Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica - zahod in 34 Cesta Andreja Bitenca - Podutiška - 1.faza

VRSTA PROJEKTNE DOKUMENTACIJE	**PZR - projektna dokumentacija za razpis** **2/2 Načrt padavinske kanalizacije**
VRSTA GRADNJE	**Rekonstrukcija**
ŠTEVILKA PROJEKTA	**9237**
ŠTEVILKA NAČRTA	**9237/2_2**
INVESTITOR	**Mestna občina Ljubljana** Mestni trg 1000 Ljubljana
PROJEKTANT	**LUZ, d.d.** Verovškova ulica 64 1000 Ljubljana
GLAVNI IZVRŠNI DIREKTOR	**dr. Jure Zavrtanik** univ. dipl. inž. arh.
PODPIS IN ŽIG	
DATUM	**julij 2026**

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Slovenija

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KAZALO VSEBINE NAČRTA

SPLOŠNI DEL		
S/1	**KAZALO VSEBINE NAČRTA**	
S/2	**NASLOVNA STRAN NAČRTA** VSE VSEBINE SO ZAJETE V PRILOŽENI PRILOGI 1C PRAVILNIKA	
S/3	**IZJAVA PROJEKTANTA NAČRTA IN POOBLAŠČENEGA STROKOVNJAKA, KI JE IZDELAL NAČRT V PZI IN PID** VSE VSEBINE SO ZAJETE V PRILOŽENI PRILOGI 2C PRAVILNIKA	
TEHNIČNI DEL		
T/1	**KAZALO TEHNIČNEGA POROČILA**	
T/2	**TEHNIČNO POROČILO**	
T/3	**ZAKOLIČBA**	
T/4	**HIDRAVLIČNI IZRAČUN**	
T/5	**STATIČNI IZRAČUNI**	
GRAFIČNI DEL		
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104.1	Zbirna karta komunalnih naprav	1:500
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PRILOGA 1C

NASLOVNA STRAN NAČRTA

2/2 Načrt padavinske kanalizacije

PODATKI O GRADNJI		
naziv gradnje		**Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica - zahod in 34 Cesta Andreja Bitenca - Podutiška (del)**
kratek opis gradnje		**Na območju OPPN 191 Podutik Kamna Gorica – zahod in Cesta Andreja Bitenca – Podutiška (del) je predvidena nova cestna povezava med Pilonovo ulico in Cesto Andreja Bitenca. Projekt obsega izgradnjo dvosmerne ceste z avtobusnima postajališčema, površinami za pešce in kolesarje, zelenicami ter krajinsko ureditvijo, hkrati pa tudi rekonstrukcijo Pilonove ulice. Predvidena je izgradnja pripadajoče gospodarske javne infrastrukture (kanalizacija, vodovod, javna razsvetljava in telekomunikacijski vodi). V 1. fazi bodo izvedeni omilitveni ukrepi za zaledne vode ter padavinska kanalizacija na Pilonovi ulici in Cesti Andreja Bitenca.**
VRSTE GRADNJE	☑	**NOVOGRADNJA - NOVOZGRAJEN OBJEKT**
označiti vse ustrezne vrste gradnje	☐	**NOVOGRADNJA - PRIZIDAVA**
	☑	**REKONSTRUKCIJA**
	☐	**SPREMEMBA NAMEMBNOSTI**
	☐	**ODSTRANITEV CELOTNEGA OBJEKTA**
	☐	**LEGALIZACIJA**
	☐	**MANJŠA REKONSTRUKCIJA**
PODATKI O PROJEKTNI DOKUMENTACIJI		
vrsta dokumentacije		**PZR (projektna dokumentacija za razpis)**
številka projekta		**9237**
PODATKI O NAČRTU		
strokovno področje načrta		**2 Načrt s področja gradbeništva**
naziv načrta		**2/2 Načrt padavinske kanalizacije**
številka načrta		**9237/2_2**
datum izdelave		**julij 2026**
datum spremembe		
PODATKI O PROJEKTANTU NAČRTA		
projektant načrta (naziv družbe)		**Ljubljanski urbanistični zavod d.d.**
naslov		**Verovškova ulica 64, 1000 Ljubljana**
odgovorna oseba projektanta načrta		**dr. Jure Zavrtanik, univ.dipl.inž.arh.**
podpis odgovorne osebe projektanta načrta		
PODATKI O IZDELOVALCU NAČRTA		
ime in priimek pooblaščenega arhitekta, pooblaščenega inženirja		**Uroš Maršič, univ.dipl.inž.grad.**
identifikacijska številka		**G-3272**
podpis pooblaščenega arhitekta, pooblaščenega inženirja		

PRILOGA 2C

IZJAVA PROJEKTANTA NAČRTA IN POOBLAŠČENEGA STOKOVNJAKA, KI JE IZDELAL NAČRT V PZI IN PID

PROJEKTANT NAČRTA	
projektant načrta (naziv družbe)	**Ljubljanski urbanistični zavod d.d.**
naslov	**Verovškova ulica 64, 1000 Ljubljana**
odgovorna oseba projektanta načrta	**dr. Jure Zavrtanik, univ.dipl.inž.arh.**

IN POOBLAŠČENI STROKOVNJAK, KI JE IZDELAL NAČRT	
pooblaščeni strokovnjak	**Uroš Maršič, univ.dipl.inž.grad.**

IZJAVLJAVA:

da načrt

vrsta dokumentacije	**PZR (projektna dokumentacija za razpis)**
strokovno področje načrta	**2 Načrt s področja gradbeništva**
naziv načrta	**2/2 Načrt padavinske kanalizacije**
številka načrta	**9237/2_2**
datum izdelave	**julij 2026**

upošteva relevantne predpise in druge normativne dokumente ter da so upoštevane ustrezne bistvene in druge zahteve.

pooblaščeni strokovnjak	**Uroš Maršič, univ.dipl.inž.grad.**
identifikacijska številka	**G-3272**
podpis pooblaščenega strokovnjaka	
odgovorna oseba projektanta načrta	**dr. Jure Zavrtanik, univ.dipl.inž.arh.**
podpis odgovorne osebe projektanta načrta	

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ZBIRNO TEHNIČNO POROČILO

1. SPLOŠNO

1.1 PREDMET PROJEKTA

Na vzhodnem območju OPPN 191 Podutik Kamna Gorica – zahod in Cesta Andreja Bitenca – Podutiška (del) je predvidena nova cestna povezava v smeri sever – jug. Gre za povezavo med Pilonovo ulico na jugu in Cesto Andreja Bitenca na severu območja. V sklopu projekta je izdelana idejna rešitev za dvosmerno cesto z avtobusnima postajališčema, površinami za kolesarje in pešce ter vmesnimi zelenicami. Predvidena je tudi krajinska ureditev območja. V sklopu projekta se posodobi tudi Pilonova ulica. Poleg prometnih površin se za območje OPPN zgradi tudi ostala komunalna in gospodarska javna infrastruktura; to je kanalizacija za odpadno padavinsko vodo, kanalizacija za komunalno odpadno vodo, vodovod, javna razsvetljava ter telekomunikacijski vodi v območju OPPN 191.

Načrtovana javna gospodarska infrastruktura omogoča priključevanje načrtovanih objektov v prostorskih enotah PE1, PE2 in za objekta H9 ter H10, ki so predvideni v skladu z veljavnim OPPN 191 Kamna Gorica - zahod in Cesta Andreja Bitenca – Podutiška.

V 1 fazi se bo urejali omilitveni ukrepi zalednih voda, ter padavinski kanali po Pilonovi ulici.

1.2 ZAKONSKE PODLOGE IN IZHODIŠČA

V območju predvidenim za gradnjo je bila izdelana naslednja projektna dokumentacija:

- projektna naloga Ureditev cest in javnih površin v OPPN 191, št: 371-570/2023-1 iz dne 17. 5. 2023 ki ga je izdelala Mestna občina Ljubljana, oddelek za gospodarske dejavnosti in promet
- projektna naloga št. 2632 V Izgradnja javnega vodovoda in kanalizacije zaradi gradnje objektov ob Cesti Andreja Bitenca (enote urejanja prostora DR-492 in del DR-494, januar 2013
- projektna naloga št. 3297 K, Izgradnja javnega vodovoda in kanalizacije zaradi gradnje objektov ob Cesti Andreja Bitenca (enote urejanja prostora DR-492 in del DR-494), ki jo je januarja 2013 izdelalo podjetje JP Vodovod – Kanalizacija, d.o.o
- projekt Cesta C2 (podaljšek ceste Pod Kamno Gorico) v območju OPPN 191 Podutik – Kamna Gorica – zahod, LUZ d.d., št.proj. 9125
- projekt Večstanovanjski objekti na območju PE2 – faza B in C, OPPN 191 Podutik Kamna Gorica – zahod, STIRIA ARHITEKTURA d.o.o., št. proj. 2023/06, september 2023
- zbirni kataster komunalnih vodov, LUZ d.d., marec 2024
- DPP Cesta C2 (Podaljšek ceste Pod Kamno Gorico) v območju OPPN 191 Podutik – Kamna Gorica – zahod.
- Idejna zasnova telekomunikacijskega kabelskega omrežja št. 07112034, ki jo je v januarju 2013 izdelalo podjetje Dekatel, d.o.o
- Idejni projekt javne razsvetljave št. 11-30-2319/2389, ki ga je v januarju 2013 izdelalo podjetje JRS, d.d

- Gradbeni zakon – GZ-1 (Uradni list RS, št. 199/21, 105/22 – ZZNŠPP, 133/23, 85/24 – ZAID-A, 47/25 – odl. US in 75/25)

- Zakon o prostorskem načrtovanju – ZPNačrt (Uradni list RS, št. 33/07; Spremembe: 70/2008-ZVO-1B, 108/2009, 80/2010-ZUPUDPP (106/2010 popr.), 43/2011-ZKZ-C, 57/2012, 57/2012-ZUPUDPP-A)
- Zakon o urejanju prostora - ZUreP-3 (Uradni list RS, št. 199/21, 18/23 – ZDU-1O, 78/23 – ZUNPEOVE, 95/23 – ZIUOPZP, 23/24, 109/24, 25/25 – odl. US in 75/25)
- Zakon o varstvu okolja – ZVO-1 (Uradni list RS, št. 39/06 – uradno prečiščeno besedilo, 49/06 – ZMetD, 66/06 – odl. US, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPNačrt-A, 48/12, 57/12, 92/13, 56/15, 102/15, 30/16, 61/17 – GZ, 21/18 – ZNOrg, 84/18 – ZIURKOE, 158/20 in 44/22 – ZVO-2)
- Zakon o graditvi objektov – ZGO-1 (Uradni list RS, št. 102/04 – uradno prečiščeno besedilo, 14/05 – popr., 92/05 – ZJC-B, 93/05 – ZVMS, 111/05 – odl. US, 126/07, 108/09, 61/10 – ZRud-1, 20/11 – odl. US, 57/12, 101/13 – ZDavNepr, 110/13, 22/14 – odl. US, 19/15, 61/17 – GZ in 66/17 – odl. US)
- Zakon o cestah – ZCes-2 (Uradni list RS, št. 132/22, 140/22 – ZSDH-1A, 29/23 in 78/23 – ZUNPEOVE)
- Zakon o vodah - ZV-1 (Uradni list RS, št. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15, 65/20, 35/23 – odl. US, 78/23 – ZUNPEOVE in 52/24 – odl. US)
- Pravilnik o pogojih za graditev gradbenih ali drugih objektov, saditev drevja ter postavljanja naprav v varovalnem progovnem pasu in v varovalnem pasu ob industrijskem tiru (Uradni list SRS, št. 2/87, Uradni list RS, št. 85/00 – ZVZP, 61/07 – ZVZelP in 30/18 – ZVZelP-1)
- Pravilnik o projektni in drugi dokumentaciji ter obrazcih pri graditvi objektov (Uradni list RS, št. 30/23)
- Uredba o odvajanju in čiščenju komunalne odpadne vode (Uradni list RS, št. 98/15, 76/17, 81/19, 194/21, 44/22 – ZVO-2, 21/25 – ZOPVOOV in 113/25)
- Direktiva evropskega parlamenta in sveta o čiščenju komunalne odpadne vode (prenovitev) (2022/0345(COD)LEX 2408)
- Splošni in posebni tehnični pogoji
- Pri izdelavi projekta so bila upoštevana tehnična navodila za kanalizacijo (JP Vodovod – kanalizacija d.o.o., Ljubljana, EAD-116244).
- Zakonski in podzakonski predpisi, ki bodo sprejeti v času izdelave te dokumentacije.

2. OPIS OBSTOJEČEGA STANJA

2.1 KANALIZACIJSKO OMREŽJE

V Cesti Andreja Bitenca poteka odpadni kanal GRP DN 250 s padcem v smeri proti zahodu. Padavinska voda ulice se zbira v odvodniku GRP DN 1000 pri objektu Cesta Andreja Bitenca 111. Na odvodnik se iz vzhodne strani navezuje GRP DN 600 in z zahodne strani GRP DN 700, ki zbira padavinsko vodo vključujoč Ulico Nade Čamernikove. Iztok iz odvodnika DN 1000 je speljan v potok Purkovec. V nadaljevanju Ceste Andreja Bitenca poteka padavinski kanal DN 300, ki v križišču s Pilonovo zavije vzdolž le-te. Dimenzija cevi se poveča na DN 800. V križišču z ulico Pod Kamno Gorico se naveže na iztok iz potoka Purkovec iz betonske cevi DN 700. Vzdolž ulice Pod Kamno Gorico nadaljuje potek GRP DN 1000. Vzdolž Pilonove poteka odpadni kanal DN 250, ki se v križišču z ulico Pod Kamno Gorico naveže na GRP DN 250, ki poteka preko privatnih zemljišč v trasi bodoče ceste. Trasa nadaljuje potek v ulici Pod Kamno Gorico.

2.2 OSTALA KOMUNALNA INFRASTRUKTURA

V Cesti Andreja Bitenca in Pilonovi ulici poteka še elektroenergetsko, plinovodno telekomunikacijsko omrežje in javna razsvetljava.

3. OPIS PREDVIDENEGA POSEGA

3.1 PADAVINSKA KANALIZACIJA

Površinsko odvodnjavanje cest se vrši preko prečnega sklona vozišča v smeri proti talnim požiralnikom, ki so priklopljeni na sistem meteorne kanalizacije. Skladno z Uredbo o emisiji snovi pri odvajanju padavinske vode z javnih cest (Uradni list RS, št. 47/05) ni potrebno odpadne meteorne vode z vozišča cest predhodno očistiti z uporabo lovilcev olj, ker prometni tok ne presega mejno vrednost iz 1. alineje 1.odstavka 4. člena Uredbe, t.j. 12.000 EOV/dan.

Za komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca in s tem vezano padavinsko odvajanje je sistem padavinske odvodnje sestavljen iz naslednjih kanalov:

- MK1, ki bo potekal v novi cesti na vzhodni strani območja in se bo navezoval na obstoječ jašek v križišču Pilonove ulice in ulice Pod Kamno gorico – ni predmet 1 faze
- MK2 ki je obstoječ kanal in se bo rekonstruiral. Potekal bo v isti trasi s večjim profilom 800 mm od revizijskega jaška RJ8 MK2
- MK2.1 ki se bo navezal na obstoječ rekonstruiran kanal MK2, potekal bo pa s ulice Andreja Bitenca in se preusmeril na Pilonovo ulico
- MK3, ki bo povezava retenzije v območju OPPN 191 in kanalizacijski sistem

- Kanal K MK je obstoječ kanal, ki se izteka v retenziji Glinščice na križišču Podutiške ceste in ulice Pod Kamno gorico

Hidravlične podatke smo dobili, z upoštevanjem projektne naloge VOKE – 3297 K Izgradnja javne kanalizacije zaradi gradnje objektov ob Cesti Andreja Bitenca – urejanje prostora DR-492 in del DR-494) in Hidrološko hidravlična analiza za gradnjo Večstanovajskih objektov Glince/Podutik v Ljubljani PE1 in PE2, OPPN 191. Za povratno dobo smo upoštevali 10 letno povratno dobo, trajanja 15 minut kar znaša 266 l/s/ha.

Preverili smo, če bi projektiran kanalizacijski sistem prevajal celotno količino zalednih vod (10 letne povratne dobe) s dovodom 200 l/s (v situaciji prispevnih površin označena kot PP1) v kanal MK2.1 v revizijskem jašku RJ5MK2.1 in dovod 620 l/s (v grafiki situacije prispevnih površin označena kot PP2) s retenzije po kanalu MK3 v obstoječ sistem, ki se konča v retenziji Glinščice na križišču Podutiške ceste in ulice Pod Kamno gorico.

V tej projektni dokumentaciji sta obdelana kanala MK2 in MK3. Ostali kanali bodo predmet drugih načrtov.

3.2 OPIS TRAS PREDVIDENIH KANALOV

3.2.1 KANAL MK2

Projektirana trasa kanala MK2 se začne na severni strani Pilonove ulice v revizijskem jašku R15 MK2, v katerega se steka kanal Mk2.1. Trasa kanala poteka v cestišču proti jugu, kjer se v revizijskem jašku PRJ13 K Mk priključi na obstoječ kanal.

Trasa projektiranega kanala (DN800-1000) poteka v cestnem telesu v skupni dolžini 345 m s padcem 5-18‰.

3.2.2 KANAL MK3

Projektirana trasa.MK3 se začne v revizijskem jašku RJ2MK3, ki je iztok s padavinskega zadrževalnika na območju OPPN 191 in se steka v obstoječo kanalizacijo.

Trasa projektiranega kanala MK3 (DN1000) poteka v v skupni dolžini 26 m s padcem 28‰.

3.2.3 PRIKLJUČKI INTERNE KANALIZACIJE

Hišni priključki niso del tega projekta.

4. TEHNIČNA IZVEDBA

4.1 PRIČETEK GRADNJE

Pred začetkom dela na gradbišču mora naročnik ali nadzornik projekta zagotoviti izdelavo varnostnega načrta.

Pred pričetkom gradnje je potrebno zavarovati gradbišče z ustreznimi zaščitnimi ograjami, signalizacijo in ostalim, kot je navedeno v predpisih o varstvu pri gradbenem delu. Zavarovanje je postaviti na mestih, kjer pričakujemo promet pešcev, kolesarjev, motornih vozil ter vozil z vprego.

Sočasno z zakoličbo projektiranega kanala je obvezno zakoličiti trase ostalih komunalnih vodov, ki tangirajo traso proj. kanala. Zakoličbo je potrebno izvajati v prisotnosti upravljalcev posameznih kom. vodov in upravljalca ceste. O zakoličbi je potrebno voditi zapisnik. V zapisniku je navesti tudi ime odgovorne osebe, ki bo dolžna vršiti nadzor varovanja komunalnih instalacij v času gradnje.

Pri projektiranju smo upoštevali obstoječ teren z vzpostavitvijo v prvotno stanje.

4.2 IZKOPI

Izkop mora potekati pod nadzorom strokovne osebe. Izkop se bo izvajal delno strojno delno ročno neposredno ob obstoječih jaških. Globina izkopa bo od 0,63 m do 3,76m. Po strojnem in ročnem izkopu jarka je potrebno dno enakomerno splanirati v projektiranem padcu z odstranitvijo grobih ostrih kamnov. Dno jarka je širine 0.80 - 1,20 m. (bruto DN cevi + 100 cm). Na tako pripravljeno dno se izdela nasip za izravnavo podlage v deb. 10 cm iz peščenega materiala gr. 8-16 mm ter utrdi do 95 % trdnosti po standardnem Proktorjevem postopku. Na nasip za izravnavo se izvede 3-5 cm debel nasip za poravnavo tal v katerega si cev izdela ležišče. Obsip cevi se nato izvaja v plasteh po 15-20 cm, na obeh straneh hkrati. Paziti je potrebno, da se cev ne premakne iz ležišča. Kot nasipni in obsipni material se uporabi peščeni material gr. 0.02-16 mm. Višina nasipa je 30 cm nad temenom cevi. Utrjuje se do 95% trdnosti po standardnem Proktorjevem postopku.

Po končanih delih je potrebno okolico gradbišča očistiti.

Projektirani kanali bodo iz cevi iz umetne mase, premera DN 250 mm.

Pred pričetkom gradnje kanalizacije morajo upravljavci ostalih že izvedenih internih komunalnih vodov trase le-teh označiti in sodelovati pri izkopih na mestih prečkanj.

Pri izvajanju gradbenih in montažnih del je potrebno upoštevati “Splošna navodila za izvajanje gradnje in tehnično izvedbo cevovodov ter spremljajočih objektov” ter navodila proizvajalcev opreme in obstoječo gradbeno zakonodajo.

4.3 STATIČNI IZRAČUN

Statični izračun nosilnosti cevi je v prilogi.

4.4 IZBIRA MATERIALA

Projektant predlaga vgradnjo (GRP) poliestrskih cevi togosti SN 10000, nazivnega tlaka PN 1, lahko pa se uporabijo tudi druge cevi, ki morajo ustrezati standardu SIST EN 14364:2013, za katere je potreben dokaz deformacij. Cev mora imeti notranji zaščitni sloj cevi iz poliestra, s ciljem doseganja kontrole tesnosti, kemijske in abrazijske odpornosti ter odpornosti na obrus pri visokotlačnem čiščenju.

Poliestrske cevi imajo veliko možnost improvizacije na terenu, ter pestro paleto fazonskih kosov zaradi česar odpadejo veliki združitveni objekti, ki so dragi in zamudni za izvedbo. Prav tako omogočajo kvalitetno naknadno vgradnjo hišnih priključkov. Poleg tega so iz poliestra predvideni tudi revizijski jaški, kar pomeni, da bo pri gradnji na gradbišču en sam material, ter s tem možnost težav manjša (dobava, prehodi med materiali,...).

Vgradnja cevi se izvaja po navodilih proizvajalca cevi. Če se bodo vgrajevale druge vrste cevi morajo ustrezati standardu SIST EN 14364:2013, ter imeti podobne karakteristike kot predvidene (vodotesnost, propustnost, hrapavost, nosilnost).

4.5 TLAČNI PREIZKUS

Tlačni preizkus je potrebno izvesti v skladu z zahtevami standarda EN 1610.

4.6 REVIZIJSKI JAŠKI

Revizijski jaški so iz poliestra Ø 1000 mm in 1200 mm, z minimalno debelino stene 9 mm, prekriti z reducirnim kosom DN 1000/800 mm na katerega se položi AB venec s pokrovom. Temelj jaška je betoniran na mestu z betonom C16/20, debelina plošče je 20 cm. Na temelj se postavi jašek iz poliestra, okrog jaška se izvede AB venec iz C16/20. Dno je izoblikovano iz poliestra, v obliki koritnice, ki usmerja odtok odpadne vode.

Pokrov jaška iz LTŽ Ø 600 mm; EN 124 D 400, z ventilacijskimi odprtinami, protihrupnim vložkom in zaklepom je vgrajen v armiranobetonski venec. Pokrov jaška na voznih površinah ne sme biti temeljen na obodno steno jaška, ampak na utrjeno gramozno nasutje ob jašku.

5. HIDRAVLIKA IN DIMENZIONIRANJE

5.1 PADAVINE

Za odvajanje padavinske vode s cestišča smo izbrali referenčno padavino povratne dobe 10 let trajanja 15 min s projekta CROSSRISK, za območje Ljubljane :

Trajanje (min)	5-letne	10-letne	25-letne	50-letne	100-letne	250-letne
5	400	467	567	633	667	767
10	283	333	400	450	500	583
15	233	267	322	367	411	478
20	192	233	275	317	358	417
30	156	183	222	250	283	333
45	122	141	174	196	222	263
60	100	119	144	164	186	219
90	78	93	111	128	144	170
120	64	76	92	106	119	140
180	50	58	70	81	91	106
240	41	49	58	66	74	88
300	36	42	50	57	64	74
360	32	37	44	50	56	65
540	24	28	33	37	42	48
720	20	23	27	30	34	38
900	17	19	23	25	28	32

1080	15	17	20	22	24	28
1440	12	13	16	17	19	22
2880	7	8	9	10	11	12
4320	5	6	6	7	8	9
5760	4	4	5	6	6	7
7200	3	4	4	5	5	6

Za polnost kanalov smo izbrali da je max polnitev 70 %.

Hidravlični izračun je dodan v prilogi.

5.2 HIDROLOŠKO HIDRAVLIČNA ŠTUDIJA – POVZETEK

Dotok z zalednih vod na izbrane kanale smo upoštevali hidrološko-hidravlične študije (HHŠ) št. IV-123/23, IZVO-VODAR d.o.o., dopolnitev april 2024,

Hidravlična obravnava sistema je izvedena na dveh ravneh:

- Kapacitivni izračuni posameznih odsekov obstoječih in načrtovanih meteornih kanalov – izvedeni na osnovi Colebrook-White-ove enačbe, primerjalno preverjeni tudi z Manningovo enačbo, za polno polnitev cevi pri merodajnem (najmanjšem) vzdolžnem padcu posameznega odseka.
- Celovito hidravlično modeliranje vodotoka Purkovec z obema pritokoma in poplavnih površin, izvedeno s programskim orodjem MIKE FLOOD (Danish Hydraulic Institute), ki s sklopitvijo modulov MIKE 11 (1D tok v strugi) in MIKE 21 (2D površinski tok) omogoča simulacijo izmenjave vode med strugo in poplavnim zaledjem v obe smeri.

Za modeliranje je uporabljeno območje velikosti približno 840 m × 1.380 m (od povirja Purkovca do zadrževalnika na Glinščici nad Podutiško cesto), diskretizirano z računsko mrežo celic 1 × 1 m, kar zagotavlja, da robni pogoj dolvodno ne vpliva na rezultate znotraj obravnavanega območja OPPN.

Manningovi koeficienti hrapavosti so bili privzeti glede na rabo tal: struga Purkovca in pritokov ng = 0,04 (določeno na podlagi terenskega ogleda), travniške površine ng = 0,07, gozd ng = 0,10, utrjene površine ng = 0,05.

Za izdelavo digitalnega modela terena so bili uporabljeni državni LIDAR podatki (ARSO, 2015), geodetski načrt GEOSVET (2019), geodetski načrt za uporabno dovoljenje kanalizacije na Cesti Andreja Bitenca (Energetika Ljubljana, 2016) ter pregled stanja padavinske kanalizacije (JP VOKA SNAGA, oktober 2023).

Hidrološka izhodišča (konice visokih vod Q10, Q100 in Q500 ter pripadajoči hidrogrami) so povzeta po študiji IV-56/15-1 (IZVO-Vodar, 2015/2017), kjer so bili s hidrološkim modelom HEC-HMS 3.4 in sintetičnim enotskim hidrogramom po metodi SCS izračunani pretoki ob predpostavki, da N-letne padavine povzročijo N-letni odtok.

Hidrološki prerez vodotoka	F (km^2)	Q500 (m^3/s)	Q100 (m^3/s)	Q10 (m^3/s)
Purkovec – zahodni pritok	0,05	0,75	0,49	0,20
Purkovec – srednji krak	0,11	1,15	0,78	0,31
Purkovec – vzhodni pritok	0,05	0,58	0,39	0,16
Purkovec med CAB in Pilonovo ul.	0,05	0,58	0,39	0,16
Skupaj na vtoku v kanalizirani odsek		**3,06**	**2,05**	**0,83**

Preglednica 1: Visoke vode potokov s Purkovca s povratno dobo 10, 100 in 500 let (vir: IV-56/15-1)

5.2.1 HIDRAVLIČNA PREVODNOST OBSTOJEČIH METEORNIH KANALOV

Prevodna sposobnost obstoječih odsekov meteorne kanalizacije je bila ocenjena za polno polnitev cevi pri merodajnem (najmanjšem) padcu posameznega odseka. Rezultati so povzeti v preglednici 2.

Lokacija / odsek	DN (mm)	i min. (‰)	Q Colebrook (l/s)	Q Manning (l/s)	Opomba
Burnikova ul., GRP 400 (RJ1–RJ2)	400	10,5	185	166	≈ Q10; presežek Q100 odteka površinsko/skozi požiralnike
Pilonova ul. zgoraj, GRP 300 (RJ15–RJ20)	300	4,0	56	48	prevaja Q100 faze A obstoječega stanja (47 l/s)
Pilonova ul. spodaj, GRP 800 (RJ6–RJ15)	800	2,0	532	460	
Iztok Purkovca, DN 700 (pri RJ 6)	700	20–45*	1.200–1.700	–	*razpon glede na negotov padec (2 %–4,5 %)
Pod Kamno Gorico, GRP 1000 (RJ4–RJ5)	1000	6,5	1.732	1.505	prevaja tudi Q100 s pomočjo nadpritiska v jaških
Klemenčičeva ul., GRP 1000 (RJ1–RJ4)	1000	12,0	2.355	2.045	

Lokacija / odsek	DN (mm)	i min. (‰)	Q Colebrook (l/s)	Q Manning (l/s)	Opomba
Dolvodno od Klemenčičeve, B DN 1100	1100	5,8	2.104	1.833	pri dejanskem padcu 1,61 % do ≈3.500 l/s
Dolvodno, B DN 1400 (iztok v zadrževalnik na Glinščici)	1400	3,5	3.087	2.708	pri dejanskem padcu 0,61 % do ≈4.000 l/s

Preglednica 2: Ocenjena pretočna sposobnost ključnih odsekov obstoječe meteorne kanalizacije (Colebrook-White in Manning, polna polnitev, merodajni padec)

5.2.2 OBSTOJEČE STANJE

Pri pretokih Q10 celotna količina padavinske vode odteka po meteorni kanalizaciji brez površinskega razlivanja. Pri Q100 del visokih vod pri vseh treh potokih odteka razpršeno površinsko: na območje PE1 doteka pretok približno 0,25 m^3/s z globinami 2–5 cm, na območje PE2 pa 0,33 m^3/s (0,16 m^3/s zahodno in 0,17 m^3/s vzhodno od Purkovca) z globinami 2–8 cm. Pri Q500 se pretoki povečajo na 0,60 m^3/s (globine do 10 cm) na PE1 in 0,94 m^3/s (globine do 15 cm) na PE2. Ker hitrosti tekoče vode na celotnem območju ne presegajo 1 m/s, karta poplavne nevarnosti (produkt globina × hitrost) ni izdelana; prisotna sta le razreda male in preostale poplavne nevarnosti.

Načrtovano stanje in omilitveni ukrepi

V model načrtovanega stanja so vključeni vsi predvideni posegi (objekti PE1–Faza A, PE2–Faza B in C, PE3, cesta C2, prestavljen in reguliran potok Purkovec) ter naslednji omilitveni ukrepi, namenjeni preprečitvi dotoka visokih vod na območje objektov:

- nov meteorni kanal DN 800 med RJ 1 in RJ 15 (Pilonova ulica / cesta C2), zgrajen v okviru rekonstrukcije;
- OM1 – kanaleta 200/335 mm, dolžine 50 m, neto prereza 3,66 m^2, skupne požiralnosti ≥ 0,50 m^3/s (Q500), z iztokom v novi kanal DN 800;
- OM1a – kombinacija kanalete 200/335 mm in travne mulde, z iztokom v kanal DN 600 in naprej v M1 DN 800 (RJ15);
- OM1b – kanaleta 200/400 mm, dolžine 5 m, neto prereza 0,71 m^2, na Burnikovi ulici, z iztokom v DN 800 na CAB;
- OM2 – kanaleta 300/545 mm, dolžine 33 m, neto prereza 3,80 m^2, požiralnosti ≥ 0,50 m^3/s (Q500), z iztokom v dodatni odvodnik v obstoječo kanalizacijo DN 1000;
- OM2a – kanaleta 200/400 mm, dolžine 5 m, neto prereza 0,71 m^2, na Ulici Nade Čamernik;
- OM3 – kanaleta 200/335 mm, dolžine 104 m, neto prereza 7,61 m^2, požiralnosti ≥ 0,50 m^3/s (Q500), z iztokom v obstoječo kanalizacijo DN 1000;
- zaščita kletnih uvozov na Pilonovi ulici (PE1) z grbino (kota 320,35 m n. m.), linijskimi rešetkami in protipoplavno zaščito višine 1 m; na PE2 in cesti C2/1 z grbino in linijskimi rešetkami;

- zamenjava iztočne cevi Purkovca iz Ø700 mm v Ø1000 mm, skupaj z ureditvijo struge (povprečna širina dna 0,6 m, na razširitvah do 3,0 m, povprečni naklon brežin 1:2);
- zadrževalniki padavinske vode za posamezne faze gradnje (obravnavani v poglavju 4).

Z upoštevanjem navedenih ukrepov omilitveni sistem pri Q100 v celoti prepreči dotok visokih vod na območje načrtovanih in obstoječih objektov OPPN 191. Pri Q500 so ogroženi le objekti H2, H3/1-H3/2 in H4/1-H4/2 (za katere se predvidevajo individualni omilitveni ukrepi v okviru pogojev DRSV); preostalo območje ostaja brez poplavne nevarnosti.

Zaradi zamenjave iztočne cevi Purkovca (Ø700→Ø1000) se pretok po dolvodnem kanalu proti Glinščici poveča z 0,80 m^3/s (obstoječe stanje) na 1,44 m^3/s pri Q100 in 1,92 m^3/s pri Q500. Ta povečava je v primerjavi z visokimi vodami Glinščice (Q100 ≈ 15 m^3/s) zanemarljiva, sovpad konic pa ni pričakovan.

Visokovodni zadrževalnik na Purkovcu (celoviti omilitveni ukrep)

Na vplivnem območju OPPN 191 je v OPN MOL predviden suh zadrževalnik visokih vod na Purkovcu nad naseljem, idejno preverjen v študiji IV-56/15-2 (IZVO-Vodar, 2015) in podrobneje razdelan v "Zasnovi visokovodnega zadrževalnika na Purkovcu" (mag. Rok Fazarinc, april 2024). Predvidena je zemeljska pregrada s krono na koti 342,50 m n. m. in varnostnim prelivom na koti 341,50 m n. m. Talni (normalni) izpust je dimenzioniran s prerezom Ø40 cm, zaščiten z grabljami, usedalnikom peska in tablasto zapornico.

Prispevna površina Purkovca do prereza CAB (F = 0,11 km^2 = 11,05 ha) je za namen analize razdeljena na tri sklope:

Prerez	**Površina (ha)**	**Q10 (l/s)**	**Q100 (l/s)**	**Q500 (l/s)**
Do pregrade – gozdne površine (Ψ=0,2; tc=60 min)	7,20	118	290	440
Pod pregrado – poseljeno (Ψ=0,8; tc=45 min)	2,05	155	380	560
Pod pregrado – gozdne površine (Ψ=0,2; tc=45 min)	1,80	41	100	150
SKUPAJ	11,05	314	770	1.150

Preglednica 3: Delitev prispevnega območja Purkovca do CAB in pripadajoči pretoki

Zadrževalnik zmanjša pretok Purkovca v prerezu pregrade z Q100 = 0,29 m^3/s na Q100,r = 0,05 m^3/s in z Q500 = 0,44 m^3/s na Q500,r = 0,07 m^3/s. Ob upoštevanju iztoka iz zadrževalnika je za hidravlične izračune dolvodno od pregrade uporabljen naslednji seštevek:

- Q100 = 380 + 100 + 50 (iztok iz zadrževalnika) = 530 l/s = 0,53 m^3/s
- Q500 = 560 + 150 + 70 (iztok iz zadrževalnika) = 780 l/s = 0,78 m^3/s

Ob upoštevanju odvajanja dela visokih vod (približno Q10) po obnovljeni meteorni kanalizaciji hidravlični izračuni z upoštevanjem vpliva zadrževalnika pokažejo, da načrtovana kanalizacija v

celoti prevaja visoke vode Purkovca s povratno dobo 100 let. Zadrževalnik je zaveza MOL in DRSV ter pogoj za izdajo uporabnega dovoljenja za objekte Faze B in C; predstavlja dodatno raven varnosti k že zadostnim omilitvenim ukrepom, opisanim v poglavju 3.2, in izboljšuje poplavno varnost naselja severno od CAB.

5.2.3 DIMENZIONIRANJE ZADRŽEVANJA PADAVINSKE VODE PO FAZAH

S pozidavo in ureditvijo utrjenih površin se pospeši odtok padavinske vode v primerjavi z današnjim stanjem, ko del padavin ponika na travniških površinah. Potrebne prostornine zadrževanja so določene v hidrološkem poročilu »Hidrološko hidravlični elaborat za OPPN Kamna Gorica« (HEK, Doroteja Starec s.p., maj 2020), na podlagi primerjave hidrogramov Q100 za obstoječe in načrtovano stanje po posameznih prostorskih enotah.

Prostorska enota	Prispevna površina (m^2)	Q100 sedanje (m^3/s)	Q100 načrtovano (m^3/s)	Povečanje (m^3/s)
PE1 – Faza A	4.951	0,047	0,070	0,023
PE2 – Faza B	12.645	0,120	0,185	0,065
PE2 – Faza C	9.905	0,093	0,135	0,042
C2	5.217	0,050	0,084	0,034

Preglednica 4: Prispevne površine in pretoki Q100 za obstoječe in načrtovano stanje po prostorskih enotah

Prostorska enota	Prostornina vala – sedanje (m^3)	Prostornina vala – načrtovano (m^3)	Povečanje vala (m^3)	Potrebno zadrževanje (m^3)	Merodajno trajanje padavin
PE1 – Faza A	442,80	606,60	163,80	30,50	105 min
PE2 – Faza B	1.124,10	1.575,90	451,80	87,00	105 min
PE2 – Faza C	882,00	1.174,50	293,00	50,70	105 min
C2	461,70	686,70	225,00	49,00	105 min

Preglednica 5: Prostornine visokovodnih valov Q100 in potrebno zadrževanje padavinske vode po prostorskih enotah

Za vsako prostorsko enoto je torej treba zagotoviti zadrževalno prostornino v zgoraj navedenem obsegu, pri čemer je merodajno trajanje padavine (105 min) enako za vse obravnavane enote. Zadrževalniki padavinske vode morajo biti zgrajeni sočasno z gradnjo posamezne faze, saj šele skupaj z drugimi omilitvenimi ukrepi zagotavljajo, da se odtok iz OPPN 191 v dolvodno kanalizacijo ne poveča. Za posamezne objekte v PE3 je treba potrebno zadrževanje izračunati in izkazati v okviru ločenih HH elaboratov za vsak objekt, skladno s pogoji DRSV.

5.2.4 ZAKLJUČEK IN POGOJI ZA IZVEDBO

Hidravlični izračuni obstoječega stanja kažejo bistveno ugodnejše poplavne razmere od tistih, prikazanih v Atlasu voda (temelječih na razmerah pred letom 2015), kar je posledica že izvedenih izboljšav meteorne kanalizacije na Burnikovi ulici, CAB in Pilonovi ulici. Ob upoštevanju vseh opisanih omilitvenih ukrepov in dimenzioniranih zadrževalnikov padavinske vode so predvideni posegi v skladu s prilogama 1 in 2 Uredbe dopustni ob upoštevanju pogojev vodnega soglasja.

Za zagotovitev poplavne varnosti je treba pri izvedbi upoštevati naslednje pogoje:

- kote pritličij novih objektov je treba načrtovati dvignjene od terena za vsaj 30 cm;
- uvozi v podzemne garaže morajo biti izvedeni tako, da preprečujejo vdor padavinske vode (grbine, linijske rešetke, protipoplavna zaščita);
- zunanje površine ob objektih je treba urediti tako, da padavinska voda odteka proti Purkovcu oziroma v ustrezno izvedeno meteorno odvodnjo;
- dosledno je treba upoštevati faznost izvedbe: pred gradnjo posamezne faze morajo biti izvedeni pripadajoči omilitveni ukrepi (OM1/OM1a/OM1b za Fazo A; OM2/OM2a/OM3 za Fazo B) ter zadrževalniki padavinske vode za to fazo;
- pogoj za začetek uporabe naselja faz B in C je izgradnja celovitega ukrepa – suhega visokovodnega zadrževalnika na Purkovcu;
- obstoječo in načrtovano meteorno kanalizacijo, vključno s požiralniki in kinetami, je treba redno vzdrževati, saj so hidravlični izračuni izvedeni ob predpostavki brezhibnega delovanja in neovirane pretočnosti sistema.

Hitrosti poplavnih vod na obravnavanem območju ne presegajo 1 m/s, zato erozijska ogroženost ni izkazana in izris kart erozijske nevarnosti ni potreben.

Vir: Hidrološko-hidravlična študija št. IV-123/23, IZVO-VODAR d.o.o., Ljubljana, april 2023, dopolnitev april 2024 (Andraž Rojnik, univ. dipl. inž. vki); hidravlični izračuni padavinske kanalizacije, LUZ d.d.; »Zasnova visokovodnega zadrževalnika na Purkovcu«, mag. Rok Fazarinc, april 2024; »Hidrološko hidravlični elaborat za OPPN Kamna Gorica«, HEK, Doroteja Starec s.p., maj 2020.

6. IZVAJANJE GRADNJE IN TEHNIČNA IZVEDBA OBJEKTOV

6.1 SPLOŠNA DOLOČILA

Vsa zemeljska dela se izvajajo po načrtih in detajlih, določilih tehničnih predpisov in skladno z obveznimi standardi.

Pri delih na prometnih površinah mora biti izvajanje del v skladu s cestno-prometnimi predpisi in izdanimi soglasji.

Pred začetkom del je izvajalec dolžan popolnoma očistiti teren, odstraniti rastline in objekte ter ves material transportirati na deponijo.

Na tako očiščenem terenu, izvajalec skupaj s predstavniki investitorja posname vse višinske kote terena, zakoliči in zavaruje celotno traso cevovoda oziroma objekte, ki se gradijo. Vse kote in ostale podatke vpiše v gradbeno knjigo zaradi točnega obračuna zemeljskih del. Potrebno

razpiranje oziroma črpanje meteorne ali podtalne vode pri izkopih jarkov ali za objekte, je izvajalec del dolžan izvršiti na lastne stroške.

Pri vseh izkopih mora izvajalec del paziti, da poškoduje čim manj obdelovalnih površin in objektov, ker gre vsaka škoda, nastala iz naslova nestrokovnega in nesolidnega dela, ter po njegovi krivdi, na stroške izvajalca del.

Vsa zemeljska dela morajo biti izvršena pravilno in upoštevaje vse kote in detajle iz načrtov. Predno se dela nadaljujejo, morajo biti vsa zemeljska dela sprejeta in potrjena s strani nadzornega organa ter zaradi obračuna, vpisana v gradbeno knjigo. Obračun vseh zemeljskih del se izvrši po dejansko izvršeni količini.

6.1.1 IZKOPI

Vsi izkopi za objekte oziroma izkopi jarkov za polaganje cevovodov ali izkopi temeljev objekta morajo biti izvršeni pravilno po kotah in detajlih iz načrtov ter predpisanih padcev.

Izkopi pri objektih se vršijo po zunanjih merah temeljev in zidov, upoštevanje dodatno razširitev za 60 cm z vsake strani in naklon v odvisnosti od kategorije zemljišča ter načrta eventualnega razpiranja. Odstranitev vsipov in njihovega kasnejšega zasipavanja gre v breme izvajalca del.

Obračuni izkopov se vršijo 1 m^3 izkopanega materiala v raščenem stanju ne glede na kategorijo zemljišča.

6.1.2 PLANIRANJE TERENA IN JARKOV

Planiranje terena okoli objekta, kakor tudi dna jarkov za cevovode ali temeljev objekta, mora biti izvršeno do zahtevane točnosti po popisu del.

Planiranje in čiščenje terena po končani gradnji, zasipanje jam na gradbišču po odstranitvi vsega preostalega materiala, kakor tudi izkopa začasnih jam, se obračuna v zaključnih delih. Obračun se vrši po 1 m^2 planirane površine.

6.1.3 PEŠČENA POSTELJICA, ZASIPI JARKOV IN ZASIPI OB OBJEKTIH

Peščena posteljica, kakor vsi zasipi jarkov za polaganje cevovoda in zasipi ob objektih, morajo biti izvršeni z materialom in na način, kakor to predvidevajo načrti oziroma opis del.

Pri zasipanju jarkov za cevovode je obvezno potrebno uporabiti nevezan material iz izkopa, če je primeren (za prvi sloj debeline cca 20-30 cm nad temenom cevi, frakcije 0,02 do 16 mm).

V nasprotnem primeru je potrebno zagotoviti ustrezen material za nasip, kot je upoštevano v predmetnem projektu.

Omenjeni prvi sloj zasipa nad cevovodi, sme biti komprimiran le ročno.

Preostali zasipi jarkov in zasipi ob objektih se lahko izvršijo z materialom iz izkopa in s strojnim komprimiranjem v slojih, kakor to predvidevajo načrti oziroma popis del.

Izbor materiala in način izvajanja zasipa jarkov za cevovode pod prometnimi površinami, se določi po predhodnem dogovoru z nadzornim organom in v soglasju z naročnikom.

Izračun se vrši po 1 mm opravljenega zasipa.

6.1.4 ODVOZ ZEMLJE IN PREOSTALEGA MATERIALA

Ves izkopani material se transportira na začasno deponijo, ki jo določi nadzorni organ. Tu se vrši izbor materiala za naknadno uporabo oziroma za odvoz na stalno deponijo.

Na posebno zahtevo naročnika je izvajalec del dolžan izvršiti ločitev izkopanega materiala po kategorijah.

Izračun se vrši po 1 m^3 transportiranega materiala z upoštevanjem nakladanja, razkladanja in razprostiranja materiala po deponiji.

6.1.5 CENE ZA ENOTO

Cene za enoto zemeljskih del vsebujejo:

- ves porabljeni material
- vse potrebno delo
- vse transporte
- najemnino za vso potrebno mehanizacijo
- najemnino ali stroške izdelave, nameščanja in odstranjevanja vseh pomožnih odrov, platojev in opiranja za izkope v večjih globinah.

Vsa zemeljska dela, v kolikor ni drugače odločeno, se obračunavajo v raščenem stanju z upoštevanjem koeficienta razrahljivosti pri ceni za enoto.

6.2 BETONSKA DELA

6.2.1 SPLOŠNA DOLOČILA

Vsa betonska in armiranobetonska dela se izvajajo v skladu z načrti, opisi del, statičnimi izračuni ter tehničnimi predpisi in standardi.

Kvaliteta vgrajenega betona mora odgovarjati zahtevam opisa del, tehničnim predpisom in standardom glede čistoče agregata, granulacije, količine in kvalitete cementa in vode.

Cement, uporabljen za vsa dela mora biti svež, pravilno skladiščen in zaščiten pred vodo in vlago, v skladu z navodili in predpisi za beton in armirani beton.

Agregat za pripravo betona naj bo po možnosti rečnega porekla, brez gline in mulja, zrnavosti po predpisih za predvideno marko betona.

Armatura mora biti dobro očiščena rje, blata in apna, krivljena in dimenzionirana po detajlih. Glede kvalitete mora odgovarjati veljavnim tehničnim predpisom.

Vse betonske in armiranobetonske konstrukcije morajo biti betonirane z marko betona predvideno v statičnem izračunu. V primeru, da v kakšni predračunski postavki ali statičnem izračunu MB ni določena, se izvaja z C25/30 za armirani beton oz. C8/10 za nearmirani beton.

Vgrajevanje betona v konstrukcije se mora izvajati po navodilih statika in zahtevah iz opisa del, ter v skladu s tehničnimi predpisi. Beton se vgrajuje strojno do potrebne zbitosti, tako da izpolni ves prostor med armaturo in opažem ter povsem obloži vso armaturo.

Vgrajevanje betona ni dovoljeno, dokler nadzorni organ ne pregleda vse položene armature. Pri prekinitvah betoniranja je mesta, kjer se betoniranje prekine, potrebno določiti že vnaprej. Za nadaljevanje del je stično ploskev potrebno očistiti rahlega betona, cementne kaše in prahu ter stik dobro namočiti in ga prepojiti s tanjšo plastjo mastne mešanice betona drobnejše zrnatosti.

Pri zahtevnih konstrukcijah statik določi vrstni red in način opaženja oziroma razopaženja ter mesta, kjer je betoniranje dovoljeno prekiniti.

Med betoniranjem je izvajalec dolžan vgraditi vse ostale elemente kot so podložke, čepi, škatle za prehode instalacij, kljuke potrebne za poznejšo pritrditev drugih montažnih elementov in instalacij.

V času in po končanem betoniranju je izvajalec dolžan v skladu z začasnimi predpisi za beton in armirani beton, beton negovati in zaščititi pred vplivom nizkih oziroma visokih temperatur. Vse armiranobetonske konstrukcije, ki ostanejo vidne, se morajo v slučaju poškodbe zakrpati in zgladiti.

Obračun betonskih in armirano betonskih del se vrši za 1 m^3 vgrajenega betona, obračun armature pa za 1 kg položene armature, če se obračunava posebej.

6.2.2 POD IN OB-BETONIRANJE KRIVIN IN CEVI

Podložni beton je treba vgraditi točno po predvidenem padcu. Pred polaganjem cevi se mora beton popolnoma strditi.

Obložni beton je treba vgraditi po polaganju in montaži cevi, tako da se popolnoma prilega cevi, podložnemu betonu in raščenemu terenu ob straneh jarka.

V posebnih primerih (sipek material, itd...) lahko izvajalec z dovoljenjem nadzornega organa izdela podlogo s pomočjo stranskega opaža. V tem primeru mora vgrajevati armirani beton boljše marke po določilih statika.

Obračun se izdela za 1 m^3 vgrajenega betona.

6.2.3 BETON IN ARMIRAN BETON ZA OBJEKTE

Vgrajuje se beton in armirani beton posameznih konstruktivnih elementov objektov po načrtih, opisu del, predpisih za beton in armirani beton ter upoštevanju ustreznih standardov, kot je že opisano v splošnih določilih za betonska dela.

Obračunava se 1 m^3 vgrajenega betona.

6.2.4 CENE ZA ENOTO

Cene za enoto betonskih in armiranobetonskih del vsebujejo:

- ves potreben material, vključno z armaturo
- vse delo potrebno za izdelavo in vgrajevanje betona ter polaganje armature
- vse potrebne transporte
- zaščito in nego betona
- se pomožne delovne odre z dohodi, potrebne za delo pri betoniranju
- pri montažnih armiranobetonskih konstrukcijah cene vsebujejo tudi montažo

Obračun vseh betonskih in armiranobetonskih del se vrši za 1 m^3 vgrajenega betona.

6.3 TESARSKA DELA

6.3.1 SPLOŠNA DOLOČILA

Ves material, ki se uporablja za izdelavo opažev, mora biti pripravljen v odgovarjajočih merah in po kvaliteti odgovarjati ustreznim tehničnim predpisom za lesene konstrukcije in ustreznim standardom.

Opaži morajo biti izdelani točno po merah v načrtih in v vseh detajlih, z vsemi potrebnimi podporami, horizontalno in vertikalno povezavo, tako da so stabilni in sposobni prevzeti težo vgrajenega betona. Stične površine morajo biti čiste in ravne.

Opaži morajo biti izvedeni tako, da se razopaženje lahko opravi brez pretresov in poškodovanja armiranobetonskih konstrukcij oziroma opažev samih.

Obračun se vrši za napravo, postavitev in odstranitev 1 m^2 opaža.

6.3.2 OPAŽI IN ODRI

Vsi opaži armiranobetonskih konstrukcij (temelji, stene, nosilci, stebri, plošče ipd...), kakor tudi vsi pomični in nepomični delovni in podporni odri, se izdelujejo po načrtih in predpisih del ter v skladu z vsemi pogoji splošnih določil.

6.3.3 CENA ZA ENOTO

Cene za enoto tesarskih del vsebujejo:

- ves potreben material
- vse potrebno delo in prenose
- vse pomožne odre, v kolikor niso predvideni v predračunu

Obračun se vrši za 1 m^2 izdelanega opaža, upoštevajoč notranje površine opažev, to je vidne površine konstrukcij.

6.4 ZIDARSKA DELA

6.4.1 SPLOŠNA DOLOČILA

Ves material potreben za zidanje, ometavanje in ostala zidarska dela, mora biti kvaliteten in mora odgovarjati tehničnim predpisom in ustreznim standardom.

Zidanje mora biti izvršeno po načrtih in statičnem izračunu. Delo mora biti izvršeno čisto, s pravilno vezavo opeke in dobro zalitimi stiki z malto. Vrste opeke morajo biti popolnoma ravne, vse zidane površine pa popolnoma vertikalne.

Vse ometane površine morajo biti popolnoma ravne in enakomerno obdelane.

Vsa dela za izvedbo hidroizolacij, toplotnih in zvočnih izolacij, vzidav in zazidav ter ostala zidarska dela morajo biti izvršena strokovno na način, ki je predpisan v posamezni postavki del.

Obračun se vrši za mersko enoto po posamezni postavki iz predračuna.

6.4.2 CENA ZA ENOTO

Cene za enoto za zidarska dela vsebujejo:

- ves potreben material

- vse potrebno delo in mehanizacijo
- vse potrebne transporte in prenose
- vse pomožne odre, če niso posebej zajeti pri tesarskih delih

Obračun se vrši za mersko enoto po posamezni postavki iz predračuna.

6.4.3 CEVI IN STIKI

Vsa dela pri montaži cevovodov je treba izvršiti točno po popisu del oziroma po navodilih proizvajalca cevi. Cevi se polaga na peščeno posteljico. V primeru slabe nosilnosti tal je potrebno izdelati poseben statični izračun. Pri jeklenih ceveh je potrebno vse zvare testirati na priznan način.

ZAKOLIČBA

Oznaka	X	Y	Stacionaža	Kota pokrova	Kota dna	Kota vtoka	Kota iztoka	Globina jaška	Fi Jaška
MK2									
PRJ13K MK	457777.235	104614.169	0	314.99	312.24	313.09	312.24	2.75	1000
PRJ1MK2	457773.248	104647.579	33.65	315.9	313.42	314.18	313.43	2.48	1200
RJ2MK2	457759.695	104651.189	47.67	316.01	314.27	314.27	314.27	1.74	1200
RJ3MK2	457743.506	104661.8	67.03	316.32	314.37	314.37	314.37	1.95	1200
RJ4MK2	457711.486	104682.188	104.99	317.51	314.97	315.3	314.98	2.54	1200
RJ5MK2	457696.636	104695.011	124.61	318.18	315.58	315.59	315.59	2.6	1200
RJ6MK2	457668.807	104724.178	164.92	319.5	316.3	316.62	316.31	3.2	1200
RJ7MK2	457650.57	104742.832	191.01	320.66	317	317.26	317.01	3.62	1200
RJ8MK2	457640.817	104748.272	202.18	320.77	317.47	317.93	317.48	3.3	1200
RJ9MK2	457626.768	104752.142	216.75	321.03	318.12	318.13	318.13	2.91	1200
RJ10MK2	457616.088	104751.804	227.44	320.78	318.23	318.24	318.24	2.54	1200
RJ11MK2	457596.88	104753.43	246.71	320.41	318.57	318.58	318.58	1.85	1200
RJ12MK2	457578.198	104758.854	266.17	320.31	318.72	318.72	318.72	1.6	1200
RJ13MK2	457559.338	104768.654	287.42	320.41	318.81	318.81	318.81	1.6	1200
RJ14MK2	457537.549	104781.846	312.89	320.53	318.92	318.92	318.92	1.62	1200
RJ15MK2	457511.738	104800.181	344.55	321.25	319.38	319.39	319.39	1.87	1200
MK3									
PRJ1MK2	457773.248	104647.579	0	315.9	313.42	314.18	313.43	2.48	1200
RJ1MK3	457772.819	104650.649	3.1	315.98	314.25	314.27	314.27	1.73	1200
RJ2MK3	457755.487	104664.417	25.23	316.49	314.89	314.9	314.9	1.6	1200
KP MK2.1									
RJ15MK2	457511.738	104800.181	0	321.25	319.38	319.4	319.39	1.87	1200
PRJ1MK2.1	457494.634	104813.315	21.57	322.67	319.91	320.92	319.92	2.76	1200
PRJ2MK2.1	457477.53	104826.45	43.13	324.46	321.45	322.46	321.46	3.02	1200
PRJ3MK2.1	457474.811	104840.261	57.21	325.03	322.53	323.27	322.53	2.5	1200
RJ4MK2.1	457497.42	104844.724	80.25	325.22	323.34	323.34	323.34	1.88	1200
RJ5MK2.1	457528.168	104851.849	111.82	325.51	323.53	323.53	323.53	1.99	1200
RJ6MK2.1	457542.862	104859.244	128.27	325.63	323.63	323.63	323.63	2	1200
RJ7MK2.1	457574.291	104879.644	165.73	326.3	324.59	324.6	324.6	1.71	1000
RJ8MK2.1	457606.457	104899	203.28	327.27	325.56	325.57	325.57	1.71	1000
KP OM2A									
PRJ3K_CAB1	457686.88	104919.02	0	327.35	323.31	325.33	323.33	4.04	1000
RJ1OM2A	457659.528	104914.374	27.74	327.61	325.61	325.61	325.61	2	1000
KP OM3A									
PRJ3K_CAB1	457686.88	104919.02	0	327.35	323.31	325.27	323.33	4.04	1000
RJ1OM3A	457694.675	104921.448	8.16	327.35	325.35	325.35	325.35	2	1000

HIDRAVLIČNI IZRAČUN

Oznaka	Polnitev [%]	Max. V [m/s]	Max Q [l/s]	Min. V [m/s]	Notranji fi [mm]	i [o/oo]	L [m]	Qsušni [l/s]	A [ha]	Ared[ha]	Ng
M1.K2.C1 (PRJ13K MK - PRJ1MK2)	66.50%	4.22	2551.35	4.22	980	10	33.65	0	0.019	0.017	0.01
M1.K2.C2 (PRJ1MK2 - RJ2MK2)	58.30%	2.94	933.67	2.93	782	6.7	14.03	0	0.016	0.015	0.01
M1.K2.C3 (RJ2MK2 - RJ3MK2)	63.30%	2.58	929.75	2.57	782	5	19.36	0	0	0	0.01
M1.K2.C4 (RJ3MK2 - RJ4MK2)	48.20%	4.17	929.75	4.16	782	16.1	37.96	0	0.057	0.051	0.01
M1.K2.C5 (RJ4MK2 - RJ5MK2)	48.60%	4.04	916.15	4.04	782	15	19.62	0	0.015	0.014	0.01
M1.K2.C6 (RJ5MK2 - RJ6MK2)	47.00%	4.31	912.43	4.31	782	17.9	40.31	0	0	0	0.01
M1.K2.C7 (RJ6MK2 - RJ7MK2)	48.50%	4.04	912.43	4.04	782	15	26.09	0	0.055	0.049	0.01
M1.K2.C8 (RJ7MK2 - RJ8MK2)	45.80%	4.48	899.22	4.47	782	20	11.17	0	0.018	0.016	0.01
M1.K2.C9 (RJ8MK2 - RJ9MK2)	48.80%	3.92	894.89	3.92	782	14	14.57	0	0.015	0.013	0.01
M1.K2.C10 (RJ9MK2 - RJ10MK2)	52.00%	3.44	891.37	3.44	782	10	10.69	0	0.551	0.115	0.01
M1.K2.C11 (RJ10MK2 - RJ11MK2)	46.10%	4.23	860.64	4.22	782	17.6	19.28	0	0.193	0.173	0.01
M1.K2.C12 (RJ11MK2 - RJ12MK2)	53.70%	2.96	814.35	2.96	782	7.2	19.45	0	0.019	0.017	0.01
M1.K2.C13 (RJ12MK2 - RJ13MK2)	61.20%	2.36	809.81	2.36	782	4.2	21.25	0	0.055	0.05	0.01
M1.K2.C14 (RJ13MK2 - RJ14MK2)	60.20%	2.38	796.53	2.38	782	4.3	25.47	0	0.028	0.025	0.01
M1.K2.C15 (RJ14MK2 - RJ15MK2)	46.10%	3.89	789.9	3.87	782	14.8	31.66	0	0.028	0.025	0.01
K3 - 'MK3'											
M1.K3.C1 (PRJ1MK2 - RJ2MK3)	45.00%	4.77	1500	4.79	1000	28.7	25.23	1500	0	0	0.013
K12 - 'KP MK2.1'											
M1.K12.C1 (RJ15MK2 - PRJ1MK2.1)	42.50%	4.62	783.19	4.62	782	24.1	21.57	0	0	0	0.01
M1.K12.C2 (PRJ1MK2.1 - PRJ2MK2.1)	42.20%	4.69	783.19	4.68	782	25	21.57	0	0.03	0.027	0.01
M1.K12.C3 (PRJ2MK2.1 - PRJ3MK2.1)	57.20%	2.52	775.95	2.52	782	5	14.08	0	0.014	0.013	0.01
M1.K12.C4 (PRJ3MK2.1 - RJ4MK2.1)	66.60%	2	772.52	2	782	3	23.05	0	0.015	0.014	0.01
M1.K12.C5 (RJ4MK2.1 - RJ5MK2.1)	54.40%	2.72	768.87	2.73	782	6	31.56	0	0.019	0.017	0.01
M1.K12.C6 (RJ5MK2.1 - RJ6MK2.1)	54.20%	2.73	764.32	2.73	782	6.1	16.45	750	0.009	0.008	0.01
M1.K12.C7 (RJ6MK2.1 - RJ7MK2.1)	26.30%	1.57	12.1	1.57	306	25.9	37.47	0	0.024	0.022	0.01
M1.K12.C8 (RJ7MK2.1 - RJ8MK2.1)	22.30%	1.3	6.31	1.29	306	25.8	37.54	0	0.026	0.024	0.01
K17 - 'KP OM2A'											
M1.K17.C1 (PRJ3K_CAB1 - RJ1OM2A)	49.40%	3.33	780	3.34	782	10	27.74	780	0	0	0.01
K18 - 'KP OM3A'											
M1.K18.C1 (PRJ3K_CAB1 - RJ1OM3A)	50.60%	2.8	390	2.8	588	10	8.16	390	0	0	0.01

STATIČNI IZRAČUNI

Structural analysis

Project:	9237 Kamna Gorica
Description:	GRP CC pipe DN 800 PN01 SN 10.000
Contractor:	LUZ d.d Verovškova ulica 64 1000 Ljubljana Mr. Luka Kranjc (01) 36 02 473
Designer:	Josip Vrtarić Application Engineering Amiblu Alpe Adria d.o.o. Kralja Zvonimira 122, Zagreb, Croatia T +385 1 618 36 91 M +385 91 604 93 97 josip.vrtaric@amiblu.com www.amiblu.com
Calculation no.:	2026/65
Date:	30/07/2026

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Pipes designed for generations

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1 Remarks

DISCLAIMER OF LIABILITY

As part of the technical service for the technical planning of projects of the Amiblu Group (hereinafter referred to as "Amiblu"), static calculations for decision-making regarding Amiblu/Flowtite/Hobas GFK pipe systems and products are regularly provided by Amiblu.

By using this free Amiblu' s technical verification service, you agree to the following terms and conditions:

1. No contractual relationship:
The use of the above mentioned Amiblu` s calculations does not constitute a contractual relationship between you and Amiblu and no consulting or information agreement is concluded. To this extent, there do not exist any contractual or quasi-contractual claims against Amiblu.

2. Requirements:
You acknowledge that the here mentioned calculations only apply to Amiblu/Flowtite/Hobas products.

3. Basis of the static calculation:
Amiblu bases the calculation according to your stated project and installation conditions and completes the missing data by itself if necessary, this to the best of its knowledge and based on the current state of knowledge and according to the requirements of the valid standards and regulations.
The trench width and installation conditions are based on the minimum requirements according to EN1610 without consideration of the trench sheet thickness (if in use). This usually represents the critical load case and is therefore on the safe side.

4. Installation specifications:
In all cases the following installation conditions must be observed for the installation of Amiblu products:

The pipe zone must be made of non-cohesive or slightly cohesive material with the quality and degree of compaction according to this calculation. The maximum grain size according to the Amiblu/Flowtite/Hobas installation instructions for buried pipes and shafts have to be observed.
To classify the bedding material, all the material in the pipeline zone has to pass through a sieve with a mesh size as specified in the installation instructions.

The pipe bedding must be at least 100 mm thick and have the specified support angle according to the static calculation. We recommend that the requirements for the pipe bedding according to EN 1610.

The degree of compaction of the pipe zone and backfill must meet or exceed the requirements of the static calculation. The installation conditions should be checked and documented. The pipe zone ends 300 mm above the pipe crown.

The quality and degree of compaction of the backfill, the existing soil and the pipeline zone must be checked and needs to meet the requirements of this static evaluation.

For the static calculation compliance with the applicable international standards and installation instructions for Amiblu/Flowtite/Hobas products is assumed. The installation instructions for Amiblu/Flowtite/Hobas can be downloaded from our homepages: http://www.flowtite.com or http://www.hobas.com or http://www.amiblu.com.

The installation conditions used for the static calculation should be compared by you or an expert engineer or the project planner with the actual conditions on site. Potential deviations may have an influence on the pipe installation.

5. Disclaimer:
The services provided are subject to Amiblu's General Conditions of Sale, insofar applicable.

The results of the calculation can only be obtained in practice if the assumptions correspond to the real construction conditions on site.

The static calculations were carried out reliably and carefully according to the professional opinion of Amiblu.

Amiblu accept liability for the static calculation carried out on the basis of customer specifications, such as e.g. contents from structural analysis forms, specifications for planning and execution, information on ground condition as well as installation and/or operation. Amiblu does not accept any liability for the correctness and completeness of the specific customer specifications.

The static calculations prepared by Amiblu are a service in the design or execution phase and usually become part of the project documentation. Amiblu assumes no liability for the applicability of the calculation results in case of deviations from the underlying assumptions.

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2 List of references

DIN 4124 - Excavations and Trenches - Slopes, planking and strutting, breadths of working space: October 2002

EN 1610 - Construction and testing of drains and sewers: December 2015

EN 805 - Water Supply Requirements for systems and components outside of buildings: March 2000

EN 1992-2 - Eurocode 2: Eurocode 1: Actions on structures Part 2: Traffic loads on bridges (consolidated version): March. 2012

EN 1796 - Plastics piping systems for water supply with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): March 2013

EN 14364 - Plastics piping systems for drainage and sewerage with or without pressure – Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): Mai 2013

EN 15383 - Plastics piping systems for drainage and sewerage - Glass- reinforced thermosetting plastics (GRP) based on polyester resin (UP) - Manholes and inspection chambers: March 2013

ISO 16611 Plastics piping systems for drainage and sewerage without pressure - Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) - Dimensions, requirements and tests: June 2017

ISO 25780 - Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin — Pipes with flexible joints intended to be installed using jacking techniques: Mai 2011

Worksheet DWA-A127 - Structural verification of sewer channels and pipe lines, 3. corrected Issue: August 2000

3 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 1,6 m

Caption of this part of the calculation:	Cover 1,6 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

3.1 Input

3.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
Allowable deflection:	6% (standard)
Treatment of internal pressure:	In accordance with Footnote 39 in ATV-DVWK-A 127
Lower safety factors for flexural compression:	No (ATV-DVWK-A 127)
Proof for not predominantly static loading:	According to standard
Consideration of dyn pvh*:	According to standard
Consideration of Type A 'predeformation' in the deformation proof:	Yes
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

3.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

3.1.3 Load

Cover depth:	h	1.60	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Soil density:	γ_B	20.0	kN/m³
Additional surface load:	p_0	0.0	kN/m²
Inner pressure, short term:	$P_{I,K}$	0.00	bar
Inner pressure, long term:	$P_{I,L}$	0.00	bar
Water fill (e.g. damming channel):	Yes		
Density of medium:	γ_F	10.0	kN/m³
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

3.1.4 Installation

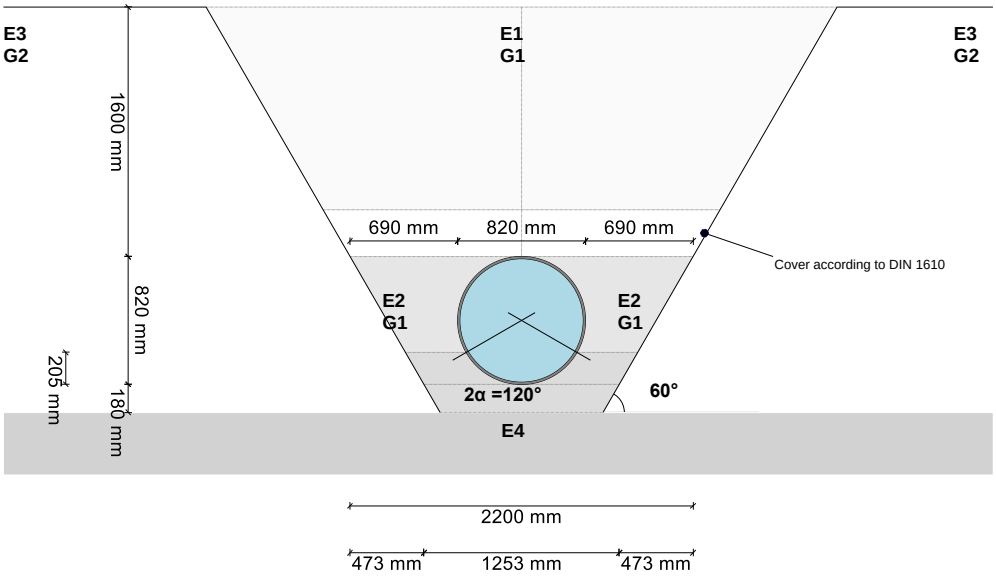
Installation:	Trench		
Trench width at pipe crown level:	b	2.20	m

Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	60	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

3.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	820	mm
Nominal diameter:	DN	800	mm
Wall thickness:	t	17.0	mm
Local predeformation:	$\delta_{v,I}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	Yes		
Creep ratio:	f_{Kriech}	2.00	[-]
Reduction factor due to temperature effect:	$A_{1,Temp}$	1.00	[-]
Reduction factor due to media attack:	$A_{2,Medium}$	1.00	[-]
Reduction factor due to dynamic loading:	$A_{3,dyn}$	1.00	[-]
Specific gravity:	γ_R	18.00	kN/m³
Poissons ratio:	v	0.30	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



3.2 Results

3.2.1 Intermediate results pipe

Inner diameter:	d_i	786.0 mm
Outer diameter:	d_a	820.0 mm
Mean radius:	r_m	401.50 mm
Wall thickness:	s	17.00 mm
Ratio radius to wall thickness:	r_m/s	23.618 [-]
Curve correction factor, internal:	α_{ki}	1.014 [-]
Curve correction factor, external:	α_{ka}	0.986 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	17.00 mm²/mm
Distance of inertia:	e	8.50 mm
Moment of inertia:	I	409.42 mm^4/mm
Outer moment of resistance:	W_a	48.17 mm³/mm
Inner moment of resistance:	W_i	48.17 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

3.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	12,646.8	6,323.4	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.359	0.815	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	9.4	4.7	N/mm²

Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$	n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$	n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$	n. def	N/mm²

3.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

3.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	800	mm
Outer diameter:	d_a	820.0	mm
Size of the bedding layer:	a	0.18	m
Minimum width at trench bottom (incl. x) according to table 1:	$min_{b,T1}$	1.22	m
Minimum clear width at trench bottom:	$min_{b,G}$	1.22	m

Slope angle:	ß	60	°
Additional width for sloped trench walls:	Δb/2	0.47	m
Required width at pipe crown level:	$min_{b,R}$	2.16	m
Trench width at pipe crown level:	b	2.20	m

The minimum trench width at trench bottom according DIN EN 1610 is met.

3.2.3 Intermediate results for load case

3.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

3.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	32.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	32.00	kN/m²
Stress due to traffic load:	P_V	12.13	kN/m²
Included impact factor:	ϕ	1.50	[-]

3.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.66	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (Diagram 5):	$α_{B0}$	0.667	[-]
Reduction factor E20 (narrow trench):	$α_B$	0.854	[-]
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.66	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

3.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	Δf	0.854	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.003	[-]

If the slope angle of the trench < 90° the trench width at the middle of pipe has to be used here instead of the trench width at crown.

Horizontal bedding stiffness:	S_{Bh}	8.217	N/mm²
Vertical bedding stiffness:	S_{Bv}	13.659	N/mm²

3.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.205	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.684	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

3.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	50,993	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	$ε_R$	1.359	0.965	0.815	%

Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	12,646.8	8,061.2	6,323.4	N/mm²

3.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0097	0.0062	0.0049	[-]
Stiffness ratio	V_S	0.4242	0.3694	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.010	---	[-]

3.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.180	1.237	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.010	---	[-]

3.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.616	1.616	---	[-]
Coefficient for maximum concentration factor	K'	0.921	0.916	---	[-]
Concentration factor above pipe, initial value	λ_R	0.842	0.805	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.911	0.890	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.760	3.760	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.600	0.600	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.911	0.890	---	[-]
Soil concentration factor	λ_B	1.053	1.065	---	[-]

3.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	41.29	40.62	---	kN/m²
Lateral pressure	q_h	16.75	16.91	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	30.23	30.70	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	3.81	4.07	---	kN/m²

3.2.4 Section forces

3.2.4.1 Section forces , short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm
Moment due to total vertical load	M_{qv}	1.737	-1.764	1.830	kNm/m
Moment due to lateral pressure	M_{qh}	-0.675	0.675	-0.675	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.882	1.013	-0.882	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.111	0.128	-0.111	kNm/m
Moment due to dead weight	M_g	0.019	-0.022	0.026	kNm/m
Moment due to water filling	M_w	0.123	-0.142	0.168	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.211	-0.112	0.356	kNm/m
		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm

Normal force due to total vertical load	N_{qv}	0.448	-16.577	-0.448	kN/m
Normal force due to lateral pressure	N_{qh}	-6.727	0.000	-6.727	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-7.002	0.000	-7.002	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.882	0.000	-0.882	kN/m
Normal force due to dead weight	N_g	0.031	-0.193	-0.031	kN/m
Normal force due to water filling	N_w	1.008	0.347	2.217	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-13.126	-16.424	-12.873	kN/m

3.2.4.2 Section forces , long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm
Moment due to total vertical load	M_{qv}	1.709	-1.735	1.801	kNm/m
Moment due to lateral pressure	M_{qh}	-0.682	0.682	-0.682	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.896	1.029	-0.896	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.119	0.136	-0.119	kNm/m
Moment due to dead weight	M_g	0.019	-0.022	0.026	kNm/m
Moment due to water filling	M_w	0.123	-0.142	0.168	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.155	-0.052	0.299	kNm/m

		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm
Normal force due to total vertical load	N_{qv}	0.440	-16.309	-0.440	kN/m
Normal force due to lateral pressure	N_{qh}	-6.791	0.000	-6.791	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-7.112	0.000	-7.112	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.943	0.000	-0.943	kN/m
Normal force due to dead weight	N_g	0.031	-0.193	-0.031	kN/m
Normal force due to water filling	N_w	1.008	0.347	2.217	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-13.367	-16.156	-13.100	kN/m

3.2.5 Short term load case

3.2.5.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.024	-0.020	0.039	%
Strain due to other loads	ε_{sonst}	0.005	-0.006	0.014	%
Total strain	ε	0.029	-0.026	0.053	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.36	1.36	1.36	%
Safety coefficient flexural tension:	γ_{BZ}	46.914	---	25.507	[-]
Safety coefficient flexural compression:	γ_{BD}	---	51.868	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.035	0.004	-0.051	%
Strain due to other loads	ε_{sonst}	-0.005	0.006	-0.013	%
Total strain	ε	-0.040	0.010	-0.064	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.36	1.36	1.36	%
Safety coefficient flexural tension:	γ_{BZ}	---	130.576	---	[-]
Safety coefficient flexural compression:	γ_{BD}	33.806	---	21.367	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.5.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00018	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	3.58	mm
Horizontal diameter change:			Δd_h	2.95	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.45	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.45	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6 Long term load case

3.2.6.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:		erf γ_{RBZ}	2.00	[-]

Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.025	-0.018	0.048	%
Strain due to other loads	ε_{sonst}	0.008	-0.009	0.026	%
Total strain	ε	0.032	-0.027	0.074	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.94	0.92	0.92	%
Safety coefficient flexural tension:	γ_{BZ}	28.919	---	12.420	[-]
Safety coefficient flexural compression:	γ_{BD}	---	33.794	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.043	-0.006	-0.067	%
Strain due to other loads	ε_{sonst}	-0.007	0.009	-0.023	%
Total strain	ε	-0.051	0.003	-0.090	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.95	0.88	0.93	%
Safety coefficient flexural tension:	γ_{BZ}	---	262.115	---	[-]
Safety coefficient flexural compression:	γ_{BD}	18.707	---	10.324	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.6.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			I/(A·rm²)·κ_Q	0.00018	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	4.00	mm
Horizontal diameter change:			Δd_h	3.00	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.50	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.50	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6.3 Stabilty proof radial, linear

Earth and traffic loads

Pipe stiffness:	$\bar{S}_R$	50,993	N/m²
Horizontal bedding stiffness:	S_{Bh}	8.217	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0062	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,128.8	kN/m²
Total vertical load:	q_v	40.62	kN/m²
Safety stability, radial:	$\gamma_{Stab,rad}$	27.79	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

3.2.6.4 stability proof, nonlinear

The nonlinear stability proof is not applicable because of VRB > 1.0 (rigid pipe) or relative vertical deformation < 6%.

3.2.6.5 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

4 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 3,2 m

Caption of this part of the calculation:	Cover 3,2 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

4.1 Input

4.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
Allowable deflection:	6% (standard)
Treatment of internal pressure:	In accordance with Footnote 39 in ATV-DVWK-A 127
Lower safety factors for flexural compression:	No (ATV-DVWK-A 127)
Proof for not predominantly static loading:	According to standard
Consideration of dyn pvh*:	According to standard
Consideration of Type A 'predeformation' in the deformation proof:	Yes
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

4.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

4.1.3 Load

Cover depth:	h	3.20	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Soil density:	γ_B	20.0	kN/m³
Additional surface load:	p_0	0.0	kN/m²
Inner pressure, short term:	$P_{I,K}$	0.00	bar
Inner pressure, long term:	$P_{I,L}$	0.00	bar
Water fill (e.g. damming channel):	Yes		
Density of medium:	γ_F	10.0	kN/m³
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

4.1.4 Installation

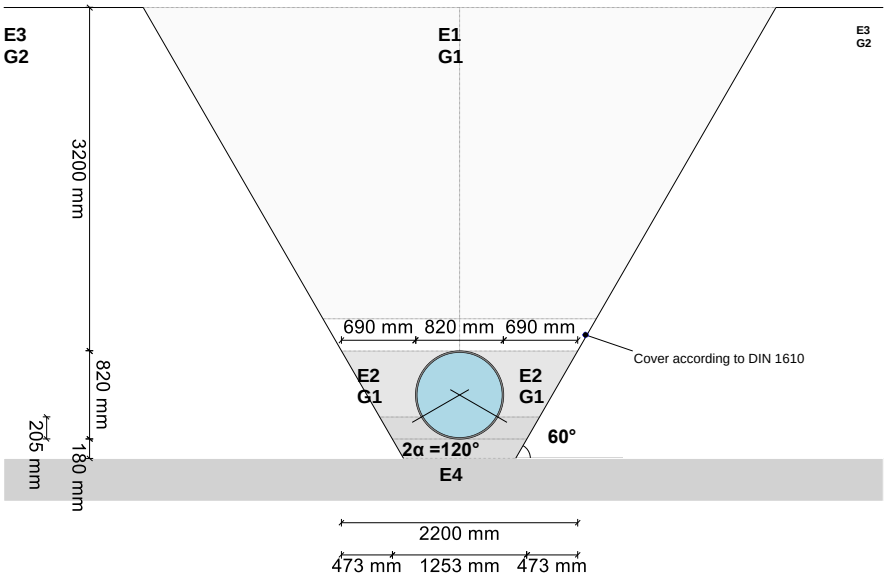
Installation:	Trench		
Trench width at pipe crown level:	b	2.20	m

Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	60	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

4.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	820	mm
Nominal diameter:	DN	800	mm
Wall thickness:	t	17.0	mm
Local predeformation:	$\delta_{v,I}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	Yes		
Creep ratio:	f_{Kriech}	2.00	[-]
Reduction factor due to temperature effect:	$A_{1,Temp}$	1.00	[-]
Reduction factor due to media attack:	$A_{2,Medium}$	1.00	[-]
Reduction factor due to dynamic loading:	$A_{3,dyn}$	1.00	[-]
Specific gravity:	γ_R	18.00	kN/m³
Poissons ratio:	v	0.30	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



4.2 Results

4.2.1 Intermediate results pipe

Inner diameter:	d_i	786.0 mm
Outer diameter:	d_a	820.0 mm
Mean radius:	r_m	401.50 mm
Wall thickness:	s	17.00 mm
Ratio radius to wall thickness:	r_m/s	23.618 [-]
Curve correction factor, internal:	α_{ki}	1.014 [-]
Curve correction factor, external:	α_{ka}	0.986 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	17.00 mm²/mm
Distance of inertia:	e	8.50 mm
Moment of inertia:	I	409.42 mm^4/mm
Outer moment of resistance:	W_a	48.17 mm³/mm
Inner moment of resistance:	W_i	48.17 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

4.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	12,646.8	6,323.4	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$

Characteristic value of ultimate strain for edge fibers	ε_R	1.359	0.815	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	9.4	4.7	N/mm²

Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$	n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$	n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$	n. def	N/mm²

4.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

4.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	800	mm
Outer diameter:	d_a	820.0	mm
Size of the bedding layer:	a	0.18	m
Minimum width at trench bottom (incl. x) according to table 1:	$min_{b,T1}$	1.22	m
Minimum clear width at trench bottom:	$min_{b,G}$	1.22	m

Slope angle:	ß	60	°
Additional width for sloped trench walls:	Δb/2	0.47	m
Required width at pipe crown level:	$min_{b,R}$	2.16	m
Trench width at pipe crown level:	b	2.20	m

The minimum trench width at trench bottom according DIN EN 1610 is met.

4.2.3 Intermediate results for load case

4.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

4.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	64.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	64.00	kN/m²
Stress due to traffic load:	P_V	4.82	kN/m²
Included impact factor:	ϕ	1.50	[-]

4.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.66	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (Diagram 5):	$α_{B0}$	0.667	[-]
Reduction factor E20 (narrow trench):	$α_B$	0.854	[-]
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.66	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

4.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	Δf	0.854	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.003	[-]

If the slope angle of the trench < 90° the trench width at the middle of pipe has to be used here instead of the trench width at crown.

Horizontal bedding stiffness:	S_{Bh}	8.217	N/mm²
Vertical bedding stiffness:	S_{Bv}	13.659	N/mm²

4.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.205	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.684	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

4.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	42,802	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	$ε_R$	1.359	0.854	0.815	%

Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	12,646.8	6,766.4	6,323.4	N/mm²

4.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0097	0.0052	0.0049	[-]
Stiffness ratio	V_S	0.4242	0.3484	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.009	---	[-]

4.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.180	1.255	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.009	---	[-]

4.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.951	1.951	---	[-]
Coefficient for maximum concentration factor	K'	0.921	0.914	---	[-]
Concentration factor above pipe, initial value	λ_R	0.820	0.764	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.899	0.868	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.520	3.520	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.397	0.397	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.899	0.868	---	[-]
Soil concentration factor	λ_B	1.060	1.079	---	[-]

4.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	62.36	60.37	---	kN/m²
Lateral pressure	q_h	30.41	30.89	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	40.02	39.51	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	3.81	4.07	---	kN/m²

4.2.4 Section forces

4.2.4.1 Section forces , short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm
Moment due to total vertical load	M_{qv}	2.624	-2.664	2.765	kNm/m
Moment due to lateral pressure	M_{qh}	-1.226	1.226	-1.226	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-1.168	1.342	-1.168	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.111	0.128	-0.111	kNm/m
Moment due to dead weight	M_g	0.019	-0.022	0.026	kNm/m
Moment due to water filling	M_w	0.123	-0.142	0.168	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.261	-0.133	0.454	kNm/m
		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm

Normal force due to total vertical load	N_{qv}	0.676	-25.039	-0.676	kN/m
Normal force due to lateral pressure	N_{qh}	-12.211	0.000	-12.211	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-9.272	0.000	-9.272	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.882	0.000	-0.882	kN/m
Normal force due to dead weight	N_g	0.031	-0.193	-0.031	kN/m
Normal force due to water filling	N_w	1.008	0.347	2.217	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-20.651	-24.886	-20.856	kN/m

4.2.4.2 Section forces , long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm
Moment due to total vertical load	M_{qv}	2.540	-2.579	2.676	kNm/m
Moment due to lateral pressure	M_{qh}	-1.245	1.245	-1.245	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-1.153	1.325	-1.153	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.119	0.136	-0.119	kNm/m
Moment due to dead weight	M_g	0.019	-0.022	0.026	kNm/m
Moment due to water filling	M_w	0.123	-0.142	0.168	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.165	-0.037	0.354	kNm/m

		crown	springline	invert	
Mean radius	r_m	401.50	401.50	401.50	mm
Normal force due to total vertical load	N_{qv}	0.654	-24.237	-0.654	kN/m
Normal force due to lateral pressure	N_{qh}	-12.402	0.000	-12.402	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-9.153	0.000	-9.153	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.943	0.000	-0.943	kN/m
Normal force due to dead weight	N_g	0.031	-0.193	-0.031	kN/m
Normal force due to water filling	N_w	1.008	0.347	2.217	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-20.805	-24.083	-20.966	kN/m

4.2.5 Short term load case

4.2.5.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.029	-0.028	0.051	%
Strain due to other loads	ε_{sonst}	0.005	-0.006	0.014	%
Total strain	ε	0.034	-0.034	0.066	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.36	1.36	1.36	%
Safety coefficient flexural tension:	γ_{BZ}	40.139	---	20.630	[-]
Safety coefficient flexural compression:	γ_{BD}	---	40.337	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.047	0.004	-0.070	%
Strain due to other loads	ε_{sonst}	-0.005	0.006	-0.013	%
Total strain	ε	-0.052	0.010	-0.083	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.36	1.36	1.36	%
Safety coefficient flexural tension:	γ_{BZ}	---	136.888	---	[-]
Safety coefficient flexural compression:	γ_{BD}	26.207	---	16.340	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.5.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00018	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	4.76	mm
Horizontal diameter change:			Δd_h	3.91	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.59	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.59	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6 Long term load case

4.2.6.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:		erf γ_{RBZ}	2.00	[-]

Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.026	-0.024	0.067	%
Strain due to other loads	ε_{sonst}	0.008	-0.009	0.026	%
Total strain	ε	0.034	-0.033	0.094	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.85	0.84	0.84	%
Safety coefficient flexural tension:	γ_{BZ}	24.994	---	9.020	[-]
Safety coefficient flexural compression:	γ_{BD}	---	25.588	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.061	-0.018	-0.104	%
Strain due to other loads	ε_{sonst}	-0.007	0.009	-0.023	%
Total strain	ε	-0.069	-0.009	-0.127	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.85	0.84	0.85	%
Safety coefficient flexural tension:	γ_{BZ}	---	---	---	[-]
Safety coefficient flexural compression:	γ_{BD}	12.398	91.264	6.685	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.6.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00018	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	5.42	mm
Horizontal diameter change:			Δd_h	3.86	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.68	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.68	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6.3 Stabilty proof radial, linear

Earth and traffic loads

Pipe stiffness:	$\bar{S}_R$	42,802	N/m²
Horizontal bedding stiffness:	S_{Bh}	8.217	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0052	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,035.1	kN/m²
Total vertical load:	q_v	60.37	kN/m²
Safety stability, radial:	$\gamma_{Stab,rad}$	17.15	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

4.2.6.4 stability proof, nonlinear

The nonlinear stability proof is not applicable because of VRB > 1.0 (rigid pipe) or relative vertical deformation < 6%.

4.2.6.5 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

5 Appendix

Amiblu®
Sustainable Water Solutions

FLOWTITE® | HOBAS®

Input Data for structural analysis

of application buried pipes in open trench condition, calculation acc. DWA-A 127

Please send to:
Amiblu Holding GmbH
Pischeldorfer Straße 128
A-9020 Klagenfurt
T +43 463 482424
info@amiblu.com

9237 Kamna Gorica	
project	
LUZ d.d	Luka Krajnc
company	contact person
Verovškova ulica 64	(01) 36 02 473
street	phone/Fax:
1000	Text input.
postcode	signature:
Ljubljana	Text input.
city	date/stamp

Pipe Details:

nominal diameter DN	800
pressure class PN	PN1
nominal stiffness SN	10000
pipe material	GRP

sewer pipe	☒
sewer pressure pipe	☐
pressure pipe	☐
potable water pipe	☐
installation in protective water area	☐
air pipe	☐
storage sewer	☐
others	Text input.

Types of native soil: acc. ATV-DVWK-A 127; DIN 18196 (please subsoil expertise ad)

		Native soil	backfilling	Pipe zone
G1	Non cohesive soils (gravel, sand) (GE, GW, GI, SE, SW, SI)	☐	☒	☒
G2	Slightly cohesive soils (GU, GT, SU, ST)	☒	☐	☐
G3	Cohesive mixed soils, silt (GÜ, GŤ, SÜ, SŤ, UL, UM)	☐	☐	☐
G4	Cohesive soils, except silts (TL, TM, TA, OU, OT, OH, UA)	☐	☐	☐
Other types of soil	Text input.	☐	☐	☐

Proctor density for native soil (Proctor density 85 – 100 %): 98 %

Foundation of pipeline
- ☒ On native soil
- ☐ very hard and rocky
- ☐ Weak soil, not stable for foundation

Soil replacement: thickness Text input. m
material Text input.
Proctor density D_{Pr} Text input. %

Specification of loads:

	Min. cover depth		Max. cover depth	
Depth of earth cover h	1.6	m	3.2	m
min. Ground water h_w above pipe invert	Text input.	m	Text input.	m
max. Ground water h_w above pipe invert	Text input.	m	Text input.	m

Other surface loads Text input. kN/m²

For pressure pipes
Short term: Text input. bar, e.g. system test pressure; hydrostatic pressure, water hammer
Long term: Text input. bar, e.g. operating pressure (OP), system pressure (PN, DP)

Traffic load
☐ no traffic

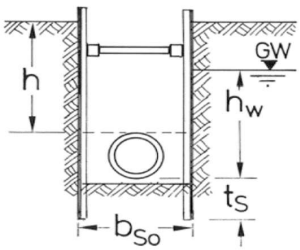
street
- ☐ HCL 60
- ☐ HCL 30
- ☒ HGV 12
- ☐ DIN EN 1991-2, TS und UDL
  - ☐ LM1-lane 3,00 m
  - ☐ LM1-lane 2,70 m
  - ☐ LM1-green field area

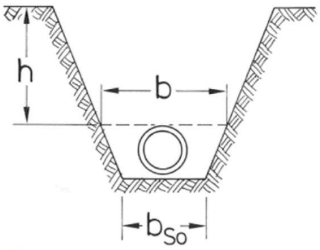
railway
- ☐ one track, UIC
- ☐ two tracks, UIC
- ☐ one track, LM 71
- ☐ two tracks, LM 71

aircraft
- ☐ BFZ 90
- ☐ BFZ 180
- ☐ BFZ 350
- ☐ BFZ 550
- ☐ BFZ 750

Other loads, e.g. special vehicle (please add load scheme with axle, wheels and wheel loads):
Text input.

Building construction:





Type of trench ☐ embankment ☒ single trench ☐ double trench [1] ☐ stepped trench [1]
[1] For special shapes add a sketch

Trench angel ☐ 90° ☒ 60° ☐ 45° ☐ Text input.

Width of trench b = 1.8 m at pipe crown

b_{So} = 3.5 m at pipe trench bottom inclusive planks

Trench planking

☐ no planks

☐ Horizontal planks, also applies to plank walls (Berlin lining)
☒ Planking with plates
☐ Vertical plank with light weight
☐ Vertical plank with boards *
☐ Vertical plank with light weight *
☐ Vertical plank with sheet piling *

bedding

☐ on native soil (acc. EN 1610)
☒ on gravel, sand
☐ on concrete [2]

[2] only as spezial construction in agreement with the pipe producer

bedding angle 2α

☐ 90° ☐ 120°
☐ 180°

* Depth of sheeting below pipe invert t_S = Text input. m

*thickness of plank (one-side) b_S = Text input. m

Cover condition for backfilling:

A1 ☐ Backfilling compacted in layers against the native soil (without proof of compaction degree); also applies to plank walls, Berlin lining

A2 ☐ Vertical pipe trench lining with boards that are not removed before backfilling. Lining boards or devices that are removed step by step during backfilling. Non-compacted backfilling/ backfilling with slurry (only suitable for soils of group G1).

A3 ☐ Vertical trench lining with sheet piling, light weight sheet connection, wooden planks, lining boards or devices that are not removed before backfilling.

A4 ☒ Backfilling compacted in layers against the native soil with proof of the required compaction degree to ZTVE-StB ; also applies to plank walls (Berlin lining). Cover condition A4 is not applicable to sails of group G4.

Bedding condition for pipe:

B1 ☒ Bedding compacted in layers against the native soil or in the embankment (without proof of compaction degree); also applies to plank walls, Berlin lining

B2 ☐ Vertical lining in the pipe zone with planks that reach down to the trench bottom and are not removed before backfilling and compaction. Lining boards or devices provided that the soil is compacted after the linings are removed.

B3 ☐ Vertical lining in the pipe zone with sheet piling or lightweight sheeting and compaction against the lining reaching down below the trench bottom. There is no safe calculation model for determining vertical lining with wooden planks, boards or devices that are not removed before backfilling and compaction the pipe zone.

B4 ☐ Bedding compacted in layers against the native soil or in the embankment with proof of the required compaction degree to ZTVE-StB. Bedding condition B4 does not apply to soils of group G4.

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Pipes designed for generations

Structural analysis

Project:	9237 Kamna Gorica
Description:	GRP CC pipe DN 1000 PN01 SN 10.000
Contractor:	LUZ d.d Verovškova ulica 64 1000 Ljubljana Mr. Luka Kranjc (01) 36 02 473
Designer:	Josip Vrtarić Application Engineering Amiblu Alpe Adria d.o.o. Kralja Zvonimira 122, Zagreb, Croatia T +385 1 618 36 91 M +385 91 604 93 97 josip.vrtaric@amiblu.com www.amiblu.com
Calculation no.:	2026/66
Date:	30/07/2026

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1 Remarks

DISCLAIMER OF LIABILITY

As part of the technical service for the technical planning of projects of the Amiblu Group (hereinafter referred to as "Amiblu"), static calculations for decision-making regarding Amiblu/Flowtite/Hobas GFK pipe systems and products are regularly provided by Amiblu.

By using this free Amiblu' s technical verification service, you agree to the following terms and conditions:

1. No contractual relationship:
The use of the above mentioned Amiblu` s calculations does not constitute a contractual relationship between you and Amiblu and no consulting or information agreement is concluded. To this extent, there do not exist any contractual or quasi-contractual claims against Amiblu.

2. Requirements:
You acknowledge that the here mentioned calculations only apply to Amiblu/Flowtite/Hobas products.

3. Basis of the static calculation:
Amiblu bases the calculation according to your stated project and installation conditions and completes the missing data by itself if necessary, this to the best of its knowledge and based on the current state of knowledge and according to the requirements of the valid standards and regulations.
The trench width and installation conditions are based on the minimum requirements according to EN1610 without consideration of the trench sheet thickness (if in use). This usually represents the critical load case and is therefore on the safe side.

4. Installation specifications:
In all cases the following installation conditions must be observed for the installation of Amiblu products:

The pipe zone must be made of non-cohesive or slightly cohesive material with the quality and degree of compaction according to this calculation. The maximum grain size according to the Amiblu/Flowtite/Hobas installation instructions for buried pipes and shafts have to be observed.
To classify the bedding material, all the material in the pipeline zone has to pass through a sieve with a mesh size as specified in the installation instructions.

The pipe bedding must be at least 100 mm thick and have the specified support angle according to the static calculation. We recommend that the requirements for the pipe bedding according to EN 1610.

The degree of compaction of the pipe zone and backfill must meet or exceed the requirements of the static calculation. The installation conditions should be checked and documented. The pipe zone ends 300 mm above the pipe crown.

The quality and degree of compaction of the backfill, the existing soil and the pipeline zone must be checked and needs to meet the requirements of this static evaluation.

For the static calculation compliance with the applicable international standards and installation instructions for Amiblu/Flowtite/Hobas products is assumed. The installation instructions for Amiblu/Flowtite/Hobas can be downloaded from our homepages: http://www.flowtite.com or http://www.hobas.com or http://www.amiblu.com.

The installation conditions used for the static calculation should be compared by you or an expert engineer or the project planner with the actual conditions on site. Potential deviations may have an influence on the pipe installation.

5. Disclaimer:
The services provided are subject to Amiblu's General Conditions of Sale, insofar applicable.

The results of the calculation can only be obtained in practice if the assumptions correspond to the real construction conditions on site.

The static calculations were carried out reliably and carefully according to the professional opinion of Amiblu.

Amiblu accept liability for the static calculation carried out on the basis of customer specifications, such as e.g. contents from structural analysis forms, specifications for planning and execution, information on ground condition as well as installation and/or operation. Amiblu does not accept any liability for the correctness and completeness of the specific customer specifications.

The static calculations prepared by Amiblu are a service in the design or execution phase and usually become part of the project documentation. Amiblu assumes no liability for the applicability of the calculation results in case of deviations from the underlying assumptions.

Rev03 11/04/2023

2 List of references

DIN 4124 - Excavations and Trenches - Slopes, planking and strutting, breadths of working space: October 2002

EN 1610 - Construction and testing of drains and sewers: December 2015

EN 805 - Water Supply Requirements for systems and components outside of buildings: March 2000

EN 1992-2 - Eurocode 2: Eurocode 1: Actions on structures Part 2: Traffic loads on bridges (consolidated version): March. 2012

EN 1796 - Plastics piping systems for water supply with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): March 2013

EN 14364 - Plastics piping systems for drainage and sewerage with or without pressure – Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): Mai 2013

EN 15383 - Plastics piping systems for drainage and sewerage - Glass- reinforced thermosetting plastics (GRP) based on polyester resin (UP) - Manholes and inspection chambers: March 2013

ISO 16611 Plastics piping systems for drainage and sewerage without pressure - Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) - Dimensions, requirements and tests: June 2017

ISO 25780 - Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin — Pipes with flexible joints intended to be installed using jacking techniques: Mai 2011

Worksheet DWA-A127 - Structural verification of sewer channels and pipe lines, 3. corrected Issue: August 2000

3 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 1,8 m

Caption of this part of the calculation:	Cover 1,8 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

3.1 Input

3.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
Allowable deflection:	6% (standard)
Treatment of internal pressure:	In accordance with Footnote 39 in ATV-DVWK-A 127
Lower safety factors for flexural compression:	No (ATV-DVWK-A 127)
Proof for not predominantly static loading:	According to standard
Consideration of dyn pvh*:	According to standard
Consideration of Type A 'predeformation' in the deformation proof:	Yes
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

3.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

3.1.3 Load

Cover depth:	h	1.80	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Soil density:	γ_B	20.0	kN/m³
Additional surface load:	p_0	0.0	kN/m²
Inner pressure, short term:	$P_{I,K}$	0.00	bar
Inner pressure, long term:	$P_{I,L}$	0.00	bar
Water fill (e.g. damming channel):	Yes		
Density of medium:	γ_F	10.0	kN/m³
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

3.1.4 Installation

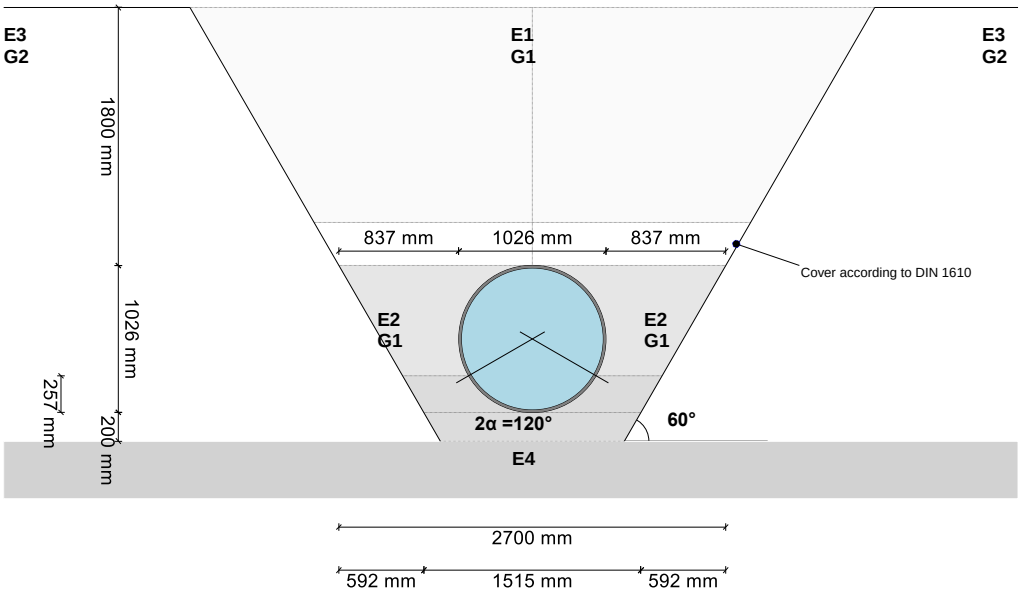
Installation:	Trench		
Trench width at pipe crown level:	b	2.70	m

Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	60	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

3.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	1,026	mm
Nominal diameter:	DN	1,000	mm
Wall thickness:	t	21.0	mm
Local predeformation:	$\delta_{v,l}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	Yes		
Creep ratio:	f_{Kriech}	2.00	[-]
Reduction factor due to temperature effect:	$A_{1,Temp}$	1.00	[-]
Reduction factor due to media attack:	$A_{2,Medium}$	1.00	[-]
Reduction factor due to dynamic loading:	$A_{3,dyn}$	1.00	[-]
Specific gravity:	γ_R	18.00	kN/m³
Poissons ratio:	v	0.30	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



3.2 Results

3.2.1 Intermediate results pipe

Inner diameter:	d_i	984.0 mm
Outer diameter:	d_a	1,026.0 mm
Mean radius:	r_m	502.50 mm
Wall thickness:	s	21.00 mm
Ratio radius to wall thickness:	r_m/s	23.929 [-]
Curve correction factor, internal:	α_{ki}	1.014 [-]
Curve correction factor, external:	α_{ka}	0.986 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	21.00 mm²/mm
Distance of inertia:	e	10.50 mm
Moment of inertia:	I	771.75 mm^4/mm
Outer moment of resistance:	W_a	73.50 mm³/mm
Inner moment of resistance:	W_i	73.50 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

3.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	13,152.9	6,576.5	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.341	0.805	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	9.6	4.8	N/mm²

Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$	n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$	n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$	n. def	N/mm²

3.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

3.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	1,000	mm
Outer diameter:	d_a	1,026.0	mm
Size of the bedding layer:	a	0.20	m
Minimum width at trench bottom (incl. x) according to table 1:	$min_{b,T1}$	1.43	m
Minimum clear width at trench bottom:	$min_{b,G}$	1.43	m

Slope angle:	ß	60	°
Additional width for sloped trench walls:	Δb/2	0.59	m
Required width at pipe crown level:	$min_{b,R}$	2.61	m
Trench width at pipe crown level:	b	2.70	m

The minimum trench width at trench bottom according DIN EN 1610 is met.

3.2.3 Intermediate results for load case

3.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

3.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	36.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	36.00	kN/m²
Stress due to traffic load:	P_V	10.21	kN/m²
Included impact factor:	ϕ	1.50	[-]

3.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.57	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (Diagram 5):	$α_{B0}$	0.667	[-]
Reduction factor E20 (narrow trench):	$α_B$	0.848	[-]
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.57	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

3.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	$Δ_f$	0.823	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.006	[-]

If the slope angle of the trench < 90° the trench width at the middle of pipe has to be used here instead of the trench width at crown.

Horizontal bedding stiffness:	S_{Bh}	8.190	N/mm²
Vertical bedding stiffness:	S_{Bv}	13.567	N/mm²

3.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.257	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.695	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

3.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	48,838	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	$ε_R$	1.341	0.923	0.805	%

Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	13,152.9	8,029.5	6,576.5	N/mm²

3.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0098	0.0060	0.0049	[-]
Stiffness ratio	V_S	0.4261	0.3659	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.010	---	[-]

3.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.179	1.242	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.010	---	[-]

3.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.575	1.575	---	[-]
Coefficient for maximum concentration factor	K'	0.921	0.916	---	[-]
Concentration factor above pipe, initial value	λ_R	0.847	0.807	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.917	0.895	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.730	3.730	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.629	0.629	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.917	0.895	---	[-]
Soil concentration factor	λ_B	1.051	1.064	---	[-]

3.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	43.22	42.43	---	kN/m²
Lateral pressure	q_h	19.24	19.43	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	29.75	30.12	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	4.77	5.10	---	kN/m²

3.2.4 Section forces

3.2.4.1 Section forces , short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm
Moment due to total vertical load	M_{qv}	2.848	-2.892	3.001	kNm/m
Moment due to lateral pressure	M_{qh}	-1.214	1.214	-1.214	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-1.360	1.563	-1.360	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.218	0.250	-0.218	kNm/m
Moment due to dead weight	M_g	0.036	-0.042	0.050	kNm/m
Moment due to water filling	M_w	0.241	-0.279	0.330	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.334	-0.186	0.589	kNm/m
		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm

Normal force due to total vertical load	N_{qv}	0.586	-21.717	-0.586	kN/m
Normal force due to lateral pressure	N_{qh}	-9.667	0.000	-9.667	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-8.626	0.000	-8.626	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-1.382	0.000	-1.382	kN/m
Normal force due to dead weight	N_g	0.047	-0.298	-0.047	kN/m
Normal force due to water filling	N_w	1.578	0.543	3.472	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-17.463	-21.472	-16.837	kN/m

3.2.4.2 Section forces , long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm
Moment due to total vertical load	M_{qv}	2.796	-2.839	2.946	kNm/m
Moment due to lateral pressure	M_{qh}	-1.227	1.227	-1.227	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-1.377	1.582	-1.377	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.233	0.268	-0.233	kNm/m
Moment due to dead weight	M_g	0.036	-0.042	0.050	kNm/m
Moment due to water filling	M_w	0.241	-0.279	0.330	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.237	-0.084	0.489	kNm/m

		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm
Normal force due to total vertical load	N_{qv}	0.576	-21.319	-0.576	kN/m
Normal force due to lateral pressure	N_{qh}	-9.764	0.000	-9.764	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-8.733	0.000	-8.733	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-1.477	0.000	-1.477	kN/m
Normal force due to dead weight	N_g	0.047	-0.298	-0.047	kN/m
Normal force due to water filling	N_w	1.578	0.543	3.472	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-17.774	-21.075	-17.126	kN/m

3.2.5 Short term load case

3.2.5.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.022	-0.020	0.038	%
Strain due to other loads	ε_{sonst}	0.006	-0.007	0.018	%
Total strain	ε	0.029	-0.027	0.056	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.34	1.34	1.34	%
Safety coefficient flexural tension:	γ_{BZ}	46.779	---	24.113	[-]
Safety coefficient flexural compression:	γ_{BD}	---	49.223	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.034	0.004	-0.050	%
Strain due to other loads	ε_{sonst}	-0.006	0.007	-0.016	%
Total strain	ε	-0.040	0.011	-0.066	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.34	1.34	1.34	%
Safety coefficient flexural tension:	γ_{BZ}	---	120.093	---	[-]
Safety coefficient flexural compression:	γ_{BD}	33.238	---	20.286	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.5.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00017	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	4.43	mm
Horizontal diameter change:			Δd_h	3.65	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.44	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.44	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6 Long term load case

3.2.6.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:		erf γ_{RBZ}	2.00	[-]

Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.022	-0.018	0.048	%
Strain due to other loads	ε_{sonst}	0.009	-0.011	0.032	%
Total strain	ε	0.032	-0.029	0.080	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.89	0.88	0.88	%
Safety coefficient flexural tension:	γ_{BZ}	27.953	---	11.049	[-]
Safety coefficient flexural compression:	γ_{BD}	---	30.575	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.043	-0.008	-0.069	%
Strain due to other loads	ε_{sonst}	-0.009	0.011	-0.029	%
Total strain	ε	-0.052	0.004	-0.097	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.91	0.86	0.89	%
Safety coefficient flexural tension:	γ_{BZ}	---	244.409	---	[-]
Safety coefficient flexural compression:	γ_{BD}	17.483	---	9.201	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.6.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			I/(A·rm²)·κ_Q	0.00017	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	4.99	mm
Horizontal diameter change:			Δd_h	3.70	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.50	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.50	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6.3 Stabilty proof radial, linear

Earth and traffic loads

Pipe stiffness:	$\bar{S}_R$	48,838	N/m²
Horizontal bedding stiffness:	S_{Bh}	8.190	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0060	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,103.2	kN/m²
Total vertical load:	q_v	42.43	kN/m²
Safety stability, radial:	$\gamma_{Stab,rad}$	26.00	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

3.2.6.4 stability proof, nonlinear

The nonlinear stability proof is not applicable because of VRB > 1.0 (rigid pipe) or relative vertical deformation < 6%.

3.2.6.5 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

4 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 2,2 m

Caption of this part of the calculation:	Cover 2,2 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

4.1 Input

4.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
Allowable deflection:	6% (standard)
Treatment of internal pressure:	In accordance with Footnote 39 in ATV-DVWK-A 127
Lower safety factors for flexural compression:	No (ATV-DVWK-A 127)
Proof for not predominantly static loading:	According to standard
Consideration of dyn pvh*:	According to standard
Consideration of Type A 'predeformation' in the deformation proof:	Yes
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

4.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

4.1.3 Load

Cover depth:	h	2.20	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Soil density:	γ_B	20.0	kN/m³
Additional surface load:	p_0	0.0	kN/m²
Inner pressure, short term:	$P_{I,K}$	0.00	bar
Inner pressure, long term:	$P_{I,L}$	0.00	bar
Water fill (e.g. damming channel):	Yes		
Density of medium:	γ_F	10.0	kN/m³
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

4.1.4 Installation

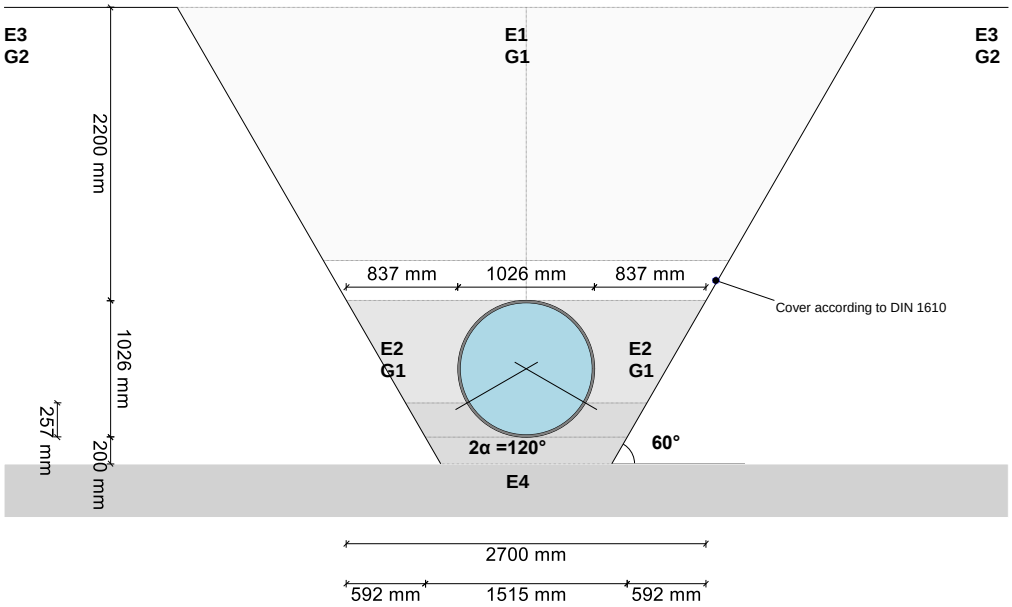
Installation:	Trench		
Trench width at pipe crown level:	b	2.70	m

Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	60	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

4.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	1,026	mm
Nominal diameter:	DN	1,000	mm
Wall thickness:	t	21.0	mm
Local predeformation:	$\delta_{v,l}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	Yes		
Creep ratio:	f_{Kriech}	2.00	[-]
Reduction factor due to temperature effect:	$A_{1,Temp}$	1.00	[-]
Reduction factor due to media attack:	$A_{2,Medium}$	1.00	[-]
Reduction factor due to dynamic loading:	$A_{3,dyn}$	1.00	[-]
Specific gravity:	γ_R	18.00	kN/m³
Poissons ratio:	v	0.30	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



4.2 Results

4.2.1 Intermediate results pipe

Inner diameter:	d_i	984.0 mm
Outer diameter:	d_a	1,026.0 mm
Mean radius:	r_m	502.50 mm
Wall thickness:	s	21.00 mm
Ratio radius to wall thickness:	r_m/s	23.929 [-]
Curve correction factor, internal:	α_{ki}	1.014 [-]
Curve correction factor, external:	α_{ka}	0.986 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	21.00 mm²/mm
Distance of inertia:	e	10.50 mm
Moment of inertia:	I	771.75 mm^4/mm
Outer moment of resistance:	W_a	73.50 mm³/mm
Inner moment of resistance:	W_i	73.50 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

4.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	13,152.9	6,576.5	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.341	0.805	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	9.6	4.8	N/mm²
Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$		n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$		n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$		n. def	N/mm²

4.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

4.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	1,000	mm
Outer diameter:	d_a	1,026.0	mm
Size of the bedding layer:	a	0.20	m
Minimum width at trench bottom (incl. x) according to table 1:	$min_{b,T1}$	1.43	m
Minimum clear width at trench bottom:	$min_{b,G}$	1.43	m

Slope angle:	ß	60	°
Additional width for sloped trench walls:	Δb/2	0.59	m
Required width at pipe crown level:	$min_{b,R}$	2.61	m
Trench width at pipe crown level:	b	2.70	m

The minimum trench width at trench bottom according DIN EN 1610 is met.

4.2.3 Intermediate results for load case

4.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

4.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	44.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	44.00	kN/m²
Stress due to traffic load:	P_V	7.78	kN/m²
Included impact factor:	ϕ	1.50	[-]

4.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.57	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (Diagram 5):	$α_{B0}$	0.667	[-]
Reduction factor E20 (narrow trench):	$α_B$	0.848	[-]
Bedding elastic modulus (reduced):	$E_{2,σ}$	13.57	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

4.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	Δf	0.823	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.006	[-]

If the slope angle of the trench < 90° the trench width at the middle of pipe has to be used here instead of the trench width at crown.

Horizontal bedding stiffness:	S_{Bh}	8.190	N/mm²
Vertical bedding stiffness:	S_{Bv}	13.567	N/mm²

4.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.257	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.695	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

4.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	46,011	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	$ε_R$	1.341	0.886	0.805	%

Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	13,152.9	7,564.7	6,576.5	N/mm²

4.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0098	0.0056	0.0049	[-]
Stiffness ratio	V_S	0.4261	0.3587	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.009	---	[-]

4.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.179	1.248	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.014	-0.009	---	[-]

4.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.662	1.662	---	[-]
Coefficient for maximum concentration factor	K'	0.921	0.915	---	[-]
Concentration factor above pipe, initial value	λ_R	0.840	0.793	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.913	0.887	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.670	3.670	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.574	0.574	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.913	0.887	---	[-]
Soil concentration factor	λ_B	1.053	1.069	---	[-]

4.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	47.94	46.82	---	kN/m²
Lateral pressure	q_h	22.65	22.92	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	31.56	31.68	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	4.77	5.10	---	kN/m²

4.2.4 Section forces

4.2.4.1 Section forces , short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm
Moment due to total vertical load	M_{qv}	3.160	-3.208	3.329	kNm/m
Moment due to lateral pressure	M_{qh}	-1.430	1.430	-1.430	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-1.443	1.658	-1.443	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.218	0.250	-0.218	kNm/m
Moment due to dead weight	M_g	0.036	-0.042	0.050	kNm/m
Moment due to water filling	M_w	0.241	-0.279	0.330	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.347	-0.191	0.619	kNm/m
		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm

Normal force due to total vertical load	N_{qv}	0.650	-24.091	-0.650	kN/m
Normal force due to lateral pressure	N_{qh}	-11.379	0.000	-11.379	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-9.152	0.000	-9.152	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-1.382	0.000	-1.382	kN/m
Normal force due to dead weight	N_g	0.047	-0.298	-0.047	kN/m
Normal force due to water filling	N_w	1.578	0.543	3.472	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-19.637	-23.846	-19.139	kN/m

4.2.4.2 Section forces , long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm
Moment due to total vertical load	M_{qv}	3.086	-3.133	3.251	kNm/m
Moment due to lateral pressure	M_{qh}	-1.447	1.447	-1.447	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-1.448	1.664	-1.448	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.233	0.268	-0.233	kNm/m
Moment due to dead weight	M_g	0.036	-0.042	0.050	kNm/m
Moment due to water filling	M_w	0.241	-0.279	0.330	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.236	-0.076	0.503	kNm/m

		crown	springline	invert	
Mean radius	r_m	502.50	502.50	502.50	mm
Normal force due to total vertical load	N_{qv}	0.635	-23.529	-0.635	kN/m
Normal force due to lateral pressure	N_{qh}	-11.517	0.000	-11.517	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-9.186	0.000	-9.186	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-1.477	0.000	-1.477	kN/m
Normal force due to dead weight	N_g	0.047	-0.298	-0.047	kN/m
Normal force due to water filling	N_w	1.578	0.543	3.472	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-19.920	-23.284	-19.392	kN/m

4.2.5 Short term load case

4.2.5.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.023	-0.021	0.040	%
Strain due to other loads	ε_{sonst}	0.006	-0.007	0.018	%
Total strain	ε	0.029	-0.029	0.058	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.34	1.34	1.34	%
Safety coefficient flexural tension:	γ_{BZ}	45.803	---	23.149	[-]
Safety coefficient flexural compression:	γ_{BD}	---	46.718	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.037	0.004	-0.054	%
Strain due to other loads	ε_{sonst}	-0.006	0.007	-0.016	%
Total strain	ε	-0.043	0.011	-0.070	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.34	1.34	1.34	%
Safety coefficient flexural tension:	γ_{BZ}	---	123.117	---	[-]
Safety coefficient flexural compression:	γ_{BD}	31.560	---	19.157	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.5.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00017	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	4.71	mm
Horizontal diameter change:			Δd_h	3.87	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.47	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.47	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6 Long term load case

4.2.6.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:		erf γ_{RBZ}	2.00	[-]

Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.014	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.022	-0.019	0.052	%
Strain due to other loads	ε_{sonst}	0.009	-0.011	0.032	%
Total strain	ε	0.032	-0.030	0.084	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.86	0.86	0.86	%
Safety coefficient flexural tension:	γ_{BZ}	27.293	---	10.235	[-]
Safety coefficient flexural compression:	γ_{BD}	---	28.689	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.986	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.047	-0.011	-0.077	%
Strain due to other loads	ε_{sonst}	-0.009	0.011	-0.029	%
Total strain	ε	-0.055	0.000	-0.105	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.87	0.85	0.87	%
Safety coefficient flexural tension:	γ_{BZ}	---	3,686.958	---	[-]
Safety coefficient flexural compression:	γ_{BD}	15.751	---	8.233	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.6.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00015	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00017	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	5.34	mm
Horizontal diameter change:			Δd_h	3.89	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.53	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.53	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6.3 Stabilty proof radial, linear

Earth and traffic loads

Pipe stiffness:	$\bar{S}_R$	46,011	N/m²
Horizontal bedding stiffness:	S_{Bh}	8.190	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0056	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,071.1	kN/m²
Total vertical load:	q_v	46.82	kN/m²
Safety stability, radial:	$\gamma_{Stab,rad}$	22.87	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

4.2.6.4 stability proof, nonlinear

The nonlinear stability proof is not applicable because of VRB > 1.0 (rigid pipe) or relative vertical deformation < 6%.

4.2.6.5 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

5 Appendix

Amiblu®
Sustainable Water Solutions

FLOWTITE® | HOBAS®

Input Data for structural analysis

of application buried pipes in open trench condition, calculation acc. DWA-A 127

Please send to:
Amiblu Holding GmbH
Pischeldorfer Straße 128
A-9020 Klagenfurt
T +43 463 482424
info@amiblu.com

9237 Kamna Gorica	
project	
LUZ d.d	Luka Krajnc
company	contact person
Verovškova ulica 64	(01) 36 02 473
street	phone/Fax:
1000	Text input.
postcode	signature:
Ljubljana	Text input.
city	date/stamp

Pipe Details:

nominal diameter DN	1000
pressure class PN	PN1
nominal stiffness SN	10000
pipe material	GRP

sewer pipe	☒
sewer pressure pipe	☐
pressure pipe	☐
potable water pipe	☐
installation in protective water area	☐
air pipe	☐
storage sewer	☐
others	Text input.

Types of native soil: acc. ATV-DVWK-A 127; DIN 18196 (please subsoil expertise ad)

		Native soil	backfilling	Pipe zone
G1	Non cohesive soils (gravel, sand) (GE, GW, GI, SE, SW, SI)	☐	☒	☒
G2	Slightly cohesive soils (GU, GT, SU, ST)	☒	☐	☐
G3	Cohesive mixed soils, silt (GÜ, GŤ, SÜ, SŤ, UL, UM)	☐	☐	☐
G4	Cohesive soils, except silts (TL, TM, TA, OU, OT, OH, UA)	☐	☐	☐
Other types of soil	Text input.	☐	☐	☐

Proctor density for native soil (Proctor density 85 – 100 %): 98 %

Foundation of pipeline
- ☒ On native soil
- ☐ very hard and rocky
- ☐ Weak soil, not stable for foundation

Soil replacement: thickness Text input. m
material Text input.
Proctor density D_{Pr} Text input. %

Specification of loads:

	Min. cover depth		Max. cover depth	
Depth of earth cover h	1.8	m	2.2	m
min. Ground water h_w above pipe invert	Text input.	m	Text input.	m
max. Ground water h_w above pipe invert	Text input.	m	Text input.	m

Other surface loads Text input. kN/m²

For pressure pipes
Short term: Text input. bar, e.g. system test pressure; hydrostatic pressure, water hammer
Long term: Text input. bar, e.g. operating pressure (OP), system pressure (PN, DP)

Traffic load
☐ no traffic

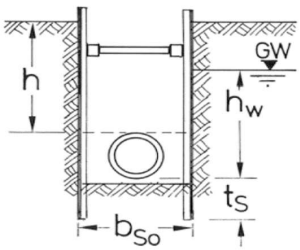
street
- ☐ HCL 60
- ☐ HCL 30
- ☒ HGV 12
- ☐ DIN EN 1991-2, TS und UDL
  - ☐ LM1-lane 3,00 m
  - ☐ LM1-lane 2,70 m
  - ☐ LM1-green field area

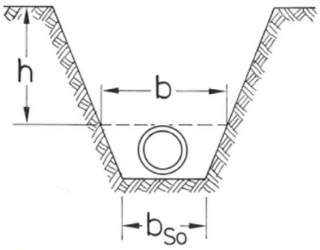
railway
- ☐ one track, UIC
- ☐ two tracks, UIC
- ☐ one track, LM 71
- ☐ two tracks, LM 71

aircraft
- ☐ BFZ 90
- ☐ BFZ 180
- ☐ BFZ 350
- ☐ BFZ 550
- ☐ BFZ 750

Other loads, e.g. special vehicle (please add load scheme with axle, wheels and wheel loads):
Text input.

Building construction:





Type of trench ☐ embankment ☒ single trench ☐ double trench [1] ☐ stepped trench [1]
[1] For special shapes add a sketch

Trench angel ☐ 90° ☒ 60° ☐ 45° ☐ Text input.

Width of trench b = 1.8 m at pipe crown

b_{So} = 3.5 m at pipe trench bottom inclusive planks

Trench planking

☐ no planks

☐ Horizontal planks, also applies to plank walls (Berlin lining)
☒ Planking with plates
☐ Vertical plank with light weight
☐ Vertical plank with boards *
☐ Vertical plank with light weight *
☐ Vertical plank with sheet piling *

bedding

☐ on native soil (acc. EN 1610)
☒ on gravel, sand
☐ on concrete [2]

[2] only as spezial construction in agreement with the pipe producer

bedding angle 2α

☐ 90° ☐ 120°
☐ 180°

* Depth of sheeting below pipe invert t_S = Text input. m

*thickness of plank (one-side) b_S = Text input. m

Cover condition for backfilling:

A1 ☐ Backfilling compacted in layers against the native soil (without proof of compaction degree); also applies to plank walls, Berlin lining

A2 ☐ Vertical pipe trench lining with boards that are not removed before backfilling. Lining boards or devices that are removed step by step during backfilling. Non-compacted backfilling/ backfilling with slurry (only suitable for soils of group G1).

A3 ☐ Vertical trench lining with sheet piling, light weight sheet connection, wooden planks, lining boards or devices that are not removed before backfilling.

A4 ☒ Backfilling compacted in layers against the native soil with proof of the required compaction degree to ZTVE-StB ; also applies to plank walls (Berlin lining). Cover condition A4 is not applicable to sails of group G4.

Bedding condition for pipe:

B1 ☒ Bedding compacted in layers against the native soil or in the embankment (without proof of compaction degree); also applies to plank walls, Berlin lining

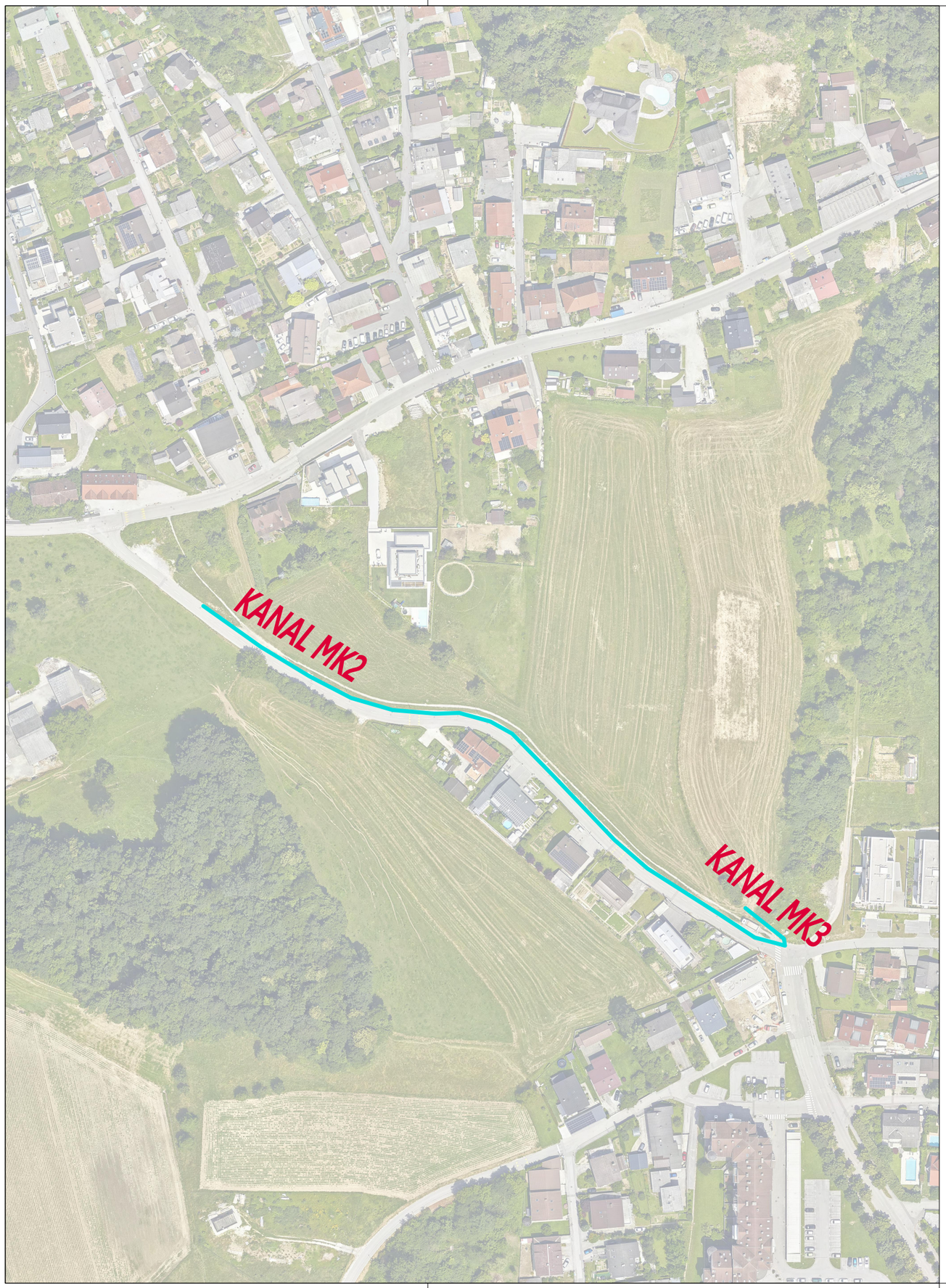
B2 ☐ Vertical lining in the pipe zone with planks that reach down to the trench bottom and are not removed before backfilling and compaction. Lining boards or devices provided that the soil is compacted after the linings are removed.

B3 ☐ Vertical lining in the pipe zone with sheet piling or lightweight sheeting and compaction against the lining reaching down below the trench bottom. There is no safe calculation model for determining vertical lining with wooden planks, boards or devices that are not removed before backfilling and compaction the pipe zone.

B4 ☐ Bedding compacted in layers against the native soil or in the embankment with proof of the required compaction degree to ZTVE-StB. Bedding condition B4 does not apply to soils of group G4.

GRAFIČNI DEL

G/1	TEHNIČNI PRIKAZI	
101.1	Pregledna situacija	1:1000
104.1	Zbirna karta komunalnih naprav	1:500
121.1	Situacija padavinske kanalizacije	1:500
131.1	Karakteristični prečni prerez, Pilonova	1:500
150.1	Vzdolžni profil kanala MK2	1:1000/100
150.2	Vzdolžni profil kanala MK3	1:1000/100
151.1	Detajl izkopa komunalnega voda	1:25
151.2	Detajl polaganja komunalnega voda	1:25
151.3	Detajl revizijskega jaška	1:25
151.4	Detajl prečkanja komunalnih vodov	1:25
151.5	Detajl požiralnika z LTŽ rešetko	1:25
151.6	Detajl vpada z požiralnika	1:25
151.7	Detajl prepadnega jaška	1:25
151.8	Detajl priključitve novega cevovoda DN 800 na obstoječo kanalizacijo Ø 1000	1:25



PREGLEDNA SITUACIJA

PROJEKTANT

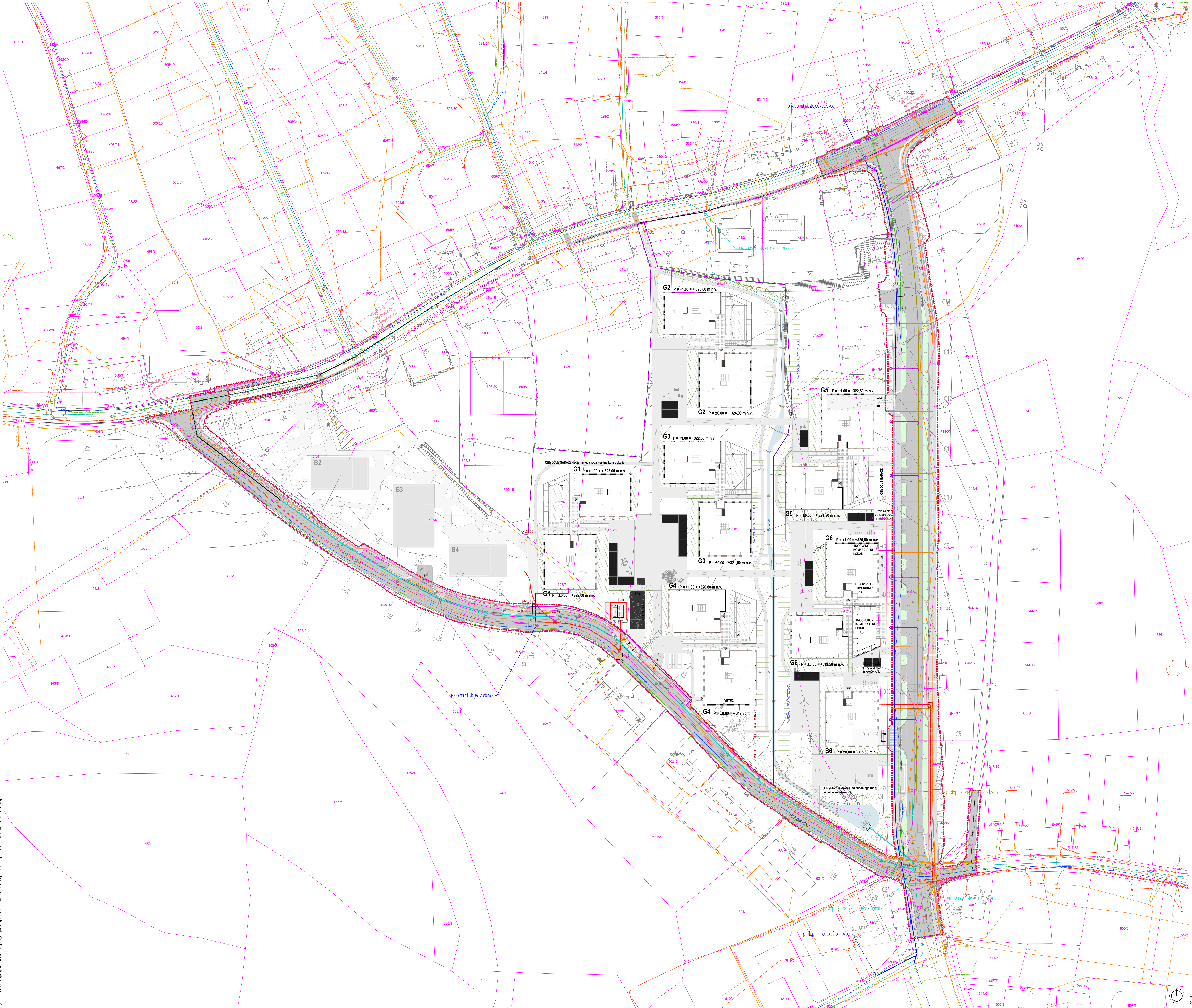
LUZ, d.d.
Verovškova ulica 64
1000 Ljubljana

W www.luz.si
E info@luz.si
T +386(0)1 360 24 00

OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	
VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Pregledna situacija padavinske kanalizacije
DATUM	julij 2026
OPOMBE	

ŠT. PROJEKTA:	**9237**
ŠT. NAČRTA:	**9237/2_2**
MERILO:	**1:2000**
ŠT. RISBE:	**101.1**

0m 10m 20m 50m
M 1:500



LEGENDA KOMUNALNIH VODOV	OBSTOJEČI	PREDVIDENI PREDMET PROJEKTA	PREDVIDENI NI PREDMET PROJEKTA
Kanalizacija			
Kanalizacija - meteorna			
Vodovod			
Plinovod			
Vročevod			
Električni vod NN			
Električni vod VN			
Javna razsvetljava			
TK Telekom			
TK Telemach			
TK ostalo			
Naftovod			

ZBIRNA KARTA KOMUNALNIH NAPRAV

PROJEKTANT	LUZ, d.d. Verovškova ulica 64 1000 Ljubljana	W www.luz.si E info@luz.si T +386(0)1 360 24 00
OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA	
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana	
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POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272	
SODELAVCI		


VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	9237
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	9237/2_2
VSEBINA RISBE	Zbirna karta komunalnih naprav	MERILO:	1:500
		ŠT. RISBE:	104.1
DATUM	julij 2026		
OPOMBE			

1.00m²

2026 x:\projekti\9237_pkg_dgd_jki_oppn_191_kamna_gorica\pzr\9237_pzr_02_2_mk_luz_zkn_d_1.dwg

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LEGENDA:

- NOVI ASFALT
- NOVI ASFALT, KOLESARSKA STEZA
- TLAKOVANJE
- ZELENICA
- TAKTILNE OZNAKE
- PREDVIDENA ZASADITEV
- PADAVINSKA KANALIZACIJA
- OBSTOJEČA FEKALNA KANALIZACIJA
- OBSTOJEČA PADAVINSKE KANALIZACIJA
- PE3 PROSTORSKE ENOTE

SITUACIJA PADAVINSKE KANALIZACIJE 1

PROJEKTANT	LUZ, d.d. Verovškova ulica 64 1000 Ljubljana	W www.luz.si E info@luz.si T +386(0)1 360 24 00
OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA	
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana	
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272	
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272	
SODELAVCI		

VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	9237
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	9237/2_2
VSEBINA RISBE	situacija padavinske kanalizacije 1	MERILO:	1:500
DATUM	julij 2026	ŠT. RISBE:	120.1
OPOMBE			

0.34m²

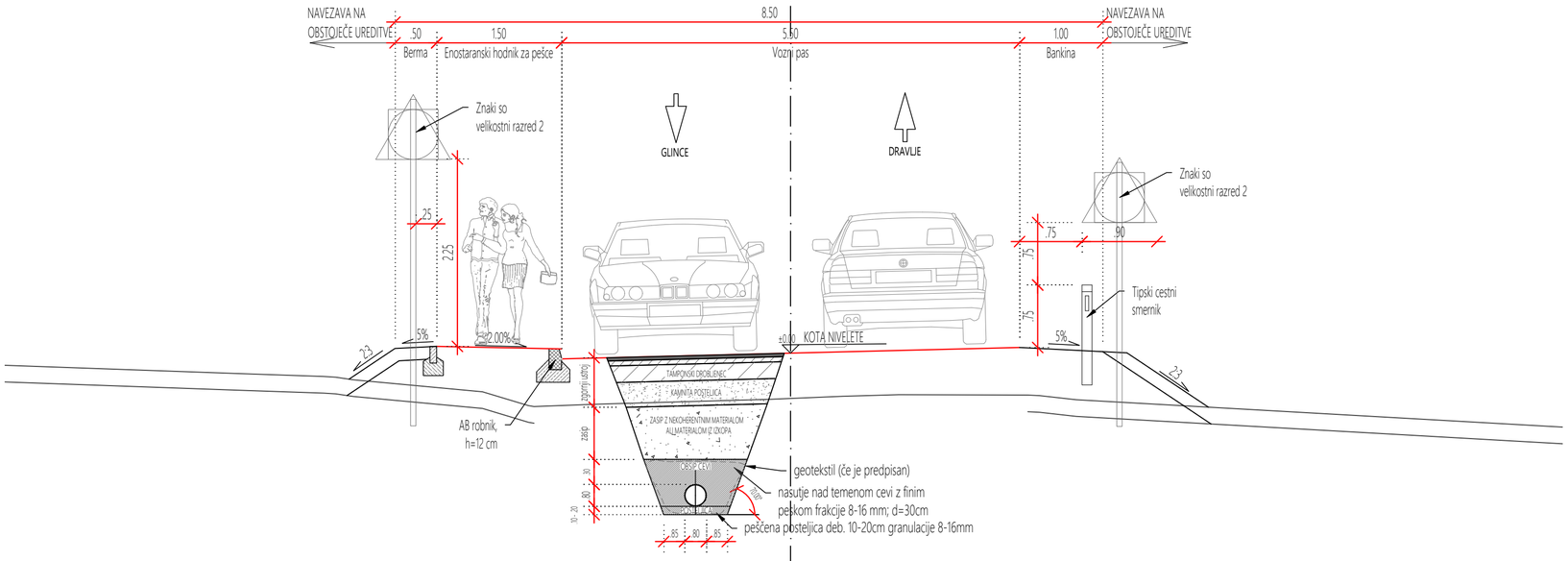
0m 1m 2m 5m

M 1:50

KPP 1,

PILONOVA ULICA, ENOSTARANSKI HODNIK ZA PEŠCE

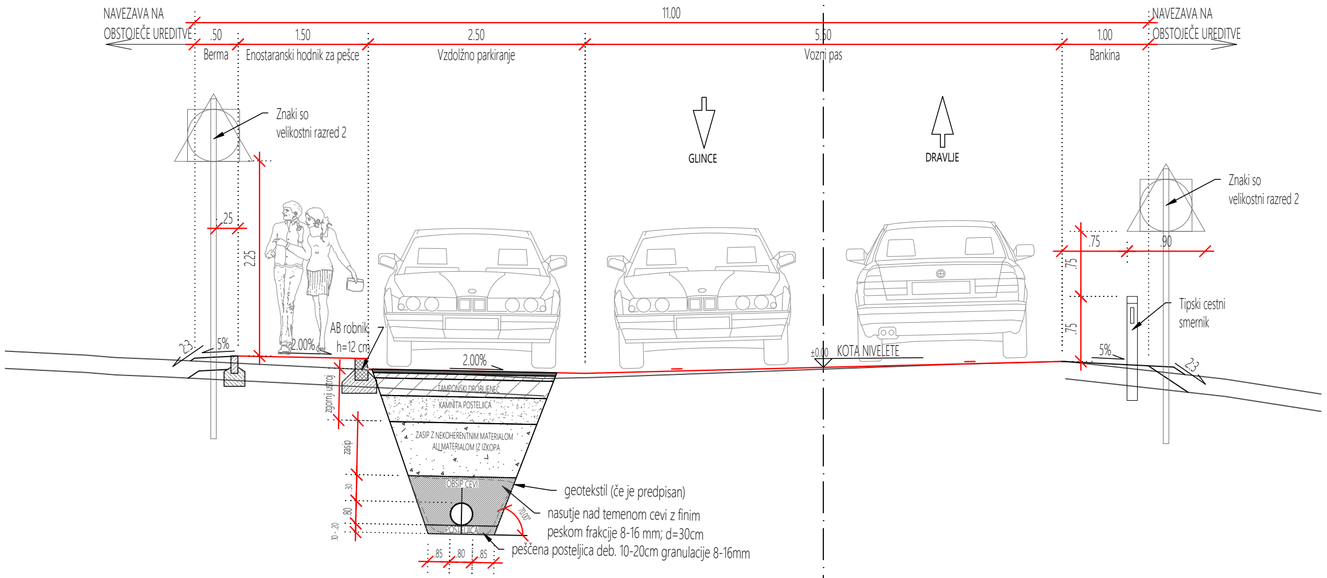
M 1:50



KPP 2,

PILONOVA ULICA, ENOSTARANSKI HODNIK ZA PEŠCE IN VZDOLŽNO PARKIRANJE

M 1:50



PROJEKTANT

LJUBLJANSKI URBANISTIČNI ZAVOD d.d.
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Telefon +386(0)1 360 24 00
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OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica - zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
INVESTITOR	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI INŽENIR	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	

VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Karakteristični prečni prerez, Pilonova
DATUM	julij 2026
OPOMBE	

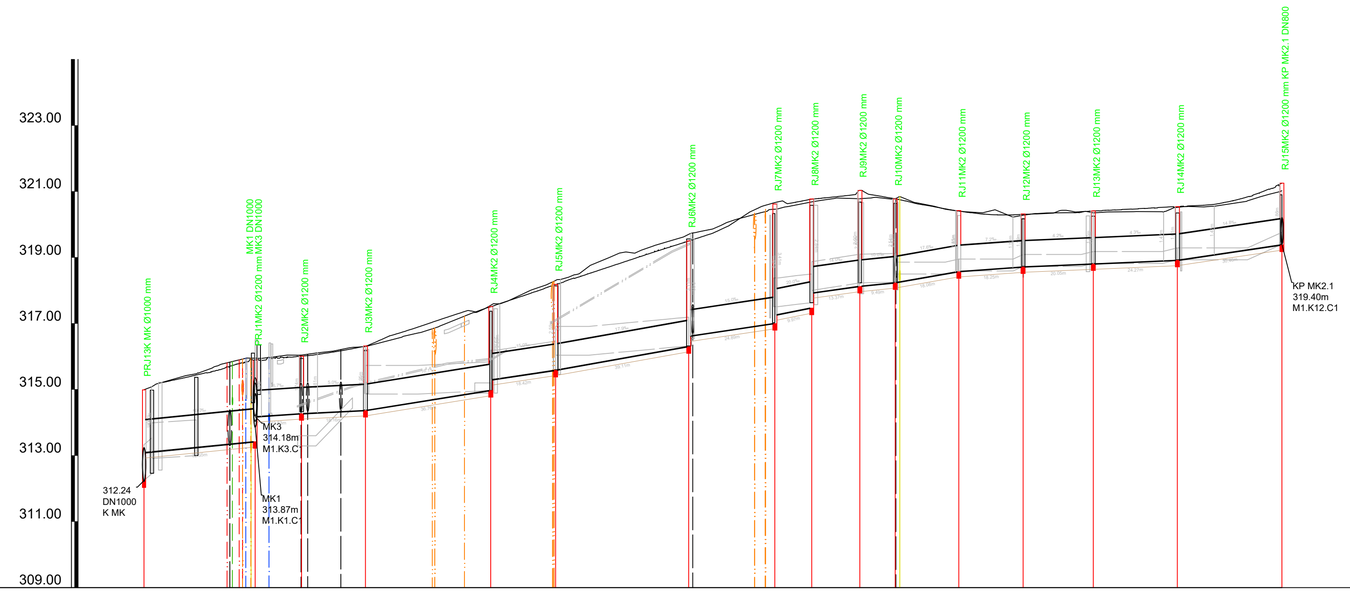
ŠT. PROJEKTA:	9237
ŠT. NAČRTA:	9237/2_2
MERILO:	1:50
ŠT. RISBE:	131.1

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0.25m²

VZDOLŽNI PROFIL KANALA MK2

MK2
M 1:1000/100
M1.K2



NAZIV	PRJ13K MK - K MK	PRJ1MK2	RJ2MK2	RJ3MK2	RJ4MK2	RJ5MK2	RJ6MK2	RJ7MK2	RJ8MK2	RJ9MK2	RJ10MK2	RJ11MK2	RJ12MK2	RJ13MK2	RJ14MK2	RJ15MK2	
STACIONAŽA	0.00	33.65	47.67	67.03	104.99	124.61	164.92	191.01	202.18	216.75	227.44	246.71	266.17	287.42	312.89	344.55	
KOTA TERENA	314.99	315.95	316.04	316.30	317.55	318.30	319.70	320.46	320.68	320.78	320.77	320.41	320.28	320.35	320.52	321.02	
KOTA IZTOKA, VTOKA	312.24	313.09	313.43	314.18	314.27	314.37	314.98	315.30	315.59	316.31	316.62	317.01	317.26	317.48	317.93	318.13	318.24	318.58	318.72	318.81	318.92	319.39	
GLOBINA IZKOPA	2.93	2.07	2.69	1.94	1.94	2.10	2.74	2.42	2.88	3.56	3.25	3.62	3.38	3.37	2.93	2.82	2.70	1.99	1.73	1.71	1.77	1.80	
NAKLON		10.0	6.7	5.0	16.1	15.0	17.9	15.0	20.0	14.0	10.0	17.6	7.2	4.2	4.3	14.8	
DOLŽINA		33.65	14.03	19.36	37.96	19.62	40.31	26.09	11.17	14.57	10.69	19.28	19.45	21.25	25.47	31.66	
CEV, PROFIL/DOLŽINA	GRP PN1 SN10000 DN1000 , L=33.65 m						GRP PN1 SN10000 DN800 , L=310.90 m										
STACIONAŽA OBJEKTOV	0.00	33.65	47.67	67.03	104.99	124.61	164.92	191.01	202.18	216.75	227.44	246.71	266.17	287.42	312.89	344.55	

PROJEKTANT

LUZ, d.d.
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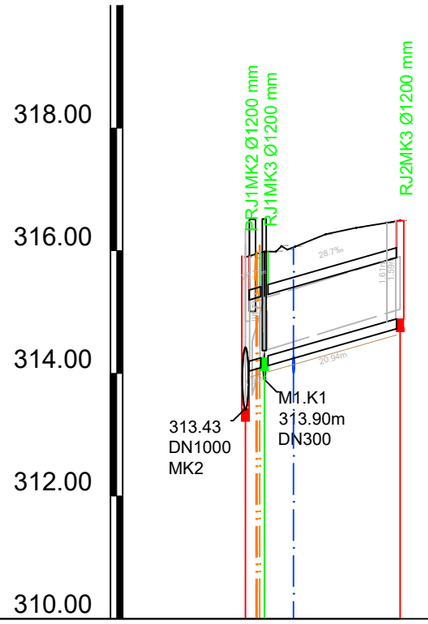
OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	

VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	9237
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	9237/2_2
VSEBINA RISBE	Vzdolžni profil kanala MK2	MERILO:	1:1000/100
		ŠT. RISBE:	150.1
DATUM	julij 2026		
OPOMBE			

0.33m²

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MK3
M 1:1000/100
M1.K3



NAZIV	RJ1MK3	PRJ1MK2 - MK2	RJ2MK3	
STACIONAŽA	0.00	3.10	25.23	
KOTA TERENA	315.90	315.98	316.49	
KOTA IZTOKA, VTOKA	313.43	314.28	314.90	
GLOBINA IZKOPA	2.73	1.98	1.85	
NAKLON		28.7		
DOLŽINA	3.10	22.14		
CEV, PROFIL/DOLŽINA	BC C35/45 DN1000 , L=25.23 m			
STACIONAŽA OBJEKTOV	0.00	3.10	25.23	

VZDOLŽNI PROFIL KANALA MK3

PROJEKTANT

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Verovškova ulica 64
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OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	

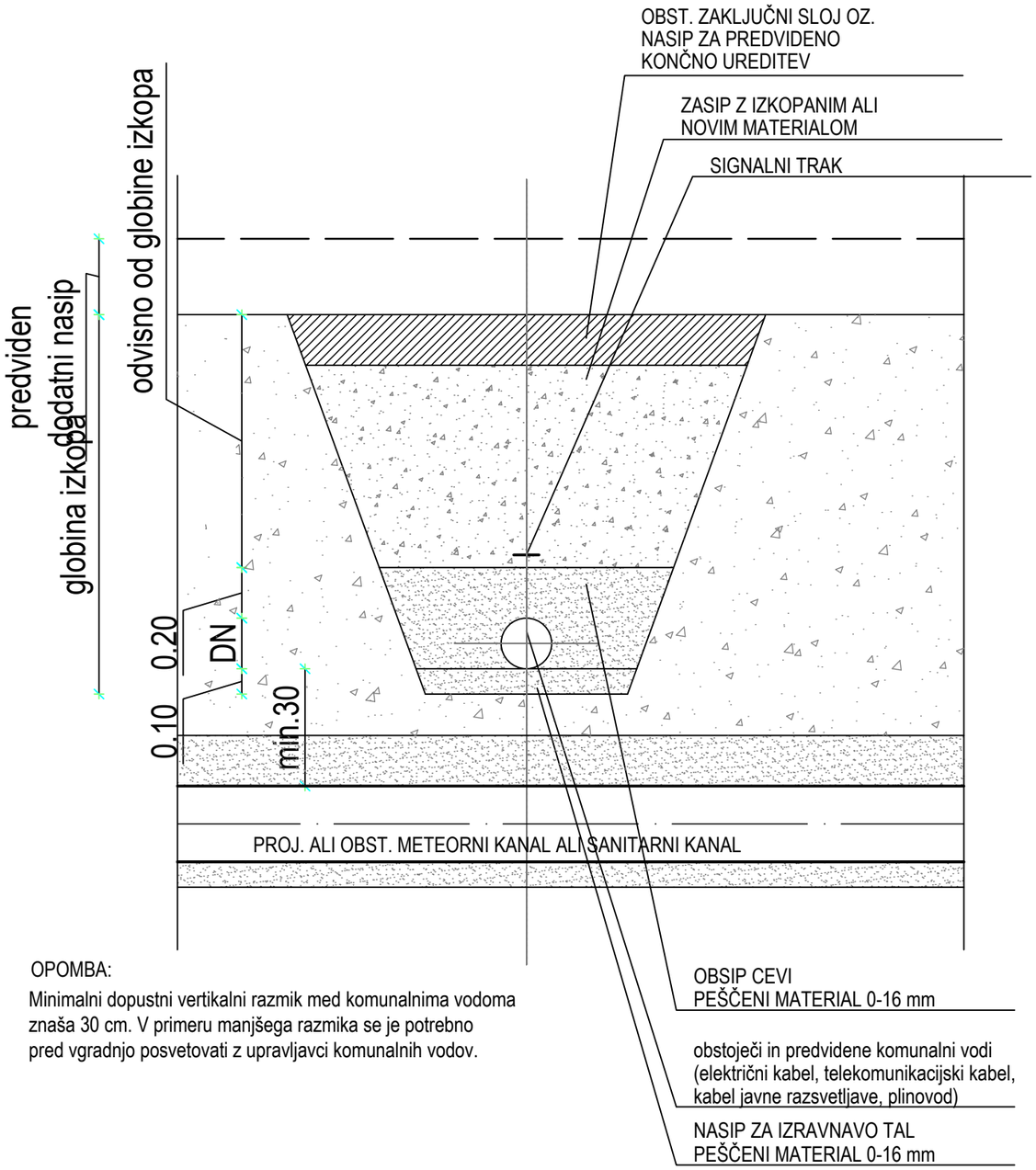
VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	9237
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	9237/2_2
VSEBINA RISBE	Vzdolžni profil kanala MK3	MERILO:	1:1000/100
		ŠT. RISBE:	150.2
DATUM	julij 2026		
OPOMBE			

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0.12m²

DETAJL - PREČKANJE KOMUNALNIH VODOV NAD PROJEKTIRANIM KANALOM

M 1:25



OPOMBA:

Minimalni dopustni vertikalni razmik med komunalnima vodoma znaša 30 cm. V primeru manjšega razmika se je potrebno pred vgradnjo posvetovati z upravljavci komunalnih vodov.

DETAJL POLAGANJA CEVI V ŠIROKEM IZKOPU

PROJEKTANT

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OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	

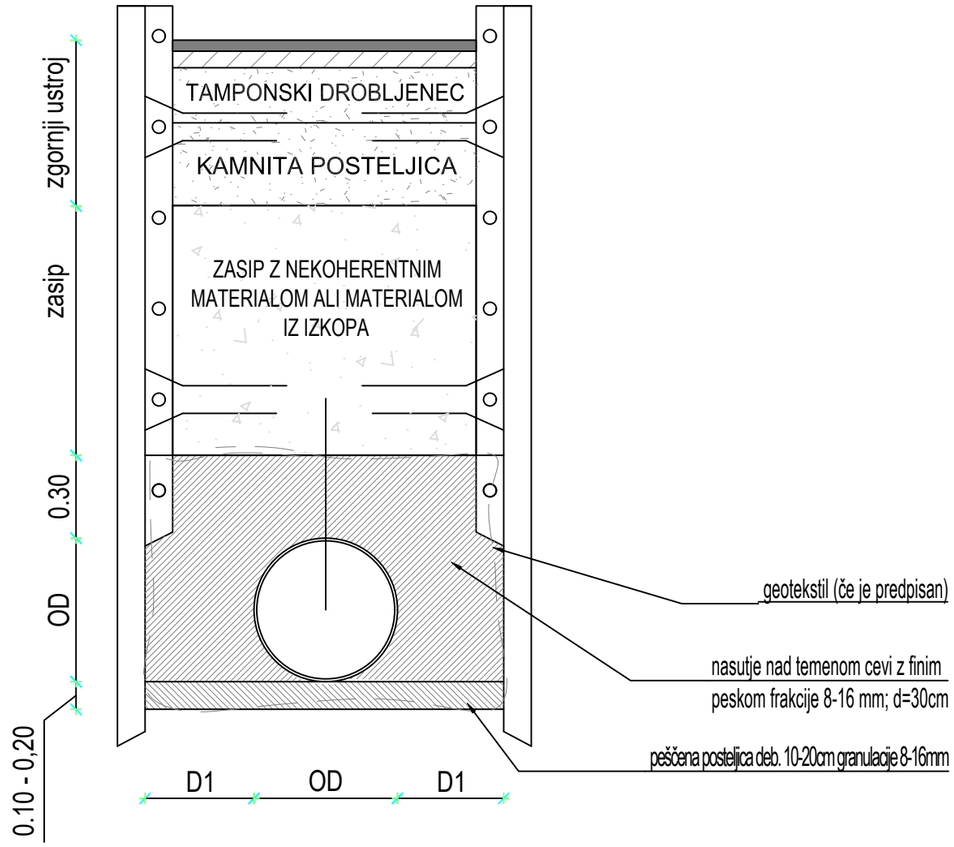
VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	9237
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	9237/2_2
VSEBINA RISBE	Detajl polaganja cevi v širokem izkopu	MERILO:	1:25
		ŠT. RISBE:	151.1
DATUM	julij 2026		
OPOMBE			

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0.12m²

DETAJL POLAGANJA KANALIZACIJSKIH CEVI V VERTIKALNEM IZKOPU

M 1:25



NAJMANJŠA ŠIRINA JARKA (odvisno od zunanjega premera cevi OD)	
premer cevi (mm)	opažen (m)
≥225	OD+0,40
>225 - ≥350	OD+0,50
>350 - ≥700	OD+0,70
>700 - ≥1200	OD+0,85
>1200	OD+1,00

NAJMANJŠA ŠIRINA JARKA (odvisno od globine jarka)	
globina (m)	širina (m)
< 1,00	ni podano
≥ 1,00 ≤ 1,75	0,80
> 1,75 ≤ 4,00	0,90
> 4,00	1,00

OPOMBE:
Za kanale manjše od ø 500 mm je posteljica 10cm za ø 500mm in večje pa posteljica minimalno 15 cm.
Kjer so temeljna tla slabše kvalitete se pod posteljico izdela tampon, debelino določi geomehanik na terenu.
Če je prisotna talna voda se pred polaganjem pod posteljico položi primeren geotekstil, ki se ga po obsipu zaviha.

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DETAJL POLAGANJA KANALIZACIJSKIH CEVI

PROJEKTANT
LUZ, d.d.
Verovškova ulica 64
1000 Ljubljana
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T +386(0)1 360 24 00

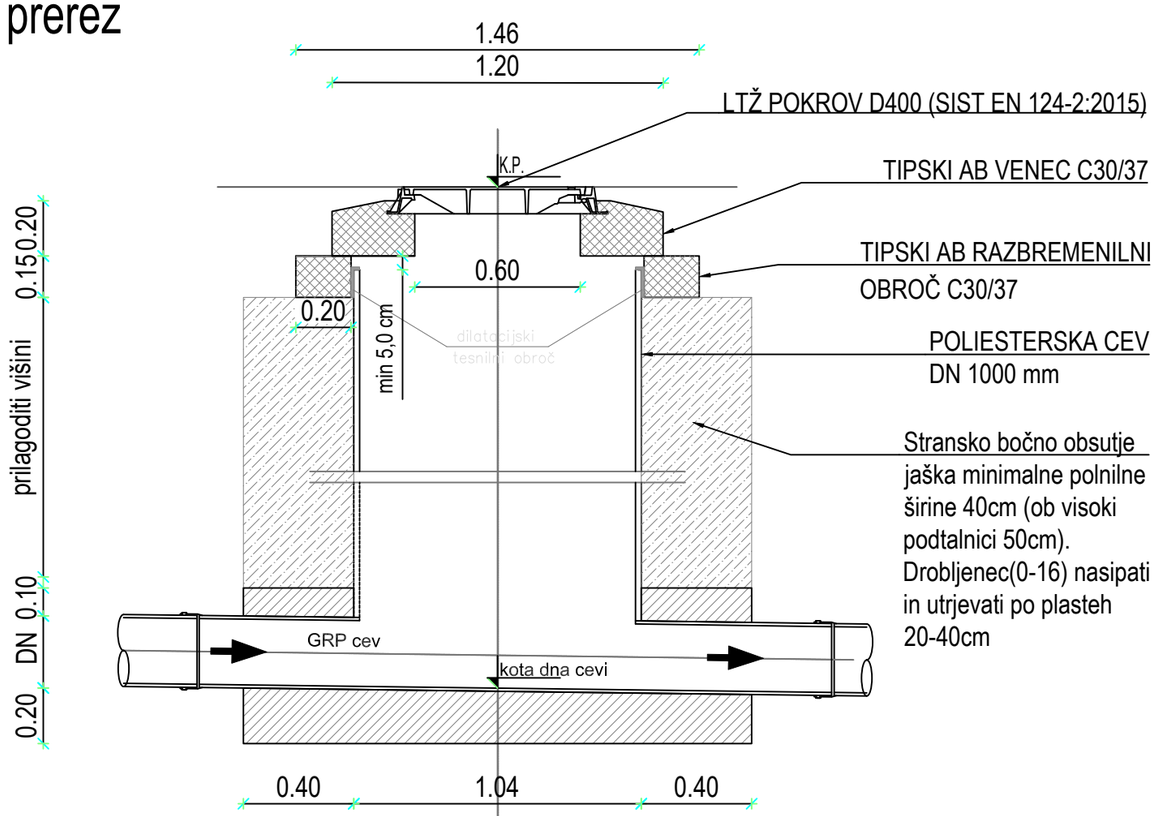
OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	
VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Detajl polaganja kanalizacijskih cevi
DATUM	julij 2026
OPOMBE	

ŠT. PROJEKTA:	**9237**
ŠT. NAČRTA:	**9237/2_2**
MERILO:	**1:25**
ŠT. RISBE:	**151.2**

0.12m²

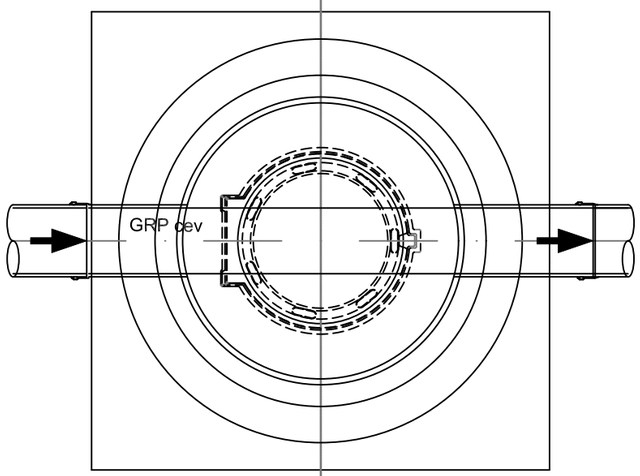
POLIESTRSKI REVIZIJSKI JAŠEK
DN 1000 mm
M 1:25

prerez



OPOMBA:
v notranjih prostorih objekta se vgradi protismradne pokrove, dim. 600x600 mm, EN 124, A15
v povoznih površinah se vgradi LTŽ pokrove, premera 600 mm, z zaklepom in protihrupnim vložkom, EN 124, D400

tloris



DETAJL REVIZIJSKEGA JAŠKA

PROJEKTANT

LUZ, d.d.
Verovškova ulica 64
1000 Ljubljana

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E info@luz.si
T +386(0)1 360 24 00

OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	
VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Detajl revizijskega jaška
DATUM	julij 2026
OPOMBE	

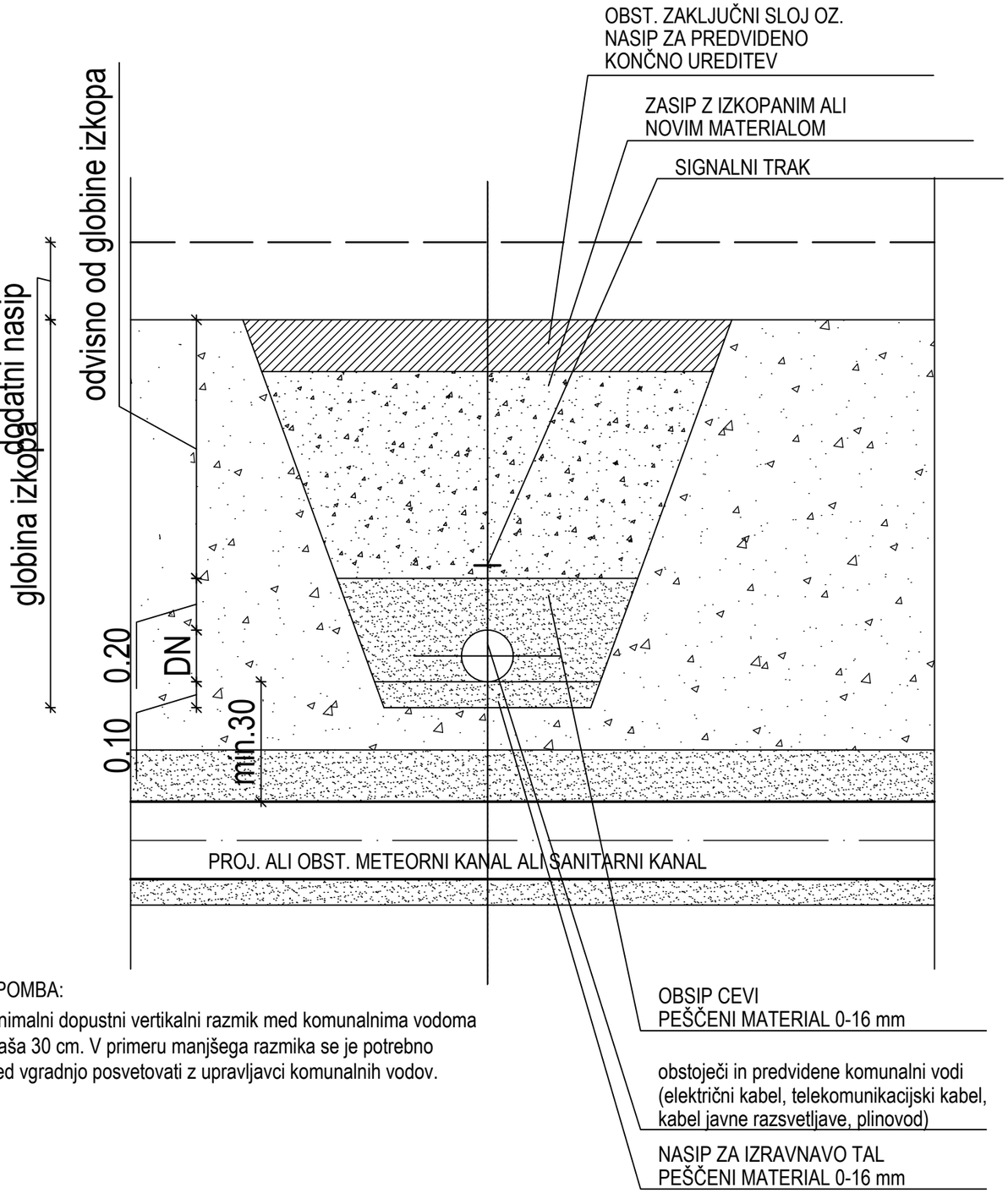
ŠT. PROJEKTA:	**9237**
ŠT. NAČRTA:	**9237/2_2**
MERILO:	**1:25**
ŠT. RISBE:	**151.3**

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0.12m²

DETAJL - PREČKANJE KOMUNALNIH VODOV NAD PROJEKTIRANIM KANALOM

M 1:25



OPOMBA:

Minimalni dopustni vertikalni razmik med komunalnima vodoma znaša 30 cm. V primeru manjšega razmika se je potrebno pred vgradnjo posvetovati z upravljavci komunalnih vodov.

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0.12m²

DETAJL PREČKANJA KOMUNALNIH VODOV

PROJEKTANT

LUZ, d.d.
Verovškova ulica 64
1000 Ljubljana

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T +386(0)1 360 24 00

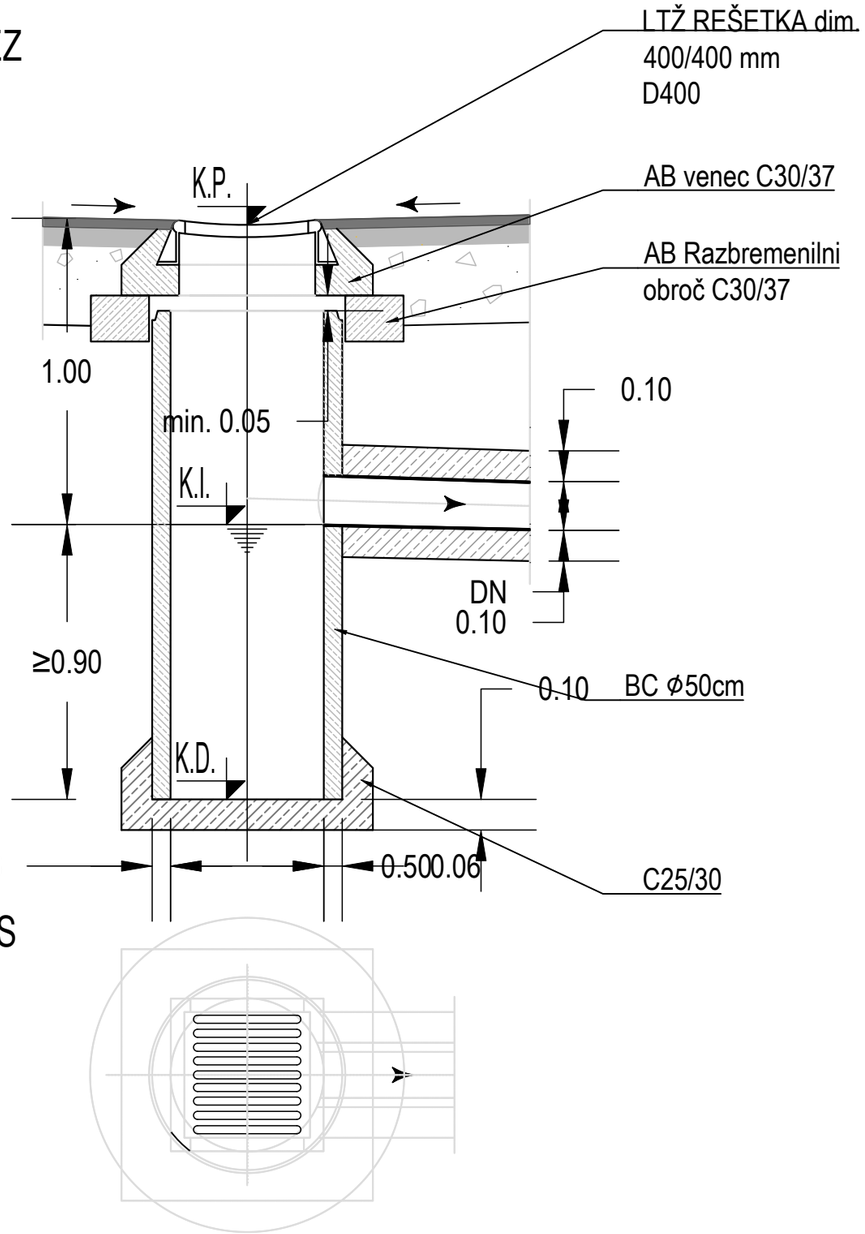
OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	
VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Detajl prečkanja komunalnih vodov
DATUM	julij 2026
OPOMBE	

ŠT. PROJEKTA:	**9237**
ŠT. NAČRTA:	**9237/2_2**
MERILO:	**1:25**
ŠT. RISBE:	**151.4**

DETAJL CESTNEGA POŽIRALNIKA Z LTŽ REŠETKO

M 1:25

PREREZ



TLORIS

OPOMBA:
zasip v območju jaška do 0,50 m v plasteh deb. do 30 cm z drobljencem 0-32 mm, zbitost po Proctorju 97%

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0.12m²

DETAJL CESTNEGA POŽIRALNIKA Z LTŽ REŠETKO

PROJEKTANT
LUZ

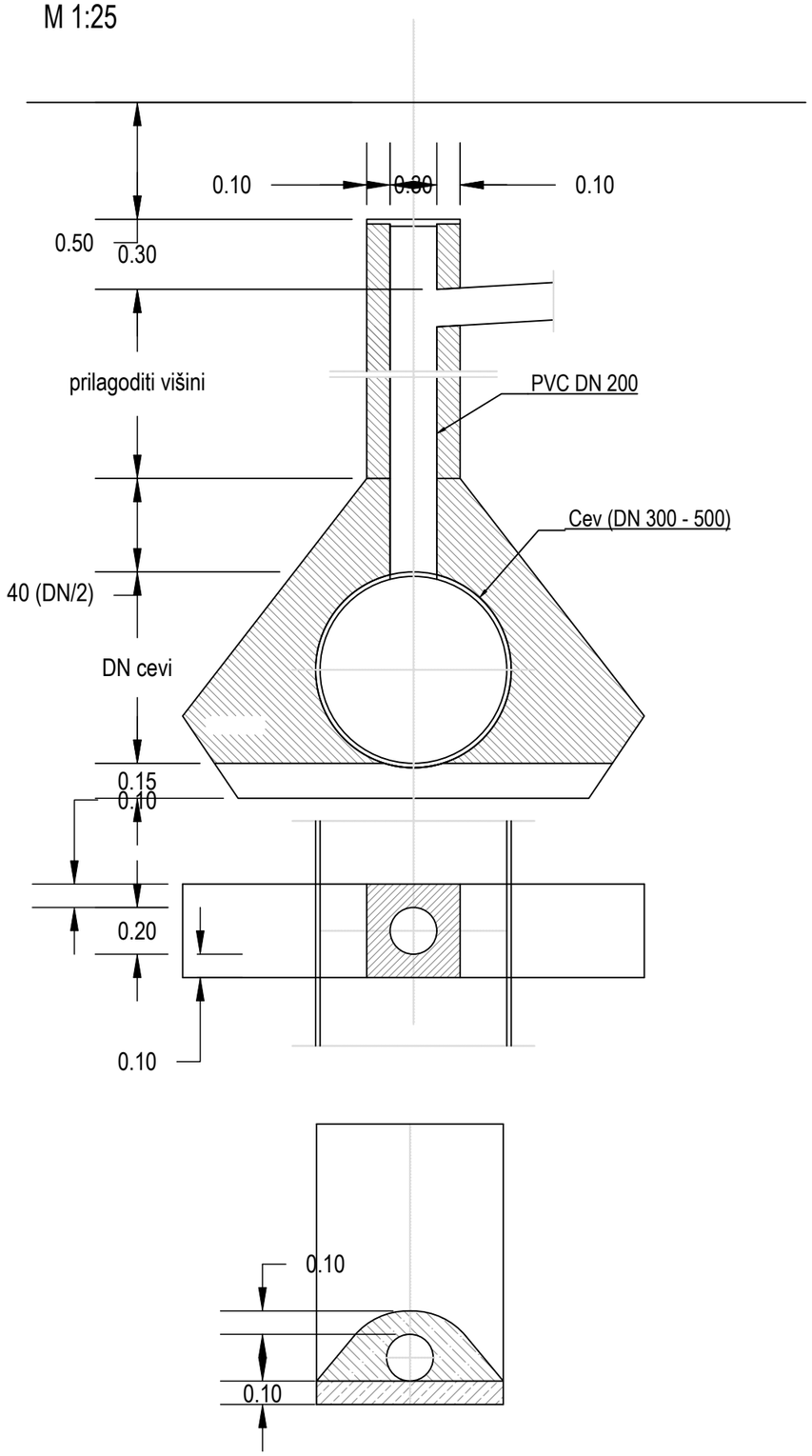
LUZ, d.d.
Verovškova ulica 64
1000 Ljubljana

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E info@luz.si
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OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	

VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	**9237**
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	**9237/2_2**
VSEBINA RISBE	Detajl cestnega požiralnika z LTŽ rešetko	MERILO:	**1:25**
		ŠT. RISBE:	**151.5**
DATUM	julij 2026		
OPOMBE			

DETAJL VPADA IZ CESTNEGA POŽIRALNIKA
M 1:25



DETAJL VPADA IZ CESTNEGA POŽIRALNIKA

PROJEKTANT

LUZ, d.d.
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1000 Ljubljana

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OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	

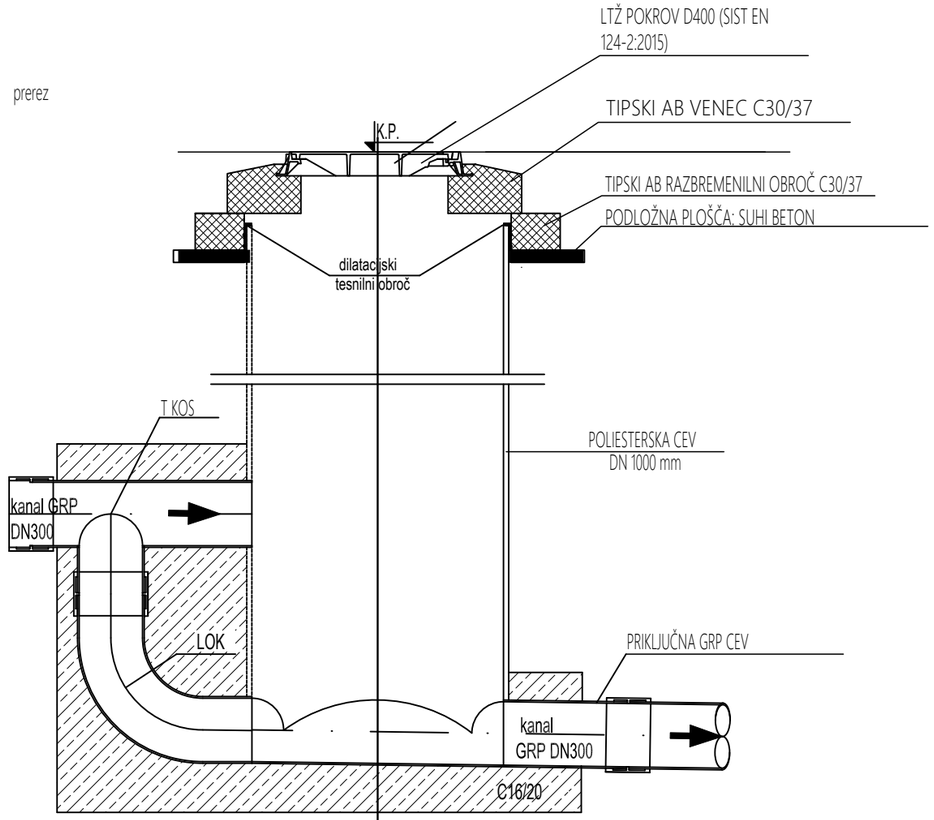
VRSTA DOKUMENTACIJE	PZR	ŠT. PROJEKTA:	9237
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije	ŠT. NAČRTA:	9237/2_2
VSEBINA RISBE	Detajl vpada iz cestnega požiralnika	MERILO:	1:25
		ŠT. RISBE:	151.6
DATUM	julij 2026		
OPOMBE			

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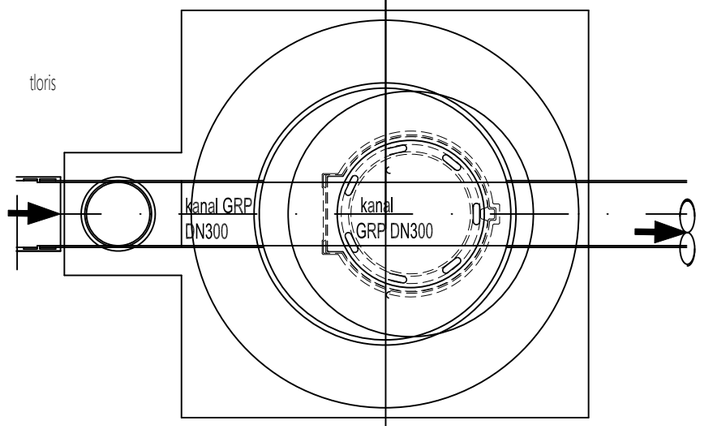
PREPADNI POLIESTRSKI REVIZIJSKI JAŠEK
DN 1200 mm
M 1:25

prerez



OPOMBA:
v notranjih prostorih objekta se vgradi protismradne pokrove, dim. 600x600 mm, EN 124, A15
v povoznih površinah se vgradi LTŽ pokrove, premera 600 mm, z zaklepom in protihrupnim vložkom, EN 124, D400

tloris



DETAJL PREPADNEGA REVIZIJSKEGA JAŠKA

PROJEKTANT

LUZ, d.d.
Verovškova ulica 64
1000 Ljubljana

W www.luz.si
E info@luz.si
T +386(0)1 360 24 00

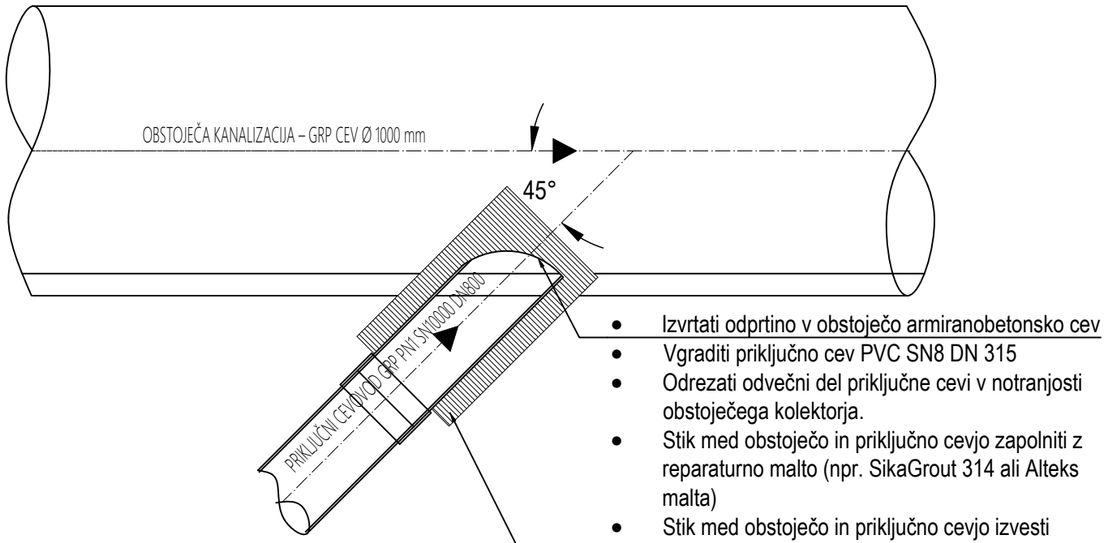
OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	
VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Detajl prepadnega revizijskega jaška
DATUM	julij 2026
OPOMBE	

ŠT. PROJEKTA:	**9237**
ŠT. NAČRTA:	**9237/2_2**
MERILO:	**1:25**
ŠT. RISBE:	**151.7**

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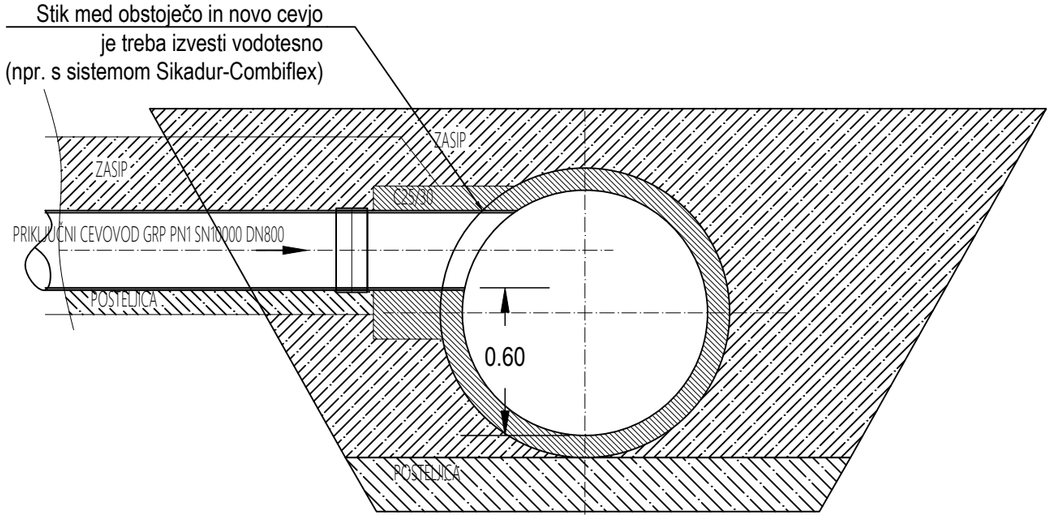
TLORIS



- Izvrtati odprtino v obstoječo armiranobetonsko cev
- Vgraditi priključno cev PVC SN8 DN 315
- Odrezati odvečni del priključne cevi v notranjosti obstoječega kolektorja.
- Stik med obstoječo in priključno cevjo zapolniti z reparaturno malto (npr. SikaGrout 314 ali Alteks malta)
- Stik med obstoječo in priključno cevjo izvesti vodotesno (npr. s sistemom Sikadur-Combiflex)

BETONSKA OBLOGA
PRIKLJUČNE CEVI
C 25/30

PREREZ



DETALJ PRIKLJUČITVE NOVEGA CEVOVODA DN 800 NA OBSTOJEČO KANALIZACIJO Ø 1000

PROJEKTANT

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OBJEKT	Komunalno opremljanje območja OPPN 191 Podutik Kamna Gorica zahod in 34 Cesta Andreja Bitenca - Podutiška - 1 FAZA
NAROČNIK	MESTNA OBČINA LJUBLJANA Mestni trg 1 1000 Ljubljana
VODJA PROJEKTIRANJA	Uroš Maršič, univ. dipl. ing. grad G-3272
POOBLAŠČENI STROKOVNJAK	Uroš Maršič, univ. dipl. ing. grad G-3272
SODELAVCI	
VRSTA DOKUMENTACIJE	PZR
VRSTA NAČRTA	2/2 Načrt padavinske kanalizacije
VSEBINA RISBE	Detalj priključitve novega cevovoda DN 800 na obstoječo kanalizacijo Ø 1000
DATUM	julij 2026
OPOMBE	

ŠT. PROJEKTA:	**9237**
ŠT. NAČRTA:	**9237/2_2**
MERILO:	**1:25**
ŠT. RISBE:	**151.8**

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