic measuring stations and measuring points in the state and local air quality monitoring network on the Belgrade city map is given in the figure.

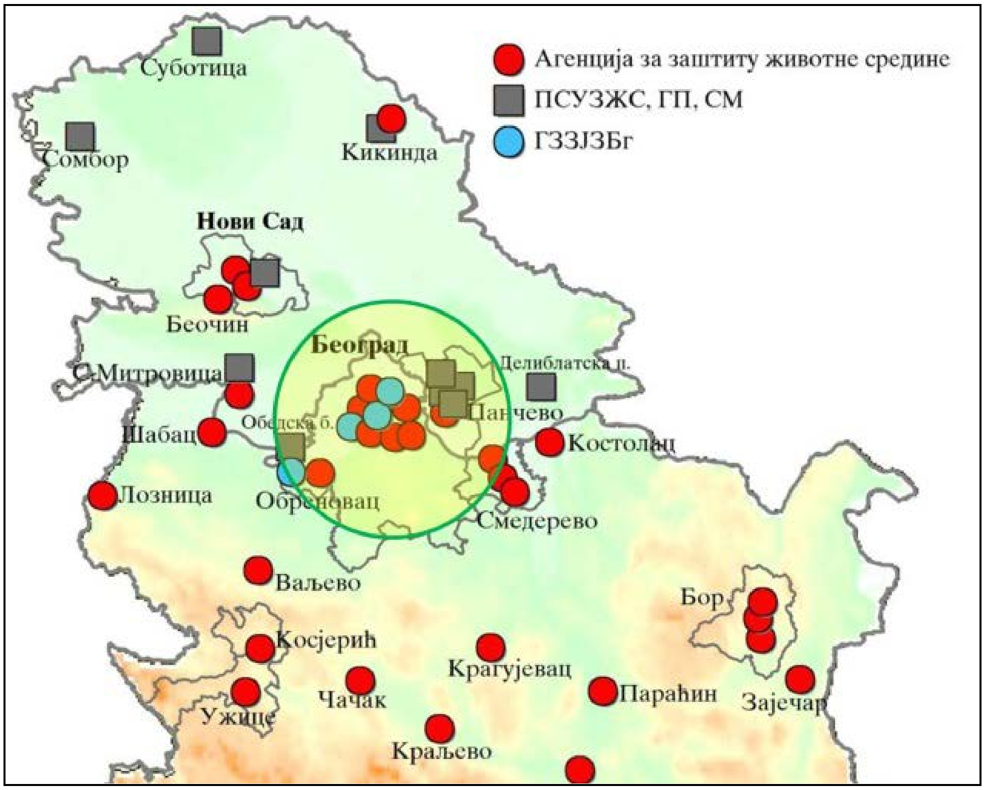


Figure 107 View of established measuring stations on the territory of RS (Belgrade)
(Source: Environmental Protection Agency (SEPA), www.sepa.gov.rs)

The following results were obtained for the City of Belgrade during 2016:

- Mean annual sulfur dioxide value above the limit value (50 µg/m^3) was not recorded during 2016, nor was the daily limit value exceeded (125 µg/m^3).
- In 2016, the annual limit value for NO was exceeded in Belgrade$_2$ of 40 µg/m^3 at Belgrade Stari Grad station, with a mean limit of 45.8 µg/m^3. Tolerance annual value of 50 µg/m^3 was exceeded at locations Belgrade_Mostar and Belgrade_Despot Stefan.
- In 2016, most stations reported exceeding the annual limit value of suspended PM_{10} particles (40 µg/m^3).
- In 2016, the exceedance of the annual limit value of suspended $PM_{2.5}$ particles of 25 µg/m^3 was not recorded.
- The annual limit value for carbon monoxide (3 µg/m^3) was not exceeded at any measuring point in Belgrade in 2016.
- The results of the benzene and ground-level ozone measurements in 2016 show that there were no exceedances of the annual limit value.

Content of heavy metals (lead (Pb), arsenic (As), cadmium (Cd) and nickel (Ni)) in PM_{10} particles in 2016 is shown in the following figure:

Figure 108 Average annual values of heavy metals in 2016 (Source: SEPA)

The recorded mean concentrations are much lower than the target value for the heavy metals indicated.

The 2016 air quality assessment is based on annual concentrations of pollutants, in accordance with the Regulation on monitoring conditions and air quality requirements.

Analysing the obtained results of continuous measurements of the level of pollutants from stationary sources of air pollution in populated areas in the state and local network during 2016 for the City of Belgrade it was concluded that *air quality in the City of Belgrade is of the third category, i.e. excessively polluted,* due to exceeding the limit values for PM_{10} and NO_2, while, generally speaking, soot and sulfur dioxide concentrations can be said to be declining.

Maximum concentrations for the period 2011-2015 for these pollutants are shown in the table.

Table 37 Maximum daily concentrations of pollutants in Belgrade

Parameter	**Concentrations by years (μg/m^3)**				
	2011	**2012**	**2013**	**2014**	**2015**
soot	238	115	183	64	172
SO_2	550	401	174	111	189
NO_2	658	245	408	231	231
PM_{10}	94	630	341	281	280

(Source: City of Belgrade Environmental Quality in 2012 2013, 2014 and 2015, Secretariat for Environmental Protection, October 2016)

Monitoring of air quality in the local network in the territory of Belgrade is determined by the Program of air quality control in the territory of Belgrade, number 501-164/16-S ("Official Gazette of the City of Belgrade", no. 14/16).

The program is in compliance with the Regulation on monitoring conditions and air quality requirements ("Official Gazette of RS", no. 11/10, 75/10, 63/13) and thus prescribes the following: selection of measuring stations and measuring sites, pollutants to be monitored, sampling methods and methods for determining pollutants, as well as air quality assessment criteria.

The program covers continuous fixed measurements (level of pollutants originating from stationary sources of air pollution in populated areas and level of pollutants originating from stationary sources of air pollution in industrial areas) and indicative measurements (level of pollutants originating from mobile sources of air pollution).

Sampling and measurement of pollutants is carried out 24 hours throughout the year. Data from automatic measuring stations ("real time" measurements) are averaged to 1 hour, and from semi-automatic to 24 hours.

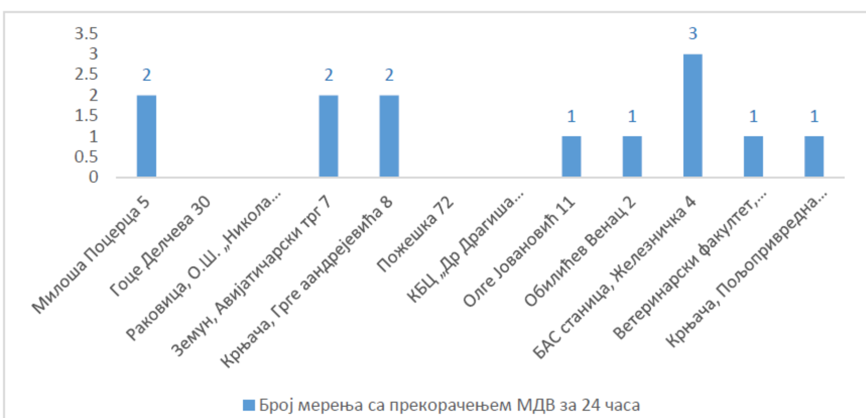
Concentrations of pollutants are expressed as mean hourly and/or mean daily values, except for carbon monoxide and ground-level ozone, which are expressed as mean eight-hour and maximum eight-hour values. The values obtained are expressed in micrograms per cubic meter, except for carbon monoxide, which is expressed in milligrams per cubic meter.

The air quality assessment was performed according to the criteria prescribed in the Regulation on monitoring conditions and air quality requirements.

Below are the data from measurement sites in the local air quality control network during 2017 (Source: Belgrade Environmental Quality for 2017, City Administration, Secretariat for Environmental Protection, 2018).

The following graphs show the mean values of daily 24-hour measurements of pollutants in the period 01.01.2017 - 31.12.2017, the lowest and highest mean 24-hour values, the number of measurements with exceeding the limit, tolerance value and maximum allowable value (for soot) for 24 hours, as well as the number of measurements with exceeding the limit and tolerance per hour (with automatic measuring stations) at 18 measuring points/stations for continuous fixed measurements of pollutant levels originating from stationary sources of air pollution in populated areas.

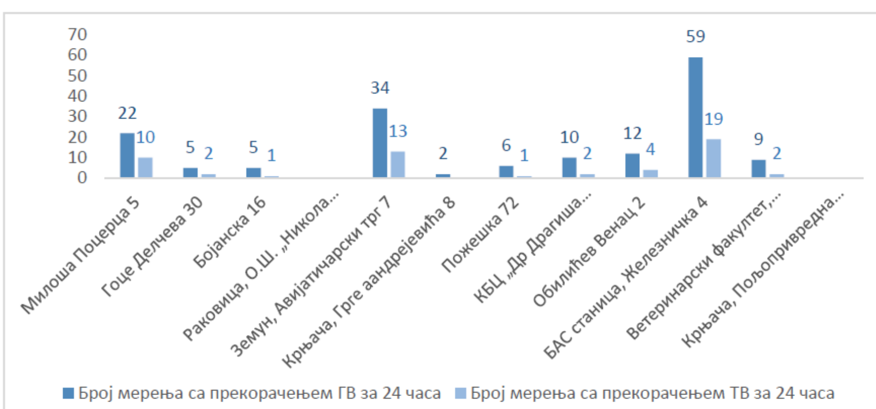
Graph 1 Lowest and highest mean 24-hour value for soot for 2017



Graph 2 Number of measurements with MDV exceedance for 24 hours for soot in 2017

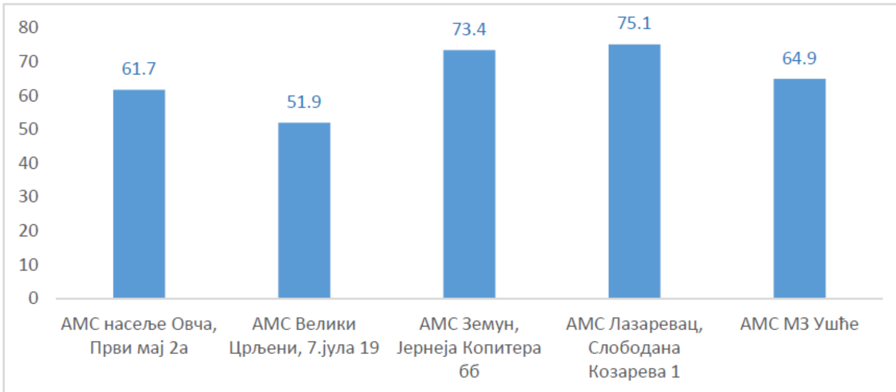
Graph 3 Lowest and highest mean 24-hour values for sulfur dioxide (semi-automatic methods) in 2017.

Graph 4 Lowest and highest mean 24-hour values for nitrogen dioxide (semi-automatic methods) in 2017.

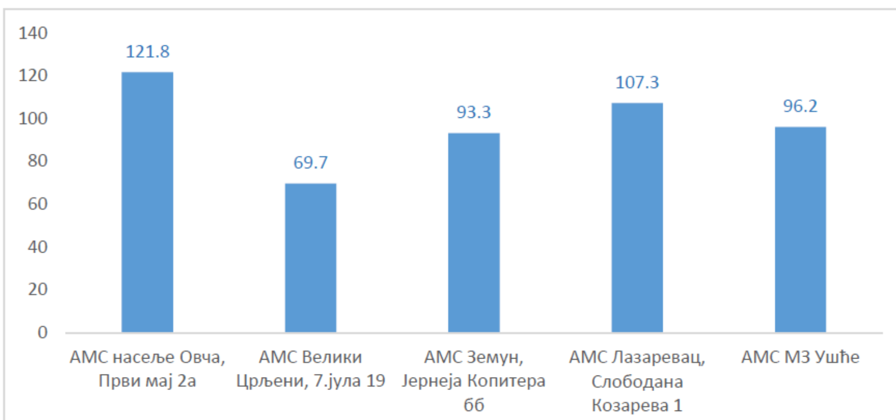


Graph 5 Number of measurements with MDV exceedance for 24 hours for nitrogen dioxide

(semi-automatic methods) in 2017

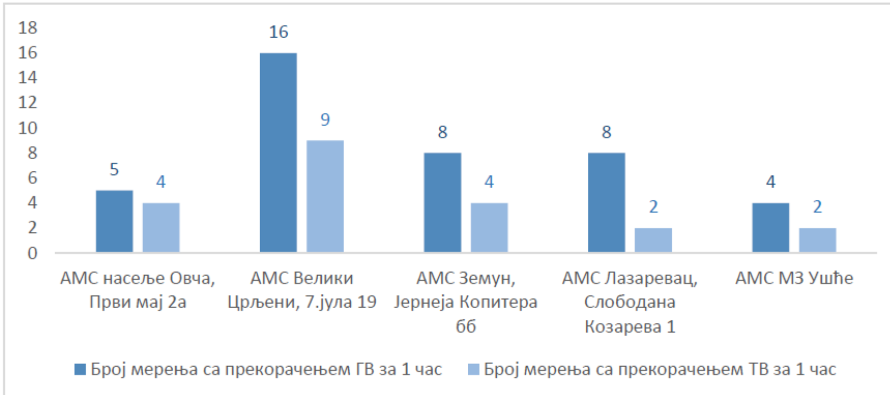


Graph 6 The highest mean 24-hour value for sulfur dioxide (automatic methods) in 2017

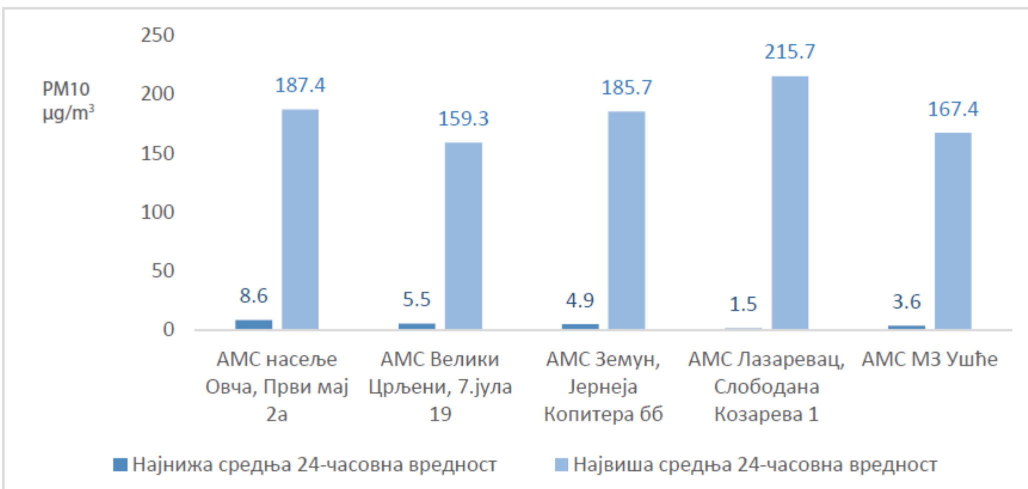


Graph 7 The highest mean 24-hour value for nitrogen dioxide (automatic methods) in 2017

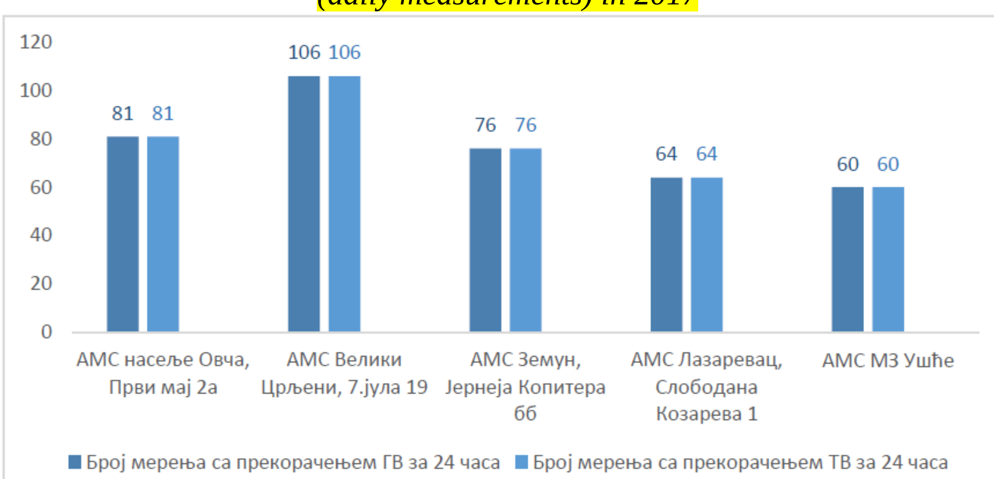
Graph 8 Number of measurements with MDV exceedance for 24 hours for nitrogen dioxide (automatic methods) in 2017



Graph 9 Number of measurements with limit and tolerance values exceeded for 1 hour for nitrogen dioxide (automatic methods) in 2017.



Graph 10 The lowest and highest mean 24-hour values for suspended particles (daily measurements) in 2017



Graph 11 Number of measurements with limit and tolerance values exceeded for 24 hours for suspended particles (daily measurements) in 2017

The analysis of the results of continuous fixed measurements of pollutant levels originating from stationary sources of air pollution in inhabited areas within the State and Local Networks in 2017 concluded that PM10 suspended particles and nitrogen dioxide are predominantly present as dominant air pollutants in Belgrade.

During 2017, no increase in radioactivity in the atmosphere was detected in the city of Belgrade. In monthly samples of air and precipitation, low concentrations of radionuclides produced (^{137}Cs i ^{90}Sr), whose presence is a consequence of the Chernobyl accident.

In addition, a natural radionuclide was detected ^{7}Be, whose concentrations in the air ranged from 0.5 mBq/m^3 up to 9.1 mBq/m^3, while in precipitation this interval was 2 Bq/ m^2 up to 79 Bq/m^2. All measured values are characteristic of Serbia. During the summer, slightly higher values were detected, which was expected due to the highly seasonal character of this radionuclide.

In the precipitation samples, an isotope ^{40}K was also present, also of natural origin and the values in which its specific activity was moving did not exceed 40 Bq/m^2, which corresponds to its normal values.

Additional monitoring of air quality during the great fire period in June 2017. (*Source: SEPA*)

During June 2017, the Vinča landfill was caught by fire. Emerging smoke spread to surrounding parts of the city. During the fire, as well as several days after the extinguishing, the City Institute of Public Health in Belgrade, which regularly monitors 24 measuring stations within the local monitoring network, continuously monitored the concentration of pollutants in the air in Belgrade, with particular emphasis on the situation regarding fire at the Vinča landfill. Particular attention was paid to Lešće, Višnjička Banja, Višnjica, Rospa Ćuprija, Karaburma, Krnjača, Kotež, Borča, Mirijevo, parts of Zvezdara in Belgrade, as well as other parts of the city that may have been affected, even if they are located at a considerable distance from the landfill, because, due to meteorological conditions during the night and during the early morning hours, pollutants do not spread very far.

Together with the Secretariat for Environmental Protection of the City of Belgrade, 4 additional measuring stations were set up to monitor the situation in more detail. Additional measuring stations measured between 8 June 2017 and 29 June 2017.

These measuring stations were selected to best demonstrate the impact of the Vinča landfill on air quality:

1. 35 Darinke Jevrić, Višnjička spa with the following parameters: suspended particles (PM_{10}) with analysis of heavy metals, polycyclic aromatic hydrocarbons and

ions, benzene and its derivatives, phenolic substances, formaldehyde, acrolein, ammonia;

2. 15 Nova 109. ulica, with the following parameters: total suspended particles with analysis of heavy metals, polycyclic aromatic hydrocarbons and ions, benzene and its derivatives, phenolic substances, formaldehyde, acrolein, ammonia;

3. Environmental Agency, 27a Ruže Jovanović Street with the following parameters: total suspended particles with analysis of heavy metals, polycyclic aromatic hydrocarbons and ions, benzene and its derivatives, phenolic substances, formaldehyde, acrolein, ammonia;

4. Vinča Pumping Station, PUC Belgrade Water Supply and Sewerage with the following parameters: suspended PM particles$_{10}$ with analysis of heavy metals, polycyclic aromatic hydrocarbons and ions, benzene and its derivatives, phenolic substances, formaldehyde, acrolein, ammonia.

In addition, a mobile eco-toxicological unit of the City Institute of Public Health in Belgrade visited the site and performed measurements of pollutants.

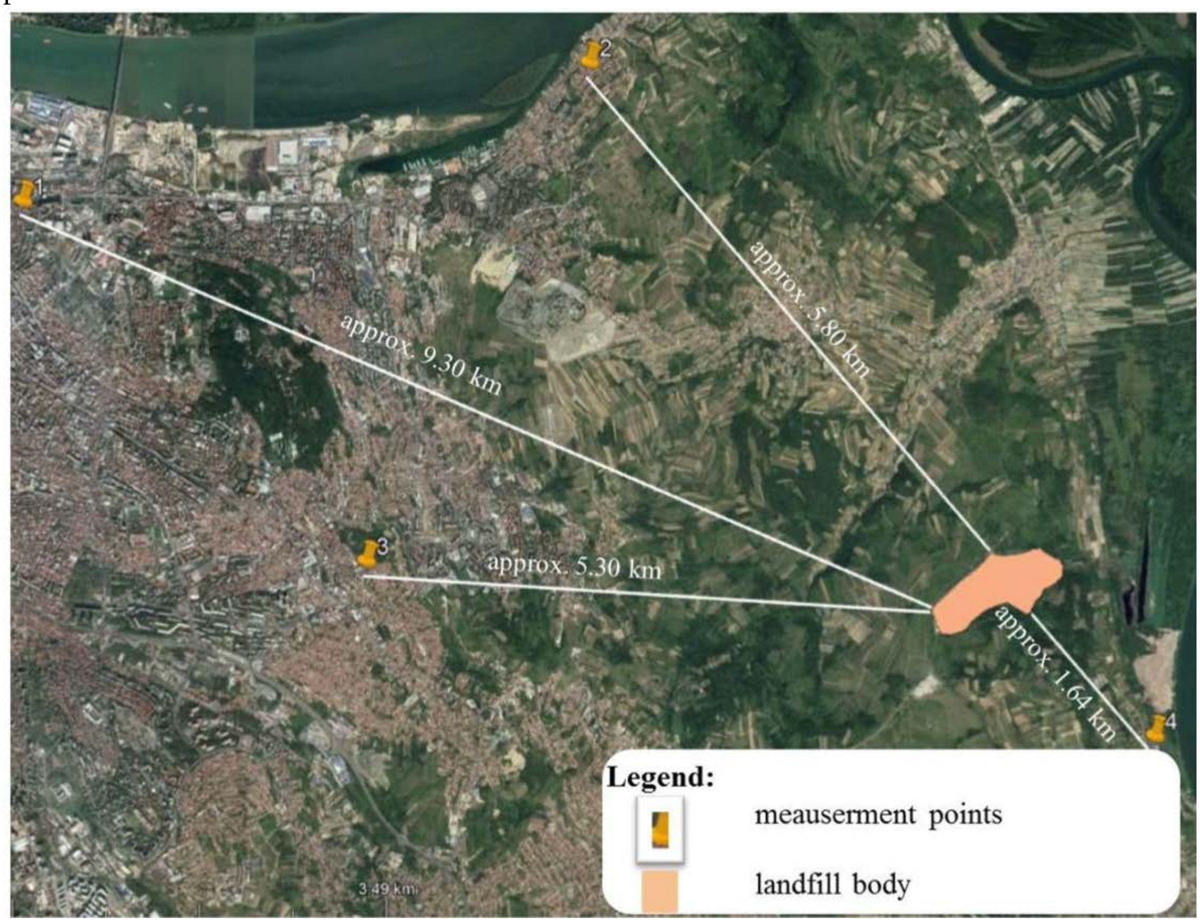


Figure 109 New measuring points for monitoring air quality during the fire (Source: SEPA)

According to the results of the City Institute of Public Health, the results obtained from the network of measuring stations of regular continuous monitoring of air quality in the period from 8 June 2017 to 29 June 2017, did not show exceedance of the limit values of the basic pollutants (carbon monoxide, oxides of nitrogen, sulfur, dioxide, suspended particles (PM_{10}), ground-level ozone), which are covered by program measurement of air pollution in Belgrade.

Results with four additional measuring stations, which measured parameters not covered by regular monitoring (PM_{10}, phenolic substances, ammonia), show that the measured values did not exceed the limit values and maximum allowable concentrations established by the Regulation on monitoring conditions and air quality requirements ("Official Gazette of RS" no. 11/2010, 75/2010 and 63/2013).

The measured concentrations of polycyclic aromatic hydrocarbons did not deviate from the values characteristic of the urban environment, except on days 11 June 2017, 12 June 2017 and 13 June 2017, when a concentration variation was observed depending on the compound. Some compounds tended to decline while some tended to grow. According to the findings of the City Institute for Public Health, oscillations in the concentrations of certain compounds from the group of polycyclic aromatic hydrocarbons are due to the presence of smoke from the fire at the Vinča landfill.

Results of the zero condition test for the purposes of this project

For the purpose of determining the zero condition of the quality of the environmental parameters, air quality monitoring was carried out in the wider area of the Vinča landfill complex before the start of works on the planned facilities.

The monitoring program combines continuous monitoring and passive monitoring carried out over the same period. The first monitoring period (January) was representative of winter conditions and, generally speaking, represented a statistically unfavourable period of high concentrations for most pollutants. Sampling and measurement was performed by the City Institute for Public Health in Belgrade, in accordance with standard methods and accreditation, in the period January-February 2018.

Continuous monitoring was performed over 28 days and included the following parameters:

- determination of mass concentration of sulfur dioxide (automatic method);
- determination of the mass concentration of nitrogen dioxide and nitrogen monoxide (automatic method);
- determination of carbon monoxide mass concentration (automatic method);
- PM_{10} particle concentration determination;

- determination of the concentration of heavy metals in PM_{10} particles;
- determination of polycyclic aromatic hydrocarbons in PM_{10} particles;
- determination of the mass concentration of ammonia, hydrogen sulfide, hydrochloride, hydrogen fluoride and volatile aromatic hydrocarbons (BTEX).

Figure 110 Spatial layout of measurement sites for “zero” air quality monitoring

The analysis of the results of the measurements revealed that the concentrations of sulfur dioxide, nitrogen dioxide, nitrogen monoxide and carbon monoxide, with an average time period of 1 and 24 h, during the period of air quality testing at a measuring point set near the administrative building within the existing landfill complex in Vinča (A1), did not exceed the tolerance limits defined in the Regulation on monitoring conditions and air quality requirements ("Official Gazette of RS", Nos. 11/2010, 75/2010 and 63/2013).

Analysis of the measurement results revealed that the concentration of PM_{10} articles and heavy metals in it, with a 24-hour aggregate period, exceeded the limit value 9 times during the period of air quality testing at the given location.

No exceedance of the limit value prescribed for lead has been observed. The concentration of heavy metals As, Cd and Ni is prescribed by the annual target value, so it is not possible to comment on the results obtained from 28 days of air quality testing, it is only necessary to note that this mean value during the monitoring period was not higher than the annual standard for air quality.

Benzo (a) pyrene is defined under the Regulation as representing a group of polycyclic aromatic hydrocarbons of compounds in PM_{10} particles through the target value on an annual basis and it is not possible to comment on the results obtained on the basis of 28 days of air quality testing.

Analysis of the results of the measurements showed that the concentrations of ammonia, hydrogen sulfide, hydrogen chloride and hydrogen fluoride, with an aggregation period of 24 hours, were below the quantification limit of the methods used, i.e. there was no exceeding of the maximum allowable concentration of these parameters during the air quality test period.

Regarding the concentration of volatile aromatic hydrocarbons (BTEX), with a 24-hour aggregation period, benzene is recognized by the Regulation as representative of the analyzed compounds through the annual limit value, therefore it is not possible to comment on the results obtained based on a 28-day air quality test period . On the other hand, the results show that the mass concentrations of toluene did not exceed the maximum permissible value for a period of 7 days.

Sampling by passive samplers was done for a period of 15 days between 31 January and 15 February 2018. Passive samplers were placed within 3 km around the location of the landfill (measuring points A2 – A6). Air pollutants measured were: PM_{10}, HF, NO_2, SO_2, HCl, Hg, BTEX and heavy metals. Average concentrations were calculated over a period of 15 days.
Content of PM_{10}, NO_2, SO_2, Pb and benzene are given in the Regulation as a daily and annual target value, therefore it is not possible to properly comment on the results obtained on the basis of the above air quality monitoring, but it should be noted that:

- Levels of NO_2, SO_2 and Pb are much lower than daily AQS
- Benzene concentrations are below the annual AQS, except for the Air 6 measuring point where this value is exceeded
- PM_{10} concentrations are below the daily and annual AQS except for the Air 3 measuring point.

Continuous measurement over 7 days in the month of April 2018 was performed at three locations (A2, A4 and A6) to determine:

- Mass concentration of nitrogen dioxide and nitrogen monoxide
- Mass concentration of suspended PM_{10} particles.

The three locations where PM_{10} concentrations and nitrogen oxides were monitored are:

- Slanci Monastery (A7); 79 Vinčanska Str (A8) and 27a Ruže Jovanović Str (A9).

The analysis of the measurement results showed that the concentrations of nitrogen oxides with a one-hour aggregation period during the period of air quality testing at the locations concerned did not exceed the limit or tolerance values defined in the Regulation on monitoring conditions and air quality requirements ("Official Gazette of RS", No. 11/2010, 75/2010 and 63/2013). It was also found that the concentrations of PM_{10} particles at defined measuring points do not exceed the values defined by the Regulation.

5.3. WATERS

Previously available data

Groundwater quality control in the territory of Belgrade već has been systematically controlled for more than 40 years by the Belgrade City Institute of Public Health in cooperation with the Secretariat for Environmental Protection. In 2017, the monitoring programme covered 24 watercourses and 28 controlling sites *(Source: Environmental quality in Belgrade for 2017, City administration, Secretariat for Environmental Protection, 2018).*

The aim of monitoring is: assessment of creditworthiness of watercourses compared to the relevant regulations, monitoring of the water pollution trend, assessment of suitability for water supply of Obrenovac, Barič and Vinča, assessment of sanitary status of watercourses and opportunities for healthy and safe recreation of citizens, suitability for fishery, irrigation of agricultural areas, monitoring of sedimentation of nonorganic and organic sediment micropollutants and bioaccumulation in hydrobionts, assessment of self-purification capacity, saprobe status and progress of the eutrophication process, provision of data for designing the wastewater treatment plant, and verification of the efficiency of taken measures for ensuring the water quality and contingent measures for remediation, protection and improvement.

The following freshwater ecosystem media are controlled through monitoting: water, sediment and hydrobionts.

In the water are determined: general and fundamental physical and chemical, microbiological parameters and elements for classification of the ecological potential and assessment of suitability for swimming, as well as priority, priority hazardous and other pollutants.

In the sediment are determined: general parameters, heavy and toxic metals and organic micropollutants, while bioaccumulation of organic and inorganic micropollutants are monitored in hydrobionts (seashell and fish).

Water quality of the Danube

The Danube is a large lowland river Danube with the domination of fine sediment and according to the Rulebook on the parameters of ecological and chemical status of surface waters and parameters of the quantitative status of groundwaters (Official Gazette of RS, No. 74/2011) it belongs to watercourses type 1. Out of 33 analysed samples in 2017, none of the Danube water samples complied with class II quality of surface waters.

Breach of norms for the prescribed class was observed with 11 (33.3 %) samples as a consequence of increased values of some microbiological and physical-chemical parameters, while in the case of 22 (66.7 %) samples deviations were observed only due to some microbiological parameters.

Concerning the chemical and physical-chemical parameters supporting the ecological status, within the constant limits of class II were: the pH value, electrical conductivity, five-day biological consumption of oxygen (BPK_5), HPK permanganate method, bichromate method, total mineralization and concentration: of TOC, orthophosphate, sulphates, chloride, nitrates, nitrites and total phosphorus solution.

The oxygen regime is more balanced than last year, with fewer deviations from class II. The amount of exceeded limit values is not large, all are in class III of river waters, and they do not therefore violate the present aquatic fauna.

Testing of the so-called “triad nitrogen” (NH_4, NO_2 i NO_3) show that the Danube load with protein substances is relatively low.
Both phases of mineralization of nitrogen substances take place successfully, which is understandable given the high discharge and great amount of oxygen..

The content of nutrients (P i N) is relatively low but sufficient to ensure the growth of algae and macrophytes, especially in areas with slow flow.

The presence of mineral oils was not detected in any tested sample.

Detergent (ABS) and phenol content was constantly below the limit of detection of the analytical method used. The situation is practically similar as in the several previous years. Among standardized non-organic and organic micropollutants, the following micropollutants were constantly below the limit of detection of the method used: Cd, Hg, Cr, Cu, Ni, PAH, while the presence of different pesticides, As, Zn, Pb, Ni was sporadically detected in the tested samples.

For many years, the microbiological pollution of the Danube in the Belgrade area, and even in Serbia has been greater and more significant than the chemical pollution, because the sanitary waste waters of Novi Sad, Belgrade and other cities on the Danube are discharged into the recipient without any purification. This is best seen through the number of bacteria which are the indicators of fecal pollution. Sanitary-microbiological tests show that none of the samples were within the limits of river waters class II. The number of total coliforms deviated from class II in 22 (66.7%) samples, the number of fecal pollution coliforms deviated from the prescribed class in 28 (80%) samples, while the number of intestinal enterococci was high in 11 (33.3%) samples. Investigations of macroinvertebrate, phytoplankton and phytobenthos communities, as well as calculated indexes, show that the ecological status of the Danube river on both tested sites is poor.

According to the Regulation on emission limit values of polluting substances (RS Official Gazette”, No. 50/2012) none of the tested parameters of the sediment samples from both sites did nod not exceed the remediation value, which is very favourable. At the Batajnica location it was established that concentrations of Cd, Zn, Cu, phenatrene, fluorantene, benzo, anthracene, benzo(a)fluoranthene, benzo(k)fluorenthene and benzo(a)pyrene were above the target values, while concentrations of Ni were above the maximum permitted value.

At the Vinča locality it was established that concentrations of Zn, Cu, Hg, phenatrene, fluoranthene, benzo(a)anthracene, benzo(k) fluoranthene, benzo(a)pyrene and total hydrocarbons were above the target values, while concentrations of nickel were above the maximum permitted value.

Compounds from the group of insecticides, herbicides and polychlorinated biphenyls were not registered in the Danube sediment.

Concentrations of Hg and As found in the muscle tissue of tested fish samples were lower than the referent values. No organic pollutants were established in the tested samples.

Through testing of sea shell muscle tissue samples, the presence of Pb, Cd, Hg was established, and the obtained concentrations were lower than the referent values. No organic pollutants were established in the tested samples.

Comparative results of the Danube waters quality, by parameter groups, in the territory of Belgrade in the last thirteen years, are shown in the following table, but we point out that the parameters of control and standards have been changed, so that the comparison is not valid:

Table 38.Quality of the Danube waters in the period 2004 - 2017 (Source: Environmental quality in Belgrade in 2017, City administration, Environmental control Secretariat, 2018)

Year	Number of taken samples	In class II of river waters		Not included in class II, due to changed parameters					
				Physical-chemical		Only physical-chemical		Only microbiological	
		Number of samples	%	Number of samples	%	Number of samples	%	Number of samples	%
2004	68	27	39,7	10	14,7	5	7,4	26	38,2
2005	68	13	19,2	26	38,2	9	13,2	20	29,4
2006	68	11	16,2	23	33,8	9	13,2	25	36,8
2007	68	20	29,4	17	25,0	8	11,8	23	33,8
2008	68	27	39,7	8	11,8	15	22,1	18	26,4
2009	68	12	17,6	14	20,6	10	14,7	32	47,1
2010	40	10	25,0	13	32,5	6	15,0	11	27,5
2011	40	18	45,0	5	12,5	4	10,0	13	32,5
2012	30	2	6,7	13	43,3	0	0	15	50,0
2013	30	3	10,0	10	33,3	3	10,0	14	46,7
2015	4	0	0	1	25,0	0	0	3	75,0
2016	16	1 6,	6,25	15	93,75	0	0	0	0
2017	33	0	0	11	33,33	0	0	22	66,7

Quality of groundwaters in the territory of Belgrade in 2017

Through systematic control of characteristics of spring waters from public taps, monitoring of the quality of ground waters in the territory of Belgrade is conducted. The programme is realized for the purpose of monitoring the indicators of the state of environment, quality of groundwaters from springs that can be used as alternative sources of water supply, also bearing in mind the preventive role regarding the citizens' health protection.

In 2017, the Programme of hygienic quality control of spring waters covered 30 public taps facilities in the city territory, where testing of 15 public taps is conducted twice a month throughout the year, and from 15 facilities in suburban settlements, once a month in the period from April to September*(Source: Environmental quality in Belgrade in 2017, City administration, Environmental control Secretariat, 2018).*

Name of facility	**Number of samples**	**Bad physical-chemical status**		**Bad bacteriological status**	
		Broj	**%**	**Number**	**%**
1. Hajdučka tap	24	2	8.3	8	33.3
2. Miljakovački Spring	24	0	0.0	13	54.2
3. Sv. Petka Kalemegdan-after filtration	24	4	16.7	6	25.0
4. Sv. Petka man. Rakovica- after filtration	22	19	86.4	0	0.0
5. Spring Sakinac Avala	24	23	95.8	5	20.8
6. Topčiderska tap – right	24	22	91.7	4	16.7
7. Topčiderska tap – left	24	23	95.8	5	20.8
8. Kakanjska tap	24	0	0.0	21	87.5
9. Pašina tap II – Zvezdara	24	24	100.0	23	95.8
10. Public tap Milošev konak	22	0	0.0	10	45.5
11. Public tap Bele vode	24	0	0.0	22	91.7
12 Spring Zmajevac	24	0	0.	24	100.0
13. Public tap Višnjica	24	1	4.2	23	95.8
14. Spring Točkić Barajevo	24	0	0.0	16	66.7
15. Public tap Higijenski zavod Grabovac	24	10	41.7	12	50.0
16. Višnjička banja	6	5	83.3	5	83.3
17. Public tap Boleč	5	0	0.0	4	80.0
18. Public tap Mokroluška	6	6	100.0	3	50.0
19. Memorial tap – Letićeva	6	6	100.0	6	100.0
20. Large tap Beli potok	2	2	100.0	1	50.0
21. Monastery Rajnovac	6	0	0.0	4	66.7
22. Spring Točak Zuce	6	6	100.0	6	100.0
23. Public tap Jajinci	6	0	0.0	3	50.0
24. Public tap Radmilovac	3	0	0.0	2	66.7

25. Public tap Čelamino brdo	6	0	0.0	0	0.0
26. Lovačka tap Beli Potok	6	0	0.0	5	83.3
27. Public tap "kod Ice", Umčari	6	4	66.7	5	83.3
28. Spring Kamenac - Beli Potok	6	3	50.0	5	83.3
29. Zorina tap – Grocka	6	6	100.0	40	66.7
30. Public tap Pandurice	6	2	33.3	6	100.0
T O T A L	438	168	38.4%	252	57.5%

Based on the results of conducted laboratory testing of water quality from public taps in the territory of Belgrade in 2017, it was noted that the majority of tested samples of spring waters did not meet the criteria foreseen by the Rulebook on hygienic safety of drinking water, where the criterion of bad microbiological quality was the greatest issue.

The most frequent reason for low hygienic quality of groundwaters from public taps was bacteriological pollution which was, except for the increased total coliform bacteria, also of fecal origin (Escherichia coli, coliform bacteria of fecal origin and Streptococcus D).

The presence of fecal bacteria in ground waters from public taps indicates poor sanitary-hygienic state of the facilities and environment and is a significant hygienic-epidemiological risk for the users.

The physical-chemical quality of waters is relatively satisfactory at most public taps, except for the spring waters of Sakinac, Topčiderska tap Mokroluška tap, Velika tap at Beli potok, spring waters of Točak in Zuce, Public tap Višnjička banja, Pašina tap II, Public tap Jajinci, Public tap "kod Ice", spring waters of Kamenac, memorial taps.

Letićeva and Zorina taps which are generally out of order due to the increased nitate and chloride content and increased electrical conductivity.

The water filter placed at the Sveta Petka spring in Kalemegdan Park, gives satisfactory results concerning water conditioning which was not good for drinking (before filtration) in the previous years, due to the presence of a greater concentration of certain chemical parameters (chlorides, nitrates, arsenic).

The water filter Filter placed at the Sveta Petka spring in the monastery of Rakovica, gives satisfactory results concerning water conditioning of groundwaters which was mostly bad for drinking before filtration, due to the presence of a greater concentration of certain chemical parameters (chromium). However, due to the unregulated level of free residual chlorium in the water, a great percentage of chemical issues was recorded after chlorination.

The biological quality of groundwaters was unsatisfatory at some public taps, where findings indicate possible penetration of surface waters into the captures, as well as the presence of organic deposits (silt), which is an excellent ground for growth and development of micro and macro organisms, and which can have a significant effect on the quality, namely hygienic quality of drinking water.

The reasons for frequently bad hygienic quality of groundwaters from public taps should be focused on the negative anthropogenic impact on environmental substrates in the urban area, and particularly in the fact that there is no regular infrastructural maintenance of facilities (repair of damages, cleaning and desinfection of captures), nor adequate environmental planning.

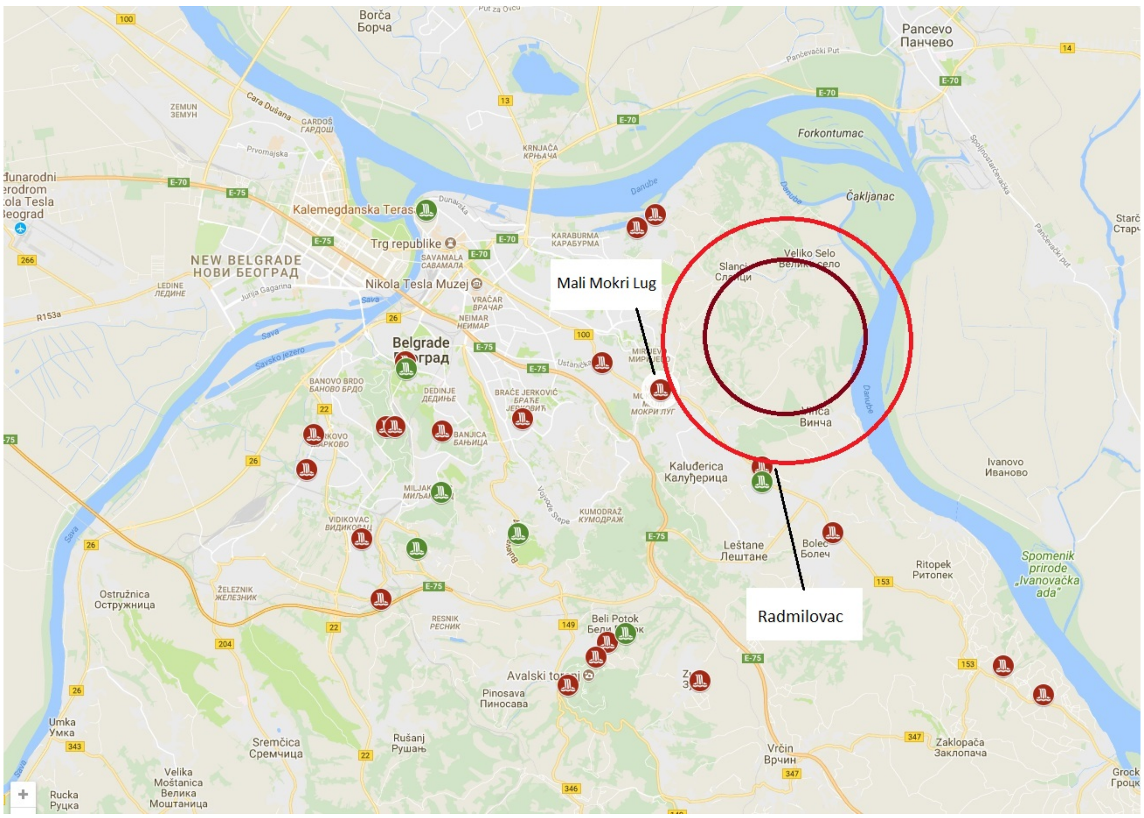


Fig. 111. Overview of public taps where there is surveillance of groundwater quality (April 2018)

Results of baseline testing for the purpose of this project

Physical-chemical analyses of surface waters

For the purpose of preparing studies on the environmental impact assessment of projects for construction of new landfill and EfW facility, and for the purpose of establishing the current baseline for suface water quality on a broader site before commencement of construction works on remediation of the current landfill, construction of new landfill and EfW facility, sampling and analysis of water samples with a total of 7 sites during March and June 2018: 1. and 2. Ošljan stream, 3. Ošljan pond (small), 4. Ošljan pond (large), 5. Leachate waters from the landfill, 6. River Danube (downstream) and 7. River Danube (upstream).

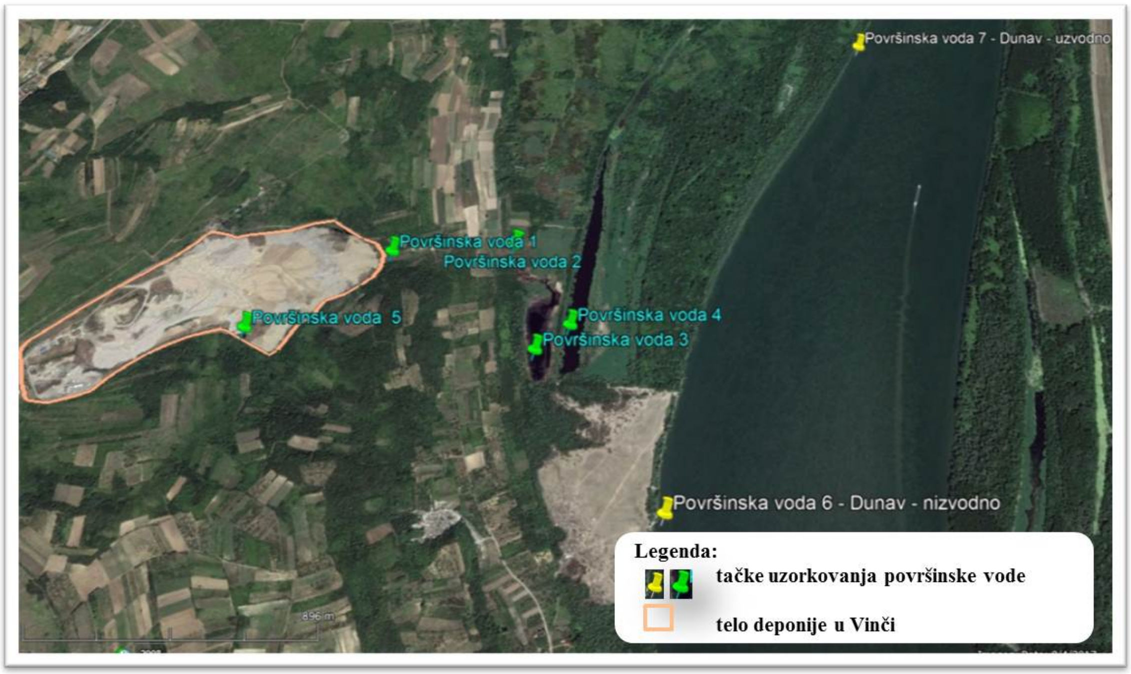


Fig. 112. Overview of the sampling site of surface waters in March and June 2018.

Fig. Translation: Surface water 1, 2,3,4,5
Legend: Sampling point of surface water
Landfill body at Vinča

Sampling and sample analysis was done by the accredited laboratory Anahem from Belgrade in accordance with the standard methods shown in the official laboratory Report.

The analysis of samples and the interpretation of results were done in accordance with the Regulation on limit values of pollutants in surface water, groundwater and sediments and deadlines for their achievement (Official Gazette of RS, No. 50/2012), the Rulebook on the establishment of surface water and groundwater bodies (Official Gazette of RS, No. 96/10), and the Regulation on limit values of priority and priority hazardous substances polluting surface water and deadlines for their achievement (Official Gazette of RS, No. 24/2014).

Since these are watercourses, except Danube, which are not covered by the Rulebook on the establishment of surface water and groundwater bodies, the limit values (LV) for the ecological status class for surface watercourse Type VI were used for the interpretation of the results (watercourses which are not covered by the Rulebook on the establishment of surface water and groundwater bodies (Official Gazette of RS, No. 96/10).

The obtained results are presented in Table, with the following colours used for the interpretation of water classes by each parameter :

LV CLASS I*	LV CLASS II	LV CLASS III	LV CLASS IV	LV CLASS V

Table 39 The test results of surface water in the landfill area, March and June 2018

	Test Parameter	Unit	SAMPLE CODE AND PERIOD OF SAMPLING CAMPAIGN								
			SW1 (1803281601)	**SW2** (1803281602)	**SW3** (1803281603)	**SW3** (1806191303)	**SW4** (1803281604)	**SW 4** (1806191304)	**SW5** (1803281605)	**SW 6** (1806191301)	**SW 7** (1806191302)
			March	march	march	march	march	June	march	june	june
	Coluor	description	Black	black	black	pale yellow	brown-black	pale yellow	black	pale yellow	pale yellow
	Odor	description	Unpleasant	unpleasant	unpleasant	present	unpleasant	present	unpleasant	present	without
	Water temperature	°C	15,4	15,4	15,5	29,0	15,3	29,0	13,7	29,0	29,0
	Air temperature	°C	16.2	16,2	16,0	27,4	15,8	28,1	14,1	25,3	24,6
	Visible floating matter	description	Present	present	present	present	present	without	present	without	without
	Turbidity	NTU	29	29	25	0,56	3,5	1,1	30	20	27
	Electric conductivity at 20 °C	µS/cm	21150	16940	18610	389	443	406	6054	442	439
	Dissolved oxygen O_2	mg/l	5,3	5,2	7,1	6,4	10,1	6,5	3,9	6,8	6,7
	pH	/	8,4	8,4	8,3	7,5	7,8	7,5	7,8	7,8	7,7
	Vapor residue (at 105 °C)	mg/l	388	376	8948	264	286	221	3516	237	250
	Chemical oxygen demand (COD)	mg/l	4855	4951	5794	10	23	20	1110	24	20
	Consumption of $KMnO_4$	mgO2/l	1063	724	1105	5,3	4,36	5,6	177	5,8	5,1
	Biochemical oxygen demand (BOD_5)	mg/l	400	450	600	4,0	10,0	5,0	190	6,0	5,0
	AOX	mg/l	2,3	1,6	2,1	<10	<0,01	<10	0,13	<10	<10
	Total nitrogen	mgN/l	1041	1027	1033	1,1	4,3	0,9	214	1,4	1,6
	Total ORGANIC nitrogen according to Kjeldahl	mgN/l	580	605	654	0,69	1,6	0,44	123	0,33	0,35
	Ammonia (mg/l NH_4-N)	mg/l	449	416	373	<0,05	1,2	<0,05	89	<0,05	<0,05
	Nitrates NO_3^-	mgN/l	12	5,7	6,3	0,43	1,5	0,52	2,3	1,1	1,3
	Nitrites NO_2^-	mgN/l	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03
	Total NON-ORGANIC nitrogen	mgN/l	461	422	379	0,43	2,7	0,52	91	1,1	1,3

	Chlorides Cl-	mg/l	2854	2080	2316	19	22	28	936	25	24
	Sulfates SO_4^{-2}	mg/l	443	193	187	28	21	27	194	24	25
	Fluorides	mg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,035	<0,05	<0,05
	Sulfides	mg/l	19	16	18	<0,5	<0,5	<0,5	14	<0,5	<0,5
	Sodium Na	mg/l	907	742	693	7,2	12	7,9	308	7,3	65

Nitrites NO_2^-	mgN/l	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03
Total ORGANIC nitrogen	mgN/l	461	422	379	0,43	2,7	0,52	91	1,1	1,3
Chlorides Cl-	mg/l	2854	2080	2316	19	22	28	936	25	24
Sulfates SO_4^{-2}	mg/l	443	193	187	28	21	27	194	24	25
Fluorides	mg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,035	<0,05	<0,05
Sulfides	mg/l	19	16	18	<0,5	<0,5	<0,5	14	<0,5	<0,5
Sodium Na	mg/l	907	742	693	7,2	12	7,9	308	7,3	65
Potassium K	mg/l	616	542	523	4,6	2,6	4,7	196	2,9	2,8
Magnesium Mg	mg/l	84	84	58	8,8	7,9	9,6	56	9,9	9,2
Calcium Ca	mg/l	105	62	74	35	39	40	84	35	34
Iron Fe	mg/l	19	16	17	<0,3	0,67	<0,3	8,3	<0,3	<0,3
Manganese Mn	mg/l	0,73	0,58	0,70	<0,05	<0,01	<0,05	0,97	<0,05	<0,05
Boron B	mg/l	5,5	4,5	5,3	<0,1	0,11	<0,1	1,9	<0,1	<0,1
Total organic carbon (TOC)	mg/l	2702	2936	2961	9,7	17,7	10,1	915	6,2	7,8
Copper Cu	mg/l	0,350	0,080	0,300	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Total chromium Cr	mg/l	0,82	0,70	0,80	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Chromium Cr VI	mg/l	<0,05	<0,05	<0,05	<0,01	<0,05	<0,01	<0,01	<0,01	<0,01
Lead Pb	mg/l	<0,02	<0,02	<0,02	<0,01	<0,02	<0,01	<0,01	<0,01	<0,01
Zink Zn	mg/l	0,30	0,38	0,28	<0,05	<0,05	<0,05	<0,01	<0,05	<0,05
Cadmium Cd	mg/l	<0,005	<0,005	<0,005	<0,0005	<0,005	<0,0005	<0,01	<0,0005	<0,0005
Arsenic As	mg/l	0,10	0,068	0,077	<0,001	<0,001	<0,001	<0,01	<0,001	<0,001
Mercury Hg	mg/l	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,01	<0,001	<0,001
Orthophosphates	mg/l	26	21	24	<0,01	0,46	<0,01	<0,01	<0,01	<0,01
Cyanides	mg/l	<0,01	<0,01	<0,01	0,004	<0,01	0,010	<0,01	<0,001	<0,001
Phenolic index	mg/l	0,104	0,088	1,12	<0,01	0,022	<0,01	<0,01	<0,01	<0,01
Mineral oils C10-C40	mg/l	12	17	15	<0,1	1,1	<0,1	<0,01	<0,1	<0,1
Benzene, µg/l	µg/l	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0
Toluene, µg/l	µg/l	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0
Ethylbenzene, µg/l	µg/l	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
Xylene, µg/l	µg/l	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
Styrene, µg/l	µg/l	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0

Alachlor, µg/l	µg/l	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0
Aldrin, µg/l	µg/l	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03
Atrazine, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
a-BHC, µg/l	µg/l	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
b-BHC, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
d-BHC, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
g-BHC, µg/l	µg/l	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
Chlorobenzilate, µg/l	µg/l	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
Chlorothalonil, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Chloroneb, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Dacthal, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
p,p'-DDD, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
p,p'-DDE, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
p, p'-DDT, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Dieldrin, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Endosulfan l, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Endosulfan II, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Endosulfan sulfate, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Endrin, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Endrin aldehyde, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Etridiazole, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
a-Chlordane, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
g-Chlordane, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Heptachlor, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Heptachlor epoxide, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Methoxychlor, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Permethrin, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Simazine, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Nonachlor, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Ametryn, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Atrazine, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Bromacil, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Butylat, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Chlorpropham, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dursban, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Cycloat, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Cyanazin, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Dichlorvos, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Diphenamid, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
EPTC, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05

Ethoprop, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Fenarimol, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Fluridone, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Hexazinone, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Methyl paraoxon, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Metribuzin, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Mevinphos, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
MGK-264, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Molinate, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
NaproPAMId, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Norflurazon, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Prometon, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Prometryn, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Pronamide, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Propazine, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Simetryne, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Tetrachlorvinphos, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Tebuthiuron, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Perban, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Triadimefon, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Trifluralin, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Acenaphthene, µg/l	µg/l	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05
Benzo(a)pyrene, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Benzo(b)fluoranthene, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo(g,h,i)perylene, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Benzo(k)fluoranthene, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Indeno(1,2,3-cd)pyrene, µg/l	µg/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Naphthalene, µg/l	µg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Total coliforms	cfu/100ml	>24000	2400	2400	>24000	<10	>24000	>24000	430	4600
Fecal coliforms	cfu/100ml	40	<10	230	150	<10	430	>24000	<10	40
Intestinal enterococci	cfu/100ml	>24000	4600	>24000	150	<10	>24000	2400	<10	40
Number of aerobic heterotrophs at 37°C	cfu/100ml	4,2 x 107	3,1 x 107	5,6 x 107	9,3 x 105	20000	1,68 x 106	9,7 x 106	8,5 x 105	1,15 x 106

Legend: SW1. and SW2. Ošljan stream, SW3. Ošljan pond (small), SW4. Ošljan pond (large), SW5. Leachate from the landfill, SW6. river Danube (downstream) and SW7 river Danube (upstream).

Based on the above, it can be concluded that the results of physical and chemical analysis of Ošljanski potok (Ošljan stream) and Ošljanska bara (Ošljan pond) at locations SW1, SW2, SW3 and SW5, show that some of the most important parameters that determine water quality (COD, BOD_5, total nitrogen, ammonia, consumption of $KMnO_4$, chlorides, phosphates, phenols, conductivity, number of aerobic heterotrophs) have significantly greater values than the parameters corresponding to the V class water. From this it can be concluded that these are uncategorized watercourses, that is non-class water. Such waters cannot be used for any purpose and their environmental impact is extremely unfavorable due to their potential for contamination. It can be concluded that surface water at these locations has poor ecological status from the chemical and microbiological aspect.

For the SW4 sample, the results of physical and chemical analyzes for the parameters BOD_5, phosphates and phenols correspond to class IV waters, and for parametres total nitrogen, consumption of $KMnO_4$ and aerobic heterotrophs to class III waters. For the parameters COD, nitrates, chlorides, sulfates, metal content, fecal coliforms, total coliform bacteria and intestinal enterococci, the obtained values correspond to class I water. Better water quality at this location compared to the other four locations is probably due to dilution due to the increased Danube water level at the moment of sampling. It can be concluded that at this location water has a mixed, excellent to poor ecological status from the chemical and microbiological aspect.

Regarding the results of the analysis of the samples of the Ošljanska bara (Ošljan pond) performed in June 2018 at locations SW3 and SW4, much better water quality is detected.

The results of the physical-chemical analysis of the small Ošljanska bara (Ošljan pond) (sample SW3) show that at the sampling site most of the analyzed parameters correspond to the quality of the water of the I class, except for the consumption parameters $KMnO_4$, BPK_5 and total nitrogen corresponding to the quality of the water of the II class. Bacteriological analysis shows that for fecal coliforms, total coliform bacteria and intestinal enterococci, the obtained values correspond to the I class, while the value obtained for aerobic heterotrophies corresponds to the quality of water V class. It can be concluded that in this location water has a mixed ecological status from the chemical and microbiological aspect.

The results of physical and chemical analyzes of the large Ošljanska bara (Ošljan pond) (sample SW4) show that at the sampling location most of the analyzed parameters correspond to the quality of the water of the I class, except for the consumption parameter KMnO4 and the total coliforms corresponding to the quality of the water class II and the oxygen-dissolved parameters, COD and BOD5 that correspond to the quality of water of the III class. Bacteriological analysis shows that for total coliform bacteria and intestinal enterococci, the obtained values correspond to class I, while the value obtained for aerobic heterotrophs corresponds to the quality of water V class. It can be concluded that in this location water has a mixed ecological status from the chemical and microbiological aspect. The reason for the different values of the parameters of the quality of these waters analyzed in March and June may lie in the increased quantity of waste water during the sampling period in May, but also in the large quantities of precipitation that were present during the entire month of June, resulting in dilution water in the pond.

Regarding the results of the Danube River analysis conducted in June 2018 at locations downstream and upstream of the existing landfill in Vinča, they show that at the sampling location, most of the analyzed parameters correspond to the quality of water I class, except for the KMnO4 consumption parametres, total nitrogen, nitrates and fecal coliforms, which correspond to the quality of the water of the II class. Some of the more important parameters that determine water quality (COD, BOD5, dissolved oxygen, total coliforms) correspond to the quality of water of the III class. It can be concluded that in this location water has a mixed ecological status from the chemical and microbiological aspect.

Physical-chemical analysis of groundwaters

Chemical analyses of the groundwater sampled from piezometers (Pz-1 to Pz-6) and some other existing boreholes (NP-11 and asphalt base well) were also performed for the purpose of determining the groundwater quality, in accordance with the Regulation on the Programmme of Systematic Monitoring of Soil Quality via Indicators for Assessment of Soil Degradation Risk and Methodology for Creation of Remediation Programmes (“Official Gazette of the Republic of Serbia”, No. 88/10), Annex 2: Remediation values of concentrations of hazardous and deleterious substances and values that could indicate significant groundwater contamination.

The results of these analyses are presented within a document named “Report on Groundwater Quality”, prepared by Energoprojekt Hidroinženjering from Belgrade in April 2018.

For the assessment of groundwater quality, two series of water sampling and analyses were performed by the certified laboratory of Occupational Safety and Environmental Protection "Belgrade" PLC and they are as follows:

− Series I: sampling was performed in November 2017 at the following locations: NP-11, Pz-1, Pz-2, Pz-4, Pz-5, Pz-6;

− Series II: sampling was performed in March 2018 at the following locations: NP-11, Pz-2, Pz-4, Pz-5 and water from asphalt base well.

As mentioned in the Report, these piezometer locations were selected for investigation in order to analyze the impacts of the existing landfill on groundwater quality (NP-11, Pz-1, Pz-2 and possibly Pz-4, which are located downstream from the existing landfill) and groundwater quality in the part that should not be exposed to the impact of the existing landfill (Pz-5, Pz-6 and asphalt base well, which are located upstream from the existing landfill). Results indicate the following conclusions:

The pH value of water in piezometers varies in the slightly alkaline range, amounting to 7.2–8, except in NP-11 and Pz-1, where the values in Series I were 6.7 and 6.9 (slightly acid medium). The values of turbidity are mostly high, ranging from 2.06 to 136 NTU. The total suspended solids are in the range of 13–390 mg/l. High values were registered in the impact zone of the existing landfill (NP-11), which is logical, but also in the asphalt base well (185 mg/l). It is interesting to note that the highest values of turbidity and suspended solids were registered in Pz-5, which is not exposed to the impact of the existing landfill (136 NTU and 390 mg/l).

Electric conductivity is the highest in the impact zone of the existing landfill i.e. in Pz-1 (12,620 μS/cm), Np-11 (4,380 μS/cm), Pz-4 (1,349 μS/cm) and Pz-2 (1,234 μS/cm). Total residue after evaporation at 180 ^{o}C corresponded to values of electric conductivity. Out of mineral substances, macro components, chlorides are most frequent in the impact zone of the existing landfill: Pz-1 (3,711.31 mg/l) and NP-11 (10,515.32 mg/l), while other values ranged from 6mg/l to 134 mg/l. The lowest value was registered in the asphalt base well. A high value of sodium was registered in the landfill impact zone, in Pz-1, being 2,156.9 mg/l. Other values ranged from 8.1 to 232.8 mg/l. The concentration of bicarbonates was the highest in NP-11 (1017 mg/l), while the values of this parameter in other piezometers ranged from 24.5 to 699.2 mg/l. Calcium concentration was the highest in Pz-1 (434.4 mg/l) and NP-11 (30.3 mg/l).

The highest concentration of nitrate was registered in Pz-1 (370.91 mg/l). The values of this parameter in other piezometers ranged from < 0.04 mg/l to 12.92 mg/l. The concentration of ammonia was also the highest in Pz-1 (21.4 mg/l), followed by Np-11 (2.72 mg/l). In other samples, it was below 1 mg/l. Nitrite concentrations in the majority of samples were <0.04 mg/l and they were 0.08 mg/l only in Pz-2 and 0.3 mg/l in Pz-5. Concentrations of phosphates and total phosphorus in all samples were < 0.08 mg/l and < 0.01 mg/l, respectively.

The value of biological oxygen demand (BOD) was highest in Pz-1 (398 mg/l) and NP-11 (63 mg/l). On the other hand, very low BOD values (1 and 2 mg/l) were registered in Pz-2, although this piezometer is under impact of the existing landfill. BOD values in other piezometers ranged from < 1 to 5 mg/l. Values of chemical oxygen demand (COD) corresponded to BOD values.

Oxygen concentration directly depends on the presence of oxidable substances. Concentrations of dissolved oxygen were lowest in NP-11 (3.5 mg/l) and Pz-1 (5 mg/l), where the lowest values of BOD and COD were also registered. Low value of oxygen concentration was also registered in the asphalt base well (4.1 mg/l). The well is very deep (300 m) and water has remained in a long period of time, while inflow of fresh (storm water) rich in oxygen through a soil layer of around 80 m in thickness is very slow.

Concentrations of heavy metals were below the remediation values, in accordance with the Regulation on the Programme of Systematic Monitoring of Soil Quality via Indicators for Assessment of Soil Degradation Risk and Methodology for Creation of Remediation Programmes (“Official Gazette of the Republic of Serbia”, No. 88/10), Annex 2: Remediation values of concentrations of hazardous and deleterious substances and values that could indicate significant groundwater contamination. The only exceptions were:

- Chromium concentration in Pz-1 (0.1 mg/l) while remediation value is 0.03 mg/l;
- Copper concentration in Pz-1 (0.13 mg/l) while remediation value is 0.075 mg/l;
- Zinc concentration in Pz-2 (1.62 mg/l) and Pz-5 (1.27 mg/l) while remediation value is 0.8 mg/l;
- Nickel concentration in Pz-1 (0.73 mg/l) and NP-11 (0.13 mg/l) while remediation value is 0.075 mg/l.

The analyses included control of mineral oils and cyanides. Concentrations of these parameters were below the respective remediation values, in accordance with the Regulation.
Based on the analyses of water quality performed in November 2017 and March 2018, it was concluded that water samples from piezometers that are exposed to the impact of the existing landfill (NP-11, Pz-1, Pz-2 and possibly Pz-4) and the ones that are not under the landfill impact differ with respect to their physical-chemical composition. It was noted that increased concentrations of some parameters (turbidity, suspended solids, nitrites, zinc) were registered in Pz-5, which is not under the impact of the existing landfill.
This situation was explained as a consequence of wash-off from the surrounding terrain (out of the existing landfill zone) and import of pollutants in groundwater. Namely, piezometer Pz-5 performed on the watershed, at the pont where there is no water flow away, so that “dead water” remains for a long time in that area. That is why the water is turbid, with a somewhat higher concentration of suspended substances and nitrite. It is not a matter of contaminated groundwaters, but of local contamination. In addition to that, piezometer Pz-5 was performed on a section which is the route through which collectors of secondary raw material transfer secondary raw material, and due to which organic substances increased on that location.

With respect to the deep well at the asphalt base, it was concluded based on one analysis performed in March 2018 that the existing landfill has no impact on water quality in the well.

Biological analysis of surface waters in the Project area

The analysis of the conditions of the aquatic ecosystems was done by the expert team from the Institute for Biological Research "Siniša Stanković" from Belgrade, in early April and middle of June 2018. The analysis of macroinvertebrate (invertebrate) communities in surface waters at the site of the landfill was carried out on samples taken at the same locations where samples for physical, chemical and microbiological analysis were taken in March 2018

Due to the increased water levels of the Danube at the moment of sampling, it was not possible to approach the same locations, so the locations from which the samples were taken somewhat differ. In the second, additional campaign carried out in June, the selected samples were taken at the same locations where samples for physical-chemical and microbiological analysis were taken.

Figure 113. **Overview of the sampling site of aquatic invertebrates at low and high water levels of the Danube, April and June 2018**

Table 40. **Overview of basic information on sampling sites - surface water**

Ord. no.	**Sample identification**	**Sampling location description**
	April 2018	
1	SW1	The site is located near the landfill body and is under the direct influence of the waters that flow from it. The water body is highly polluted, it has an intense odour that resembles the decomposition of organic matter. There are clear indicators of pollution in the water - oily layers on the surface, sediment of intense and unnatural colour, residues of different waste and other.
2	SW2	The site is also located near the landfill body and the same conditions as in the case of sampling site SW1 are recorded.
3	SW3	Sampling sites are located in the flooding zone of the Danube, downstream from Veliko Selo and the side-arm called Mala voda (Small Water). The water level in this water body depends directly on the Danube river level and it represents a typical wetland area.
4	SW4	
5	SW5	
6	SW6	
	June 2018	
1	SW3	Sampling sites are located in the flooding zone of the Danube, downstream from Veliko Selo and the side-arm called Mala voda (Small Water). The water level in this water body depends directly on the Danube river level and it represents a typical wetland area.
2	SW4	

Biological material was collected using nets with mesh diameter of 500 µm, in accordance with the standard method EN 27828:1998 (Methods for surveying aquatic macro invertebrates in running and standing waters are specified by the international standard). All habitats which are estimated to cover more than 5% of targeted water bodies were included in the sampling.

Research has shown that the presence of macro invertebrates is very poor in all these locations and in both sampling campaigns (April/June).

Regarding the investigation carried out in April 2018, on locations SW1 and SW5, located right by the body of the landfill, no water invertebrates were found. At locations SW2, SW3, SW4 and SW6, a total of 15 species from 10 different groups of water macro invertebrates were recorded. During the analysis, only the species which inhabit aquatic habitats were taken into account, while for other taxa (terrestrial species), only their presence was recorded.

It is important to note that the hydrological situation for the collection of aquatic macro invertebrates in the sampling period in April at the SW2, SW3, SW4 and SW6 locations was not favourable, since the water level was high and that a significant part of the area around the swamp was flooded. Communities of aquatic macro invertebrates in the area which was covered with water during this period are not representative of the entire water body. The above is not true for the locations SW1 and SW5.

Table 41. Results of the analysis for the presence of macro invertebrates in the surface waters, April 2018

Ord. no.	*Types/taxa*	Number or recorded species according to the sampling site			
		SW2	SW3	SW4	SW2
1	Nematodes				1
2	Limnoodrilus udekemianus Claparède, 1862	4	2	7	5
3	Limnoodrilus sp	3		1	4
	Cyclops sp.	150	110	35	50
	Daphnia sp.	50	41	33	35
4	Niphargus valachicus Dobreanu & Manolache, 1933	2			1
5	Asellus aquaticus (Linnaeus, 1758)	1	22	36	40
	Ostracoda	12	11	6	120
6	Planorbarius corneus (Linnaeus, 1758)				1
7	Viviparus viviparus (Linnaeus, 1758)	1			
8	Hydrobiidae	15	2	11	
	Hygromiidae	20	16	4	1
	Oxyloma elegans (Risso, 1826)	1		1	
9	Dytiscidae	2	4	1	2
10	Tipula sp.	9			2
11	Chironomus sp.	2		4	1
12	Ceratopogonidae				1
	Trichoptera				1
13	Hemiptera	1			
14	Notonecta glauca (Linnaeus, 1758)	1			
	Collembola	2			
	Milipaeda	8			1

Ord. no.	*Types/taxa*	Number or recorded species according to the sampling site			
		SW2	SW3	SW4	SW2
15	Argyroneta aquatica (Clerck, 1758)	1			
16	Hydrachnidia	1			1

Based on the results of the research of the communities of aquatic macro invertebrates in the wider area of the landfill in Vinča, indicative ecological the status of the water bodies at locations SW1 and SW5 can be characterized as poor (Class V), in accordance with all parameters prescribed by the Rulebook on Parameters of Ecological and Chemical Status of Surface Waters and Parameters of Chemical and Quantitative Status of Groundwaters (Official gazette of RS, No. 74/2011). It should be noted that it is intentionally stated as indicative since the status assessment procedure requires a larger number of samples and, according to the law, is not the subject of individual studies for projects of this type. Water bodies represented by the samples from the locations SW1 and SW5 can be defined as artificial and consequently, their indicative ecological potential can be characterized as poor.

Indicative ecological status of standing water body, in accordance with the results obtained for samples taken from locations SW2, SW3, SW4 and SW6, can also be assessed as poor, in accordance with applicable Regulation.

In the campaign launched in June 2018, the apparent similarity of the communities is present in both ponds, i.e., to both selected sampling points (SW3, SW4, June 2018).

The dominant species in the community are larvae of insects, mainly Diptera larvae that make up about 90%. The mosquito larvae (Culex sp.) and the hover fly (Eristalis sp.) were the most common. Other insect groups include Hemiptera and Coleopteran from the Dytiscidea and Hidrophilide families, with representatives typical of standing water that are under severe organic pollution. Cleon dipterum (Ephemeroptera) was also recorded on both locations, while one damselfly larva Ishnura elegans (Odonata / Zygoptera) was recorded at the SW4 site at the larger pond.

Indicative ecological status of these standing waters can be assessed as poor, in accordance with the Rulebook on parameters of ecological and chemical status of surface waters and parameters of chemical and quantitative status of groundwater ("Official Gazette of RS", No. 74/2011).

Table 42. **Results of the analysis for the presence of macro invertebrates in the surface waters in the landfill area, June 2018**

Ord. no.	***Types/taxa***	Number of recorded species according to the sampling site	
		SW3	SW4
1	Crustacea		

Ord. no.	*Types/taxa*	Number of recorded species according to the sampling site	
		SW3	SW4
	Cyclops sp.	5	3
	Ostracoda	1	1
2	Odonata		
	Ischnura elegans	1	0
3	Ephemeroptera		
	Cleon dipterum	5	3
4	Hemiptera		
	Corixa sp.	4	5
	Mesovelia sp.	1	1
	Velia sp.	1	1
	Plea lechi	2	1
5	Coleoptera		
	Agabus sp.	2	3
	Hidrophilidae ad	2	2
	Hidrophilidae Lv	4	4
	Coelostoma sp.	1	1
	Cercion laminatus	1	1
	Laccophilus sp.	1	1
	Helochares sp.	1	1
6	Diptera		
	Eristalis pupae	2	3
	Eristalis sp.	23	20
	Ephidridae pupae	4	2
	Dichaeta caudata	2	3
	Culex sp.	190	220
	Ceratopogonidae	1	1
	Chironomus sp.	4	5
7	Hydracarina	1	1

From all of the above, it can be concluded that it is necessary to continue the monitoring of the status in the aforementioned water bodies, for the purpose of achieving the target ecological potential class i.e. maximum ecological potential which can be achieved in the given water bodies.

5.4. SOIL

The soil pollution testing programme in the territory of Belgrade in 2017 was performed by the City Institute of Public Health Belgrade based on the Contract entered into with the City Secretariat for Environmental Protection.

During the implementation of the soil pollution testing programme in the territory of Belgrade in 2017, sampling and laboratory testing was carried out on a total of 48 soils samples.

In accordance with the testing target and bearing in mind the purpose and manner of soil use, the soil pollution testing programme in the territory of Belgrade in 2017 focused on the following testing areas:

I Soil in the area of sanitary protection of the central water supply source area in the territory of Belgrade – 12 sites

II Soil in agricultural areas – 3 sites

III Soil in the vicinity of large traffic routes – 2 sites IV Soil in public areas and within non-hygienic settlements – 7 sites

On all sites sampling was done from the depth of 0.10 and 0.50m.

During the sampling, a composite sample was formed at each site and depth, obtained by capturing soil from 3 different locations on the surface of around 20-30m².

Laboratory testing was performed in accordance with the provisions of the ISO 17025:2006 Standard, and the overcount and interpretation of results in accordance with the Regulation on the Programmme of Systematic Monitoring of Soil Quality, Indicators for Assessment of the Risk of Land Degradation (“Official gazette”, no. 88/2010).

According to the results of performed testing of the soil composition at 24 sites in the territory of Belgrade (Source: Environmental quality in Belgrade for 2017, City administration, Secretariat for Environmental Protection, 2018), in the surface soil layer (up to 50 cm), there is an increased concentration of certain testing parameters.

Taking into account all results of soil pollution testing in the territory of Belgrade, most of the deviations referred to increased nickel content in the soil (in 40 out of 48 analyzed samples) compared to the limit values according to the Regulation (“Official gazette”, no. 88/2010).

The finding of increased nickel content in the soil is in reference with the specific geochemical composition of surface soil layers in this area and in most cases was not dominantly caused by contamination of antropogenous origin. This may be concluded based on the analysis of a large number of samples and multi-annual monitoring of soil pollution in the observed area, given that similar concentrations of nickel are recorded in most of the tested samples within the General Plan of the City. There is also a similar situation in other areas outside the territory of the City of Belgrade (Smederevo, Požarevac etc.).

Considering the fact that soil contamination by means of nickel is possible due to the impact of industry, thermal power complex, traffic, utility services etc., we cannot completely exclude the antropogenous impact.

Causes of greater concentration of other metals: copper (32 samples), zink (13 samples), arsenic (3 samples), chrome (2 samples) and lead and cadmium (1 sample of each) should be searched in the harmful impact of the environment, mostly as a consequence of purposes and activities in the direct vicinity of sampling locations (point source contamination) and/or air pollution (diffusion of polluting substances).

Recorded increased content of organic parameters: total hydrocarbons (C_{10}-C_{40}) (9 samples) and polycyclic aromatic hydrocarbons (2 samples) is not so significant regarding the established concentrations and sites, but indicates that its presence in the soil requires further monitoring, considering the long period of semi-decay and other important ecotoxicological characteristics (possible inclusion into the food chain, harmful health effects etc.).

The present number of recorded deviations of heavy metal content (first of all nickel) and other pollutants in the soil in the territory of Belgrade can, other than the antropogenous harmful effect, be in reference with the implementation of the Regulation ("Official gazette", no. 88/2010). This Regulation introduces the procedure of establishing – calculating the limit and remediation value for each tested parametre, based on the content of organic matter and clay. Considering that the aforesaid regulation was completely copied from the Dutch legislation, the natural characteristics of soil composition in our territory were not taken into account. The consequence of that was an unreasonable reduction of the limit and remediation value for some tested parameters, which also resulted in the fact that almost all tested soil samples have a greater nickel content. The above situation hampers the assessment of the actual contribution of soil pollution in a certain territory/site.

Within the zone of sanitary protection of the central water supply source area deviations in terms of concentration of tested parametres were recorded on 3 sites. Those sites are: Water Supply Mladenovac – well B10, Serava Source; Water Supply Obrenovac – well No.2 "Vić Bare" and Water Supply Lazarevac – well B10.

In soil samples taken from agricultural areas as well as in the area of large traffic routes impact, no significant deviations were recorded in 2017 compared to the current Regulation standards.

Investigations performed in public areas showed that there were no significant deviations in the content of tested soil parameters within the Protected natural area of Avala – near the Avala tower and in the vicinity of "Planinarski dom Čarapića brest".

Contrary to that, at the sites of 3 unhygienic settlements: Jabučki rit, in Vuka Vrčevića Street at Čukarička padina, there are exceeded limits of a large number of tested pollutants, mostly heavy metals, some of which have, in addition to the limit value, also exceeded the remediation value.

Most of the deviations were recorded in the soil at the site in Vuka Vrčevića Street, where the limit values were exceeded in concentrations of: Pb, Zn, Cu, Ni, total hydrocarbons C_{10}-C_{40} and polycyclic aromatic hydrocarbons (PAH). Thereby, concentrations of zink (Zn), and copper (Cu) in sample 10-17-0040 (h=10cm), in addition to exceeding the limit values, have also exceeded the remediation value.

Significant exceedance of the remediation value for arsenic (As) was also recorded in both samples 17-10-0042 and 17-10-0043 (h=10 and 50cm) at the site of the unhygienic settlement Čukarička padina. In addition to arsenic, the limit value was also exceeded in concentrations of Cd, Zn, Cu, Ni and total hydrocarbons C_{10}-C_{40}.

At the site of the unhygienic settlement Jabučki rit there was a greater content of Zn, Cu, Ni and of total hydrocarbons C10-C40, whereby concentration of copper (Cu) in sample 10-17-0032 (h=50cm), in addition to exceeding the limit values, have also exceeded the remediation value. At the site of the unhygienic settlement there was also a greater content and total hydrocarbons, whereby concentration of copper in the sample, in addition to exceeding the limit values, have also exceeded the remediation value.

The above deviations of pollutants which have exceeded the limit value, some of which also significantly exceed the remediation value, indicate at the sites of unhygienic settlements that the soil at the referent sites is significantly affected by the antropogenous impact, namely exposed to the presence of hazardous and harmful substances concerning the way of using and and arranging the soil.

In the specific case the finding can be in correlation to the use of soil for the purpose of disposal of collected secondary raw materials and waste which is unproperly collected and disposed of on the soil (with no protective measures), with the application of procedures of partial waste processing or treatment through inadequate procedures.

Baseline testing results

Within the scope of ascertaining the baseline for environment quality parameters, before the commencement of works on the construction of planned facilities, soil and sediment quality determination was performed in the wider area of the Vinča complex *(Source: ESIA, Egis, ver. 03).*

Sampling was performed on 29th March 2018 by the Anahem laboratory from Belgrade, at 10 measurement locations - 7 for the soil and 3 for the sediment. Analysis of the samples, for determining physical-chemical and microbiological parameters was performed by the same laboratory, where the testing for the presence of asbestos, on 5 out of a total of 10 locations, was performed by the Mol Institute laboratory from Stara Pazova. Moreover, Egis performed specific sampling investigation in order to perform sampling points SS3 * and SS6 * of additional soil for specific analyses (Polychlorinated dibenzodioxins PCDD and polychlorinated dibenzofurans PCDF), and the analysis was performed by the International accredited Alcontrol laboratory (currently Sinlab).

Fig.114 Spatial view of locations for sampling of soil and sediment

Fig. translation: Surface soil 1,2,3,4,6,7,8
Surface soil 5,9,10 (sludge)

Table 43 Basic data on sampling sites - soil and sediment

Ord.no.	Measurement site identification	Sample type	GPS coordinates	Performed testing for the presence of asbestos
1	Surface soil 1	Soil	N 44° 47’ 10.30’’ E 20° 35’ 21.20’’	NO
2	Surface soil 2	Soil	N 44° 47' 18.20" E 20° 35' 31.20"	YES
3	Surface soil 3	Soil	N 44° 47' 31.20" E 20° 35' 11.10"	NO
4	Surface soil 4	Soil	N 44° 47' 20.78" E 20° 36' 00.98"	YES
5	Surface soil 5, sludge	Sediment	N 44° 47' 20.05" E 20° 36' 17.31"	YES
6	Surface soil 6	Soil	N 44° 47' 06.15" E 20° 36' 13.60"	NO
7	Surface soil 7	Soil	N 44° 46' 54.03" E 20° 35' 49.80"	YES
8	Surface soil 8	Soil	N 44° 46' 54.05" E 20° 35' 36.58"	NO
9	Surface soil 9, sludge	Sediment	N 44° 47' 16.37" E 20° 36' 41.02"	YES
10	Surface soil 10, sludge	Sediment	N 44° 47' 08.99" E 20° 36' 35.72"	NO

All soil and sediment samples were subjected to the same analysis. Two samples of soil of the 15th of March were subjected to analysis of polychlorinated dibenzodioxins and dibenzofurans. The table below shows all compounds analyzed in soil and sediment samples.

Table 44 List of analyzed compounds

Sample reference	Analyzed compounds
Points SS1 – SS4, SS7 – SS9	Metals, chlorinated volatile organic compounds (CVOC), polychlorinated aromatic compounds (PAHs), polychlorinated biphenyls (PCBs), volatile hydrocarbons C_5-C_{10}, benzene, ethylbenzene, toluene, xylenes (BTEX), bromides, nitrates, fluorides, chlorides, sulphates.
Points SS3* and SS6*	Polychlorinated dibenzodioxins PCDD and polychlorinated dibenzofurans PCDF[2]

The table below shows the results for compounds whose concentration is above the quantification determination value (> LV), while the gray colour indicates concentrations that exceed the detection threshold.

[2] Taking into account the wind rose and topography, it is assumed that great amounts of smoke caused by fire have a greater impact on the area with SS3 and SS6, considering the fact that the points of measurement are far from traffic routes which could be the source of such pollutants.

Table 45 Results of sediments analysis

Parametre	Sample identification and respective MACs													
	1	* MAC	2	* MAC	3	* MAC	4	* MAC	6	* MAC	7	* MAC	8	* MAC
Dry matter, %	82		77		76		82		82		80		80	
Organic matter, %	3.4	-	5,5	-	4.8	-	4.6	-	3.5	-	4.2	-	5.1	-
Mineral oil, mg/kg	<10	50[1]; 5000[2]	<10	50[1]; 5000[2]	<10	50[1]; 5000[2]	<10	50[1]; 5000[2]	<10	50[1]; 5000[2]	<10	50[1]; 5000[2]	<10	50[1]; 5000[2]
pH	6.9	-	7,1	-	7.3	-	7.4	-	7.2	-	7.3	-	7.2	-
Metals, mg/kg														
Cadmium (Cd)	0.56	0.72[1]; 11[2]	0,60	0,76[1];11[2]	0.56	0.73[1];11[2]	0.44	0.73[1];11[2]	0.45	0,71[1];11[2]	0.53	0,72[1];11[2]	0.57	0.76[1];11[2]
Arsenic (As)	4.5	30[1];56[2]	5,1	30[1];58[2]	4.8	29[1];55[2]	3.4	29[1];55[2]	2.9	29[1];55[2]	3.9	29[1];55[2]	4.2	31[1]:58[2]
Chrome (Cr)	49	116[1];441[2]	68	116[1];441[2]	58	112[1];426[2]	31	112[1];426[2]	37	114[1];433[2]	30	112[1];426[2]	39	118[1];448[2]
Mercury (Hg)	0.04	0.32[1];11[2]	0,08	0,32[1];11[2]	0.13	0.31[1];10[2]	0.19	0.31[1];10[2]	0.07	0,31[1];10[2]	0.05	0,31[1];10[2]	0.04	0.32[1];11[2]
Copper (Cu)	41	37[1];194[2]	29	38[1];201[2]	24	36[1];192[2]	15	36[1];192[2]	15	36[1];192[2]	14	36[1];191[2]	16	38[1];203[2]
Nickel l (Ni)	35	43[1];258[2]	78	43[1];258[2]	71	41[1];246[2]	35	41[1];246[2]	45	42[1];252[2]	31	41[1];246[2]	42	44[1];264[2]
Lead (Pb)	17	85[1];539[2]	20	89[1];552[2]	19	86[1];534[2]	12	86[1];534[2]	13	86[1];533[2]	15	85[1];531[2]	16	89[1];556[2]
Zinc (Zn)	56	154[1];792[2]	55	157[1];809[2]	52	150[1];771[2]	38	150[1];771[2]	45	151[1];778[2]	43	149[1];768[2]	45	160[1];821[2]
Other compounds														
HC C_{5-10}, mg/kg	<0.15	-	<0.15	-	<0.15	-	<0.15	-	<0.15	-	<0.15	-	<0.15	-
CVOC (sum), mg/kg	<0.22	-	<0.22	-	<0.22	-	<0.22	-	<0.22	-	<0.22	-	<0.22	-
Bromides,,	<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-
Chlorides i,	340	-	6.3	-	316	-	24	-	33	-	19	-	28	-
Fluorides,	<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-	<0.05	-
Nitrates, mg/kg	16	-	47	-	33	-	20	-	67	-	39	-	26	-
Sulfates, mg/kg	39	-	5.6	-	171	-	12	-	19	-	7.6	-	13	-

** Based on the Regulation on the Limit Values of Polluting, Harmful and Dangerous Substances in Soil Regulation, Annex 1, "Official Gazette RS" No.30/2018 (1-MACs, 2-remediation values of hazardous and harmful substances)*

Surrounding soil sample analysis has shown that, according to the Regulation on the Programme for Systematic Monitoring of Soil Quality, Indicators for Assessing the Risks from Soil Degradation and Methodology for Developing Remediation Programmes, Appendix 3 (“Official Gazette”, no. 88/2010):

- Measured copper concentration exceeds the limit value at the site 1 (Surface soil 1), located on the northwest boundary of the landfill complex;
- Measured nickel concentration exceeds the limit values in the soil samples taken at sites 2, and 3 (Surface soil 2, Surface soil 3) located on the northwest boundary of complex and site 6 (Surface soil 6), located on the southeast of complex;
- Measured concentrations of all studied parameters do not exceed remediation concentration values of hazardous and harmful substances in the soil;
- Presence of asbestos was not detected in any of the analyzed soil and sediment samples.

The analysis of samples SS3* and SS6* shows relatively low concentrations of dibenzodioxins (<56 ng/kg) and dibenzofurans (<35.1 ng/kg). The Regulation on the Programme of Systematic Monitoring of Soil Quality, Indicators for Assessment of the Risk of Land Degradation and the Methodology for Development of Remediation Programmes defines the Remediation value for dioxin concentration (1 µg/kg) in soil. If taken into account for the sum of dioxins (<0.056 µg/kg), this value is not exceeded in any of the soil samples.

As for the sediment analysis, the table on the following page shows the results for compounds whose concentration is above the determination value The table below shows the results for compounds whose concentration is above the quantification determination value (> LV), while the gray colour indicates concentrations that exceed the detection threshold.

The analysis of sediment samples showed that, in accordance with the Regulation on limit values of pollutants in surface water, groundwater and sediments and deadlines for their achievement (Official Gazette of RS, No. 50/2012), in accordance with the limit values for sediment quality assessment when thrown from waterways:

- Measured nickel concentration in sample 9 (surface 9 – sediment) and 10 surface sediment – sediment) exceed the target values to a small extent. Based on the clearly defined criteria for sediment quality assessment from the Regulation, it was ascertained that the sediment was slightly polluted. In accordance with the definitions given in this Regulation, its disposal is permitted during its dislocation without any special protective measures within the strip 20 m wide in the vicinity of the watercourse.
- Measured concentrations of pollutants in the sediment 5 sample (surface soil – sediment) are on the level of the natural telephone, so that the referent sediment can be dislocated without any special protective measures.

-

Presence of asbestos was not detected in any of the analyzed soil and sediment samples.

Table 46 Results of sediments analysis

Parameter	Sample identification and respective MACs					
	5	* MAC	9	* MAC	10	* MAC
Dry matter, %	68		78		78	
Organic matter, %	5.3	-	5.4	-	4.1	-
Mineral oils, mg/kg	<10	50^1; 5000^2	<10	50^1; 5000^2	<10	50^1; 5000^2
pH	7.6	-	7.6	-	6.9	-
Cadmium (Cd)	0.41	$0,68^1$; 10^2	0.46	$0,66^1 9,9^2$	0.53	0.74^1;11^2
Arsenic (As)	2.4	26^1;49^2	3.7	25^1;47^2	2.2	30^1;57^2
Chrome (Cr)	43	94^1;357^2	53	88^1;334^2	36	118^1;448^2
Mercury (Hg)	0.09	$0,28^1$;$9,4^2$	0.12	$0,27^1$;$9,1^2$	0.14	0.32^1;11^2
Copper (Cu)	15	21^1;166^2	25	30^1;156^2	26	38^1;200^2
Nickel l (Ni)	31	32^1;192^2	35	29^1;174^2	49	44^1;264^2
Lead (Pb)	13	77^1;482^2	16	74^1;164^2	18	88^1;549^2
Zinc (Zn)	40	124^1;637^2	64	115^1;592^2	59	158^1;813^2
HC C_{5-10}, mg/kg	<0.15	-	<0.15	-	<0.15	-
CVOC (sum), mg/kg	<0.22	-	<0.22	-	<0.22	-
Bromides, mg/kg	<0.05	-	<0,. 5	-	<0.05	-
Chlorides, mg/kg	623	-	921	-	80	-
Fluorides, mg/kg	<0.05	-	<0.05	-	<0.05	-
Nitrates, mg/kg	55	-	1685	-	40	-
Sulfates, mg/kg	368	-	136	-	34	-

* *Regulation on the Limit Values of Polluting, Harmful and Dangerous Substances in Soil Regulation, Annex 1, "Official Gazette RS" No.30/2018 (1-MACs, 2-remediation values of hazardous and harmful substances).*

5.5. FAUNA AND FLORA

Flora and flora habitats

Based on the field surveys on biodiversity conducted in April 2018 (Environmental baseline survey for the Vinča landfill location, Belgrade, Republic of Serbia, DVOKUT – ECRO ltd. June 2018) the following habitats were found within the project area:
Anthropogenic habitants:

- Landfill body;
- Leachate channels and ponds;

Other anthropogenic habitat types:

- Semi-natural (extremely modified) habitats:
- Intermittent streams;

Natural habitats:

- Subcontinental shrubs;
- Subcontinental shrubs and temperate grassland in mosaic distribution.

Habitats of the landfill surrounding area (planned project buffer area) are:

- Anthropogenic habitats:
  . Agricultural habitat types
  . Other anthropogenic habitat types.
- Natural habitats:
  . Freshwater ponds (oxbow ponds) with associated riparian vegetation;
  . Alluvial forests;
  . Oak forests.

Distribution of all detected habitats is shown on the figure below.

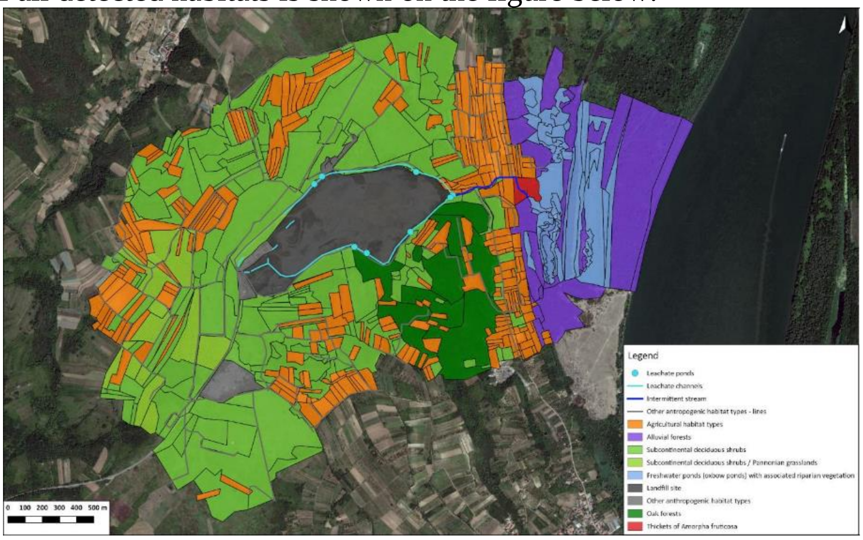


Figure 115 Habitats map created based on the data obtained during the biodiversity field survey.

Habitats on landfill body

The body of the landfill was created during decades of waste disposal. Part of the landfill is still active, other parts are partially covered by inert waste/soil. Vegetation, consisting mostly of various grass species (*Poaceae spp*.), ribwort plantain (*Plantago lanceolata L.*), broadleaf plantain (*Plantago major L*.), shepherd's purse (*Capsella bursa-pastoris* (L.) Medik.) and field mustard (*Brassica rapa* L.) has started to overgrow older parts of the landfill.

Leachate channels and ponds

Leachate channels and pond are located around the landfill body and they cover a relatively small area. In a few locations small reed bed patches, i.e. patches of Scirpo-Phragmitetum Koch 1926 association vegetation has succeeded to develop.

Vegetation on their edges contains curly dock (Rumex crispus L.), cleavers (Galium aparine L.), poison hemlock (Conium maculatum L.), field mustard (Brassica rapa L.), whitetop (Lepidium draba L.) and grasses (Poaceae spp.)

Agricultural habitats

In the landfill surrounding area, large plots of land are used for vegetable and fruit production. Some of the plots have since been abandoned, so there are four types of habitats:

- orchards – where different fruit tree species have been detected: apple (*Malus pumila* Miller), apricot (*Prunus armeniaca* L.), cherry (*Prunus avium* L.), sour cherry (*Prunus cerasus* L.), plum (*Prunus domestica*) and pear (*Pyrus communis* L.);
- abandoned orchards, where trees have been cut down or removed, and are slowly being overgrown;
- arable land and
    - abandoned arable land that is in different stages of succession.

Within the project area, most of the agricultural land is abandoned, however several orchards are still used (south of the landfill body). These habitats, especially those still being maintained, are under extreme human influence due to the activities that are being performed. Apart from selective planting, some areas are maintained by setting fires or by applying herbicides, as the survey has shown. This is emphasised since these practices can have negative impacts on adjacent habitats.

Other anthropogenic habitats

This habitat type includes various anthropogenic habitats that cover negligible areas and are not important for maintaining biodiversity of the region. This also includes other landfill infrastructure, roads and field paths, landfill buildings and manipulative surfaces. These are poorly permeable or unvegetated areas.

Nearby asphalt plant and a minor peacock rearing facility (yard) are also included in this habitat type. Landscaping around landfill buildings has introduced into the environment different plants of some horticultural value, e.g. conifers. Along paths and roads nitrophilic ruderal vegetation is formed, characterized by tall herbaceous greens: stinging nettle (*Urtica dioica L.*) and curly dock (*Rumex crispus L.*).

Intermittent streams

Ošljanski potok (Ošljan stream) was classified in this study as an intermittent stream based on data obtained from the topographic map (1:25 000) of the Republic of Serbia. Ošljanski potok (Ošljan stream) originates under the landfill and merges with leachate water. Due to this, its riparian vegetation is very similar to that of the drain channels. Riparian vegetation consists of tall herbaceous greens, characteristic for nutrient enriched or disturbed soil: curly dock (*Rumex crispus L.*), cleavers (*Galium aparine L.*), poison hemlock (*Conium maculatum L.*), greater burdock (*Arctium lappa L.*), stinging nettle (Urtica dioica L.). Ošljanski potok (Ošljan stream) is without aquatic vegetation. Near the inflow into Ošljanska bara (Ošljan pond) thickets of an invasive species false indigo-bush (*Amorpha fruticosa L.*) have developed.

Subcontinental deciduous shrubs

Subcontinental deciduous shrubs are the most widespread natural habitat in the planned project area. They developed because earlier land use was abandoned, which which may be concluded from the terraced, now overgrown slopes. Here succession led to grassland development, followed by development and spreading of low bushes, and in the later stages by formation of well-developed shrubs. Depending on the location they developed as thick, impassable stands or thickets, or as less dense stands in an interchange with grassland.

The species composition is mainly homogeneous, dominantly composed of common dogwood (*Cornus sanguinea L.*), midland hawthorn (*Crataegus laevigata* (Poir.) DC.) and blackthorn (*Prunus spinosa L.*). West from the landfill the vegetation of shrubs is very dense, and it has completely covered the land disabling the establishment of other plant species and inhibiting larger animals' migration. Other higher shrub species present such as common hawthorn (*Crataegus monogyna Jacq.*), field rose (*Rosa arvensis Huds.*) and common barberry (*Berberis vulgaris L.*) were present in variable percentages. Stands of blackberries *Rubus spp.* are also regularly present. Occasionally smaller individuals of tree species such as black elder (*Sambucus nigra L.*), common hazel (*Corylus avellana L.*) and Turkey oak (*Quercus cerris L.*). Invasive species false indigo-bush (*Amorpha fruticosa L.*) and black locust (*Robinia pseudacacia L.*) were significantly present at all sites. In some smaller fragments black locust dominated over shrub vegetation (e.g. north from the landfill).

Subcontinental deciduous shrubs / Pannonian grasslands

In the area south-west from the landfill, where shrubs are less dominant, and grassland, such as cat grass (*Dactylis glomerata L.*), false oat-grass (*Arrhenatherum elatius* (L.) P.Beauv. ex J.Presl & C.Presl) and common meadow-grass (*Poa pratensis L.*) has greater cover. Some of the other present species were curly dock (*Rumex crispus L.*) and white clover (*Trifolium repens L.*).

Freshwater wetlands (oxbow ponds) with associated riparian vegetation

One such habitat consists of the Ošljan oxbow ponds (Ošljanske bare), located approximately 600 m from the landfill site.

These freshwater ponds are still partially connected to the Danube River, and their water is refreshed during periods of high water levels. This is important because of the fact that impacts of the leachate water inflows can be periodically mitigated, at least to an extent.

During the field survey, high Danube water levels made oxbow ponds difficult to access, which hindered possibilities for a thorough vegetation analysis.

Ošljan ponds include large areas of *Scirpo-Phragmitetum* (Koch 1926) associated vegetation. Namely, rather large reed beds composed of *Phragmites australis* were noticed during the survey. These reed habitats are extremely important for maintaining biodiversity, being favourable habitats for wetland birds.

Reed beds are better developed in areas further away from the mouth of the Ošljan stream (Ošljanski potok). In the area of the oxbow pond near the mouth of the stream, there are dense thickets of invasive species called false indigo-bush (*Amorpha fruticosa L.*).

Alluvial forests

An alluvial forest in the survey area is located in the buffer zone around the Ošljan Pond. Vegetation class *Salicetea purpureae* Moor 1958 contains riparian willow scrub and willow-poplar forests distributed along rivers – on river islands, river banks, and along other freshwater bodies (e.g. marshes, lakes). They are not biogeographically determined. Instead, they are uniform throughout Europe, determined by the period of the year their root systems are fully submerged underwater. The dominant species are white willow (*Salix alba L.*), silver poplar (*Populus alba L.*), cottonwood poplar (*Populus nigra L.*) and grey poplar (*Populus x canescens* (Aiton) Sm.). Scrub and forest patches are alternating around the Ošljan pond.

Invasive plant species

The planned project area was characterized by the presence of invasive plant species: black locust (*Robinia pseudacacia*), false indigo-bush (*Amorpha fruticosa*), and tree of heaven (*Ailanthus altissima*). Old (at least ten years old) and young specimens (sprouts) were both found. Copses of black locust have, at times, completely suppressed local vegetation (e.g. near the asphalt plant and in place of some shrubs). False indigo-bush was homogenously present in areas with subcontinental deciduous shrubs and had a significant presence in grassland fragments. Tree of heaven specimens have spread mostly near forest paths, but have been found in other habitats as well. Young plants of common ragweed (*Ambrosia artemisiifolia*) were found only in one location, near the northern edge of the landfill. As this species is known for its rapid dispersal over disrupted environments, its population is probably in the early stages of the local invasion.

Close to the Ošljan stream, in the buffer zone, a few specimens of honey locust (*Gleditsia triacanthos*) were also found. This species has already been detected in Serbia, and it is occasionally locally invasive. Its invasions are especially successful in alluvial forests. Due to the considerable habitat degradation in the wider area, this species can be assumed to have a strong invasive potential. In the area of the oxbow pond near the mouth of the Ošljan stream (in the project buffer zone), dense thickets of an invasive species false indigo-bush have developed.

Above discussed invasive species: black locust (*Robinia pseudacacia*), false indigo-bush (*Amorpha fruticosa*), tree of heaven (*Ailanthus altissima*) and common ragweed (*Ambrosia artemisiifolia*) were declared highly invasive in Serbia. Disrupted natural environments (such as abandoned agricultural land, abandoned grasslands, polluted land) are sensitive to invasion, which means that an even more rapid dispersion and population growth of these organisms can be expected in the future, which would represent a threat to local biodiversity.

<u>Oak forests</u>

In the surrounding area of the landfill, oak forests are today not extensively developed, and cover limited fragments and include considerable areas of forest edges, which fall under the category of shrub habitat described above. They are located to the south-east from the landfill. The most determinative tree species is Turkish oak (*Quercus cerris L.*), but the following elements are prevalent (mixed forest): field maple (*Acer campestre L.*), common hazel (*Corylus avellana L.*), common dogwood (*Cornus sanguinea L.*), perfoliate honeysuckle (*Lonicera caprifolium L.*), blackberry (*Rubus spp*.), field elm (*Ulmus minor L.*). Similarly to other habitats, invasive species, such as black locust (*Robinia pseudacacia L.*). are present in this habitat.

Fauna and fauna habitats

During the field survey (Environmental baseline survey for the Vinča landfill location, Belgrade, Republic of Serbia, DVOKUT – ECRO ltd. June 2018), wild boar traces (of digging in the mud) were found in the southern part of the planned project area of the Vinča landfill. Preferable habitats for this species are well-developed forests. This indicates that individuals occasionally use this area as a feeding ground.

The landfill provides a very good shelter and food source for large populations of various small rodents, such as mice (*Mus spp*., *Apodemus spp*.) and rats (*Rattus spp*.). The population of brown rat is dominant at the landfill over the native species of black rat. Large numbers of small mammals (mice and common voles) are present throughout the study area (within the planned project area and the buffer zone).

Substantial populations of small rodents are main food source of beech marten (*Martes foina*), which has been observed hunting at the southern border of the current landfill.

The most densely distributed species of reptiles was the common wall lizard (*Podarcis muralis*). These lizards are very easily spotted at sites under direct sunlight, such as natural and artificial surfaces without vegetation. They were usually present in groups of up to five specimens. A dense common wall lizard population was found in the planned project area, as well as in the buffer zone.

This pattern depends on the large diversity of insects associated with the landfill (such as those of the species *Diptera*), as they are an important food source for lizards. Another reptile species in the planned project area was the European green lizard (*Lacerta viridis*), a species that preferers natural habitats such as shrubs and thickets.

The landfill provides adequately sheltered and wet habitats for species of millipedes (*Julidae sp.*) and land isopods such as the rough woodlouse (*Porcellio scaber*). Populations of snails of the family *Helicidae* were often found in places overshadowed by vegetation. Various spider webs were found in areas covered by shrubs. A typical representative species is the nursery web spider (*Pisaura mirabilis*).

The most common and largest group of insects at the landfill were *Diptera* families *Muscidae*, *Calliphoridae*, and *Sarcophagidae*. The *Diptera* larval stages, known as maggots, were the only invertebrates present in landfill leachate pools and the Ošljan stream. This indicates a substantial resilience of these organisms to water pollution.

The whole survey area, especially around Ošljan oxbow ponds, is inhabited by a large and diverse population of *Diptera* family mosquitoes (*Culicidae*).

The second largest group of insects at the landfill, next to the *Diptera* order, were cockroaches (*Blattodea*), represented by two species: German cockroach (*Blatella germanica*) and Oriental cockroach (*Blatella orientalis*), which were very easy to detect at the landfill and around it, within the planned project area.

Various flowering herbaceous plants and flowering bushes provide food for insects feeding on nectar. Nine species of butterflies are present at the site, belonging to the following families: *Hesperiidae, Nymphalidae, Papilionidae, Pieridae, Lycaenidae, Erebida*e and *Hesperiidae*.

A common beetle found on flowering plants was the green rose chafer (*Cetonia aurata*). The order of *Hymenoptera* was represented by *Apidae* and *Vespidae*, with a considerable domination of the wester honey bee (*Apis mellifica*). Some specimens of this order are also found at the body of the landfill.

The order of Hemiptera was represented by three species from the families *Pyrrhocoridae* and *Pentatomidae*. The most dominant species of this order was fire bug (*Pyrrhocoris apterus*), which was very easy to detect due to its bright colour and specific behaviour (specimen grouping).

The small fragments of grasslands were inhabited by ants (*Formicidae*) and nymphs of bush crickets (*Tettigoniidae*). The beetles of families *Coccinellidae* were found at plants which were infested with members of parasitic plant mites.

Only two insects connected with wet and aquatic habitats were noted: a single specimen of spread-winged damselfly (*Lestidae*) and a single specimen of aquatic beetle (*Dytiscidae*), but they were not associated with landfill leachate waters.

During the bird survey of the Vinča landfill, 57 species of birds were identified (Bird survey at "Vinča" city landfill - Preliminary Report, prepared by Marko Šćiban and Nikola Stanojević from the Bird Protection and Study Society of Serbia (BPSSS) in April 2018). Some bird species use the landfill body for foraging and resting, while other species are only flying over the survey area.

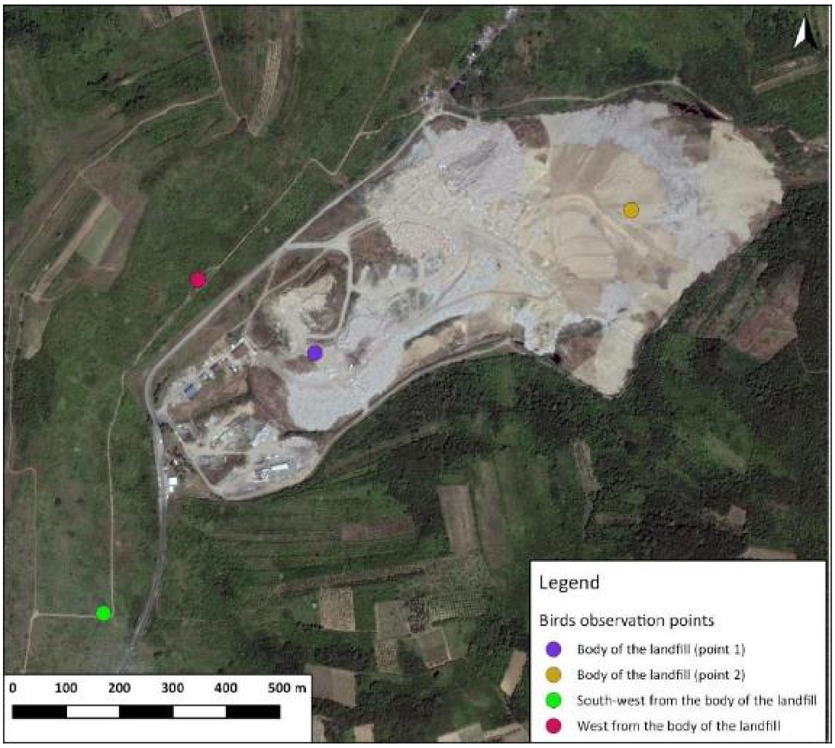


Figure 116 Bird observation points within the planned project area

The most numerous species was Black-Headed Gull (*Larus ridibundus*), with an estimated population of around 3,000 specimens at the landfill site. Other common species such as Caspian/Yellow-legged gull (*Larus cachinnans/michahellis*), Lesser Blackbacked Gull (*Larus fuscus*) and Great Cormorants (Phalacrocorax carbo) were also identified, but their populations were considerably smaller.

Gulls (*Larus spp.*), White Storks *(Ciconia ciconia*), Starlings (*Sturnus vulgaris*) and species from the Crow family (*Corvidae*) were present in the vicinity of the landfill personnel and vehicles. Raptor species kept some distance and spent most of their time at parts of the landfill where waste disposal was not taking place.

The bird population of the Danube River and Ošljan oxbow ponds is characterized by the presence of wetland species (such as *Aythya nyroca, Spatula clypeata, Spatula querquedula, Mareca strepera, Podiceps nigricollis, Microcarbo pygmaeus*).

Flora and fauna species of particular interest - endangered and protected species

For the purposes of an environmental impact assessment study, birds were monitored and studied in a wider landfill area in Vinča over an entire calendar year, through four campaigns. Relevant environmental data were collected on locally distributed species and specificities of the area in question.

A preliminary survey was conducted in April 2018 (Bird survey at "Vinča" landfill - preliminary report, Preliminary Report, Bird Protection and Study Society of Serbia, Novi Sad, April 2018, by M. Šćiban, N. Stanojević). A number of surveys followed: in September/October 2018 (Bird survey at the Vinča landfill and its surroundings in Belgrade, during the migration of birds from September to October 2018, Preliminary Report, October 2018, League for Ornithological Action of Serbia, by D. Simić) and in December 2018 (Bird survey at the Vinča landfill and its surroundings in Belgrade in December 2018, Preliminary Report, January 2018, League for Ornithological Action of Serbia, by D. Simić). In October 2018, available literature and field data were summarised in the Overview of previous sightings of birds at the Vinča landfill and surrounding areas (published by Dragan Simić, League for Ornithological Action of Serbia).

Monitoring of bird populations continued in May and June 2019 (Survey of the rearing of birds at the Vinča landfill in Belgrade, May-June 2019, Preliminary Report, July 2019, D. Simić, M. Raković).

Preliminary survey in April 2018

During the April survey, 56 bird species were identified at the Vinča landfill. Many species were really using the landfill to foraging and resting, while some other species were only registered while they were flying over the survey area. The most numerous species was Black-Headed Gull (*L. ridibundus*) with an estimated population of over 6,000 specimens observed at the landfill site, flying and resting at the Danube River (OP6). Three species attracted more attention than the others: Lesser Blackbacked Gull (*L. fuscus*), with less than 13 specimens - which was one of the largest numbers of this species ever detected at the site (Šćiban at al., 2015); Mediterranean Gull (*L. melanocephalus*), a species which is believed not to be drawn by landfills and which has only once been identified on that site; and Black Kite (*M. migrans*), a species belonging to the national category of critically imperilled species, with a small population, out of which 1 or 2 specimens spent a lot of time at the site, indicating a possibility of mating in the vicinity. A newly identified active nest of White-tailed eagle (*H. albicilla*) is located in the buffer zone. Gulls, White storks, Starlings and species from the Crow family were feeding in the vicinity of landfill personnel and vehicles, while raptor species kept a certain distance and spent most of their time at the parts of the landfill where waste disposal was not taking place.

Flooded retention basins found between the landfill and the Danube River and the Vinča pond (Vinčanska bara) had not been previously surveyed, and their importance for migrations of water birds has not been determined. During this survey, several rare species and species of importance for protection were identified (*A. niroca, S. clipeata, S. kuerkuedula, M. strepera,* *P. nigricollis, M. pigmaeus*), which indicates the importance of this wetland for preservation of species.

Survey conducted in September-October 2018

In late September and the first half of October 2018, 47 (+1) species were identified at the landfill and in the buffer zone, which is defined as an area 1.5 km from the landfill. The most numerous were the two dominant species of gulls (Yellow-Legged Gull and Black-Headed Gull), numbering in the thousands, followed by the Common Starling and Common Wood Pigeon, numbering in lower hundreds, followed by 13 further identified species, ranging from 10 to 99 individuals. Further 31 species were identified in the range of 1 to 9 specimens. The number of White-tailed Eagles was particularly high in the early mornings in the Vinča pond - up to 6 specimens. Most of them were observed at too large a distance to be able to determine their age, but, unlike other birds, who were flying, trying to hunt, or simply flew away, two birds were sitting by each other's side, motionless, throughout the observation period, which suggested that they were a territorial pair. Although it was very polluted by wastewater from the landfill, the Vinča pond is, generally, a place with the most developed biodiversity in the survey area, with, inter alia, Mute Swan, Northern Shoveler, Gadwall, Mallard, Eurasian Teal, Little Grebe, Eurasian Coot, Dunlin, Common Snipe, Marsh Sandpiper, Black-Headed Gull, Yellow-legged Gull, Pygmy Cormorant, Great Cormorant, Grey Heron, Great White Egret, Little Egret, Eurasian Sparrowhawk, White-tailed Eagle, Common Buzzard, Common Kestrel, together with various singing birds, including White Wagtail (at the height of its migration, 20 specimens at once) and Water pipit (which is, in Balkans, a species that lives in high mountains, usually above the tree line).

Southeast slopes are characterized by the most diverse habitats, and therefore also the highest diversity of species. As gulls use that area as a flying corridor (and, to a lesser extent, the Vinča pond as a resting place), the total number of birds identified in this area is approximate to the number identified at the landfill.

The number of species identified at the landfill and the southwest slopes is half or less than half of the number of those identified on the southwest slopes. In view of the species and the individual number, the southwest slopes were the poorest part of the surveyed area.

Survey in December 2018

From mid to late December 2018, 31 species were identified at the landfill and in the buffer zone. The most numerous species was Black-Headed Gull (up to 21,000), followed by Yellow-Legged Gull, Gull-billed Tern and Caspian Gull, in the lower hundreds, followed by Rook and Eurasian Teal, with about 100 specimens. Several winter species deserve particular attention: Gulls (of all species) as a group which directly uses the landfill, mostly as an area for foraging and residing; Grey Herons, who have recently multiplied their numbers (5x) and reside at the landfill; a territorial White-tailed Eagle in the Vinča pond, and many Water pipits, using the pond as their winter habitat.

Survey conducted in May-June 2019

A total of 51 bird species were identified during the survey, out of which 12 are protected, and 37 strictly protected in accordance with the national legislation (Strictly protected wild species of plants, animals and fungi, 2010/2011). Four out of the identified species have been included in the Red Book of Fauna of Serbia III – Birds (Radišić et al., 2018.). One of them - European Turtle Dove - is facing the risk of extinction.

Out of the total of 51 detected species, 36 were recorded as having reproduced, 6 as species that might reproduce, 22 as likely to reproduce, and, finally, 8 as species confirmed to reproduce. Further 15 species were detected in activities entailing reproduction. A total of 22 breeding pairs were identified. The seven most numerous species together had 156 breeding pairs, or 69,4% of that number. Separately, the two most numerous species, Common Whitethroat and Common Nightingale, with 78 breeding pairs, constitute over one third or 34.8% of the total number of active nests.

Table 47. Observed protected and strictly protected bird species and their general distribution within the planned project area

Species	National protection status*	April 2018			September-October 2018			December 2018			May 2019	June 2019
		Body of the landfill	South-west from the body of the landfill	West from the body of the landfill	South-west from the body of the landfill	Body of the landfill	South-west from the body of the landfill	Body of the landfill	Landfill complex	Buffer zone (green belt)	Landfill complex	Landfill complex
Grey Partridge (Perdix perdix)	PROTECTED		✓									
Common Pheasant (Phasianus colchicus)	PROTECTED	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Common Woodpigeon (Columba palumbus)	PROTECTED	✓				✓	✓		✓		✓	✓
Collared Dove (Streptopelia decaocto)	PROTECTED	✓			✓						✓	✓
White Stork (Ciconia ciconia)	STRICTLY PROTECTED	✓									✓	✓
Grey Heron (Ardea cinerea)	PROTECTED	✓			✓				✓			
Great Cormorant (Phalacrocorax carbo)	PROTECTED		✓		✓				✓			
Black-headed Gull (Chroicocephalus ridibundus)	PROTECTED	✓			✓	✓	✓	✓	✓	✓	✓	✓

Mediterranean Gull (Larus melanocephalus)	STRICTLY PROTECTED	✓										
Common Gull (Larus canus)	PROTECTED	✓						✓				
Lesser Black-backed Gull (Larus fuscus)	STRICTLY PROTECTED	✓				✓						
Black Kite (Milvus migrans)	STRICTLY PROTECTED	✓										
Common Buzzard (Buteo buteo)	STRICTLY PROTECTED	✓			✓	✓	✓	✓	✓	✓	✓	✓
Common Kestrel (Falco tinnunculus)	STRICTLY PROTECTED	✓			✓	✓	✓	✓			✓	✓
Eurasian Jay (Garrulus glandarius)	PROTECTED	✓			✓	✓	✓		✓		✓	
Common Magpie (Pica pica)	PROTECTED	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Eurasian Jackdaw (Corvus monedula)	PROTECTED	✓				✓		✓			✓	✓
Rook (Corvus frugilegus)	PROTECTED	✓			✓	✓		✓	✓		✓	
Common Raven (Corvus corax)	PROTECTED	✓			✓	✓	✓	✓	✓	✓	✓	✓
Hooded Crow (Corvus cornix)	PROTECTED	✓										
Great Tit (Parus major)	STRICTLY PROTECTED			✓	✓		✓		✓		✓	✓
Hooded Crow (Corvus cornix)	STRICTLY PROTECTED			✓								✓
Barn Swallow (Hirundo rustica)	STRICTLY PROTECTED	✓										
Long-tailed Tit	STRICTLY PROTECTED		✓		✓		✓					

(Aegithalos caudatus)												
Common Chiffchaff (Phylloscopus collybita)	STRICTLY PROTECTED	✓		✓	✓	✓						
Eurasian Blackcap (Sylvia atricapilla)	STRICTLY PROTECTED	✓	✓		✓						✓	✓
Nuthatch (Sitta europea)	STRICTLY PROTECTED	✓										
Common Starling (Sturnus vulgaris)	PROTECTED	✓		✓	✓	✓	✓		✓		✓	✓
Song Thrush (Turdus philomelos)	STRICTLY PROTECTED	✓		✓								
Black Redstart (Phoenicurus ochruros)	STRICTLY PROTECTED			✓								
Stonechat (Saxicola torquata)	STRICTLY PROTECTED		✓									
Eurasian Tree Sparrow (Passer montanus)	PROTECTED		✓		✓	✓	✓	✓	✓	✓	✓	✓
White Wagtail (Motacilla alba)	STRICTLY PROTECTED	✓			✓	✓			✓		✓	✓
Yellow Wagtail (Motacilla flava)	STRICTLY PROTECTED	✓										
Meadow pipit (Anthus pratensis)	STRICTLY PROTECTED			✓								
Water pipit (Anthus spinoletta)	STRICTLY PROTECTED	✓										
Common Chaffinch (Fringilla coelebs)	STRICTLY PROTECTED	✓			✓			✓				
Greenfinch (Carduelis chloris)	STRICTLY PROTECTED		✓									

Goldfinch (Carduelis spinus)	STRICTLY PROTECTED			✓								
Linnet (Carduelis cannabina)	STRICTLY PROTECTED	✓										
Hawfinch (Coccothraustes coccothraustes)	STRICTLY PROTECTED		✓								✓	✓
Mute Swan (Cygnus olor)	PROTECTED						✓		✓			
Northern Shoveler (Spatula clypeata)	STRICTLY PROTECTED				✓							
Gadwall (Mareca strepera)	STRICTLY PROTECTED				✓							
Common Quail (Coturnix coturnix)	PROTECTED											✓
Mallard (Anas platyrhynchos)	PROTECTED				✓						✓	✓
Eurasian Teal (Anas crecca)	PROTECTED				✓				✓			
Little Grebe (Tachybaptus ruficollis)	STRICTLY PROTECTED				✓				✓			
Feral Rock Dove (Columba livia f. Domestica)					✓	✓	✓	✓	✓	✓	✓	✓
Common Woodpigeon (Columba palumbus)	PROTECTED					✓	✓		✓		✓	✓
European Turtle Dove (Streptopelia turtur)	PROTECTED										✓	✓
Common	STRICTLY PROTECTED											

Whitethroat (Sylvia communis)												
Lesser Whitethroat (Sylvia curruca)	STRICTLY PROTECTED										✓	✓
Barred Warbler (Sylvia nisoria)	STRICTLY PROTECTED										✓	✓
Common Cuckoo (Cuculus canorus)	STRICTLY PROTECTED										✓	✓
Common Swift (Apus apus)	STRICTLY PROTECTED											✓
Eurasian Nightjar (Caprimulgus europaeus)	STRICTLY PROTECTED											✓
Eurasian Coot (Fulica atra)	PROTECTED				✓							
Dunlin (Calidris alpina)	STRICTLY PROTECTED				✓							
Common Snipe (Gallinago gallinago)	STRICTLY PROTECTED				✓							
Marsh Sandpiper (Tringa stagnatilis)	STRICTLY PROTECTED				✓							
Black Stork (Ciconia nigra)	STRICTLY PROTECTED											✓
Whiskered Tern (Chlidonias hybrida)	STRICTLY PROTECTED											✓
Yellow-legged Gull (Larus michahellis)					✓	✓	✓	✓	✓		✓	✓
Caspian Gull (Larus cachinnans)	PROTECTED							✓				
Yellow-legged/Caspian Gull (Larus	PROTECTED								✓			

michahellis/cachinnans)												
Great Black-backed Gull (Larus marinus)	STRICTLY PROTECTED					✓						
Pygmy Cormorant (Microcarbo pygmaeus)	STRICTLY PROTECTED				✓							
Great White Egret (Ardea alba)	STRICTLY PROTECTED				✓						✓	
Little Egret (Egretta garzetta)	STRICTLY PROTECTED				✓							
Eurasian Sparrowhawk (Accipiter nisus)	STRICTLY PROTECTED				✓							
White-tailed Eagle (Haliaeetus albicilla)	STRICTLY PROTECTED				✓	✓	✓	✓	✓		✓	
Little Owl (Athene noctua)	STRICTLY PROTECTED											✓
Long-eared Owl (Asio otus)	STRICTLY PROTECTED											✓
European Bee-eater (Merops apiaster)	STRICTLY PROTECTED										✓	✓
Eurasian Golden Oriole (Oriolus oriolus)	STRICTLY PROTECTED										✓	✓
Eurasian Wryneck (Jynx torquilla)	STRICTLY PROTECTED										✓	
Great Spotted Woodpecker (Dendrocopos major)	STRICTLY PROTECTED								✓		✓	✓
Syrian Woodpecker (Dendrocopos	STRICTLY PROTECTED								✓			

syriacus)												
Great Spotted/Syrian Woodpecker (Dendrocopos major/syriacus)	STRICTLY PROTECTED				✓				✓			
Red-backed Shrike (Lanius collurio)	STRICTLY PROTECTED											
Eurasian Hobby (Falco subbuteo)	STRICTLY PROTECTED										✓	
Hooded Crow (Corvus cornix)	PROTECTED				✓	✓			✓	✓	✓	✓
Barn Swallow (Hirundo rustica)	STRICTLY PROTECTED											
Spotted Flycatcher (Muscicapa striata)	STRICTLY PROTECTED					✓						
European Robin (Erithacus rubecula)	STRICTLY PROTECTED				✓							
Black Redstart (Phoenicurus ochruros)	STRICTLY PROTECTED				✓	✓						
Eurasian Blackbird (Turdus merula)	STRICTLY PROTECTED				✓	✓					✓	✓
Water Pipit (Anthus spinoletta)	STRICTLY PROTECTED				✓				✓			
House Sparrow (Passer domesticus)	PROTECTED					✓		✓			✓	✓
Green Sandpiper (Tringa ochropus)	STRICTLY PROTECTED											
Common Nightingale (Luscinia megarhynchos)	STRICTLY PROTECTED											

European Goldfinch (Carduelis carduelis)	STRICTLY PROTECTED											✓
European Serin (Serinus serinus)	STRICTLY PROTECTED											✓

It is likely that at least some of species observed south-west from the body of the landfill or west from the body of the landfill nest in the area, such as Grey Partridge (*Perdix perdix*), Common Pheasant (*Phasianus colchicus*), Magpie (*Pica pica*), Great Tit (*Parus major*), Blue tit (*Cyanistes caeruleus*), Long-tailed Tit (*Aegithalos caudatus*), Chiffchaff (*Phylloscopus collybita*), Blackcap (*Sylvia atricapilla*), Starling (*Sturnus vulgaris*), Song Thrush (*Turdus philomelos*), Stonechat (*Saxicola torquata*), Tree Sparrow (*Passer montanus*), Meadow pipit (*Anthus pratensis*), Greenfinch (*Carduelis chloris*), Goldfinch (*Carduelis spinus*) and Hawfinch (*Coccothraustes coccothraustes*). For other species, such as Great Cormorant (*Phalacrocorax carbo*), habitats found in this area are not adequate for nesting.

Two protected plant species were detected on the very border of the planned project area - true comfrey (*Symphytum officinale L.*) and littleleaf linden (*Tilia cordata Mill.*), and as individuals. However, two species that are constitutional elements of the shrub habitats found within the planned project area - midland hawthorn (*Crataegus laevigata* (Poir.) DC.) and common hawthorn (*Crataegus monogyna* Jacq.) are also protected.

5.6. ENVIRONMENTAL NOISE LEVEL

Previously available data

Municipal noise in Belgrade is mainly caused by traffic, while the noise caused by the industry, small businesses, construction and other activities is of minor importance.

In 2017, levels of municipal noise in Belgrade were measured in two cycles, at 35 measurement points located in the city, selected in agreement with the Secretariat for Environmental Protection. Measurement points were selected as representative of certain urban zones of different purposes and along the most important traffic routes. The results showed that the measured municipal noise levels in the observed period were high (relative to the prescribed values).

According to the measurement results (Source: Environmental quality in Belgrade in 2017, City Administration, Secretariat for Environmental Protection, 2018), noise levels at 28 of the 35 sites exceeded the prescribed values (for day, evening and night).

According to the numeration included in the list of noise measurement sites, the measurement points belong to the following zones:

- points # 1, 4, 5, 17, 18, 19, 24, 27, 27, 28 and 31 to the residential zone (noise levels permitted: day - 55 dB(A), night - 45 dB(A));
- points # 6, 9, 11, 12, 13, 14, 15, 20, 21, 22, 23, 32, 33, 34 i 35 along heavy traffic routes (day - 65 dB(A), night - 55 dB(A));
- points 2, 3, 8, 10 i 16 in the city centre zone (day and night - 65 dB(A), night 55 dB(A));
- points 7 and 30 in the industrial zone (noise level should correspond to the level determined for a zone bordering the industrial zone);
- point # 27 in the school zone (day and evening 55 dB(A), night 45 dB(A));
- point # 13 in the hospital zone (day and evening 50 dB(A), night 45 dB(A));
- point # 11 in the recreation zone (50 dB(A) for day, evening and 40 dB(A) for the night).

First measurement cycle

Residential zone				
Nº	**Measuring point**	**Daytime**	**Evening**	**Night**
1.	Jurija Gagarina 259	63	63	55
4.	Nemanjina 2	62	61	57
5.	Zahumska 23	57	56	55
17.	Gandijeva 55a	66	65	59
18.	Radojke Lakić 15 ulaz II	50	48	40
19.	Pohorska – Pošta Srbije	61	62	58
24.	Stevana Filipovića 32	61	68	56
27.	Ugrinovačka 147	63	61	58
28.	Perside Milenković 1	24	24	24
31.	Hopovska 26	46	53	46

Zone of heavy traffic routes			
6.	Blagoja Parovića 82	65	64
9.	Krivolačka – Dž Voždovac	59	57
11.	Vojvode Mišića 43	65	65
12.	Vojvode Stepe 66	64	64
13.	Ustanička – DZ Voždovac	57	57
14.	Bulevar Despota Stefana 122	72	72
15.	Zemun – Glavna, Theatre “Madlenianum”	68	67
20.	Karađorđeva 23	73	71
21.	Borča – Bele Bartok 26	56	52
22.	Arsenija Čarnojevića	61	58
23.	Goce Delčeva 1	66	66
32.	Mirijevski bulevar 10	65	64
33.	Nedeljka Gvozdenovića 54	64	64
34.	Jovana Brankovića	64	68
35.	Vojvođanska	67	65

City centre zone				
2.	Bulevar Kralja Aleksandra 70	67	67	62
3.	Kraljice Natalije 66	72	68	65
8.	Uzun Mirkova – Ethnographic Museum	60	59	58
10.	Dalmatinska 1	65	66	59
16.	Jug Bogdanova 3	66	65	59

Industrial zone				
7.	Kraljice Jelene 22	64	64	58
30.	"Grmeč" – Republic Geodetic Authority.	58	55	53

School zone			
Zemun - Gymnasium	49	54	24

Hospital zone				
13.	Clinical Centre of Serbia	58	56	53

Recreation zone				
11.	Kalemegdan – Cvijeta Zuzorić Art Pavilion	46	45	38

• **values exceeding the permitted levels for a specific zone**
• values below the permitted levels for a specific zone

During the first measurement cycle in the residential zone, noise exceeded the permitted day-evening-night levels at the majority of measurement points. In this zone, measured levels exceed the permitted levels: day level by 7 dB(A), evening level by 8 dB(A), and night level by 12 dB(A) on average.

In the zone of heavy traffic routes, where noise is measured at 15 sites, the noise level exceeded the permitted day level at 8 measurement points, by 2.87 dB(A) on average. In the evening regime, noise levels exceeded limit values by 3.57 dB(A) on average at 7 measurement points. At 12 measurement points, limit values for the night regime were exceeded by 5.50 dB(A) on average.

At other measurement points by zones (by purposes) where the measured values exceeded the permitted ones, limit values of day and night noise levels were exceeded by 0.7 dB(A) to 12.6 dB(A).

Second measurement cycle

Residential zone				
1.	Jurija Gagarina 259	69	57	52
4.	Nemanjina 2	64	64	61
5.	Zahumska 23	59	56	53
17.	Gandijeva 55a	65	69	57
18.	Radojke Lakić 15 ulaz II	46	44	39
19.	Pohorska – Pošta Srbije	66	66	61
24.	Stevana Filipovića 32	61	61	55
27.	Ugrinovačka 147	63	61	58
28.	Perside Milenković 1	50	47	42
31.	Hopovska 26		5	48

Zone of heavy traffic routes				
6.	Blagoja Parovića 82	68	67	61
9.	Krivolačka – Dž Voždovac	58	58	52
11.	Vojvode Mišića 43	65	65	62
12.	Vojvode Stepe 66	61	60	56
13.	Ustanička – DZ Voždovac	68	66	61
14.	Bulevar Despota Stefana 122	70	70	65
15.	Zemun – Glavna, Theatre “Madlenianum”	66	65	62
20.	Karađorđeva 23	73	72	68
21.	Borča – Bele Bartok 26	51	50	46
22.	Arsenija Čarnojevića	66	65	62
23.	Goce Delčeva 1	65	65	59
32.	Mirijevski bulevar 10	65	64	60
33.	Nedeljka Gvozdenovića 54	65	63	59
34.	Jovana Brankovića	64	63	59
35.	Vojvođanska - Surčin	65	63	59

City centre zone				
2.	Bulevar Kralja Aleksandra 70	66	65	61
3.	Kraljice Natalije 66	66	65	63
8.	Uzun Mirkova – Ethnographic Museum	60	59	58
10.	Dalmatinska 1	55	56	51
16.	Jug Bogdanova 3	67	65	64

Industrial zone				
7.	Kraljice Jelene 22	66	65	63
30.	"Grmeč" – Republic Geodetic Authority.	63	59	56

School zone				
27.	Zemun - Gymnasium	44	44	36

Hospital zone				
13.	Clinical Centre of Serbia	58	56	54

Recreation zone				
11.	Kalemegdan – Cvijeta Zuzorić Art Pavilion	48	46	39

In the second measurement cycle, the noise level in the residential zone exceeded the permitted level at 7 measuring points for daytime as well as for evening, while at 8 measuring points the limit values were exceeded for night time. In this zone, the measured levels are higher than allowed by an average of 8.85 dB (A) for daytime, 7 dB (A) for evening and 10.75 dB (A) for night time.

The measurement results show that in the zone along the traffic roads, the noise level was within the permitted limits at only one measuring point in all three modes, while at 5 measuring points the noise level did not exceed the limit values in the day and evening modes. Out of a total of 15 measuring points in this zone, the night-time noise level was exceeded at 12 locations by an average of 5.91 dB (A).

In the central parts of the city, noise was within the permissible limits at all measuring points in the evening mode, while at two locations the measured noise level did not exceed the limit values in any of the three modes. Noise levels measured in the school and recreation area did not exceed the limit values.

Based on the deviation of the L_{day}, $L_{evening}$ and L_{night} indicators from the permitted limits both in the first measurement cycle and in the second cycle during 2017, it is concluded that at a large number of measurement sites the noise level exceeds the permitted limits relative to the assumed acoustic zone to which it belongs both for the night and for the evening and daytime.

Results of the baseline survey

With the goal of determining the baseline state *(Source: ESIA, Egis, ver. 03)*, before the start of construction works on the planned facilities, noise level monitoring was carried out on the wider area of the Vinča complex. Measurement of noise was performed in March 2018 at 10 measuring points by the City Institute of Public Health in Belgrade, and in accordance with standard methods and scope of accreditation.

Table 48 Results of the noise level measurement in the wider area of the Vinča landfill complex

Measuring point mark	**The measured equivalent noise level, L_{AeqT} [dBA]**
NM7	65.9
NM6	75.1
NM4	41.3
NM5	44.9
ST3	39.3
NM1	50.3
ST6	51.6
ST5	45.9
ST2 (1)	45.3
ST2 (2)	48.2
ST1 (1)	48.5
ST1 (2)	47.1

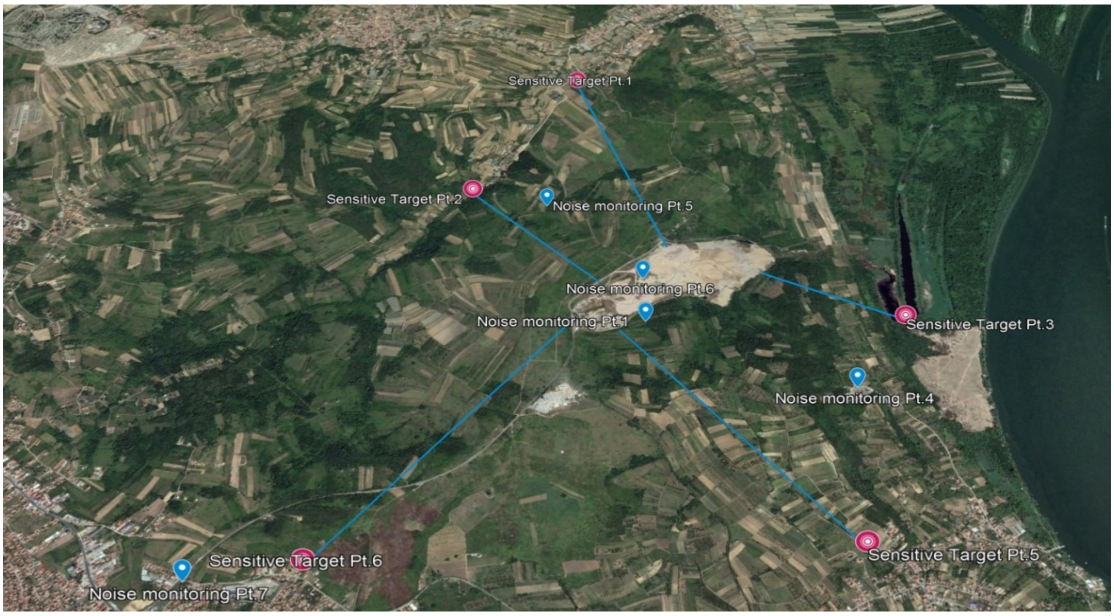


Figure 117 Spatial display of measuring points for determining of noise levels in the wider area of the Vinča landfill complex

- In accordance with the Law on Protection from Noise Pollution in the Environment ("Official Gazette of RS", No. 36/2009 and 88/2010), the Regulation on noise indicators, limit values for methods for assessing noise indicators, disturbances and adverse effects of noise in the environment ("Official Gazette of RS", No. 75/2010) and the Rulebook on Noise Measurement Methods, Content and Scope of the Noise Measurement Reports ("Official Gazette of RS", No. 72/2010), it is estimated that:

- the measured noise level of 66 dB at the measurement point NM7 EXCEEDS the limit value of 65 dB, in the open air, in the daily and evening mode. According to the Regulation, this measuring site is located in Zone 5 "City center, crafts, commercial, administrative zone with apartments, zone along highways, state and city roads";
- the measured noise level of 54 dB at the measurement site ST6 DOES NOT EXCEED the limit value of 65 dB, in the open air, in the daily and evening mode. Also, the measured value of 48 dB at this measuring site DOES NOT EXCEED the limit value of 55 dB in night mode. According to the Regulation, this measuring site is located in Zone 5 "City center, craft, commercial, administrative zone with apartments, zone along the highways, state and city roads";
- the measured noise level of 54 dB at the measurement site ST5 DOES NOT EXCEED the limit value of 55 dB, in the open air, in the daily and evening mode. Also, the measured value of 43 dB at this measuring site DOES NOT EXCEED the limit value of 55 dB in night mode. According to the Regulation, this measuring site is located in the Zone 3 “Exclusively residential areas”;
- the measured noise levels of 51 and 50 dB (48-hour measurement) at the measurement site ST1 DO NOT EXCEED the limit value of 55 dB, in the open air, in the daily and evening mode. Also, the measured values of 40 and 37 dB at this measuring site DO NOT EXCEED the limit value of 55 dB in night mode. According to the Regulation, this measuring site is located in the Zone 3 “Exclusively residential areas”;
- reference points NM6, NM5, NM1, ST3 and ST2 are located outside the zoned areas.

5.7. BUILDINGS, IMMOVABLE CULTURAL GOODS, ARCHAEOLOGICAL SITES AND AMBIENT UNITS

Within the boundaries of the project, there is a registered archaeological site “Ošljane”, defined as the cultural property, enjoying preliminary protection under the Law on Cultural Heritage.

The Figure below shows the location with the remains of a veteran villa from the Roman period. The place is in the valley of the Ošljanski potok (Ošljan stream), west of the village road Vinča - Veliko Selo, on a gentle slope on the right bank of the stream. The location is known to archaeologists because of accidental discovery of Roman pottery. In 1975 the Belgrade City Museum carried out exploratory excavations of a smaller scope. The archaeological finds place the remains of this villa in the period from second to third century.

It is also important to note that the location of the archaeological site of Ošljane, in the conditions issued by the Institute for the Protection of Cultural Monuments, is spatially very imprecisely displayed, without clearly defined location of the described object of a veteran villa. The question is where the discovered object is located within the defined zone *(Source: ESIA, Egis, ver. 03)*.

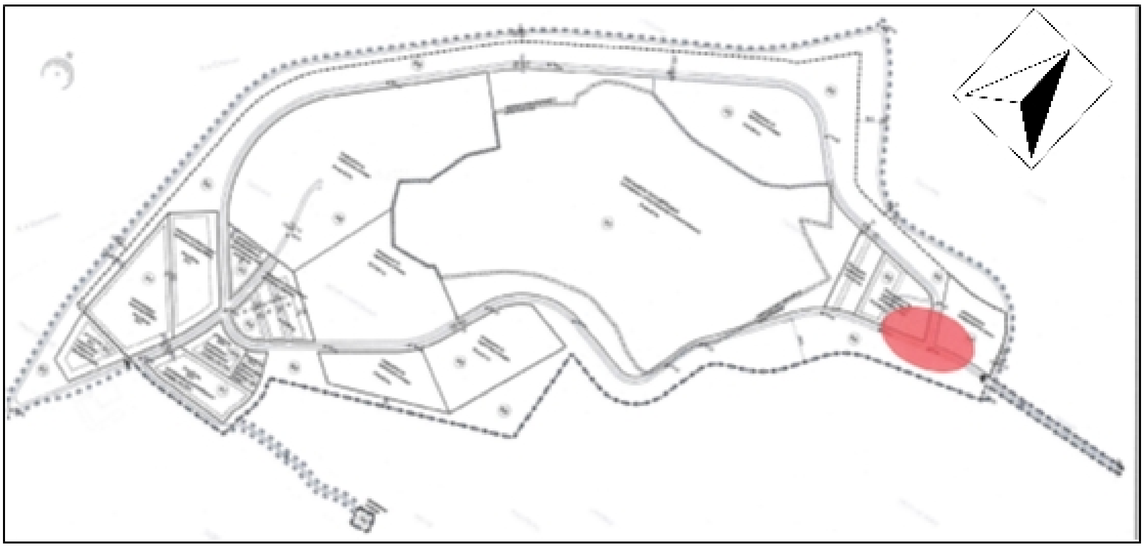


Figure 118. The spatial position of archaeological site "Ošljane"

on two locations („Zone 1" and „Zone 2").

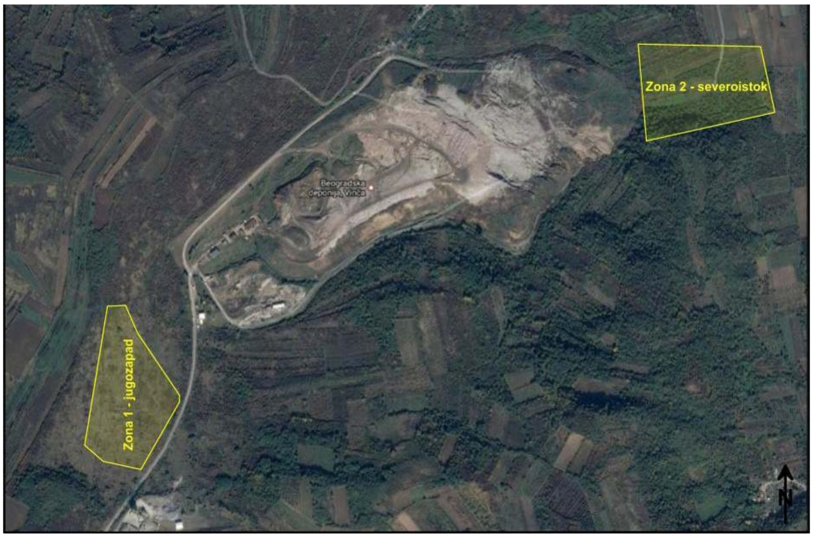


Figure 119 The spatial position of the two locations of magnetometric tests

A map of the distribution of vertical gradations of the total signal for location/Zone 1 was made (southwest). By analyzing the map of the high frequency part of the signal, a low change of the geomagnetic field on the whole surface of location/Zone 1 was discovered. It was concluded that there are no anomalies that could be relevant to this field of research.

The abovementioned procedures of magnetometric data processing were also applied for the location/Zone 2 (northeast), the research field in the northeastern side of the landfill. By analyzing the map of the high frequency part of the signal, a low intensity of the change of the geomagnetic field on the whole surface of location/Zone 2 was found. This indicates the absence of significant anomalies that could be relevant to this field of research.

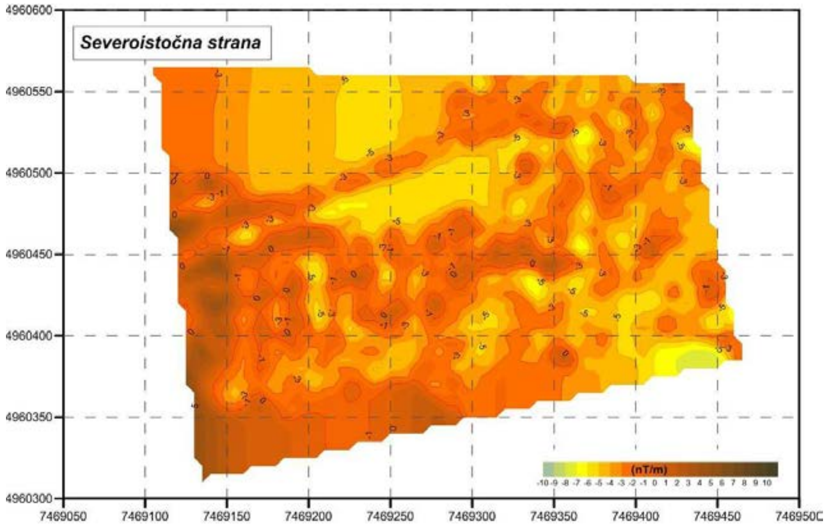


Figure 120 The total geomagnetic field intensity, Location 2 - northeast

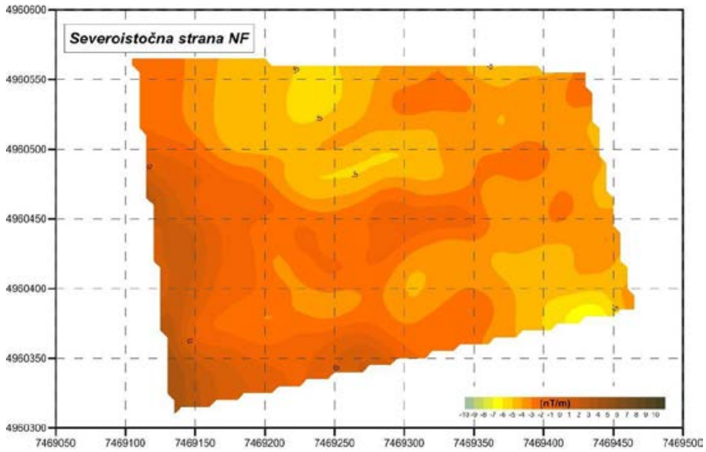


Figure 121 The total geomagnetic field intensity, low-frequent part of the signal, Location 2 - northeast

Photogrammetric/morphometric measurements were conducted on March 5, 2017, when it was moderately cloudy, which contributed to the high quality of photographs.

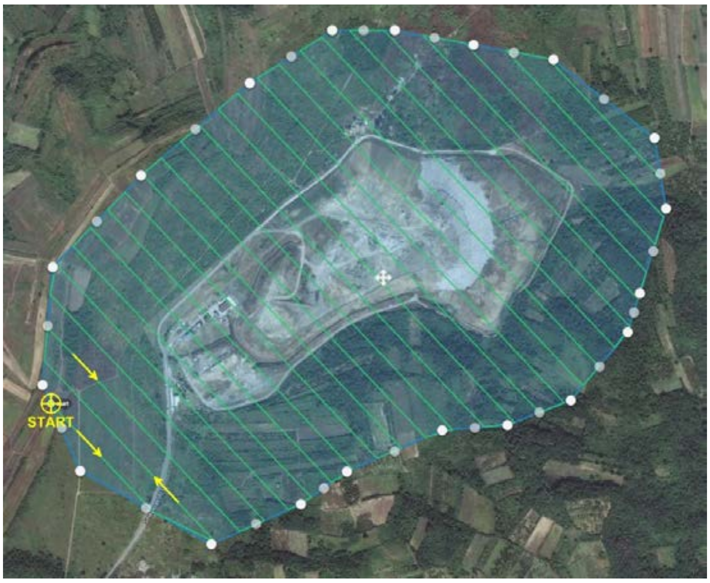


Figure 122 Wider zone of landfill in Vinča with displayed drone routes during photogrammetric measurements

The photogrammetric procedure was also applied, by scanning the surface with a mapping technique. A drone equipped with a high-resolution camera flew over the broader landfill zone. During the flight, it shot 1,840 photographss. Through the synthesis of all the photos and their software processing, the orthophoto image and the 3D model of the wider zone of the landfill are generated. By analyzing morphometric data, no distinctive forms and anomalies have been noticed that indicate the existence of archaeological objects on the examined terrain.

Based on the results of geophysical magnetometric and morphometric explorations in in the Vinča landfill exploration area, it is concluded that there are no anomalies that indicate the presence of archaeological objects and materials.

5.8. LANDSCAPE

A 5 km buffer zone can be considered as the narrower area with significance to the subject project. This is an area of potential significant visual contact with components of the planned project.

Figure 123 Landscape structure in the 5 km zone

Edge areas of Belgrade suburbs are within a 2-3 km circle. On the west and south side are areas of accentuated urban features (e.g. Kaluđerica, Mirjevo and Vinča). They have a classic structure of suburban settlements. In the landscape structure prevails a mixture of built elements, infrastructure and green areas. This is a set of residential and commercial uses, public green areas, sports and recreational purposes and fragments of the industry. On suburbs edge is contact zone with mosaic rural landscape.
More agricultural character prevails in the Veliko Selo and Slanci which are located on the northern part of the buffer zone. They possess a specific landscape pattern which is composed of buildings, greenhouses and agricultural areas. Visual contact with the landfill is prevented due to the hilly relief, vegetation and microlocation of landfill site.

Danube River is located at the bottom of the slope, about 1 km east from the landfill. Visual contact from the Danube riverside towards the landfill is largely disabled due to high vegetation. For the Danube landscape, apart from the riverbed, alluvial forests along the coast, river islands and wet habitats have high importance. River with riverside is a landscape element with natural character. They represent a linear element of landscape structure and distinctive feature of wider area.

On the east side of Danube River is a large area of intensive agriculture. Landscape image is composed of agricultural areas and macadam roads on a flat relief. Urban structures of Starčevo and Pančevo are settled on a North side. Due to relief flatness significant visual contact is stronger towards hilly area in the West.

Industrial landscape of Pančevo is located outside the 5 km buffer zone and can be described as anthropogenic landscape with strong industrial character. As such is a spatial phenomenon that causes negative visual and symbolic connotations

The Vinča landfill complex site is located in the landscape of moderate value. This is a specific agricultural landscape under the strong influence of natural heritage between Belgrade's periphery and the Danube River. The location of the complex is existing and has elements of landscape degradation. So it presents a negative visual look that is visible in the immediate vicinity and from the agricultural territory on the east bank of Danube river.

6.0. DESCRIPTION OF THE POSSIBLE SIGNIFICANT IMPACTS OF THE PROJECT ON ENVIRONMENT

This chapter considers the possible impacts of the implementation of the project for the construction of a New landfill with accompanying facilities that includes several phases:

- the preconstruction phase
- construction phase
- the phase of regular operation and
- other possible risks and impacts

6.1. POSSIBLE IMPACTS DURING THE PRECONSTRUCTION PHASE

The preconstruction phase includes activities such as: collecting baseline data and conducting investigation works, preparation of the project design, permitting (including obtaining conditions), setup of the project site (activities on site that precede construction). Due to the type of the project, no adverse impacts are expected during the preconstruction phase.

6.2. POSSIBLE IMPACTS DURING THE CONSTRUCTION PHASE

During the construction phase, local air quality can be impacted by emissions of exhaust gases from vehicles and machinery used for construction of facilities at the landfill and in the wider project area (for example, near access roads), construction works (increased dust emissions) and local increase in noise level.

The possible potential impacts and expected impacts are temporally and spatially limited and are of local character.

Surface and underground waters and soil

The possible negative impacts on soil and agricultural land near the site are as follows:

- soil degradation during excavation,
- improper disposal of excavated material and land on and around the project site,
- discharge of liquid substances (diesel fuel, lubricants) at the construction site from construction machinery or during their maintenance/on-site repairs,
- taking of a larger area of land than necessary.

Negative impacts on soil and agricultural land during construction, such as the discharge of liquids (diesel fuels, lubricants) due to temporary storage on the construction site or during the maintenance of machinery and vehicles (including fueling), are mainly due to irresponsible behavior of construction workers and/or inadequate site organization.

If the construction activities are well organized and in accordance with the legal regulations and conditions required by the competent authorities, soil and agricultural land pollution by the aforementioned possible negative impacts will be reduced to a minimum.

The construction of a new landfill with accompanying contents may have a negative impact on water in the event of an accident involving the spillage or leakage of oils and lubricants from vehicles and construction machinery into land and underground layers. These negative impacts can be prevented by the proper organization of the site and respecting the defined protection measures.

The project site is located outside the boundaries of water protection (water protection areas are those where special conditions and prohibitions for protection of drinking water from harmful impacts have been established) and flood areas which makes this site suitable for all activities that are part of the project.

The planned area for the construction of the project is located on diluvial deposits (loess diluvium) which are dusty-clay-sandy composition and have a dense structure and low permeability and in which smaller quantities of water accumulate periodically. The loess diluvium that is hypsometrically dominated by parts of the terrain with the function of the hydrogeological aquifer is vertically watertight. In physical-mechanical terms, the material is poorly consolidated and practically permanently saturated.

Based on investigative works carried out at the project site, it has been established that drilled sediments have modest filtration characteristics. Due to the dominant presence of pebbly sediments characterized by low water supply and modest yield, these sediments can be assessed as poorly permeable from the hydrogeological point of view.

Groundwaters were registered on 12 piezometers, and the average relative water levels (depth from the surface to groundwater) in these piezometers were from 3.40 to 28.00 meters. The monitoring, which lasted from 25/10/2017 to 30/3/2018, showed that groundwater levels are lower than the disposed waste. (Source: Geological-geotechnical study for engineering and construction of a new landfill and rehabilitation of the existing Vinča municipal solid waste landfill (Energoprojekt Hidroinzenjering a.d., Belgrade, December 2017)).
The location planned for the New Landfill Project is located southwest of the body of the "old" landfill. The nearest piezometers relevant to the New Landfill are NP-2 and BH-5. Levels of groundwater in these two piezometers from 25/10/2017 until 30/03/2018, are shown in the following table.

Piezometer	**Earth depth**	**Measured groundwater level**						
		25/11/2017	01/12/2017	13/12/2017	01/02/2018	07/03/2018	30/03/2018	**Absolute water level**
NP-2	201.0	189.3	189.3	189.2	189.0	189.0	188.0	189.2
BH-5	188.0	180.0	180.0	180.0	179.9	180.1	179.4	180.0

(Source: Geological-geotechnical study for engineering and construction of a new landfill and rehabilitation of the existing Vinča municipal solid waste landfill (Energoprojekt Hidroinzenjering a.d., Belgrade, December 2017)).

During excavation works (the excavation depths of 170.00 masl to 178.00 masl are lower than the observed groundwater levels), local underground streams are likely to be found and they will be temporarily or permanently redirected to a natural recipient.

During the rainy season, a certain amount of groundwater may occur and possibly cause a partial flooding of the site, if technical measures (such as wall membrane construction) are not implemented. Therefore, during the construction phase, the impacts of the project on groundwater and vice versa are to be expected, due to the high levels of groundwater at the site which should be further examined in the next monitoring.

Flora

The construction of the planned facilities will cause a local but permanent conversion of the existing anthropogenic habitats and some natural habitats, currently present at these sites, into the new types of anthropogenic habitats.

Natural habitat types (shrubs, lawns, oak forests ...) are located outside the planned project area, so that their loss inside the planned project area will not endanger their existence and favourable status in the wider area.

In the planned project area four protected species of flora, protected by national regulations, are found: true comfrey (*Symphytum officinale* L.), littleleaf linden (*Tilia cordata* Mill.), midland hawthorn (*Crataegus laevigata* (Poir.) DC), and common hawthorn (*Crataegus monogyna* Jacq.). These species are commercial species in Serbia, mostly used for their phytopharmaceutical properties.

The true comfrey is a widely distributed plant in Europe, including the whole of Serbia. Within the planned project area, one specimen was found during the drafting of the baseline study. This plant is typical of various habitats such as wet grasslands, areas near water streams and wet habitats near paths. Considering the variety of habitats suitable for this species and its wide distribution in Serbia, it can be concluded that the removal of one specimen found inside the planned project area would not pose a threat to the population of the true comfrey in Serbia. Still, with the aim of reducing the overall impact of the project, a measure of relocating this plant to a suitable habitat has been planned as part of the project.

The investigated area is a border area in terms of the distribution of littleleaf linden found within the planned project area, as it is not typical of the Pannonian bio-geographical region, but is widely distributed in most other European bio-geographical regions and in other locations in Serbia. During the survey, a single specimen was found within the project area. Considering the variety of habitats suitable for this species and its wide distribution in Serbia, it can be concluded that the removal of a single specimen found inside the planned project area would not pose a threat to the population of the littleleaf linden in Serbia. Still, with the aim of reducing the overall impact of the project, a measure of relocating the tree to a suitable habitat has been planned as part of the project.

The species of midland hawthorn (*Crataegus laevigata* (Poir.) DC) and common hawthorn (*Crataegus monogyna* Jacq.) are typically found among the subcontinental deciduous species inside the project area and the wider area of Vinča landfill. This habitat type is very well developed in the wider area, so the loss of specimens present inside the planned project area will not significantly endanger the population of these species in Serbia. However, in order to minimize the impact of the project on the abundance of these species, they will be used during the formation of a green belt around the project site.

Fauna

During construction, the existing fauna will be disturbed by noise, vibrations and the frequent presence of people. As all these types of impacts are already present at the site, the disturbance will not be changed significantly in relation to the existing condition.

Due to the habitat alteration, the present mammals, reptiles, arthropods (including the protected species of insects) will change their distribution in search of more suitable habitats. Since suitable habitats are abundantly present in the wider area, and these impacts will affect only a small number of individual specimens, this local impact cannot endanger their populations.

An increase in adult bird fatalities is not expected given the mobility and adaptation of birds to vehicles movement at the present landfill. If active bird nests are present within the construction area, some nestling fatalities are possible. Given the number of the protected and strictly protected bird species found at the site, this impact should be mitigated by removal of natural habitat vegetation prior to the bird nestling period.

The diversity of bird fauna (some of which are protected by national regulations) within the planned project area is largely related to the vicinity of habitats in wet areas.

Protected natural areas

Due to the significant distances of protected areas from the construction site, construction works will not have an impact on them.

Air

During the construction phase, the air quality can be affected by the emission of exhaust gases from construction machinery and dust from the construction site, especially in a dry and windy period.

Regarding dust emissions, they may be reduced to a low significance level through good practice. Regarding the impacts of the exhaust gases, as these types of impacts are already present at the site, they will not cause a significant change from present or future condition (operation phase).

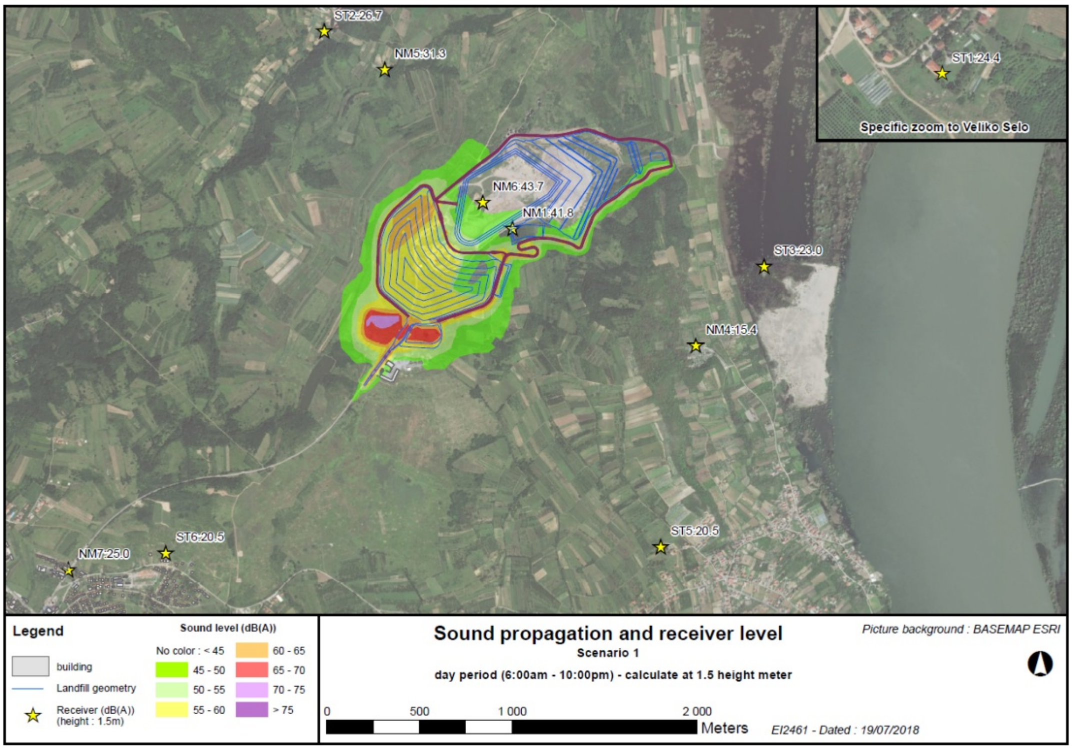
Additional traffic due to construction works will take place mainly within the boundaries of the project, with, to a lesser extent, occasional and temporary traffic outside of them.

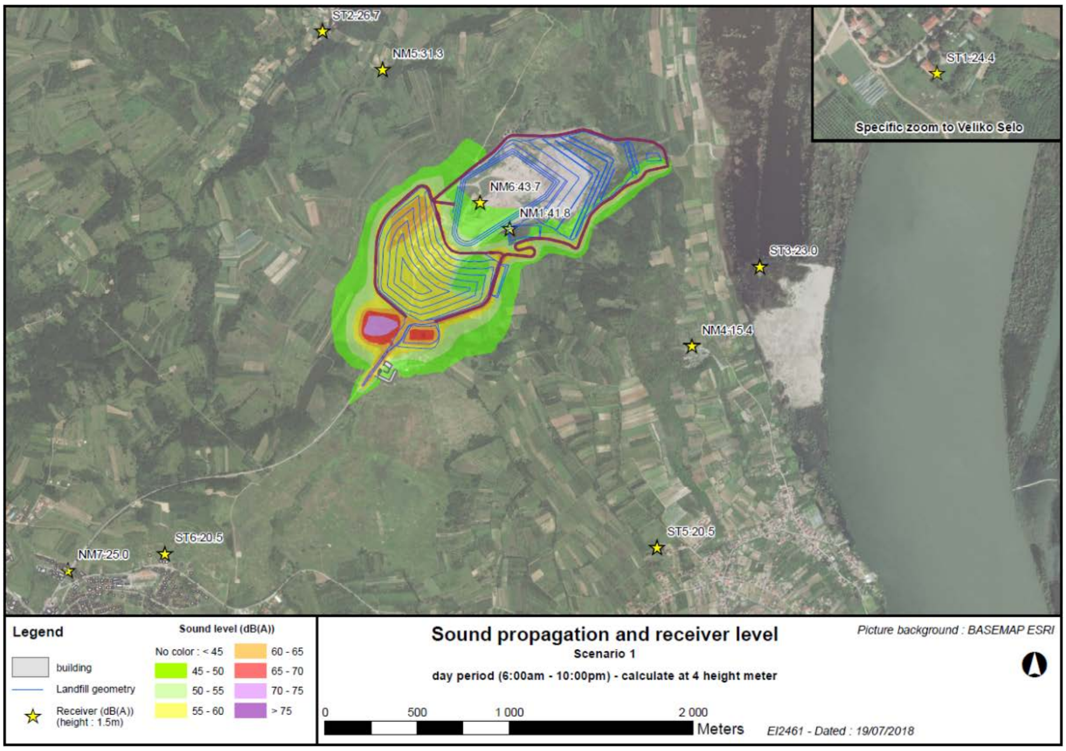
Noise

In order to predict the impact of noise during the project construction phase, 3D acoustic modelling (CadnaA 2018 version software) was performed. Modelling integrates the following parameters:

- terrain topography,
- mobile sources of noise at the locality (vehicles).

In order to model the noise levels caused during the construction phase, all the data relating to noise generated by the equipment, its level and spectrum, and the time of activity are taken into account. The results of the model are shown in the following figures, with calculations at two different heights: one at the height of a human (Scenario 1) and the other one at a height of 4m (Scenario 2).


ST2:26.7
NM5:31.3
ST1:24.4
Specific zoom to Veliko Selo
NM6:43.7
NM1:41.8
ST3:23.0
NM4:15.4
ST6:20.5
NM7:25.0
ST5:20.5
Legend
building
Landfill geometry
Receiver (dB(A)) (height : 1.5m)
Sound level (dB(A))
No color : < 45
45 - 50
50 - 55
55 - 60
60 - 65
65 - 70
70 - 75
> 75
Sound propagation and receiver level
Scenario 1
day period (6:00am - 10:00pm) - calculate at 1.5 height meter
Picture background : BASEMAP ESRI
0
500
1 000
2 000
Meters
EI2461 - Dated : 19/07/2018



Based on the results of modelling at the selected locations (measuring points), the level of noise in the environment during the construction phase ranged from 20.5 to 31.3 dB (A). Compared to the real measurements performed at the same measuring points (noise measurements were made in March 2018 at 10 measuring points by the City Public Health Institute - see chapter 5.6 *The level of noise in the environment*, *The results of examining the baseline for this project*), the calculation values were always lower for about 10 dB (A).

Landscape

The location of the project stretches over four landscape structures: landfills and natural areas, which occupy most of the project area, and agricultural areas and forests, which appear on a very small section of the site.

In the project construction phase, the existing landscape will be changed in the area designated for construction of the New Landfill and accompanying facilities.

Cultural heritage

Based on the consolidated results of geophysical magnetometric and morphometric surveys in the Vinča landfill investigation area („*Tehnohidrosfera*“ doo March 2017), it has been concluded that there are no anomalies that indicate the presence of archaeological objects or materials in the planned project area.

Infrastructure

Construction of a new facility requires transportation and delivery of materials by trucks along the existing road network. Potentially, poorly trained or inexperienced vehicle drivers could increase risk of accidents involving other vehicles, pedestrians, and equipment. Construction vehicles, as well as on-site private vehicles, also pose potential risk of collision.

Potential collisions could result in the congestion of the existing regional two-lane road (Smederevo road).

Transportation of workers is also anticipated, but it will have less of an impact on congestion. The impact will be temporary and limited to the period of construction. Possible impacts on traffic during construction will be limited in time and space. With good traffic/logistics management, they can be reduced to a low significance level.

During construction, some elements of the water management system and/or power supply can be physically damaged as a result of an incident, which can potentially lead to negative effects (stoppage of water supply, power outage, etc.).

Waste

Environmental load resulting from inappropriate waste handling may occur due to improper disposal of construction and other waste, or if waste is improperly deposited and temporarily stored in the surrounding area. By a proper organization of the site, all potentially adverse effects, mainly related to inadequate disposal of waste, soil, construction waste, etc., will be kept to a minimum.

In order to prevent negative impacts on the environment on the location, the generated waste should be handled in such a way that it is re-used at the same construction site (backfilling, levelling etc.) to the maximum, while the surplus and potentially generated waste must be handed over to the legal entities authorised for waste management. Depending on the type of the generated waste, further treatment or disposal should be carried out in accordance with the regulations relating to waste management.

6.3. POSSIBLE IMPACTS DURING REGULAR OPERATION

Possible impacts on the local community in regular operation in terms of air quality, noise, water quality, soil quality, transport and traffic are considered. It can be said that the project carries certain risks and produces impacts on the environment quality and local community, but these impacts will be significantly reduced or eliminated in relation to the existing conditions.

Potential impacts on the health and safety of workers are related to the workplace and the worker’s job description.

The Vinča complex will be surrounded by precipitation drainage canals, so the rainwater around the complex will not get to the project area.

The possible impacts of the New Landfill project and accompanying facilities are:

- improper disposal of municipal waste, residues from EfW plants and inert waste
- emissions of landfill gas
- dust emissions from the CDW platform
- leachate generation
- generation of waste and oily waters in the Entrance-Control Zone and on the Operation Platform
- an increase in the level of noise in the complex
- improper handling of petroleum products (diesel fuel)
- improper handling of generated hazardous waste, etc.

During the operation phase, it is likely that the opening of the cells at the New Landfill will obstruct groundwater flows and reroute them temporarily or permanently to natural recipients.

In order to prevent the potential negative impact on the quality of the environment, health, safety and security of the population, a specific chapter of this study defines the appropriate measures designed to prevent, reduce and eliminate the adverse impacts of the project.

6.4. OTHER POSSIBLE RISKS AND IMPACTS

Social risks and impacts

Generally speaking, the implementation of the comprehensive project of the Vinča landfill complex regulation and construction will result in the reduction of negative impacts on the environment.

The existing landfill has not been constructed in accordance with the requirements applicable to sanitary landfills or the principles of environmental protection.

The pollution of the Ošljan stream (*Ošljanski potok*) and Ošljan pond (*Ošljanska bara)*, as well as the contamination of the surrounding agricultural land with contaminated leachate, represent the most severe examples of environmental pollution. Landfill gas is prone to inflammation and explosion, and the resulting fire can last for weeks.

Unpleasant odours and their spread outside the landfill complex are also a factor of possible inconveniences to the surrounding population.

Taking into consideration what was said above, the rehabilitation of the existing landfill, the construction of a new sanitary landfill in accordance with the existing EU legislation and norms, the provision of a leachate collection and treatment system, the provision of a system for the collection of landfill gas and its exploitation in the BEP plant for the production of electricity and hot water and the combustion of solid waste in the EfW plant to generate electricity and heat, would have an exceptional positive impact on the quality of life in the complex surrounding.

Thanks to the planned project, most of the existing negative impacts on the environment and human health will be eliminated or reduced in relation to the current situation. After completion of the planned activities on the landfill complex, a significant increase in the quality of life of the residents in the nearby settlements is expected. The rehabilitation and construction of the New Landfill is a measure of preservation and protection of the environment.

In addition to the above mentioned positive effects, there are also risks that the project implementation may bring, such as:

- The influx of external workforce for construction and other works and activities can lead to various negative social risks, impacts and conflicts. Many of these risks may be already present or may occur regardless of the external workforce influx.
- An increased risk of illegal conduct and crime;
- A risk of increasing competition in service provision;
- An increased risk of contagious diseases and growing burden on the local health care services
- Increasing pressure on accommodation and renting costs.

It is essential that the presence of external workforce should affect the locals as little as possible.

Increase in waste management tariffs

Currently, the City of Belgrade is charging citizens and businesses with the municipal waste collection and transport tax only. Since the project is aimed to provide services for the disposal and treatment of the solid communal waste and utilization of generated energy, the City of Belgrade plans to introduce a new pricing for services. As this is a sensitive issue, its introduction is carefully prepared, with the aim to ensure that the services are provided at an affordable cost to every household.

Risks and social impact

It is to be expected that the local community will have concerns and dilemmas regarding various environmental, social and economic issues. Although the local community may have a negative perception of the project itself, the project will surely bring some significant benefits. It is therefore crucial to hold public consultations, educate and inform the concerned public about the planned activities.

In the construction phase there will be the opportunities for short-term employment of the local population and engagement of local companies. In addition, in the subsequent phases of the project implementation, there will be the possibilities for employment of qualified and trained employees, especially those recruited from the population of the working age living in the neighbouring villages.

The project envisages the employment of about 120 workers, with different qualifications, for work in:

- administration
- maintenance
- laboratories
- production facilities (CDW, EfW and BEP)
- security, etc.

These jobs will primarily be offered to local residents, which will have a significant positive effect on the employment rate in these communities. This may be an opportunity to increase the number of employed women, which brings a moderate, positive and long-term effect on gender equality.

In addition to direct employment on the construction site, it may be possible for the local population to provide support services, such as: catering, transportation (transport of workers and/or construction materials to the site) and security.

There is also an increased demand for renting accommodation and other services (opening of mixed-goods stores, clothing stores, mechanic services, etc.).

Long-term economic benefits can mainly be attributed to the activation of agricultural production in the vicinity of the landfill, as the project will significantly reduce or eliminate certain existing negative effects on the landfill complex.

Risks and impacts on health and safety of people and employees

Impacts on the health and safety of the community are directly linked to the negative impacts in the physical environment relating to emissions of pollutants into the air, water and land, as well as to noise, unpleasant odours, etc. The project envisages a significant reduction or elimination of some of these negative impacts.

Potential impacts on the safety of the labour employed for construction works on the facilities will be those expected for any construction project involving physical work, the use of heavy machinery and equipment, the transport of building materials, etc. There is a risk of inhalation of aerosols from the existing landfill. A prolonged exposure to particles present in the air poses a risk and potentially can negatively affect the health of the employed workers.

The Contractor is obliged to provide the employees with a safe workplace and appropriate personal protective equipment, depending on the type of the activity and the work they perform. A construction project can involve specific risks, such as:

- falls, electric shocks, injuries, exposure to the high levels of noise and dust, exposure to toxic substances, collapse of trench walls, risks related to weather conditions (work at very low or high temperatures), etc.
- hygiene, food supplies, etc.

Project impact on climate change

A potential impact of climate change is directly related to the green house gas emission of the project. The calculation of such emission takes into account the following:

- Emission from the existing landfill, after rehabilitation;
- Emission from the new landfill (excluding inert parts);
- Direct emission from EfW (from waste combustion (CO_2 and N_2O) and use of fuel)
  - all the equipment used at the location (fuel consumption);
- Indirect emission from electric energy consumed for operation on the site;
- GHG is avoided by energy recovery at EfW:
  - by generating electric energy
  - by generating heat.

Table 49 GHG emissions – the whole location components

Emitter	***GHG***	**2015**	**2025**	**2035**	**2050**	**2075**
Old landfill	*Total*	585 999	342 754	44 226	0	0
	Captured	0	210 075	33 170	0	0
	Released	0	132 679	11 057	0	0
New landfill	*Total*	0	187 962	210 075	4 423	3 317
	Captured	0	121 622	132 679	3 317	2 211
	Released	0	66 339	77 396	1 106	1 106
EfW		0	116 021	116 021	116 021	116 021
Site (electricity and fuel)		0	34 644	34 644	34 644	34 644
Avoided (electricity and heat)		0	-229 564	-229 564	-229 564	-229 564
TOTAL		585 999	120 119	9 553	-77 794	-77 794

The Project will have a positive impact on the green house gas emission because of the generation of electric energy and heat and the connection to the Serbian grid (with a positive contribution due to CO_2 emission in the real mixture of Serbian electricity generation) and because of the remarkable reduction of CO_2 emission from the old landfill. A huge continuing improvement of greenhouse gas emission (due to remediation of landfill, shift to emission control process and generation of heat and power) will result in saving of more than 11.5 million tons of CO_2 over the global period from 2025 to 2046, with the mean annual reduction of green house gasses being equivalent to more than 112,670 passenger cars per year or 250,800 hectares of forests (Source: *US EPA Calculator for Greenhouse Equivalents*, consulted in September 2017).

The impact of climate change on the project

The impact of climate change on the landfill and the EfW plant has been analysed in accordance with the Guidelines on how to increase the project resilience to climate change (Source: Non-paper guidelines for project managers *Making vulnerable investments climate resilient*). The goal of the analysis is to determine sensitivity and the extent of the exposure of the project to the primary and secondary climatic impacts in order to make a final assessment of the potential risks to the project, and depending on the risk, to identify and assess adaptation options to mitigate the risk. The analysis can be evaluated through seven modules shown in the table below.

Table 50 Modules in the process of climate resilience

Module	Description of module
1	Sensitivity analysis
2	Exposure assessment
3	Vulnerability analysis (incorporating outputs of Modules 1 and 2)
4	Risk assessment
5	Identifying adaptation options
6	Adaptation option assessment
7	Integrating adaptation action plan into the project

According to the guidelines applied, Modules 1 through 3 are used for assessment of the project vulnerability to the climate change.

With the analysis completed as shown below, it has been determined that all the weaknesses seem to be insignificant and do not require any further measures to be taken, while modules 4 through 7, which include risk assessment, identification of options in response to vulnerability and risks and modification of the project design, do not need to be used.

Sensitivity analysis

The project sensitivity to key climate changes (the primary and secondary changes) has to be assessed based on the four following topics:
1. Property and processes on site
2. Inputs (water, energy, other)
3. Outputs (products and markets)
4. Transport connections (transportation).

The project sensitivity is based on four topics in relation to the climatic variables and is graded in line with the tables below.

Table 51 Possible sensitivity of the project

Project sensitivity	
High sensitivity	3
Medium sensitivity	2
No sensitivity	1

Where:

• High sensitivity: The climate variable / threat may have a significant impact on assets and processes, input and output data and transport connections.

• Medium sensitivity: The climate variable / threat may have insignificant impact on assets and processes, input and output data and transport connections.

• No sensitivity: The climate variable / threat has no effect.

Table 52 Project sensitivity to climate variables and secondary effects of climate change

	SENSITIVITY TO CLIMATE	LANDFILL				EfW			
		Property and processes on site	Input data (water, energy, other)	Outputs (products and market)	Transport connections (transportation)	Property and processes on site	Input data (water, energy, other)	Outputs (products and market)	Transport network (transportation)
PRIMARY EFFECTS	Annual/seasonal/ monthly average air temperature	2	2	2	1	2	2	2	1
	Extreme air temperature (frequency and range)	2	2	2	1	2	2	2	1
	Annual/seasonal/ monthly average precipitation	2	1	2	2	1	2	2	2
	Extreme rainfalls (frequency and range)	2	1	2	2	1	2	2	2
	Average wind speed	2	1	2	1	1	1	2	1
	Maximum wind speed	2	1	2	2	1	1	2	2
	Air humidity	2	1	2	1	1	1	2	1
	Solar radiation	1	1	1	1	1	1	1	1
SECONDARY EFFECTS	Water temperature	1	1	1	1	1	1	1	1
	Water availability	1	1	1	1	2	2	2	1
	Storm (impacts and intensity) including storm surge	2	2	2	2	1	2	2	2
	Flood	2	2	2	2	2	2	2	2
	Storm dust	2	2	2	2	2	2	2	2
	Soil erosion	2	2	2	2	2	2	2	2
	Soil salinity	1	1	1	1	1	1	1	1
	Wild fire	3	1	2	2	3	2	2	2
	Air quality	1	1	2	1	1	1	2	1
	Soil instability (landslides, avalanches)	2	1	2	2	1	1	1	1
	Effect of urban heat island temperature	1	1	1	1	1	1	1	1
	Length of growth season	1	1	1	1	1	1	1	1

Exposure assessment

The project exposure to 20 climatic aspects is assessed for the current and the future situation. The exposure data should be collected for climatic variables and related threats to which the assets exhibit high or medium sensitivity (from Module 1) of the project. The exposure is assessed based on the three grades shown in the table below.

Table 53 Location exposure to climate change

Location exposure	
High exposure	3
Medium exposure	2
No exposure	1

Where:

• High exposure: The climate variable / threat can be significantly changed in the future periods being relevant to the project life span.

• Medium exposure: The climate variable / threat can be insignificantly changed in the future periods being relevant to the project life span.

• No exposure: The climate variable / threat should not be changed in the future.

Table 54 Location exposure to the current and future climate change

	LOCATION EXPOSURE	CURRENT SITUATION	FUTURE SITUATION
		Location	Location
PRIMARY EFFECTS	Annual/seasonal/ monthly average air temperature	2	2
	Extreme air temperature (frequency and range)	2	2
	Annual/seasonal/ monthly average precipitation	2	2
	Extreme rainfall (frequency and range)	2	2
	Average wind speed	2	2
	Maximum wind speed	2	2
	Air humidity	2	2
	Solar radiation	2	2
SECONDARY EFFECTS	Water temperature	1	1
	Water availability	2	2
	Storm (impacts and intensity) including storm surge	1	1
	Flood	1	1
	Storm dust	1	1
	Soil erosion	2	2
	Soil salinity	1	1
	Wild fire	1	1
	Air quality	2	2
	Soil instability (landslides, avalanches)	2	2
	Effect of urban heat island temperature	1	1
	Length of growth season	1	1

Vulnerability analysis

If a certain project is simultaneously sensitive and exposed to specific climate changes, it is considered vulnerable in terms of that specific effect of climate change. Accordingly, vulnerability can be calculated as the product of sensitivity and exposure, as per formula: $V = S \times E$, where V is project vulnerability, S is project sensitivity and E is exposure.

If the product (V) is greater than or equal to 6, the project is considered extremely vulnerable in terms of the observed effect of climate changes. If the product (V) is greater than 1 and less than 6, the project is moderately vulnerable.

Table 55 Results of project vulnerability to climate changes

		Sensitivity		
		No sensitivity	Medium	High
Exposure	No exposure	1	2	3
	Medium	2	4	6
	High	3	6	9

Table 56 Landfill vulnerability to current and future effects of climate changes

	VULNERABILITY TO CLIMATE – LANDFILL	CURRENT SITUATION				FUTURE SITUATION			
		Property and processes on the site	U Input data (water, energy, other)	Outputs (products and market)	Transport connections (transportation)	Property and processes on the site	Input data (water, energy, other)	Outputs (products and market)	Transport connections (transportation)
PRIMARY EFFECTS	Annual/seasonal/monthly average temperature	4	4	4	2	4	4	4	2
	Extreme air temperature (frequency and range)	4	4	4	2	4	4	4	2
	Annual/seasonal/monthly average precipitation	4	2	4	4	4	2	4	4
	Extreme rainfalls (frequency and range)	4	2	4	4	4	2	4	4
	Average wind speed	4	2	4	2	4	2	4	2
	Maximum wing speed	4	2	4	4	4	2	4	4
	Air humidity	4	2	4	2	4	2	4	2
	Solar radiation	2	2	2	2	2	2	2	2
SECONDARY EFFECTS	Water temperature	1	1	1	1	1	1	1	1
	Water availability	2	2	2	2	2	2	2	2
	Storm (impacts and intensity) including storm surge	2	2	2	2	2	2	2	2
	Flood	2	2	2	2	2	2	2	2
	Storm dust	2	2	2	2	2	2	2	2
	Soil erosion	4	4	4	4	4	4	4	4
	Soil salinity	1	1	1	1	1	1	1	1
	Wild fire	3	1	2	2	3	1	2	2
	Air quality	4	2	4	2	4	2	4	2
	Soil instability (landslides, avalanches)	4	2	4	4	4	2	4	4
	Effect of urban heat island temperature	1	1	1	1	1	1	1	1
	Length of growth season	1	1	1	1	1	1	1	1

Table 57 EfW vulnerability to current and future effects of climate changes

	VULNERABILITY TO CLIMATE RANJIVOST NA KLIMU - EfW	CURRENT SITUATION				FUTURE SITUATION			
		Property and processes on the site	Input data (water, energy, other)	Outputs (products and market)	Transport connections (transportation)	Property and processes on the site	Input data (water, energy, other)	Outputs (products and market)	Transport connections (transportation)
PRIMARY EFFECTS	Annual/seasonal/monthly average temperature	4	4	4	2	4	4	4	2
	Extreme air temperature (frequency and range)	4	4	4	2	4	4	4	2
	Annual/seasonal/monthly precipitation	2	4	4	4	2	4	4	4
	Extreme rainfalls (frequency and range)	2	4	4	4	2	4	4	4
	Average wind speed	2	2	4	2	2	2	4	2
	Maximum wind speed	2	2	4	4	2	2	4	4
	Air humidity	2	2	4	2	2	2	4	2
	Solar radiation	2	2	2	2	2	2	2	2
SECONDARY EFFECTS	Water temperature	1	1	1	1	1	1	1	1
	Water availability	4	4	4	2	4	4	4	2
	Storm (impacts and intensity) including storm surge	1	2	2	2	1	2	2	2
	Food	2	2	2	2	2	2	2	2
	Storm dust	2	2	2	2	2	2	2	2
	Soil erosion	4	4	4	4	4	4	4	4
	Soil salinity	1	1	1	1	1	1	1	1
	Wild fire	3	2	2	2	3	2	2	2
	Air quality	4	2	4	2	4	2	4	2
	Soil instability (landslides, avalanches)	2	2	2	2	2	2	2	2
	Effect of urban heat island temperature	1	1	1	1	1	1	1	1
	Length of growth season	1	1	1	1	1	1	1	1

Based on the analysis, the project is not significantly vulnerable to the assessed primary and secondary effects of climate change.

As the analysis is made on the basis of the current projections of climate change, the adaptation of the project to climate change has to be regularly checked and analysed. Further analyses should be part of the Environment Management System within the framework of the Environment Permit.

Possible impacts of the existing landfill on the new landfill

The following elements add to the avoidance of impacts of the existing landfill on the new one:

- Water and leachate management on the new landfill and the existing landfill is kept separate, as illustrated in Figure 124.
- Atmospheric water management relies on gravity. The new landfill lies upstream from the existing landfill, and the atmospheric water will flow from the existing landfill eastward (while the new landfill is located to the west).
- Similarly, leachate from the existing landfill flows downstream (eastward).
- A layer on the bottom of the new landfill will provide for collection of leachate and will be watertight to the composite layer shown in Figure 125.

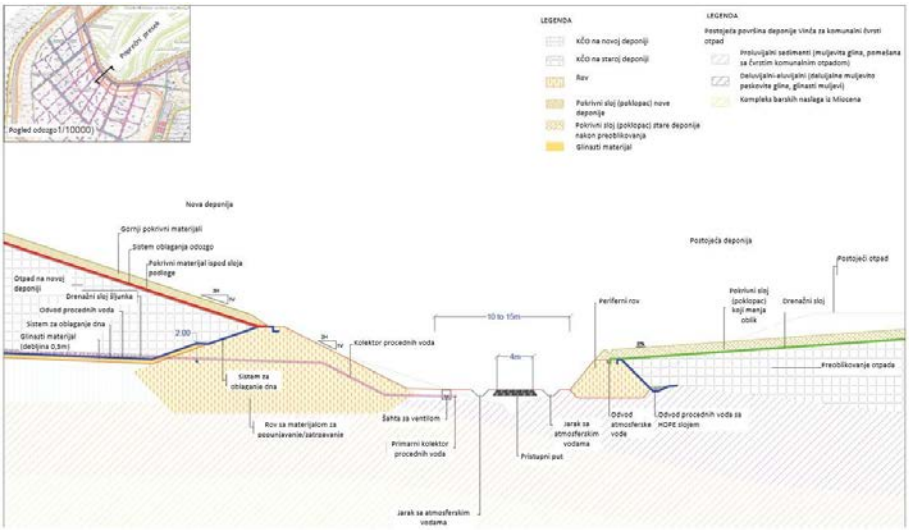


Figure 124 Typical cross-section between new and old landfill (Source: Suez Consulting, 2018)

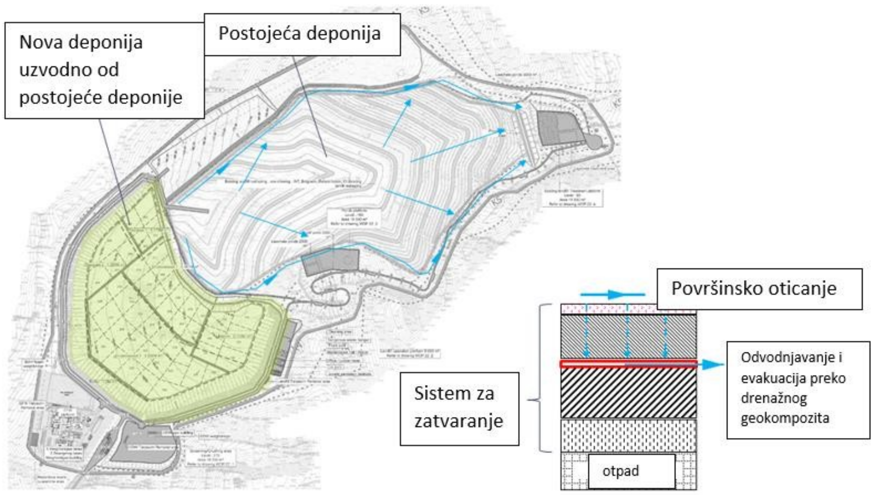


Figure 125 Atmospheric water management from existing landfill (Source: Suez Consulting, 2018)

***Slika 124*/ Figure 124**

leva strana /on the left

Cross section

View from above 1/10000

New landfill

Top cover materials

Top lining system

Cover material under foundation layer

Waste at new landfill

Gravel drainage layer

Leachate outlet

Bottom lining system

Clay material (depth 0.5m)

Bottom lining system

Trench with backfilling material

Leachate collector

Manhole with valve

Primary leachate collector

Access road

desna strana/on the right Old landfill

Existing waste

Drainage layer

Top shape-changing layer (cover)

Rainwater outlet Leachate outlet with *HDPE* layer

Peripheral trench

Ditch with rainwater

Legend: (on the left/*levo*)

Municipal solid waste (MSW) at the new landfill

MSW at the old landfill

Trench

Top layer (cover) of the new landfill

Top layer (cover) of the old landfill after reshaping

Clay material

Legend: (on the right/*desno*)

Existing surface of Vinča landfill for municipal solid waste

Proluvial sediments (silt clay, mixed with municipal solid waste)

Deluviun-eluvium (deluvial sandy silt clay, clay silt)

Complex of Miocene swamp deposits

***Slika 125* / Figure 125**

New landfill lying upstream from existing landfill Existing landfill

Surface outflow

Closing system Water drainage and evacuation via geocomposite drainage

Waste

6.5. CUMULATIVE EFFECTS WITH OTHER FACILITIES

The wider area of the Vinča complex is mainly used for agriculture. However, some of the parcels are now abandoned (there is a succession of agricultural land). Forests are reduced to forest patches and those that have remained in the alluvial areas along the Danube River. A smaller number of agricultural land parcels are located next to the landfill.

The asphalt plant is located south of the body of the landfill (about 400 m). Larger industrial areas are located in the western parts of Belgrade at a considerable distance. In relation to the landfill, they lie southwest, west and northwest, at the distance of 5km.

A high-voltage block is located 3 km northwest of the landfill.

The most important industrial zone is located in the southern part of Pančevo. There are an oil refinery, a chemical industry complex and a river port there. In relation to the landfill, they are located at a distance of about 8 km to the north-east, on the left bank of the Danube.

Considering all the activities planned to be carried out at the site of a comprehensive landfill project in Vinča and in its immediate vicinity, it is not expected that the effects of the project could be so great to cause, together with other plants, any significant cumulative impacts.

7.0. ENVIRONMENTAL IMPACT ASSESSMENT IN CASE OF AN ACCIDENT

Accidents in industrial plants, such as unexpected events with undesirable short-term or long-term effects on the health and safety of people and the environment, can be the result of natural risks of the site, technical and technological risks, characteristics of raw materials, equipment, chemicals, products, external influences - both intentional and unintentional, and, most often, human factors.

7.1. NATURAL RISKS

At the site and in the wider surroundings of the municipal waste landfill in Vinča, the following natural risks are possible:
- Landslides
- Floods
- Earthquakes.

Landslides

According to the data from the Cadastre of landslides, unstable slopes in Belgrade, including areas affected by active, stabilized or remediated landslides, cover about 377 km^2. The occurrence of major landslides have been noted in the foothills and hilly terrain south of the Sava and the Danube: on the Sava slope (*Savska padina*) stretching from Duboko to Umka, in the city proper, on the right Danube slope (*Karaburma, Višnjica, Vinča, Ritopek, Grocka*), and in the valleys of the right tributaries of the Sava and the Danube.

Colluvial processes can be observed on the Danube slope. Landslides are mostly active, with great depths exceeding 10 – 15 m. An extension of the landfill to this part of the field should not be planned.

The sliding process in the valley of the Ošljan stream (*Ošljanski potok*) is less developed. Local landslides are much smaller in size and depth (on average 3-5 m) and the intensity of slope movement is not high. In this area, four landslides can be distinguished, including:

- Landslide in the catchment area of the southern branch of the *Ošljanski potok* (Ošljan stream). The landslide is active to a greater extent. The estimated sliding depth is about 3-5 m. Under the conditions of inadequate technogenic impacts, the sliding process might be activated.

- Landslide on the right slope in the lower part of the *Ošljanski potok* (Ošljan stream). This landslide is somewhat larger in terms of the area affected and somewhat more complex. However, in natural conditions it is stable. Inadequate technogenic impacts could re-activate the process.

- Landslide on the location of "Todorović vineyard" (north of the existing landfill) is in one small part an active landslide, while in the larger part of the terrain there are no clear traces of earlier movements any longer. As is the case of the previous landslides, inadequate operation could lead to the re-activation of the sliding process.

Floods

Vinča landfill complex is located 1.6 km west of the Danube River. The nearest water monitoring stations are Zemun, Pančevo and Smederevo. The table below shows the maximum levels of the Danube River at the indicated water monitoring stations.

Table 58 Recorded maximum water levels

Station	Level „0“, (m)	Record high water level (cm)	Maximum water level (mwl)
Zemun	67,87	783	75,7
Pančevo	67,33	777	75,1
Smederevo	65,36	845	73,8

The lowest section of the Vinča landfill is located approximately at 85 meters above sea level, which is approximately 10 meters higher than the maximum water level recorded in the wider observed area. Thus, it can be concluded that there are no risks of flooding.

Earthquakes

Under the Amendment to the Rulebook on Technical Standards for Construction of High Buildings in Seismic Area (“Official Gazette of SFRY” no. 59/90), the observed area, like other areas of Belgrade, have been assigned a higher degree of seismic intensity, from VII to VIII MCS, with the values of ground seismicity coefficient of Ks = 0.05.

7.2. FIRE AND EXPLOSION RISK

At landfills, a fire is a significant and possible accident situation. Fires can be caused by spontaneous combustion of waste (disposal of flammable materials, disposal of smouldering materials, when glass acts as a lens, and similar), human activities (burning of waste, smoking, use of spark discharge devices), motor vehicles (sparks) or natural causes (friction, lightning). Fire, as described above, appears as a surface fire.

Fires at landfills pollute the atmosphere with harmful combustion products and pose a risk to the environment (population, animals, vegetation). Fires can occur as a surface fire which is usually caused by a fire spreading to the body of the landfill, where gases produced by the fermentation of waste and biodegradable process are generated.

Fire is a phenomenon relatively typical of landfills, but the waste disposal technology which includes compacting and covering with inert material reduces its occurrence to a minimum.

In June 2017, the municipal waste landfill in Vinča caught fire (Source: Serbian Environmental Protection Agency, *www.sepa.gov.rs*). The smoke that was created was spreading to the surrounding parts of the city. During the fire, as well as several days after the fire was extinguished, the City Public Health Institute in Belgrade, which regularly monitors 24 measuring stations within the local monitoring network, was continuously monitoring the concentration of pollutants in the air on the territory of Belgrade, focusing especially on the situation regarding the fire at the Vinča landfill.

Special attention was paid to the neighbourhoods of Lešće, Višnjička Banja, Višnjica, Rospi ćuprija, Karaburma, Krnjača, Kotež, Borča, Mirijevo, parts of Zvezdara, and some other parts of the city, even though they were located at a considerable distance from the landfill, since due to the weather conditions during the night and in the early morning hours pollutants could have spread over a long distance.

Together with the City of Belgrade Secretariat for Environmental Protection, four additional measuring stations were established in order to ensure a more detailed monitoring of the resulting situation. The additional measurement stations made their measurements from 8 June 2017 to 29 June 2017. These measurement stations had been selected to determine the impact of fire at the Vinča landfill on air quality in the best possible way.

According to the results obtained by the City Institute of Public Health, no excessive values were recorded for the common pollutants (carbon monoxide, nitrogen oxides, sulphur dioxide, suspended particles below 10 microns (PM_{10}), and ground-level ozone) included in the air pollution program measurement for the territory of Belgrade.

The results obtained from four additional measuring stations, which were measuring the parameters not included in regular monitoring (PM_{10}, phenolic substances, ammonia), showed that the measured values did not exceed the limit values and the maximum permissible concentrations determined by the Regulation on Monitoring Conditions and Air Quality Requirements ("Official Gazette of RS" No 11/2010, 75/2010 and 63/2013).

The measured concentrations of polycyclic aromatic hydrocarbons did not deviate from the values characteristic of the urban environment, except on June 11 2017, 12 June 2017, and 13 June 2017, when a variation of the concentration, depending on the compound, was observed. Some compounds had a decreasing trend, while some had an increasing trend.

According to the findings of the City Institute of Public Health, the oscillations in concentrations of certain compounds from the group of polycyclic aromatic hydrocarbons were caused by the presence of smoke from the fire at the Vinča landfill.

Although higher concentrations were detected, they were not at the levels that could cause serious health effects. Recommendations were given to sensitive groups of citizens (such as people with chronic cardiovascular and respiratory diseases, elderly people, children, pregnant women and medical workers) to reduce the presence of smoke in the air in the event of smoke and unpleasant odour.

The concentrations of heavy metals (arsenic As, cadmium Cd, nickel Ni, lead Pb) in suspended PM_{10} particles were at the levels characteristic of the urban environment.

In addition to fire, explosion of generated methane and hydrogen from landfill gas is also possible. Methane is a gas which, when found concentrated from 5 to 15%, forms an explosive mixture with air. A negative impact can occur due to the failure to comply with the landfill deposition technology, i.e., failure to cover the waste with inert materials, which may lead to build up of methane under the impermeable surfaces.

7.3. EXTERNAL RISKS

External risks of relevance to the project site are related to deliberate actions intended to inflict serious material damage and/or to endanger human life (terrorist act) or arise as a result of the "domino" effect caused by an accident at other industrial plants in the surroundings.

On the basis of the available data submitted so far to the Ministry of Environmental Protection by the operators of Seveso plants/establishments, it has been determined that, within the area covered by the Detailed Regulation Plan of the Vinča Sanitary Landfill, there is no Seveso plants/establishments, while on the territory of the City of Belgrade, to which the municipality of Grocka belongs, there is a large number of Seveso establishments, but the effect of potential major chemical accidents there do not pose a threat to the area covered by the above stated Detailed Regulation Plan. On the other hand, the area covered by the mentioned Detailed Regulation Plan may be affected by chemical accidents on the territory of the neighbouring City of Pančevo, in the worst case scenario of an accident in a Seveso establishment *HIP "Azotara" d.o.o. Pančevo*.

The area covered by the Detailed Regulation Plan of the Vinča Sanitary Landfill is situated within the zone of ammonia toxic cloud effects, which is a possible result of the worst case scenario envisaged by this establishment, in part for the IDLH (immediately dangerous to life or health) concentration (300 ppm of ammonia), during a 30 minute exposure period, and in part for the 0.1IDLH concentration (30 ppm of ammonia), during a 30 minute exposure period.

This accident scenario is a level IV accident – the regional level of accident, and the likelihood of the occurrence is assessed as low (4.7×10^{-7} /year). On 5 August 2016, the operator HIP "Azotara" d.o.o. Pančevo passed the Decision on Approval of the Safety Report and Accident Protection Plan, where the identified accident scenarios, accident impact zones, and prevention measures undertaken by the operator to prevent an accident were described.

7.4. RISK OF ACCIDENTS CAUSED BY HUMAN FACTOR

Statistically, most of accident situations arise due to a human factor caused by insufficient training, unclear operational procedures and/or negligence.

8.0. DESCRIPTION OF MEASURES PROVIDED FOR PREVENTION, REDUCTION AND ELIMINATION OF ADVERSE ENVIRONMENTAL IMPACTS OF THE PROJECT

8.1. MEASURES PROVIDED BY LAW AND OTHER REGULATIONS, NORMATIVES AND STANDARDS AND DEADLINES FOR THEIR IMPLEMENTATION

The legislation and the EU directives regulating waste management are volumenous and just a section of them is presented in the chapter listing the documentation used for the study. The application of the provisions set out in legislation is binding for the Client, regardless of the protection measures envisaged by this study.

- According to the Regulation on Waste Disposal in Landfills ("Official Gazette of RS", No 92/2010), the Client is obliged to respect the technical and technological conditions regarding designing, construction and operation of a waste landfill, the type of waste deposing of which is forbidden, the amount of biogradable waste which can be deposited, criteria and procedures for acceptance or non-acceptance in the landfill, the methods and procedures of landfill operation and closure, the scope and method of landfill operation monitoring, and subsequent maintenance after the landfill closure.
- According to the Law on Waters („Official Gazette of RS"No 95/2018), it is the responsibility of the Client to regularly monitor, by employing an authorized laboratory, the quality of wastewater before its entering into the recipient.
- The concentration of pollutants in wastewater discharged into the recipient must not exceed the limit values prescribed by the Regulation on Emission Limit Values of Pollutants in Water and Deadlines for Achieving them („Official Gazzette of RS" No 67/11, 48/12 and 1/16).
- When discharging wastewater, the criteria stated in the following regulations should be considered:
    - Decision on Determining Inventory of First-Order Streams ("Official Gazette of RS", No 83/10),
    - Regulation on Watercourse Classification ("Official Gazette of SRS", No 5/86),
    - Rulebook on Hazardous Substances in Water ("Official Gazette of SRS", No 31/82).
- Law on Waste Management ("Official Gazette of RS", No 36/09, 88/10, 14/16, and 95/2018 – other law), setting out the procedure for obtaining waste management permit, defines, *inter alia*, the obligation of control, monitoring and reporting on suspended particles, control of unpleasant odours, control and monitoring of noise, control of vermin and birds, control of spreading of waste and other matters in landfills.
- Waste materials should be treated in accordance with the Law on Waste Management ("Official Gazette of RS", No 36/09, 88/10, 14/16, and 95/2018 – other law).

- The Client is obliged to treat hazardous waste in accordance with the Rulebook on the Manner of Storage, Packaging and Labeling of Hazardous Waste ("Official Gazette of RS" No 92/10).
- Waste oils should be treated in accordance with the Rulebook on Conditions, Manner and Procedure of Management of Waste Oils ("Official Gazette of RS", No 71/10).
- Whenever hazardous waste is taken over by an authorized institution, a document on the movement of waste is to be prepared in accordance with the Rulebook on the Form of Hazardous Waste Movement Document, the Form of Advance Notification, the Manner of its Delivery and Filling in Instructions ("Official Gazette of RS" No 17/17).
- The movement of the waste which makes secondary raw material, as well as the movement of any other waste, except for municipal and hazardous waste, has to be accompanied with a document on the movement of waste to be filled in according to the Rulebook on the Form of Waste Movement Document and Filling in Instructions ("Official Gazette of the RS ", No 114/13).
- During the operation of the plant, all the requirements defined by the Law on Environmental Noise Protection ("Official Gazette of RS", No 36/09 and 88/10) have to be applied.
- Within the complex, all the requirements defined by the Fire Protection Law ("Official Gazette of RS" No. 111/09 and 20/15) have to be applied.
- Law on Integrated Prevention and Control of Environment Pollution (“Official Gazette of RS” No 135/2004 and 25/2015) defines the conditions and procedure for issuing an integrated permit for plants and activities that may have a negative impact on human health, environment and material goods, the type of activities and plants, oversight and other issues being relevant for prevention and control of the environment pollution.
- Rulebook on Methodology for the Development of the Rehabilitation and Remediation Design (“Official Gazette of the RS” No 74/2015) defines the procedure of developing design for rehabilitation and remediation of existing non-sanitary landfills.

In this project, the guidelines derived from the EU directives, reference BAT documents, international conventions and agreements to which the Republic of Serbia is a signatory party are also binding.

The obligations under the laws, regulations, standards and other documents, on which the preparation of the project technical documentation is based, are part of the conditions set by the competent authorities and institutions.

By implementing the project in accordance with the revised and adopted technical documentation, under control and supervision of the competent administrative bodies, the implementation of the environmental protection measures that arise from legislation, standards, normatives and this study should be ensured.

8.2. MEASURES TO BE TAKEN IN ACCIDENT SITUATIONS

Multiple measures are to be taken in the event of an accident. These measures can be categorized into:

- accident prevention measures;
- accident preparedness and response measures; and
- accident consequences remediation measures.

Based on the above, the Client is obliged:

1. To comply, in all implementation phases, with the technical documentation, especially the fire protection design.
2. To develop procedures and operating instructions on how to deal with accident situations.
3. To train the employees how to respond to accident situations.
4. To develop appropriate accident response flowcharts.
5. To appoint the persons responsible for dealing with accidents.
6. To clearly mark the areas with hazardous materials with appropriate notice boards, warnings and prohibition of specific activities at critical points in the plant.
7. To provide appropriate installations for supply and distribution of fire-fighting water.
8. To provide appropriate stable fire-fighting facilities in line with the design.
9. To provide hand-operated and movable mobile fire extinguisher for fire fighting at the outbreak of fire in line with the design.
10. To provide appropriate video surveillance installations.
11. To test employees' skills and knowledge with regard to fire protection and in accordance with the training programme approved by the competent body of the Ministry of Interiors.
12. To conduct periodically training and exercises in simulated accidental situations, in accordance with the training programme.
13. To ensure regular maintenance of fire-fighting equipment for initial fire extinguishing and control of hydrant network condition. Inspections and maintenance must be carried out by authorized companies only.
14. In case of a small-scale fire/accident, to respond immediately using the appropriate installed/provided equipment. This is the obligation of all individuals present/ employed, except in case of immediate threat to their own safety and life.
15. To evacuate highly flammable materials from the zone caught or likely to be caught by fire.
16. In case of an accident, to use all available fire fighting and fire spread prevention equipment.
17. In case of a large-scale fire, to activate stable fire fighting system and inform the authorities on the accident.
18. If assessed that fire cannot be tackled with the existing equipment and power, to inform immediately the Ministry of Interior competent body – Sector for Emergency Management.
19. Having assessed the unfolding situation, the responsible person should inform other emergency services (emergency medical service), poison control centre, state

authorities, local authorities and residing population, in accordance with the adopted accident emergency measures procedure.

20. Upon arrival of professional services, their instructions should be followed.
21. During the accident, basic environmental factors must be monitored.
22. After an accident, a report on the accident that took place has to be made. The report should envisage the mandatory measures to be taken to prevent the same or similar accident from occurring again.
23. Depending on the scale and consequences of the accident, post-monitoring of the environmental factors affected by the accident has to be carried out.
24. The Client is obliged to provide resources for remediation after the accident and mitigation of the consequences caused by the accident, in accordance with the accident consequences remediation plan.
25. Design documentation provides for the fire fighting system which consists of the following:

- fire water tank
- fire water pumping stations
- external and internal hydrant networks
- installations with spray water.
- Supply with fire extinguishing water is enabled:
  - from a 72 m^3 tank with constant water inflow
  - through "B" fire extinguishers from fire trucks
  - water distribution is provided through a fire pump plant.

26. The pumps are dimensioned to match the most unfavourable quenching zone while simultaneously enabling operation of the external and internal hydrant network.
27. All roads, detours and platforms to be used if intervention of fire fighting vehicles is needed are planned in accordance with the Rulebook on Technical Norms for Access Roads, Detours and Arranged Platforms for Fire fighting Vehicles in the Vicinity of Facilities with Increased Risk of Fire ("Official Gazette of FRY “No 8/95) in effect.
28. There are a small number of employees in facilities, but regardless of that fact there is a plan for safe evacuation of employees and visitors from each facility.

8.3. PLANS AND TECHNICAL SOLUTIONS FOR ENVIRONMENTAL PROTECTION

During the design development, many environmental protection measures have already been integrated into the project itself. In addition, in order to reduce or avoid any negative impact, as well as to boost the positive impacts, in this chapter, due to the complexity of the project, the planned protection measures are itemised for each phase of the project implementation:

Project preparation phase

Given the complexity of the Project, the Client must adhere to the provisions of national legislation and guidelines provided by EU directives and must apply them when conceptualizing the design and selecting the equipment.

The national legislation is defined by the laws, regulations and rulebooks governing the following areas:

- Planning and construction of facilities;
- Environmental protection;
- Protection of health and safety;
- Protection of nature and biodiversity;
- Protection of cultural heritage;
- Protection from fire and accident situations;
- Protection of air, water and land;
- Protection from environmental noise.

During the project preparation and designing phase, the Client is obliged to obtain the conditions from the competent authorities and institutions.

In all subsequent phases of project development, it is necessary to comply with the requirements and guidelines set in the conditions of the competent authorities and institutions and technical and design documentation.

Pre-construction phase – site mobilization

Water and land

- Temporary facilities for accommodation of workers on site (offices) are envisaged.
- The sufficient number of chemical toilets is envisaged and it is necessary to ensure that the toilets should be discharged by an authorized company.
- Containers for municipal and other types of waste and packaging are envisaged. The containers have to be regularly and adequately emptied.

Landscape and noise

- Designate and secure areas – green spaces which will not be used in the construction phase.
- Mark the space and, if needed, enclose the space (deep excavation) where construction activities will be performed.

Construction phase

Water

- On all platforms where accidental leakage of liquid materials may be expected, protective foils, tanks or similar should be installed.
- On all platforms and places where accidental leakage of fluids (diesel fuel, oil, chemicals, etc.) may be expected, suitable drains connected to a sedimentation tank and/or an oil and grease separator should be installed.
- Petroleum products necessary for the operation of machines have to be stored in storage areas designed for that purpose in order to prevent any leaks, in accordance with regulations.

Land and agricultural land

-Provide a surface area for deposition of excavated materials and soil within the construction site.

-Perform surface planning on the site.

-Ensure that all movements and manipulations of vehicle and machinery within the construction site are performed in an organized and controlled manner, with the minimum use of the green areas.

- Fill the vehicles and construction machinery with fuel at the designated places only.
- Keep vehicles and equipment in good working condition to prevent oil and fuel from leaking.
- Provide equipment/material for the collection and disposal of spilled petroleum products, if any.
- Contaminated adsorbents have to be disposed of in appropriate containers and treated in accordance with the regulations governing waste management.
- Potentially contaminated soil must be stockpiled separately from clean soil.
- Ensure controlled disposal of the content from concrete mixers in the process of washing and removal of excess material (specially created pits coated with foils or any other acceptable solution).

Biodiversity

- Works on removing natural vegetation inside the planned project area should be carried out from the beginning of September to the end of February in order to protect fauna of the locally nesting bird.
- The protected species of midland hawthorn (*Crataegus laevigata* (Poir.) DC.) and common hawthorn (*Crataegus monogyna* Jacq.) have to be used to form a greenbelt, or in places where individual trees have been removed, damaged or got sick.
- Natural vegetation cover must be preserved wherever possible, especially by limiting working/manipulation area.
- All highly invasive species present in the project area should be removed.
- If highly invasive species reappear, they should be regularly removed from all surfaces (especially common ragweed (*Ambrosia artemisiifolia*).
- If strictly protected species are encountered during execution of works, take all necessary protective measures and act in accordance with the conditions prescribed by the Institute for Nature Conservation.
- Deliberate killing, capturing or disturbing of strictly protected species and other fauna is forbidden.

Air

-Erect barriers (curtains) around dust raising activities (e.g. demolition of existing structures, etc.)
-All vehicles should turn off their engines in the event of a prolonged standstill during operation -Wash or clean all vehicles before leaving the construction site -All loads entering and leaving the site must be covered.
-Transport vehicles should meet the best local exhaust emissions standards.
-Use water as dust suppressant on the construction site (different types of sprayers etc.), especially during summer and windy periods.
-Minimize dust-generating activities.
-Take excess soil off the construction site.

Noise

-Turn off engines during breaks and when machinery is not directly involved in construction works.

Landscape

-Use the green space on the construction site as little as possible. Restore possibly damaged green areas which are not planned for activities on the construction site.

-After the completion of the construction phase, the land is to be restored and green areas are to be planted in accordance with the Landscape Design.
-During the excavation, the topsoil will be separated, and will be used for rehabilitation of the terrain in the later stages after the works have been completed.

Traffic and transport
-Draft the Traffic Management Plan on and off the construction site. If necessary, provide temporary access alternatives to the complex.
-Plan routes for truck transport off the site to avoid unexpected traffic jams - "rush hour".
-Placement of warning signs and notices along the route for truck traffic is necessary.
-Trucks that transport bulk material (soil, sand, gravel, etc.) must be covered with a tarp in order to prevent its dispersion during transport.
-Before leaving the construction site, especially during the rainy season, removal of mud from wheels is mandatory.

Waste
-The generated during construction will be sorted on-site (household, plastics, cardboard, metal, hazardous waste...), using relevant storage options (bags, bins, containers).
-On the construction site, establish a temporary plateau for the installation of the appropriate storage options for the generated waste.
-Ensure regular transport of generated waste from the construction site.
-For the removal of the generated waste from the construction site, engage legal entities with the appropriate waste management license.
-Waste management on the construction site is the obligation of the contractor.

Regular operation phase

-In the Entrance-control zone, provide control and records of entering the complex.
-Provide control of input waste for radioactivity.
-Provide a video surveillance system for visual inspection of bulk load in trucks.
-Provide weighbridges for weighing loaded and empty vehicles.
-Ensure the washing of the wheels of trucks coming out of the complex.

Water
-Buried diesel fuel tank must be equipped with a double mantle and a waterproof reinforced concrete bundwall.
-The bundwall must have sufficient capacity in order to accept the total amount of fuel stored.
-In all areas where leakage of fluids can occur (diesel fuel, oil, chemicals, etc.), suitable drains must be installed with drainage to treatment in the sedimentation trap and/or separator of grease and oil, in accordance with the design.
-Grease and oil separators/sedimentation traps should be regularly maintained/emptied.
-Emptying and the contents of the oil and grease separators must be entrusted/handed over to the Operator with the appropriate permit for operating this type of waste.
-All the surfaces where manipulation of liquids (oil derivatives, chemicals, etc.) is expected must be concreted or paved.
-Provide adequate collection and drainage of water to the designed sedimentation trap/separator on these surfaces.
-Due to the occasional large daily amounts of precipitation, it is necessary to control and regularly maintain the condition of the perimeter channels.

-Atmospheric, unpolluted waters should be drained via adequate sewage system in accordance with the design.
-Atmospheric, potentially contaminated waters should be drained via adequate sewage system to sedimentation trap/separator in accordance with the design.
-Sanitary-faecal water should be drained to a device for treatment of such waters.
-In accordance with the project documentation, make maximum use of unpolluted atmospheric waters and treated technological wastewater - by a recirculation system.
-Ensure proper monitoring of all the waters that are being fed into the natural recipient.
-Conduct water monitoring to the recipient.
-The monitoring of the waters should be entrusted to an authorized and accredited laboratory/legal entity.
-All buried objects, as well as parts of objects that are buried, should be built of watertight concrete.
-Provide a system for collection, evacuation and treatment of leachate waters.
-Build lagoons for leachate waters and atmospheric waters with a suitable waterproof surface.

Soil and agricultural land
-Provide surface water drainage system, in order to ensure that surface water runoff is not accumulating on the site and is not spilled outside the borders of the project.
-Provide adequate adsorbents for collection of possibly spilled liquids (petroleum products, chemicals, etc.)
-Provide appropriate storage options/packaging (e.g. metal barrels) for the disposal of contaminated adsorbents.
-Treat contaminated adsorbents as substances that have hazardous waste properties, according to the report on the previously performed characterization of this type of waste, in accordance with the law.
-Provide a place for temporary disposal of packaging with collected hazardous waste.
-The collection of generated waste should be entrusted to a legal entity with the appropriate waste management permit.

Biodiversity
-Regularly remove highly invasive species from all surfaces if they reappear.
-External light sources should point downward, i.e. be directed at the work surfaces.

Air
-Provide reduction of dust diffusion emissions from all surfaces under the impact of the project (landfill, CDW platform, Operating platform ...), using water bowser trucks with sprinklers, using water, especially in dry and windy periods.

Noise
-Turn off engines of the vehicles within the complex during a break or longer standstill.
-Provide adequate personal protective equipment for all employees that are in active contact with sources of noise.
-Provide adequate housings, antivibration pads, and sound insulation on equipment which represent a significant source of noise and vibration.
-In facilities with equipment that is a noise emitter, keep any doors to the outside closed. -Limit the speed of vehicles within and outside the complex.

Landscape
-Within the green belt, it is necessary to remove and replace any damaged or withered vegetation with the specimens of the same species, in accordance with the Landscape Design.

Traffic and transport
-Adhere to the Traffic Management Plan on and off the site.
-Organized and controlled movement of vehicles must be within defined traffic routes.
-Set up speed limit traffic signs within the complex.
-Washing of wheels of waste delivery vehicles and other delivery vehicles, before they enter the public road, is mandatory.

Waste
- Develop a Waste Management Plan.
- The monitoring system must include the production of biogas and leachate waters and their treatment in accordance with applicable regulations and good industrial practices.
- The structural stability and watertightness of the final cover system should be monitored
regularly.
- Due to possible large daily amounts of precipitation, it is necessary to control and regularly maintain the condition of the perimeter channels.
- Regular controls of the surface water drainage system are necessary in order to ensure that surface water drainage does not accumulate at the site.
- -Provide adequate adsorbents for collection of possibly spilled liquids (petroleum products, chemicals, etc.)
- Provide adequate daily covering of landfilled waste in order to prevent the dispersion of light fractions from the landfill body (dust, paper, bags, etc.) and reduce rainwater infiltration.
- Surplus soil from excavation works shall be reused at the site.
- In order to prevent seagulls from gathering and feeding on site in large numbers, the active areas of the new landfill should be covered daily.
- Regularly check the compactness of the enclosure around the landfill in order to prevent large mammals from entering the project site.
- Regularly remove highly invasive species from all surfaces if they reappear.
- Mowing at the landfill complex should be performed only once a year, so as to allow for succession of natural grassland communities and prevent seagulls from using this area as a loafing habitat.
- Enable the development of high herbaceous vegetation wherever possible (near roads, channels, lagoons).
- The covered areas of the active new landfill, which will not be used for at least a month, should be planted with a mixture of fast-growing grasses.
- Flue gas parameters should be monitored regularly, in accordance with legislation.
- Monitor gas collection and combustion systems in order to control and prevent gas loss.
- Perform efficient covering and use of material placed on the received waste in order to prevent odours from spreading.
- Provide adequate personal protective equipment for all employees that are in active contact with sources of noise.
- Within the green belt, it is necessary to remove and replace any damaged or withered vegetation with the specimens of the same species.
- Washing of wheels of vehicles is performed in the landfill reception/control area, prior to their entrance onto a public road.

-Waste generated during operations, such as office waste, packaging, hazardous waste, etc., will be sorted on site.

-Depending on the type of waste (non-hazardous/hazardous), conduct its adequate disposal in the appropriate packaging.
-Waste packaging should be stored on defined surfaces and in facilities (depending on the type of waste), in accordance with the Waste Management Plan.
-Keep the waste chemicals in the original packaging and store together with the chemical packaging in the facility/room for hazardous waste.
-Special waste streams should be stored in accordance with legislation and the Waste Management Plan.
-Waste control also involves keeping records, in accordance with legislation.
-Waste which does not meet the criteria for landfilling shall be returned to the owner of the said waste.

Social aspects

Project preparation phase
-The Resettlement Action Plan and Livelihood Restoration Action Plan have been developed.
-The implementation of the Action Plan falls under the competence of the City of Belgrade.

Construction phase
-The Action Plan defines the informing of companies and waste collectors about the expected start and duration of the individual phases of the project.
-Encourage contractors to hire local labour.
-Identify seasonal workers and ensure that their position is no less favourable than other workers performing similar functions.

Regular work phase
-Provide educational materials on waste management.
-Organize forums with stakeholders (population, local communities,
NGOs...) and familiarize them with risks, applied protection measures, project benefits...
-Ensure cooperation with the local health institution.
-Provide grievance mechanisms for workers/employees and other stakeholders.
-Prohibit entry to unauthorized persons, citizens, and especially children.
-Provide a basic programme of professional development and special courses for workers/employees.
-Encourage the engagement of women on appropriate jobs at the plant.
-Train workers in terms of a "good neighbourhood" policy, in order to avoid causing distrust in the project.

Project-technical solutions

- A system for the collection and evacuation of landfill (bio)gas to the BEP plant has been designed.
- In the event of a BEP plant stoppage, the control system of this plant shall automatically redirect the generated biogas to the torch system.
- Conditionally unpolluted atmospheric waters are accepted by an internal system of (mostly open) channels for the reception of atmospheric waters within the entire complex, directed towards the lagoons for atmospheric waters on the Upper and Lower platforms.
- The waters from the lagoon for atmospheric waters are used to wet the surfaces within the complex (the exception being landfill cells), in order to reduce dust within the complex and other technological needs
(at the EfW plant).

- Leachate waters and atmospheric contaminated water are collected in the lagoons for leachate waters.
- From the leachate water lagoon, they are directed to the leachate treatment plant (LTP) before entering into the recipient.
- Prior to the discharge of purified wastewater into a natural recipient, the installation of flow meters is foreseen.
- Oiled atmospheric and other waters are taken to the sedimentation trap/separator, at the Operational Platform.
- Sanitary-faecal wastewater is treated at a sewage treatment plant (STP).
- All areas where liquid leakage (diesel fuel, oil, chemicals, etc.) may occur are concreted/paved with an appropriate drain towards the sedimentation trap/oil and grease separator.
- All lagoons for atmospheric waters and leachate waters (on the Upper and Lower platforms) are provided with a suitable waterproof liner/casing.
- Areas and facilities for temporary storage of all generated types of waste (non-hazardous and hazardous) on the Operational platform are planned.
- A diesel fuel pumping station is designed on the Operational platform.
- The diesel fuel tank has a double mantle.
- "Open waste" is checked in the control zone, by worker checking the waste (directly) on the weighbridge or by using a video camera.
- The location of the entire Vinča landfill complex will be enclosed by an adequate wire fence to prevent the entry of medium and large animals into the complex.
- Landscaping of surfaces is done in accordance with the Landscape Design.
- A supporting structure is designed on the periphery of the body of the "old" landfill.
- The supporting structure has been designed with adequate hydrotechnical facilities for atmospheric and leachate waters from the "old" landfill.

8.4. OTHER ENVIRONMENTAL PROTECTION MEASURES FOR PREVENTION OR REDUCTION NEGATIVE IMPACT ON ENVIRONMENT

- The archaeological site "Ošljane" represents a resource that enjoys preliminary protection on the basis of the Law on Cultural Heritage. In order to protect the archaeological site "Ošljane", during the execution of any earth works or the construction of new facilities, the obligation of the Leading Contractor is to provide permanent archaeological surveillance and protective archaeological interventions if archaeological objects or objects are found.
- In accordance with the Conditions of Preservation, Maintenance and Use of Cultural Resources and Resources that Enjoy Preliminary Protection, and the conditions of the Institute for Protection of Cultural Monuments of the City of Belgrade (arch. No. P2249/14 from 23 July 2014, confirmed by letter P432/18 of 23 February 2018), the envisaged archaeological supervision should be realized according to the special Programme, to be done at the Institute for Protection of Cultural Monuments of the City of Belgrade, in cooperation with the Leading Contractor.
- If an archaeological site is discovered, there is a possibility that archaeological works i and conservation of the site, relocation of findings, or displacement of parts of the project will be required. The Leading Contractor is obliged to respond to the possible requirements of the Institute for Protection of Cultural Monuments.

- Also, if archaeological material is discovered during the works anywhere within the planned project area, it is necessary, according to the Articles 28 and 29 of the Law on Cultural Property ("Official Gazette of the RS", No. 71/94, 52/11 – other law, 92/11 – other law), to the Institute for Protection of Cultural Monuments of the City of Belgrade and proceed in line with their instructions.
- If problems with odour outside the fence are discovered, carry out a preliminary research on the concentrations of substances that are carriers of the said odour in order to determine the origin and method of dispersion of the odour outside the complex.
- The aforementioned research must also include a proposal for additional measures for the reduction of odours.
- In case of persistent odour issues arising outside the borders of the complex, an odour survey should be performed according to European standard EN 16841-2: 2016 or European standard EN 16841-1: 2016 (depending on the odour and its possible source) in order to characterise the odour, its source and conditions of its occurrence.

9.0. ENVIRONMENTAL IMPACT MONITORING PROGRAMME

The purpose of the environmental impact monitoring is for regular sampling and laboratory analysis of the affected samples to be carried out at a certain time interval, in accordance with the legislation. Subsequently, based on the defined limit values, the impact on the examined environmental factors is determined and, if necessary, the measures for reduction of the observed negative impacts are defined.

- The monitoring the quality of wastewater shall be carried out in accordance with the Regulation on Emission Limit Values for Pollutants in Waters and Deadlines for their Reaching ("Official Gazette of the RS", No. 67/2011, 48/2012 and 1/2016), and in accordance with the Rulebook on the Manner and Conditions for Measuring the Quantities and Examining the Quality of Waste Water, and the Contents of Reports on Performed Measurements ("Official Gazette of the RS", No. 33/2016);
- The monitoring of the quality of surface waters shall be carried out in accordance with the Regulation on Emission Limit Values for Pollutants in Surface and Ground Waters and Sediments and the Deadlines for their Reaching ("Official Gazette of the RS", No. 50/2012), the Regulation on Limit Values of Priority Substances and Priority Hazardous Substances Polluting Surface Waters, and the Deadlines for their Reaching ("Official Gazette of the RS", No. 24/2014), and the Rulebook on Parameters of Ecological and Chemical Status of Surface Waters, and Parameters of Chemical and Quantitative Status of Ground Waters ("Official Gazette of the RS" No. 74/2011), Annex 3, Type 1, Danube River, Ecological status class boundaries and boundary of ecological potential classes for surface water types;
- The monitoring of groundwaters shall be carried out in accordance with the Regulation on Emission Limit Values for Pollutants in Surface and Ground Waters and Sediments and the Deadlines for their Reaching ("Official Gazette of the RS", No. 50/12) and the Regulation on Limit Values of Pollutant, Harmful and Hazardous Substances in the Soil ("Official Gazette of the RS", No. 30/2018) Annex 2: Remediation Values of Polluting, Harmful and Hazardous Substances in the Aquifer;
- Soil monitoring is carried out in accordance with the Regulation on Limit Values for Polluting, Harmful and Hazardous Substances in the Soil ("Official Gazette of the RS", No. 30/2018), Annex 1: Limit, Maximum and Remediation Values of Polluting, Harmful and Hazardous Substances in the Soil;

- Monitor the noise in accordance with the Rulebook on the Methods of Noise Measurement, Content and Scope of the Noise Measurement Reports ("Official Gazette of RS" No. 72/10) and the Regulation on Noise Indicators, Limit Values, Noise Indicators Assessment Methods, Annoyance and
Harmful Effects of Environmental Noise ("Official Gazette of the RS" No. 75/10);
- Monitoring of waste shall be carried out in accordance with the Law on Waste Management ("Official Gazette of the RS", No. 36/2009, 88/2010 and 14/2016), the Rulebook on the Form of Waste Movement Document and Filling-in Instructions ("Official Gazette of the RS", No. 72/09, 114/13) and the Rulebook on the Form of Hazardous Waste Movement Document, the Template of the Previous Notification, Manner of Their Submission, and Filling-in Instructions ("Official Gazette of the RS", No. 17/2017);

Based on the aforementioned legislation, the main environmental factors are followed by monitoring:
- air
- water
- land and
- the noise level in the environment

9.1. OVERVIEW OF THE STATE OF ENVIRONMENT BEFORE THE COMMENCEMENT WITH PROJECT'S OPERATION AT LOCATIONS WHERE THE ENVIRONMENTAL IMPACT IS EXPECTED

The state of the environment before the commencement with project's operation, in "zero state", is described in detail in Chapter 5.0 - Overview of the state of environment on site and in its vicinity.

9.2. PARAMETERS, LOCATIONS AND FREQUENCY OF MEASUREMENT OF DETERMINED PARAMETERS

The frequency of monitoring and parameters of pollutants are defined by the aforementioned legislation, for each listed environmental factor.

The Leading Contractor is obliged to develop a Monitoring Plan. The Monitoring Plan is envisaged for a comprehensive project on the organization of the municipal waste landfill site in Vinča. The Monitoring Plan contains (both for the period of the operation phase and for the period after the closure of the project) the monitoring of:

- Air quality
- Concentration of pollutant emissions in the air
- Quality and quantity of raw leachate waters (generated from the body of the landfill and collected in leachate water lagoons)
- Quality and quantity of treated leachate and other waters (prior to being discharged into the recipient)
- Quality and quantity of atmospheric waters
- Quality of groundwater
- Soil quality
- Environmental noise level
- Landfill stability, peripheral embankment and dam stability
- Meteorological parameters and

- Bird population

Considering that the subject of this study are planning units K2, K3, K4 and K5, in the text below is an excerpt of the Monitoring Plan related to the Project in question.

Monitoring of leachate waters quality

The quantities of generated leachate waters are monitored monthly, during the phase of landfill operation, and biannually, during the post-operational phase (after the closure of the project). Levels of leachate waters are monitored at the bottom of the landfills (using drainage wells/biothorns for biogas/leachate waters) and in the lagoons for leachate waters.

Parameters		Sampling location	Frequency during operation phase	Frequency post operation phase
Monitoring the quantity of leachate waters	Levels of assessed leachate waters in drainage wells. Levels of leachate waters in the lagoons for leachate waters. The amount of leachate waters directed to treatment plants.	Drainage wells for the collection of leachate waters and biogas, leachate water lagoons	Monthly	Biannual
Flow rate of leachate waters	Flow rate of leachate waters	Lagoon inflow	Monthly	Biannual
Monitoring of raw leachate waters	Oxidation-Reduction Potential Measurement, pH, Chemical Oxygen Demand, Biological Oxygen Demand, Total Dissolved Solids, Total Organic Carbon, Total Hydrocarbons, Chlorides, Fluorides, Sulphates, Ammonia, Nitrates, Nitrites, Total Phosphorus, Phosphates, Total Metals, Total N, Conductivity, Phenols, Adsorbable Organic Halogens (AOX), PCBs, PAHs	Wastewater lagoons	Quarterly	Biannual
Monitoring of treated leachate waters (prior to discharging)	Volume and flowrate of discharged leachate waters	Treatment station outlet	Monthly	Biannual
	Temperature, pH, Chemical Oxygen Demand, Biological Oxygen Demand, Total Dissolved Solids, Total Organic Carbon, Total Hydrocarbons, Chlorides, Ammonia, Total Phosphorus, Total Metals, Total N, Free Cyanide, Conductivity, Phenols, Adsorbable Organic Halogens (AOX), Fluorides	Treatment station outlet	Monthly	Quarterly
Meteorological data	Rainfall intensity, temperature, sunlight rate, evaporation rate, wind strength and direction, atmospheric humidity, evapotranspiration (see also Meteorological Monitoring)	Weather station on site	Daily	Biannual

Surface waters monitoring

Internal atmospheric waters are collected on landfill covers, roads and platforms and are taken by the collection and evacuation system to the lagoons for atmospheric waters (on the Upper and Lower platforms). The monitoring of internal atmospheric waters will be carried out at the following locations:

- Upper lagoon for atmospheric waters

- Lower lagoon for atmospheric waters

Parameters		Sampling location	Frequency during operation phase	Frequency post operation phase
Monitoring of atmospheric waters quality	Temperature, pH, Conductivity, Chemical Oxygen Demand, Biological Oxygen Demand, Total Dissolved Solids, Total N	Upper and Lower lagoon for atmospheric waters	Quarterly (or if pH and/or conductivity values are inconsistent)	Biannual (or if pH and/or conductivity values are inconsistent)
	Temperature, pH, Redox Potential, Conductivity, Chemical Oxygen Demand, Biological Oxygen Demand, Total Organic Carbon, Total Dissolved Solids, Chlorides, Fluorides, Phosphates, Total Phosphorus, Total N, Ammonia, Nitrates, Nitrates, Free Cyanide, Phenols, Total Hydrocarbons, Total Metals, Adsorbable Organic Halogens (AOX)		Annual	Annual
Atmospheric waters flow rate	Flow rate	Points of discharge for upper and lower lagoon	Quarterly	Biannual
Discharged volume of atmospheric waters	Visual inspection in order to assess the possible damage, clogging or malfunctions	Atmospheric waters	Quarterly	Biannual

Surveillance of the efficiency of surface waters drainage

Monthly controls, of all drainage channels and pipes for drainage of water and groundwater outside and around the landfill complex, shall be performed monthly. The controls consist of:

- visual inspections of all drainage channels;
- measurement of the flow of water at the point of discharge of drainage pipes for groundwater;
- checking the functionality of rainwater drainage pipes during the rainy periods.

The results of these monthly checks will be published and shall serve to update the Action Plan for the implementation of mitigation measures with priority levels.

The annual video surveillance of the longest drainage pipes for drainage of leachate waters and groundwater shall be carried out in order to check the integrity and functionality of the pipes. If necessary, a cleaning procedure shall be carried out in order to prevent any stoppage or blockage.

Natural springs monitoring

Prior to the commencement with exploitation of the New Landfill and during works on the remediation of the "old" landfill, the initial state of the quality of the spring waters is reported.

The quality of natural springs around the landfill complex will be determined by taking samples and analysing water. During operation, and especially at the commencement of the landfill operation, the water will be sampled and analysed in order to compare its quality with the initial state (once per month, during the first year), and later at the quarterly basis. After the landfill ceases its operation, during the first 5 years, water quality will be monitored every six months, and later, after its closure, only if there is evidence on exceeding the defined values.

Groundwater monitoring

Based on previous geological investigations, it has been established that the sediments of the Miocene era of horizontal expansion lie below the quaternary deposits. Given the slopes of the terrain in the landfill zone and downstream of the landfill, it could be assumed that the same aquifer (which could be referred to as the other - deeper aquifer) does not have the same status continuously throughout the complex.

In order to cover the entire subject area with a future groundwater monitoring network, shallow and deep piezometers should be comprehensively considered, whether they are existing or if new ones should be made.

In regards to the analysed situation and the conditions which have already been defined, the plan is for:

- Shallow piezometers (depths up to 30 m) to have the function of control points for the quality of the groundwater of the first aquifer in the zones: upstream of the future landfill, between the future and the existing landfill and downstream of the entire landfill complex.
- A deep piezometer, set upstream of the projected landfill, controls the quality of the waters of the other aquifer that goes towards the landfill zone.
- The medium deep piezometer, located between the future and existing landfill, controls the impact of the New Landfill on the deeper aquifer, while
- The deep piezometer meter, downstream from the landfill complex, controls the impact of the existing "old" landfill downstream and further impacts of the New Landfill on the other/deeper aquifer in this zone.

The function of the upstream piezometer is to control the water quality of the deeper aquifer, with the task of identifying possible pollution coming from the upstream direction (e.g. asphalt base) that is not a result of the operation of the landfill.

Bearing in mind that the main purpose of the groundwater monitoring system is to monitor the spread of potential pollutants - from soil surface to the aquifers - in a vertical direction, the proposed concept of piezometer layout is fully fulfilling its purpose.

Taking into account the results of the previously conducted hydrogeological investigations, as well as all of the stated facts and previously defined conditions, it was concluded that monitoring activities will include 10 sampling points for both aquifers:

- **4 existing piezometers** intended for monitoring of shallow aquifer, of which:
  - three piezometers (PZ-5, PZ-6 i PZ-7) installed upstream from the new landfill location, and
  - one piezometer (NP-11) installed downstream from the existing landfill body.
- **3 new piezometers** with average depth up to 30 m, which will be installed with the purpose of monitoring the shallow aquifer, of which:
  - two piezometers will be installed within the zone between the new and the existing landfill, and
  - one piezometer will be installed upstream of the exiting landfill's body.
- **3 new deep piezometers** intended for monitoring of other, deeper aquifer, of which:
  - 1 deeper piezometer, intended for monitoring of the other aquifer, will be installed upstream of the new landfill and will have maximum depth of cca 120 m or more to the static level of groundwater
  - 1 deeper piezometer, intended for monitoring of the other aquifer, will be installed upstream of the existing landfill and downstream of the new landfill, i.e. within the zone between the two landfills, and will have maximum depth of cca 100 m or more to the static level of groundwater
  - 1 deeper piezometer, intended for monitoring of the other aquifer, will be installed within the lowest zone, downstream of the existing landfill and the entire complex, and will have maximum depth of cca 100 m or more to the static level of groundwater.

The piezometer locations have been selected to provide permanent observation points with a timetable for construction - in accordance with the timetable for the construction of other facilities within the landfill complex.

All foreseen works will enable the possibility of defining the initial "baseline state" of groundwater quality in accordance with ISO 5667-2, Part 11, 1993, as well as by continuous sampling and monitoring throughout the entire period of the landfill operation.

Field and laboratory work will be designed and implemented to ensure precise definition of the position of both aquifers, as well as the zone to be isolated, in order to provide representative samples from each of the aquifers.

Monitoring programme and parameters

Taking into account all the above, the Suez Group and Beo Clean Energy will perform a check of the baseline state of groundwater quality prior to the commencement with the construction works (phase I - baseline state) with a regular list of parameters, in accordance with the regulations on water quality - Rulebook on Limit Values for Pollutants in Surface Waters and Groundwater and Sediments and Deadlines for their Reaching ("Official Gazette of the RS", No. 55/2005, 71/2005, 101/2007, 65/2008 and 16/2011), Rulebook on Determining the Status of Surface Waters and Groundwater ("Official Gazette of the RS", No. 96/2010), Rulebook on Reference Conditions for Types of Surface Waters ("Official Gazette of the RS", No. 67/2011), Rulebook on Parameters of Ecological and Chemical Status of Surface Waters, and Parameters of Chemical and Quantitative Status of Groundwater ("Official Gazette of the RS", No. 74/2011), as well as in accordance with the proposals of the Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration

- - Part B Minimum list of pollutants and their indicators for which Member States have to consider the establishment of limit values in accordance with Article 3 of the Regulation on Limit Values of Pollutant, Harmful and Hazardous Substances in the Soil ("Official Gazette of the RS", No. 30/2018), Annex 2

Restrictions on the remediation of pollutants, harmful and hazardous substances in aquifer, will also be considered during the analysis of the results obtained.

As part of groundwater monitoring, five phases will be considered:

- Phase I: Fully determining the baseline state of groundwater quality before the commencement of construction works,
- Phase II: Until the start of the provision of temporary services (including operation phase),
- Phase IIa: Operation phase (6-6 months),
- Phase IIIb: Operation phase (after 6 months of operation),

- Phase IV: Phase after completion of the works.

Parameters	Phase I	Phase II	Phase IIIa	Phase IIIb	Phase IV
Groundwater quality	Complete analysis, One time	Quarterly	Quarterly, every 15 days on at least 3 points	Every 6 months	Annually
Groundwater quality	Temperature, pH, Conductivity, Redox Potential, Dissolved O2+,Chemical Oxygen Demand (COD), Chlorine (Cl), Sodium (Na+), Pottasium (K+)		Monthly	Monthly	
Groundwater quality	Radioactivity measured by Gamma-spectrometry, One time	Annually	Annually	Every 5 years	Every 5 years
Groundwater level	One time	Quarterly	Quarterly, every 15 days at 3 points	Every 6 months	Annually

The list of parameters can be reduced at each phase, in accordance with the results of Phase I (they need to be defined after Phase I and define the actual baseline phase after the results of the remediation project which runs in parallel). For example, in the case of positive development of different parameters, during Phase
III - Operation Phase, it may be decided to "relax" the monitoring regime and focus only on the following group of parameters:

- Oxygen regime,
- Salinity and hardness of water,
- Metals.

The following groups of parameters are excluded from the monitoring range or their frequency is reduced:

- Organic substances,
- Microbiology.

The Regulation defines that groundwater monitoring in the operation phase is carried out while taking into account the defined baseline phase (Phase I) values as the benchmark values for the comparison, in accordance with ISO 5667-2, Part 11, 1993.

Adjusting the monitoring programme:

- In the event of an increase in the frequency of changes in the groundwater level, the frequency of sampling should be increased.
- If a critical level of concentration of the parameters is reached, the frequency should be based on the possibility of undertaking corrective measures between the two sampling, i.e. the frequency must be determined on the basis of knowledge and estimation of the rate of flow of groundwater.
- When a critical level of concentration of the parameters is reached, it is necessary to perform a check-up by repeating the sampling. Once the concentration level is confirmed, the monitoring plan must be updated.

If the test results of the samples taken show that the values obtained exceed the limit values in accordance with the defined limits, the adequate research shall be carried out in order to verify the cause of these exceedings and whether the accident situation has occurred on the protective layers of the landfill. In this case, in accordance with the the Rulebook on the Disposal of Waste at Landfills, additional hydrogeological facilities (piezometers) shall be installed, taking into account the hydrogeological conditions at the site.

Landfill stability monitoring

Total topographical surveys will be conducted every year at the landfill after operational works, and at the final layer at the new landfill, and every month in the active area of operation. Drone will be used to obtain data by using a topo-photogrammetric method.

The obtained data and reports are arranged annually, showing changes on waste cells, including:

- Primary compacting (mechanical compaction of waste during filling operations and self-compacting of waste due to its own weight);
- Secondary compacting (due to bio-degradation of waste);
- Potential sliding of waste mass.

On the downstream slope of the old landfill, a topographical survey by a drone will be completed by survey topographic criteria, because the stability of this zone is of primary concern for the stability of the old landfill and because the slight evolution of the topography may hide the vegetation that will develop on the last top cover.

Topographic landmarks will be located:
- At the top and on the berms of the downstream slope of the landfill, spaced 40 to 60 meters from each other;
- At the top and on the berms of peripheral embankments (in the entire length on several parts, spaced 50 to 100 meters apart at each level of monitoring: medium berms);

Surveying with a monitoring device will be conducted quarterly during the first two years and annually thereafter. The results will be processed in order to monitor the behaviour of the waste body and anticipate any issue of stability.

If movement is detected, further research will be carried out to determine whether mitigation and additional stabilization measures are required.

Moreover, the operational plan will be updated on an annual basis and will show the results of activities at the “old” and the new landfills, as follows:

- surface filled with waste;
- volume of waste;
- disposal period and the lifetime of each cell;
- the remaining capacity of the landfill.

Finally, an annual visual inspection is carried out to detect and report problems in respect of integrity or functionality of the landfill (holes, cracks, gas emissions, water stagnation, reduction of the flora, development of deep roots...). The results of the annual survey will be used to develop an Action Plan for measures to mitigate the effects of landfill operation.

Monitoring of the protective layer of landfill bottom for the new landfill

National regulations require the following: "The monitoring of the protective layers of the landfill will be done continuously with sensors built in artificial waterproof coatings (if installed), while the data will be monitored in the landfill laboratory. Monitoring of the protective layers of the landfill will be carried out continuously during the exploitation of the landfill, and after monitoring the exploitation data, monitoring and processing shall be carried out at the intervals specified in the permit for the operation of the landfill."

In accordance with EU Directive (1999/31/CE on the landfill of waste), the protection of soil, groundwater and surface is achieved by combining geological barrier (passive barrier) and the lower line (active barrier) during the operation/active phase. If the natural geological barrier does not meet the above conditions, it will be artificially reinforced using geocomposite clay.

In addition to the above-described geological barriers, a system for collecting and evacuating the leachate waters (HDPE line that is connected with the geocomposite for drainage of leachate waters, drainage wells and drainage pipes will be added, to ensure that the accumulation of water on the landfill will be minimal.

This dual system is designed to ensure that, if there is an occurrence in the active barrier, the passive barrier will mitigate the risk of potential leakage.

Noise levels monitoring

Noise monitoring will be carried out in the wider area of the Vinča landfill complex, according to the monitoring plan, with an annual frequency during the construction and operation phase. Noise measurement will be carried out over a 24-hour period, and the results are compared with the noise thresholds regulated in Serbia.

Meteorological monitoring

Measurement of meteorological parameters is carried out in the manner stated in the following table:

Parameters	Active phase	Passive phase
Amount of precipitation	Daily	Daily, monthly value is added
Temperature (min, max. at 14.00h)	Daily	Monthly average
Speed and direction of air flow	Daily	Not necessary
Evaporation (lysimeter, or other method)	Daily	Daily, monthly value is added
Atmospheric humidity (at 14.00h)	Daily	Monthly average

Measurements will be made by the weather station at the location, while the competent authority does not require so in accordance with the Law and the Regulations on Waste Disposal ("Official Gazette of the RS", No. 92/2010).

Bird population monitoring

A bird survey, which was launched during baseline state, should be continued during the construction and operation phase in order to assess the impact of the works and functioning. The field methodology, observation points and methods of conclusion should be identical to those in the baseline state or, if necessary, they can be adapted to scientific justifications.

Three stages will be considered for bird monitoring:

- Phase I: Updating the baseline state,
- Phase II: Until commencement with temporary services (including the operation phase),
- Phase III: Operation phase.

Parameters	Phase I	Phase II	Phase III
Identical as in baseline state	Migration period 2018 and every season after, until Phase II	Seasons of nursing and nesting every year	One year-round investigation (4 investigations) after 5, 10 and 20 years

10.0. NON-TECHNICAL OVERVIEW OF THE STUDY

The non-technical presentation of the data from individual chapters of the Study is given as a separate, and represents an integral part of this Study.

11.0. DATA ON TECHNICAL DEFICIENCIES

During the preparation of the Study, no technical deficiencies were identified due to which the operation of the Project would endanger the environment. Also, no lack of expertise and skills in respect of designing and implementation of environmental protection measures has been established.

12.0. BASES FOR STUDY DRAFTING

Legislation

- Law on Environmental Protection ("Official Gazette of the RS", No. 135/04, 36/09, 72/09 and 14/16);
- Law on Environmental Impact Assessment ("Official Gazette of the RS", No. 135/04, 36/09, 72/09 and 43/11 - CC decision and 14/2016);
- Law on Planing and Construction ("Official Gazette of the RS", No. 72/09, 81/09-corr., 64/10-CC decision, 24/11, 121/12, 42/13-CC decision, 50/13-CC decision, and 98/13-CC decision, 132/2014 and 145/2014, 23/15);
- Law on Soil Protection ("Official Gazette of the RS", No. 112/15);
- Law on Water ("Official Gazette of the RS", No. 30/10, 93/12 and 101/16);
- Law on Water Regime ("Official Gazette of the FRY", No. 59/98 and "Official Gazette of the RS", No. 105/05);
- Law on Air Protection ("Official Gazette of the RS", No. 36/09 and 10/13);
- Law on Chemicals ("Official Gazette of the RS", No. 36/2009, 88/10, 92/11, 93/12 and 25/15);
- Law on Waste Management "Official Gazette of the RS", No. 36/2009, 88/2010, 14/2016 and 95/2018 - other law);
- Law on Packaging and Packaging Waste ("Official Gazette of the RS", No. 39/09);
- Law on Protection from Noise Pollution ("Official Gazette of the RS", No. 36/09, 88/10);
- Law on Nature Conservation ("Official Gazette of the RS", No. 36/09, 88/10, and 91/10 - corr. 14/2016);
- Law on Cultural Property ("Official Gazette of the RS", No. 71/94)
- Law on Fire Protection ("Official Gazette of the RS", No. 111/09 and 20/15);
- Law on Standardization ("Official Gazette of the RS", No. 36/09);
- Law on Flammable Liquids and Combustible Fuel Gases "Official Gazette of the RS", No. 54/15);
- Law on Integrated Prevention and Control of Environmental Pollution ("Official Gazette of the RS", No. 135/04 and 25/15);
- Law on Strategic Environmental Impact Assessment ("Official Gazette of the RS", No. 135/04 and 88/10);
- Occupational Health and Safety Law ("Official Gazette of the RS", No. 101/05, 91/15 and 113 of 17/17);
- Rulebook on Contents of the Environmental Impact Assessment Study ("Official Gazette of the RS", No. 69/05);
- Rulebook on the Manner and Conditions for Measuring the Quantities and Examining the Quality of Waste Water, and the Contents of Reports on Performed Measurements ("Official Gazette of the RS", No. 33/16);
- Regulation on the Designation of Surface Water and Groundwater Bodies ("Official Gazette of the RS", No. 96/10);
- Rulebook on Parameters of Ecological and Chemical Status of Surface Waters, and Parameters of Chemical and Quantitative Status of Ground Waters ("Official Gazette of the RS", No.

- Rulebook on the Method of Determining and Maintaining Sanitary Protection Zones of Water Supply Sources ("Official Gazette of the RS", No 92/08);
- Rulebook on Determining Melioration Areas and their Boundaries ("Official Gazette of the RS", No. 38/11);
- Regulation on Determining Water Units and their Boundaries ("Official Gazette of the RS", No. 8/18);
- Rulebook on the Methods of Noise Measurement, Contents and Scope of the NoiseMeasurement Reports ("Official Gazette of the RS", No. 72/10);
- Rulebook on the Form of Waste Movement Document and Filling-in Instructions ("Official Gazette of the RS", No. 72/09, 114/13);
- Rulebook on the Form of Hazardous Waste Movement Document, the Form of Prior Notification, the Manner of their Submission and Filling-in Instructions ("Official Gazette of the RS", No. 17/2017);
- Rulebook on the Waste Categories, Examination and Classification ("Official Gazette of the RS", No. 56/10);
- Rulebook on the Form of a Daily Record and Annual Waste Report, with the Filling-in Instructions ("Official Gazette of the RS", No. 95/2010, 88/2015);
- Rulebook on Forms of Reports on Packaging and Packaging Waste Management ("Official Gazette of the RS", No. 21/2010);
- Rulebook on Amendments to the Rulebook on Forms of Reports on Packaging and Packaging Waste Management ("Official Gazette of the RS", No. 10/2013);
- Rulebook on Technical Standards for Access Roads, Turners and Arranged Plateaus for Firefighting Vehicles in the Vicinity of an Increased Risk of Fire ("Official Gazette of the SFRY", No. 8/95);
- Rules on Technical Standards for Fire Hydrant Network ("Official Gazette of the SFRY", No. 30/91);
- Rulebook on Technical Standards for the Protection of Objects from Atmospheric Discharges ("Official Gazette of the FRY", No. 11/96);
- Rulebook on Technical Standards for Protection of Electric Power Plants and Devices against Fire ("Official Gazette of the SFRY", No. 74/90);
- Rulebook on Technical Standards for Stable Fire Alarm Installations ("Official Gazette of the SFRY", No. 87/93);
- Rulebook on Preventive Measures for Safe and Healthy Work in the Use of Work Equipment ("Official Gazette of the RS", No. 23/09, 123/12 and 102/15);
- Rulebook on Preventive Measures for Safe and Healthy Work during the Use of Personal Protective Equipment and Devices ("Official Gazette of the RS", No. 92/08);
- SRPS EN 2 (sr) - 2011 Fire classification;
- SRPS Z.C0.005 - 1979 Classification of materials and goods depending on their behaviour in a fire;
- SRPS Z.C0.012 - 1980 Categories and grades identification of the fire hazards of materials;
- SRPS U.J1.220 - 1981 Fire protection - Standard symbols for designs;
- SRPS U.J1.240 - 1995 Fire protection in civil engineering - Stage of the fire resistance of a building;
- SRPS TP19 2003 Technical recommendation for structural fire protection in industrial buildings - Analytically required fire resistance time
- Rulebook on the Limits of Exposure to Non-Ionizing Radiation ("Official Gazette of the RS", No. 104/09)
- Rulebook on Conditions, Manner and Procedure for Waste Oils Management ("Official Gazette of the RS", No. 71/10)
- Rulebook on the List of Hazardous Substances and their Amounts and Criteria for Determining the Type of Documents Produced by the Operator of Seveso Installation or Establishment ("Official Gazette of the RS", No. 41/10, 51/15)
- Rulebook on Technical Standards for the Construction of High-rise Buildings in Seismic Areas ("Official Gazette of the SFRY", No. 31/81, 49/82, 29/83, 21/88 and 52/90)
- Rulebook on Technical Standards for Installation of Hydrant Fire Extinguishing Network ("Official Gazette of the RS", No. 3/2018)
- Rulebook on the Methodology for the Development of Rehabilitation and Remediation Projects ("Official Gazette of the RS", No. 74/2015)
- Rulebook on Hazardous Substances in Waters ("Official Gazette of the FRS", No. 31/82),

- Regulation on Reference Conditions of Surface Water Types (“Official Gazette of the RS”, No. 67/11),
- Regulation on Emission Limit Values for Pollutants in Surface and Ground Waters and Sediments and the Deadlines for their Reaching (“Official Gazette of the RS”, No. 50/12);
- Regulation on Limit Values of Priority Substances and Priority Hazardous Substances Polluting Surface Waters, and the Deadlines for their Reaching (“Official Gazette of the RS”, No. 24/14);
- Regulation on the Amount of Water Fees (“Official Gazette of the RS”, No. 14/18);
- Regulation on Emission Limit Values for Pollutants in Waters and the Deadlines for their Reaching (“Official Gazette of the RS”, No. 67/11, 48/12 and 1/16);
- Regulation on Limit Values of Pollutant, Harmful and Hazardous Substances in the Soil (“Official Gazette of the RS”, No. 30/2018);
- Regulation on Measurements of Air Pollutant Emissions from Stationary Sources ofPollution (“Official Gazette of the RS”, No. 5/16);
- Regulation on Limit Values of Air Pollutant Emissions from Combustion Installations (“Official Gazette of the RS”, No. 6/16);
- Regulation on Limit Values of Air Pollutant Emissions from Stationary Sources of Pollution, Except from Combustion Installations (“Official Gazette of the RS”, No. 111/15);
- Regulation on Noise Indicators, Limit Values, Noise Indicator Assessment Methods, Annoyance and Harmful Effects of Environmental Noise (“Official Gazette of the RS”, No. 75/10).
- Regulation on Disposal of Waste on Landfills (“Official Gazette of the RS”, No.92/10)
- Regulation on Types of Activities and Installations for which Integrated Permits are Issued (“Official Gazette of the RS”, No. 84/05)

List of technical documentation

Book (Volume)	Volume	Ident. No.
Book 0	The main volume	17048-IDP-00
Volume 1/1	Architectural Project - Plateau of the crushing plant	17048-IDP-01-01
Volume 1/2	Architectural Project - Operational Plateau	17048-IDP-01-02
Volume 2/1	Construction Project - Landfill Complex ’’Vinča’’	17048-IDP-02-01
Volume 2/2	Construction Project - Plateau of the crushing plant	17048-IDP-02-02
Volume 2/3	Construction Project - Operational Plateau	17048-IDP-02-03
Volume 2/4	Construction Project - Biogas network from the body of the rehabilitated existing landfill	17048-IDP-02-04
Volume 2/5	Construction Project - Biogas network from the body of the new sanitary landfill	17048-IDP-02-05
Book 2/6	Roads Project - Landfill Complex ’’Vinča’’	17048-IDP-02-06
Volume 2/7	Roads Project - Plateau of the crushing plant	17048-IDP-02-07
Volume 2/8	Roads Project - Operational Plateau	17048-IDP-02-08
Volume 2/9	Construction Project - Torch System	17048-IDP-02-09
Volume 2/10	Roads Project - Torch System	17048-IDP-02-10
Book 3/1	Hydrotechnical Installation Project - Entrance, weighbridges, utility paths with water supply infrastructure, fire protectionand faecal sewerage	17048-IDP-03-01
Volume 3/2	Hydrotechnical Installation Project - Peripheral channelsoutside the body of the landfills	17048-IDP-03-02

Volume 3/3	Hydrotechnical Installation Project - New landfill andinert landfill	17048-IDP-03-03
Volume 3/4	Hydrotechnical Installation Project - Rehabilitation of the old landfill	17048-IDP-03-04
Volume 3/5	Hydrotechnical Installation Project - Upper platform	17048-IDP-03-05
Volume 3/6	Hydrotechnical Installation Project - Lower platform	17048-IDP-03-06
Volume 3/7	Hydrotechnical Installation Project - Plateau of the crushing plant	17048-IDP-03-07
Volume 3/8	Hydrotechnical Installation Project - Operational Plateau	17048-IDP-03-08
Volume 3/9	Hydrotechnical Installation Project - Biogas network from the body of the landfill	rehabilitated existing
Volume 3/10	Hydrotechnical Installation Project - Biogas network from the body of the new sanitary landfill	17048-IDP-03-10
Volume 4/1	Electricity Installations Project - Transformer stations TS1, TS2 and TS3	17048-IDP-04-01
Volume 4/2	Electricity Installations Project - Illumination of internal roads	17048-IDP-04-02
Volume 4/3	Electricity Installations Project - Entrance zone, water supply and fire protection facilities and lagoons on the upper and lower platforms	17048-IDP-04-03
Book (Volume)	**Volume**	**Ident. No.**
Volume 4/4	Electricity Installations Project - Plateau of the crushing plant	17048-IDP-04-04
Volume 4/5	Electricity Installations Project - Operational Plateau	17048-IDP-04-05
Volume 4/6	Electricity Installations Project - Biogas network from thebody of the rehabilitated existing landfill	17048-IDP-04-06
Volume 4/7	Electricity Installations Project - Biogas network from the body of the sanitary landfill	17048-IDP-04-07
Volume 4/8	Electricity Installations Project - Torch System	30/18- 02 -IDP-4/8
Volume 5/1	Telecommunication and Signalling Installations Project - Landfill	17048-IDP-05-01
Volume 5/2	Telecommunication and Signalling Installations Project - Input zone	17048-IDP-05-02
Volume 5/3	Telecommunication and Signalling Installations Project - Plateau of the crushing plant	17048-IDP-05-03
Volume 5/4	Telecommunication and Signalling Installations Project - Operational Plateau	17048-IDP-05-04
Volume 6/1	Mechanical Installations Project - Water supply	17048-IDP-06-01
Volume 6/2	Mechanical Installations Project - Upper platform	17048-IDP-06-02
Volume 6/3	Mechanical Installations Project - Lower platform	17048-IDP-06-03
Volume 6/4	Mechanical Installations Project - Plateau of the crushing plant	17048-IDP-06-04

Volume 6/5	Mechanical Installations Project - Operational Plateau -Heating, ventilation and air conditioning	17048-IDP-06-05
Volume 6/6	Mechanical Installations Project - Operational Plateau - Mechanical fluid distribution	17048-IDP-06-06
Volume 6/7	Mechanical Installations Project - Biogas network from the body of the rehabilitated existing landfill	17048-IDP-06-07
Volume 6/8	Mechanical Installations Project - Biogas network from the body of the new sanitary landfill	17048-IDP-06-08
Volume 6/9	Mechanical Installations Project - Torch System	30/18- 02 -IDP-6/9
Volume 7/1	Technology Project - New landfill First Phase, Phase Two,Phase Three, inert landfill	17048-IDP-07-01
Volume 7/2	Technology Project - Remediation of the old landfill	17048-IDP-07-02
Volume 7/3	Technology Project - Plateau of the crushing plant	17048-IDP-07-03
Volume 7/4	Technology Project - Biogass network from the body of the rehabilitated existing landfill	17048-IDP-07-04
Volume 7/5	Technology Project - Biogas network from the body of the new sanitary landfill	17048-IDP-07-05
Volume 8	Transport and Traffic Signalization Project	17048-IDP-08
Volume 9	Project of External Arrangement - Protective Green Belt, landscaping, fence	17048-IDP-09
Study	Fire Protection Study - Landfill complex ''Vinča''	P-21/19
Study	Fire Protection Study - Torch System	30/18-02-IDP-E

Book (Volume)	Volume	Ident. No.
	DELTA INŽENJERING DOO, BELGRADE 2019.	
0	Main volume, Treatment of leachate waters	31/18-01-E-0.1
2/1.1	Construction Project	31/18-01-IDP-2/1.1
3/1	Hydrotechnical Installation Project	31/18-01-IDP-3/1
4/1.1	Electricity Installations Project	31/18-01-IDP-4/1.1

4/2	Management, Measurement and Regulation Project	31/18-01-IDP-4/2
6/1.1	Mechanical Installations and Equipment Project	31/18-01-IDP-6/1.1
7/1	Technology Project	31/18-01-IDP-7/1
	HIDROZAVOD DTD, NOVI SAD, 2018.	
PZI	Project of Landfill Landslide Remediation and Stabilization of part of the Landfill ’’Vinča’’	
0	Main volume	E – 116/17-4
1	Supporting Structure Project	E – 116/17-4
2	Construction Project	E – 116/17-4
3	Hydrotechnical Installation Project	E – 116/17-4
10	Preparatory Works Project	E – 116/17-4

Legal acts

- "EPS Distribucija" Belgrade/Center, ROP-MSGI-5396-LOC-1-HPAP-7/2019, dated 8 April 2019.
- JSC "Elektromreža Srbije", ROP-MSGI-5396-LOC-1-HPAP-6/2019, dated 29 March 2019.
- PUC "Belgrade Waterworks and Sewerage" - Waterworks, ROP-MSGI-5396-LOC-1-HPAP-8/2019, dated 28 March 2019.
- PUC "Belgrade Waterworks and Sewerage" - Sewerage, ROP-MSGI-5396-LOC-1-HPAP-9/2019, dated 28 March 2019.
- PUC "Belgrade Waterworks and Sewerage" - protection of water sources, ROP-MSGI-5396-LOC-1-HPAP-10/2019, dated 28 March 2019.
- JSC "Telekom Srbija", ROP-MSGI-5396-LOC-1-HPAP-2/2019, dated 1 April 2019.
- PUC "Gradska čistoća", ROP-MSGI-5396-LOC-7-HPAP-11/2019, dated 26 March 2019.
- Belgrade City Institute for the Protection of Cultural Monuments, ROP-MSGI-5396-LOC-1-HPAP-17/2019, dated 29 March 2019.
- Institute for Nature Conservation of Serbia, ROP-MSGI-5396-LOC-1-HPAP-16/2019, dated 5 April 2019.
- MoI Belgrade, Emergency Management Sector, Emergency Management Directorate in Belgrade, ROP-MSGI-5396-LOCH-2-HPAP-1/2019, dated 12 April 2019.
- MoI Belgrade, Emergency Management Sector, Emergency Management Directorate in Belgrade, ROP-MSGI-5396-LOCH-2-HPAP-2/2019, dated 12 April 2019.
- Belgrade Secretariat for Environmental Protection, ROP-MSGI-5396-LOC-1-HPAP-5/2019, dated 27 March 2019.

- Ministry of Defence of Serbia, ROP-MSGI-5396-LOC-1-HPAP-15/2019, dated 26 March 2019.
- Civil Aviation Directorate of the Republic of Serbia, ROP-MSGI-5396-LOC-1-HPAP-14/2019, dated 27 March 2019 and ROP-MSGI-5396-LOC-1-HPAP-14/2019, dated 27 March 2019.
- Civil Aviation Directorate of the Republic of Serbia, ROP-MSGI-5396-LOC-1-HPAP-14/2019, dated 27 March 2019 and ROP-MSGI-5396-LOC-1-HPAP-19/2019, dated 27 March 2019.
- Ministry of Agriculture, Forestry and Water Management - Republic Water Directorate, ROP-MSGI-5396-LOC-1-HPAP-3/2019 of 25 March 2019.
- Ministry of Agriculture, Forestry and Water Management - Republic Water Directorate, ROP-MSGI-5396-LOC-1-HPAP-21/2019, dated 3 April 2019.
- Ministry of Health, Sector for Sanitary Control, Department of

APPENDICES

are given under Volume 2 - Legal acts and drafts, September 2019, and form an integral part of the Study