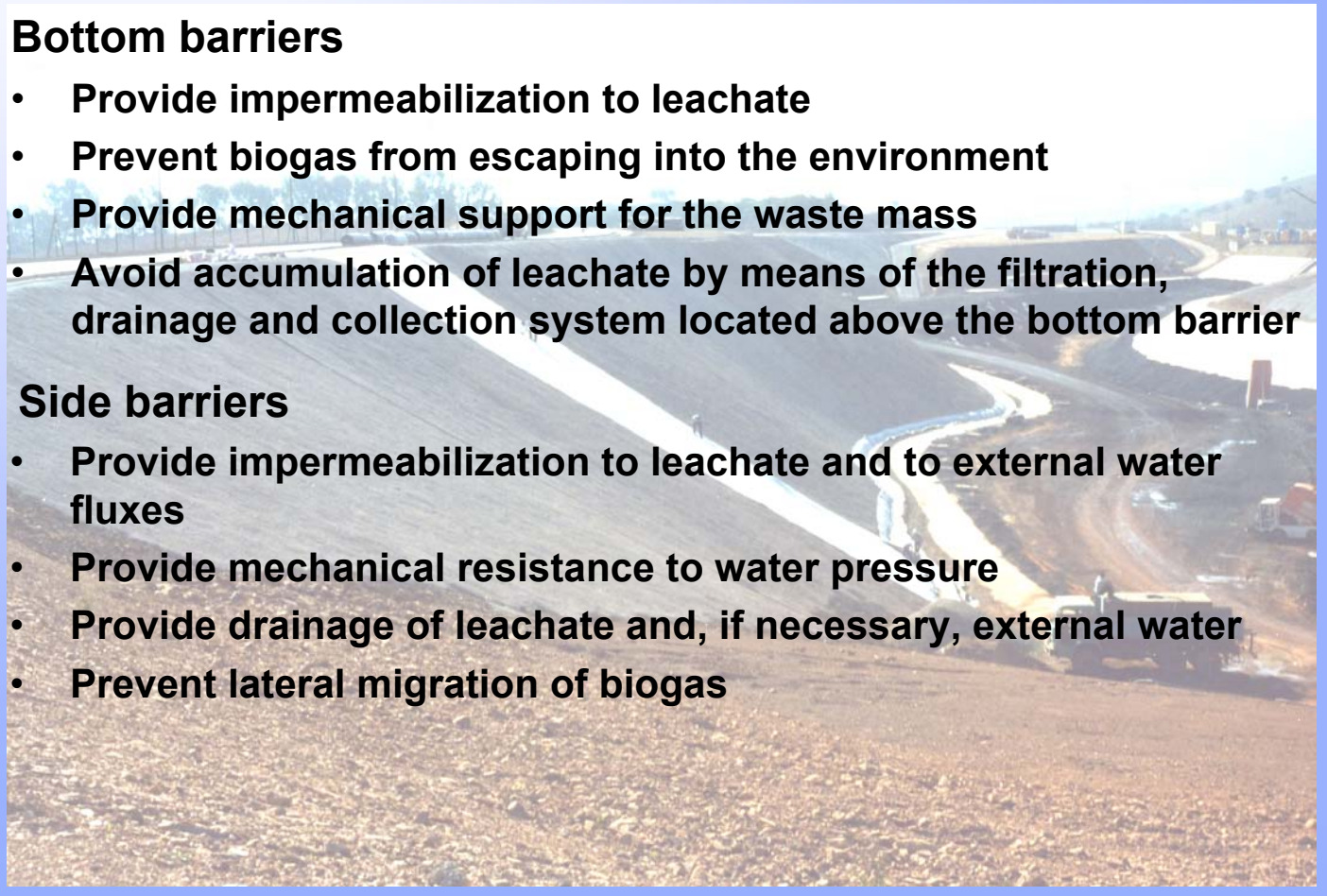
SISTEMI DI IMPERMEABILIZZAZIONE DELLE DISCARICHE



Bottom barriers

- Provide impermeabilization to leachate
- Prevent biogas from escaping into the environment
- Provide mechanical support for the waste mass
- Avoid accumulation of leachate by means of the filtration, drainage and collection system located above the bottom barrier

Side barriers

- Provide impermeabilization to leachate and to external water fluxes
- Provide mechanical resistance to water pressure
- Provide drainage of leachate and, if necessary, external water
- Prevent lateral migration of biogas

Elementi del sistema barriera di base

Materiali naturali:
- Argilla
- Bentonite
- Miscele di sabbia e bentonite
- Sabbia

Materiali sintetici (detti anche geosintetici):
- Geomembrane
- Geotessili
- Geogriglie
- Georeti
- Geompositi

Functions of barrier system components

1. Lining
2. Leachate percolation
3. Leachate drainage and collection
4. Soil reinforcement
5. Mechanical protection
6. Separation
7. Erosion control
8. Water filtration
9. Water drainage and collection
10. Biogas migration control

APPLICABILITY LEVEL

- high
- medium
- low

		Functions									
		1	2	3	4	5	6	7	8	9	10
Natural materials	Bentonite soil mixture	high				medium					
	Clayey soil	high				medium					
	Sand		medium	low		high	low		high	low	high
	Gravel		high	high	low		low		low	high	high
Synthetic materials	Geomembrane	high									
	Geotextile		low		medium	high	high	low	high	low	low
	Geonet			high	medium		medium	medium		high	low
	Geogrid				high			high			
	Geocomposite bentonite	high				medium	low				
	Geocomposite drain		low	medium	low	low	medium		medium	high	high

(T. H. Christensen *et al.*, 1994)

Natural materials used in the construction of lining systems

- *Clayey soil*

  is the most common natural lining material. The main factors which affect the quality of clay liners are hydraulic conductivity, degree of compaction, moisture content, clay composition, field placement technique and liner thickness

- *Bentonite*

  Is a general term for indicating clay minerals capable of swelling, when wet, up to 15-18 times their dry volume. Mixtures of bentonite and sandy soil can provide a low permeability liner, particularly useful in areas where natural clay is not available

Natural materials used in the construction of lining systems

- *Sand*

  is widely used to protect synthetic liners and to increase filter stability

- *Gravel*

  Is the main material for filtering and draining. The efficiency of a granular bed depends on the porosity, grain shape and strength, the rock quality (resistance to weathering and carbonate content), stability of the filter, the drainage layer thickness and general engineering of the system

Synthetic materials used in the construction of lining systems

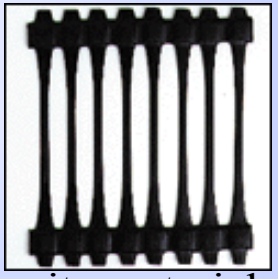
- *Synthetic membranes*
  are materials of low permeability and serve as barriers in the liner system between mobile polluting substances and the groundwater; syntheticmembranes are also used in final cover systems as barrier layers to minimize the amount of rainwater entering closed unuts
- *Geotextiles*
  are used in liner systems to provide separation between solid wastes and the leachate collection system or between the membrane and cover or embankment soils, to reinforce the membrane against puncture from the subgrade or the waste that is placed above it, and to provide filtration around collection pipes
- *Geonets*

  Are grid-like products based on polyethylene (PE) or polypropylene (PP) and are used exclusively as in-plane drainage systems; they are always used with geotextiles, membranes or other materials in the planes above and below them

Synthetic materials used in the construction of lining systems

- *Geogrids*

  Are used in the construction of waste disposal units to reinforce soils in the dikes; they are also used within landfills to steepen earth slopes or to create embankments between cells. Geogrids should not be confused with geonets which are used exclusively for drainage



- *Geocomposites*

  Identify a large range of composite materials that consist of two or more geosynthetics. Drainage geocomposites are sometimes used as leachate-collection subsystems with a geotextile filter attached, but they appear to be particularly useful as surface water collectors in a landfill closure system where normal stresses are relatively low

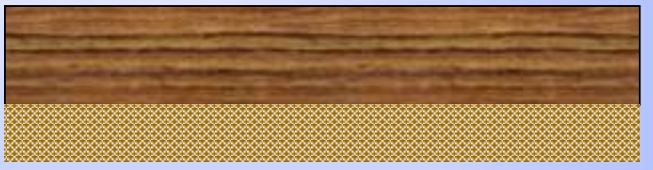
- *Pipes and fittings*

  Plastic pipes based primarily on PVC or high-density pilyethylene (HDPE) are used in constructing leachate-collection and leak-detection systems and in gas venting applications.

Structure of the barrier system

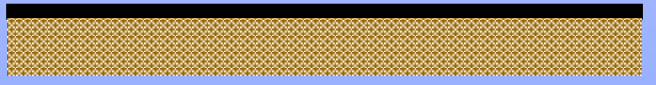
a) Single liner of natural material (low permeability soil)

this configuration represents the simplest lining system still most widely adopted, although it is considered accettable only under specific and fully safe hydrological situations

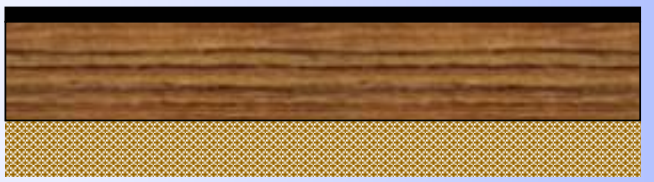


b) Single liner of synthetic material (geomembrane)

a single geomembrane in the case of waste containment does not afford any safety guarantee and may be used only under conditions similar to those mentioned for a)



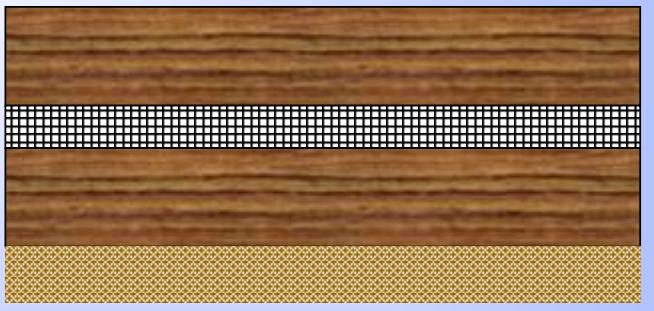
c) *Single composite liner (clayey soil + geomembrane)*



d) *Single composite liner (geomembrane + clayey soil + geomembrane)*

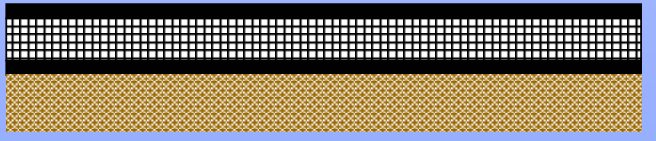
e) Double liner of natural material

this configuration, which is rarely used, foresees the installation of separation material (such geotextiles) between the mineral layers and the drainage layers



f) Double liner of synthetic material

the double synthetic liner has often been proposed, particularly for the side barrier systems. Synthetic materials, such as geonet, can be conveniently adopted. The efficiency of this configuration is severely influenced by the quality of the installation and long-term behaviour of the geomembranes

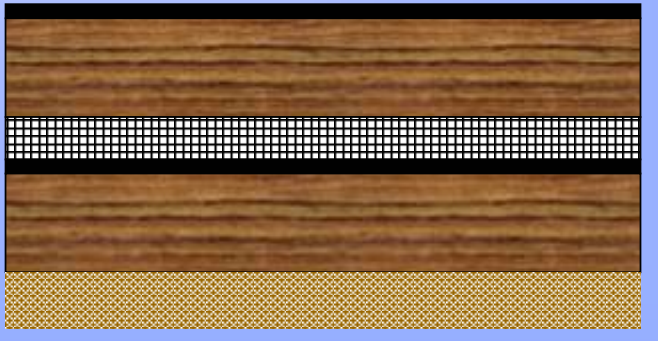


g) Double semicomposite liner (double synthetic top liner+single ntural liner

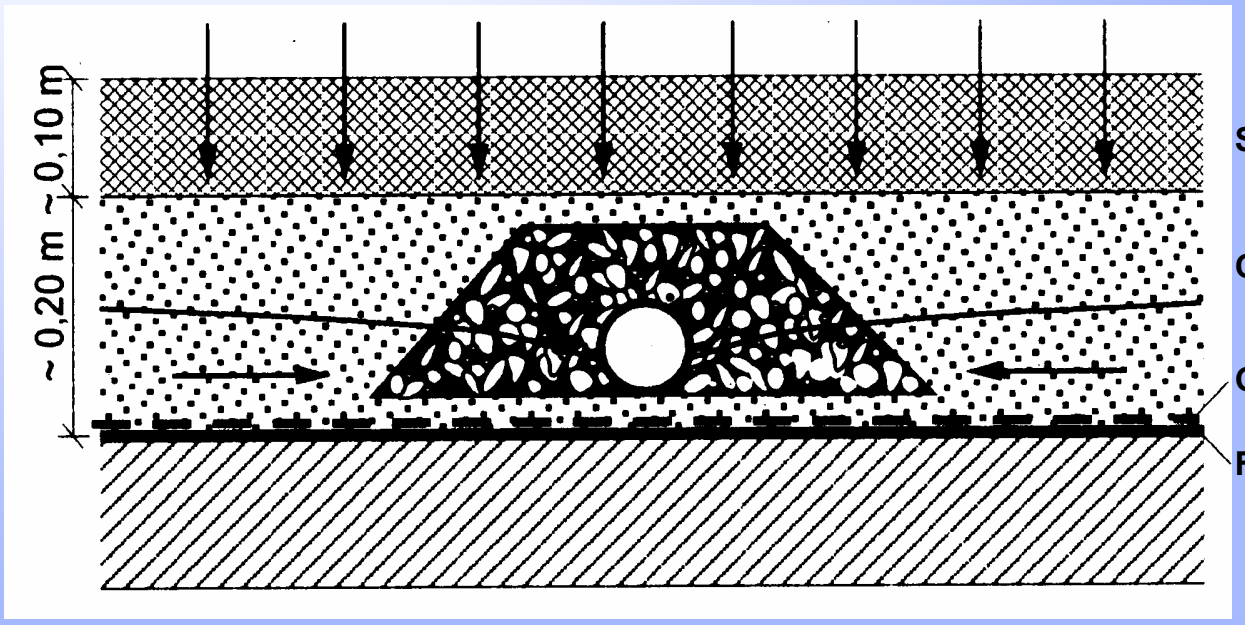
this structure tends to couple the advantages of the single compoite liner and the double synthetic liner, thus providing further safety level. Global efficiency still depends on the long-term behaviour of the geomembrane

h) Double composite liner

this configuration fully exploits the possibility of a control drainage for the double lining system. It is the most expensive solution and nowadays is adopted mainly for industrial waste lndfill. The interest for MSW landfill applications is, however, increasing in order to minimize any adverse environmental impact



Drainage solution



Leakage in liner system

- Leakage through a clay-only liner:

$$Q_s = k_s \cdot i \cdot A$$

Q_s = leakage rate through the clay
k_s = hydraulic conductivity of the clay (m/s)
i = gradient (dimensionless), expressed as the ratio of leachate head (m) to the liner thickness (m)
A = area of liner considered (m^2)

- Leakage through a single hole in a geomembrane-only liner

$$Q_G = C_B \cdot a \cdot (2gh)^{½}$$

Q_G = leakage rate through a hole in the geomembrane
C_B = dimensionless coefficient dependent on the shape of the orifice
a = area of the hole (m2)
g = acceleration due to gravity (m/s^2)
h = leachate head (m)

Assumptions:
• Frequency of 10 holes per hectare, each having a diameter equal to the thickness of the geomembrane
• Very high permeabilities of the media above and below the geomembrane

- Leakage through a geomembrane/clay composite

$$Q_G = 0{,}21 \cdot a^{0,1} \cdot h^{0,9}\, k_s^{0,74}$$

Assuptions
- Very large hydraulic conductivity of the materials above and below the liners
- No lateral gradients

Leakage rates can be reduced by one or two orders of magnitude by the use of a composite liner.

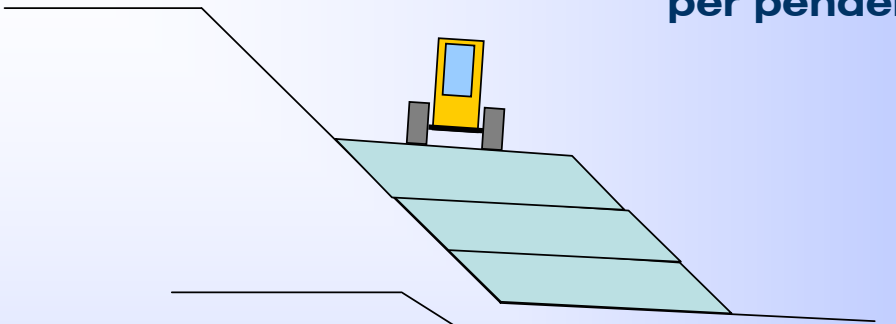
Progettazione e realizzazione sistemi di impermeabilizzazione

Principali tecnologie di imp. con materiali naturali:

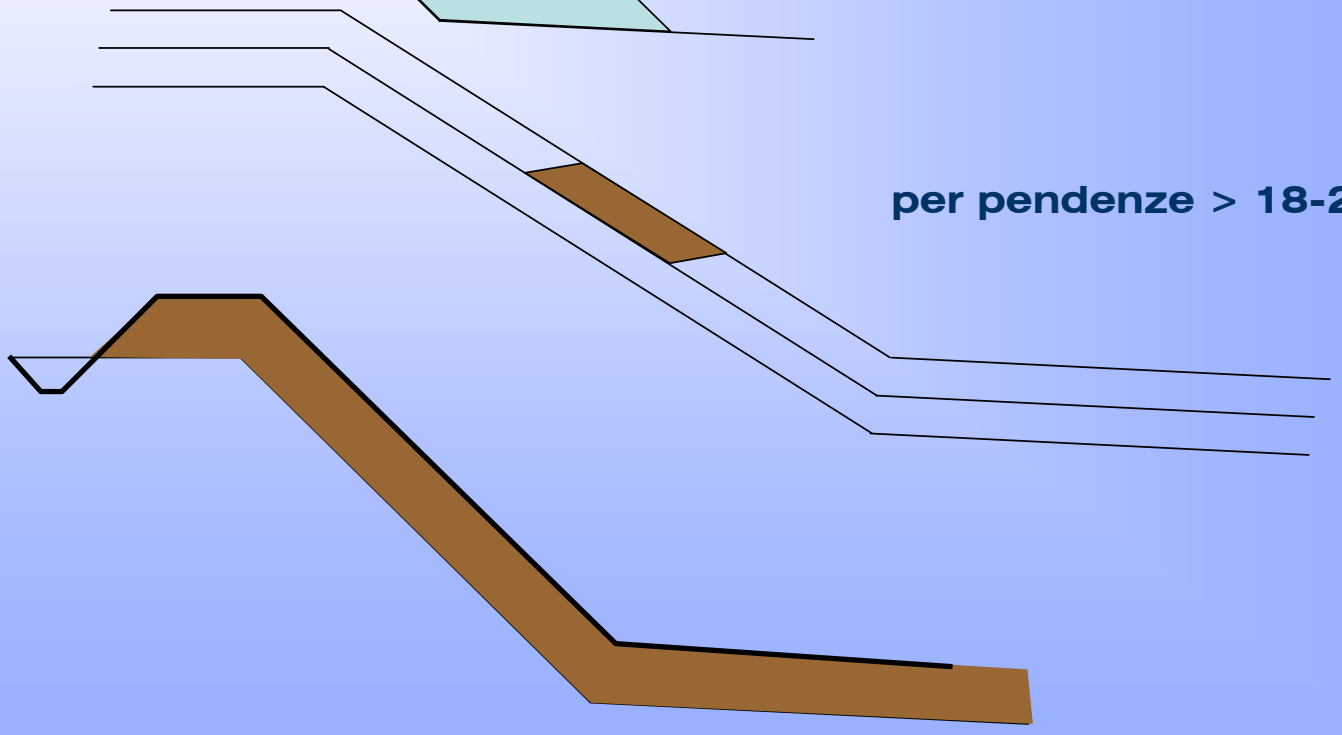
- **depositi di argilla in situ ($k < 10^{-7}$ cm/s)**
  - → va verificata l'omogeneità
- **miscele sabbia – bentonite**
  - → raggiungibili basse permeabilità
  - → problema: sembrano perdere efficienza con il percolato
- **argilla lavorata, compattata, disposta in strati**
  - → occorre controllare i parametri di funzionalità, in part.:
    - cond. Idraulic ⟺ compattazione, umidità
    - tecniche di stesura
    - spessore strato

Posa dell'argilla sulle pareti della discarica

per pendenze < 18-22°



per pendenze > 18-22°



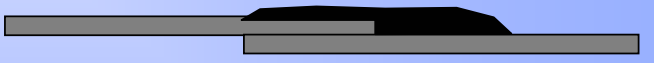
Impiego di materiali sintetici:

- **Geomembrane in polietilene (HDPE)**

  → C + H - facilmente ossidabile dai raggi UV
  aggiungo nerofumo x migliorare esposizione
  → spessori 2-2,5 mm
  → fornite in rotoli 4-10 m
  → saldatura a caldo, due tipi:

cordone interposto

cordone sovrapposto



- **geotessili:** resistente chimicamente (polietilene PE o polipropilene PP);

- ~~**PVC:**~~ attaccabile dai batteri (veniva utilizzato battericida)
  bassa resistenza a punzonatura

Requisiti indicativi dei geotessili:

H ≤ 10 m

Massa minima: > 600 g/m²
CBR > 3500 N

10 < H < 20 m

Massa minima: > 800 g/m²
CBR > 5000 N

H ≥ 20 m

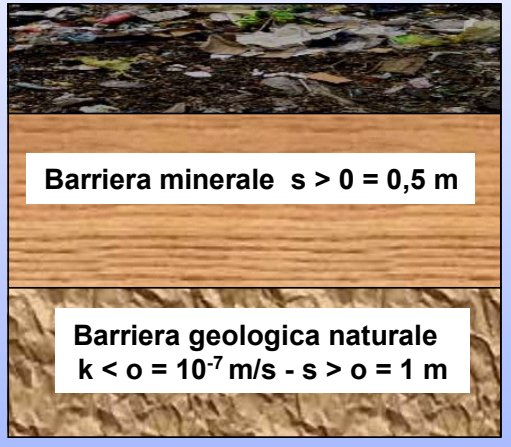
Massa minima: > 1200 g/m²
CBR > 6500 N

Progettazione e realizzazione sistemi di impermeabilizzazione

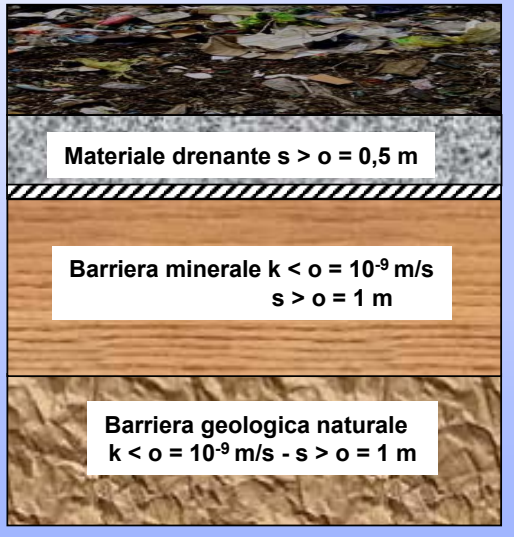
secondo D. Lgs 36/2003

Il NUOVO DECRETO LEGISLATIVO 36/2003 PREVEDE:

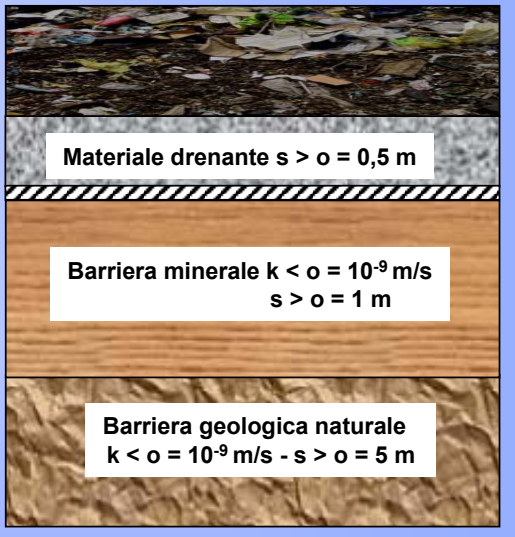
Discariche per inerti



Discariche per rifiuti non pericolosi



Discariche per rifiuti pericolosi



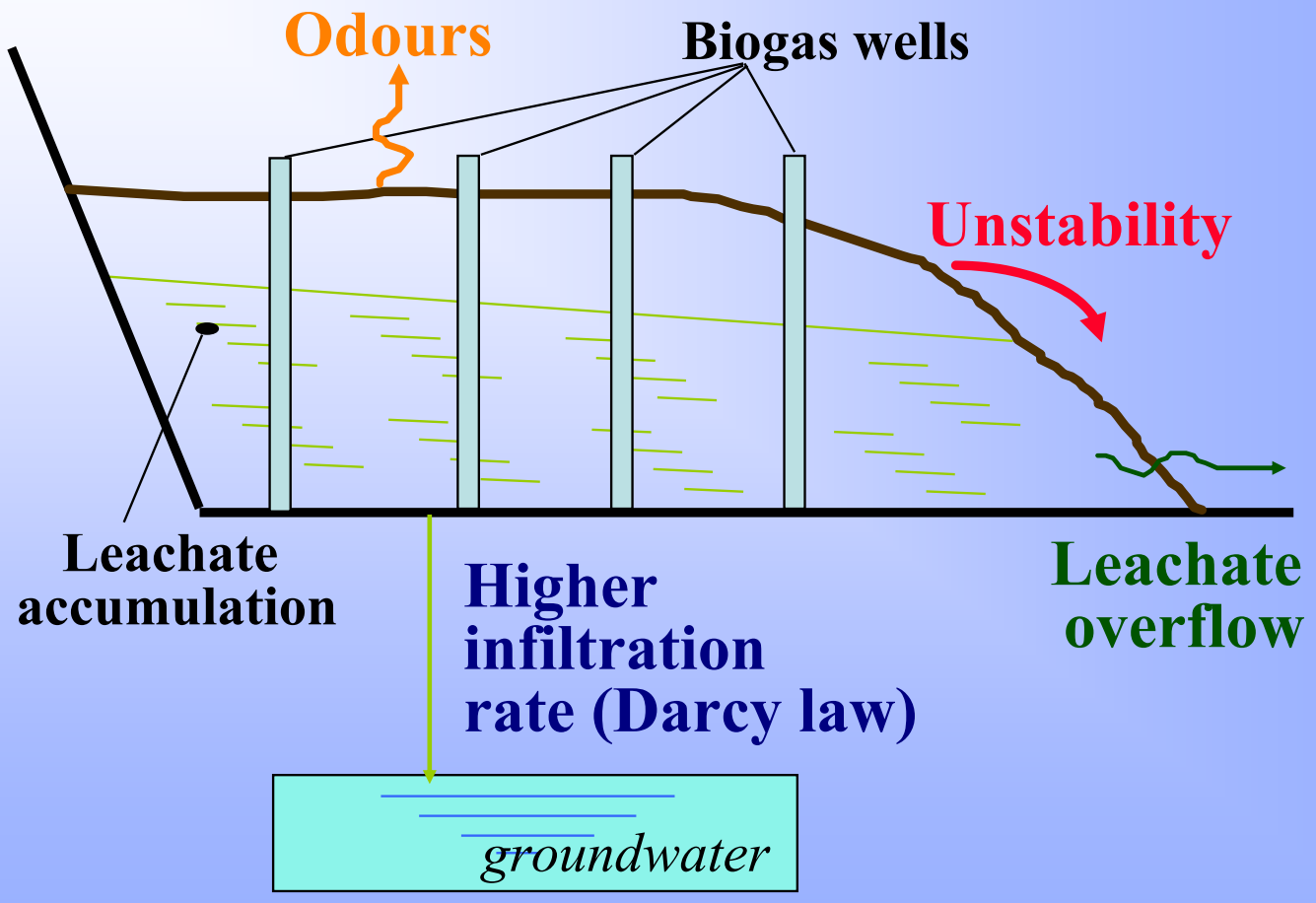
La normativa prevede un franco dal piano di imposta di 1,5 m da acquifero confinato e 2 m da acquifero non confinato

Sistemi di raccolta del percolato

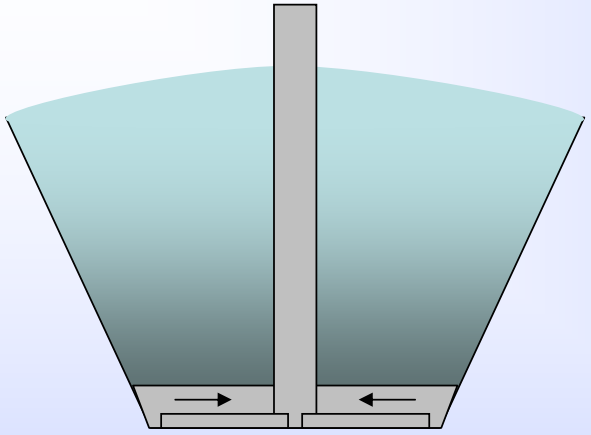
- Design strategies are addressed to minimize the transport of contaminants through the barriers to the environment.
- Drainage and collection systems are essential components in a containment landfill and can be considered as a barrier.
- When efficient they prevent leachate buildup and consequently decrease potential leakage to groundwater through the low permeability bottom liner.

home

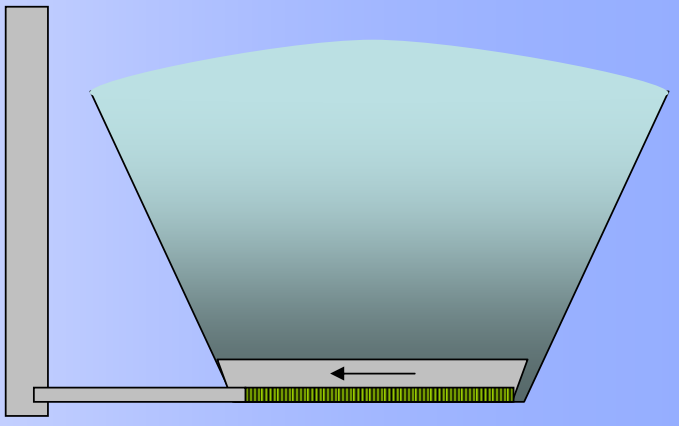
Leachate accumulation



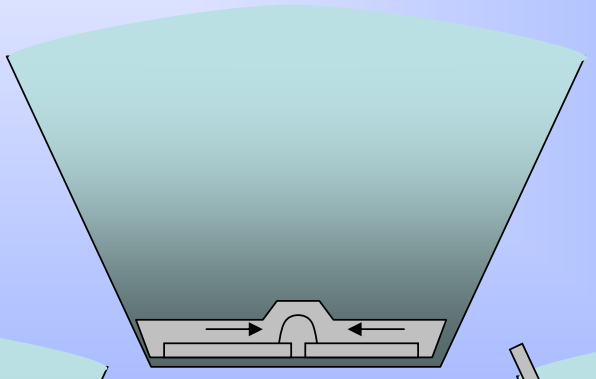
Different possible configurations for leachate extraction wells



Central internal shaft

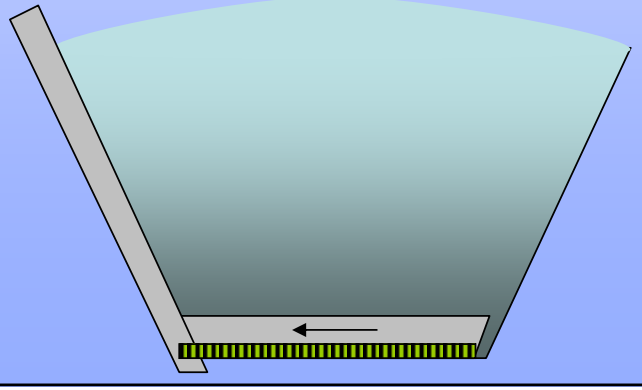


Lateral out-site well

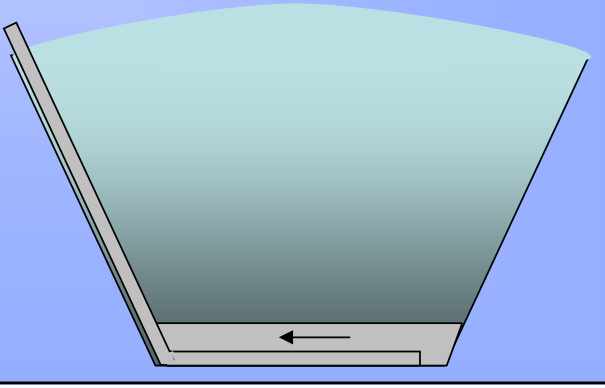


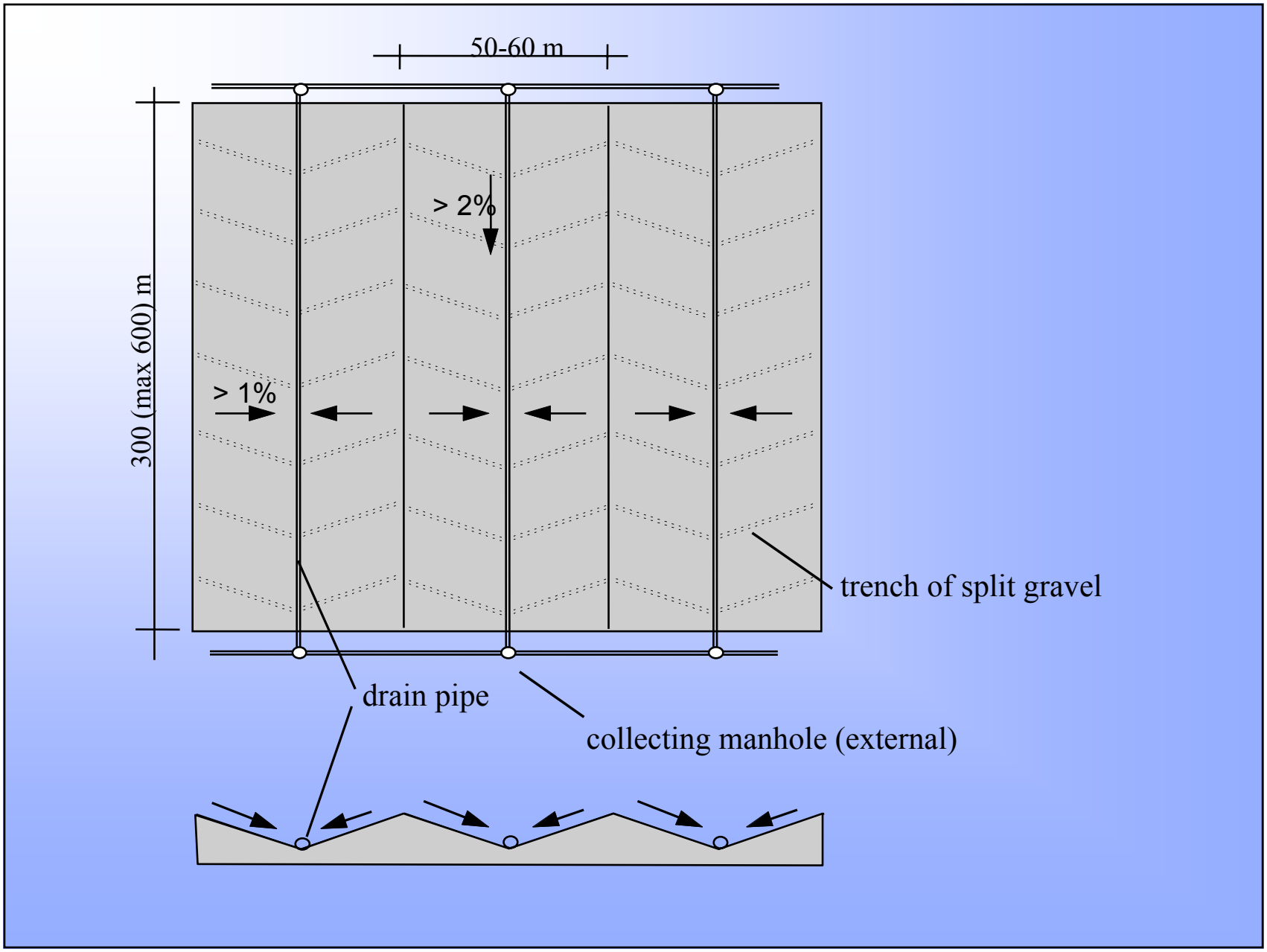
Tunnel

Lateral slope

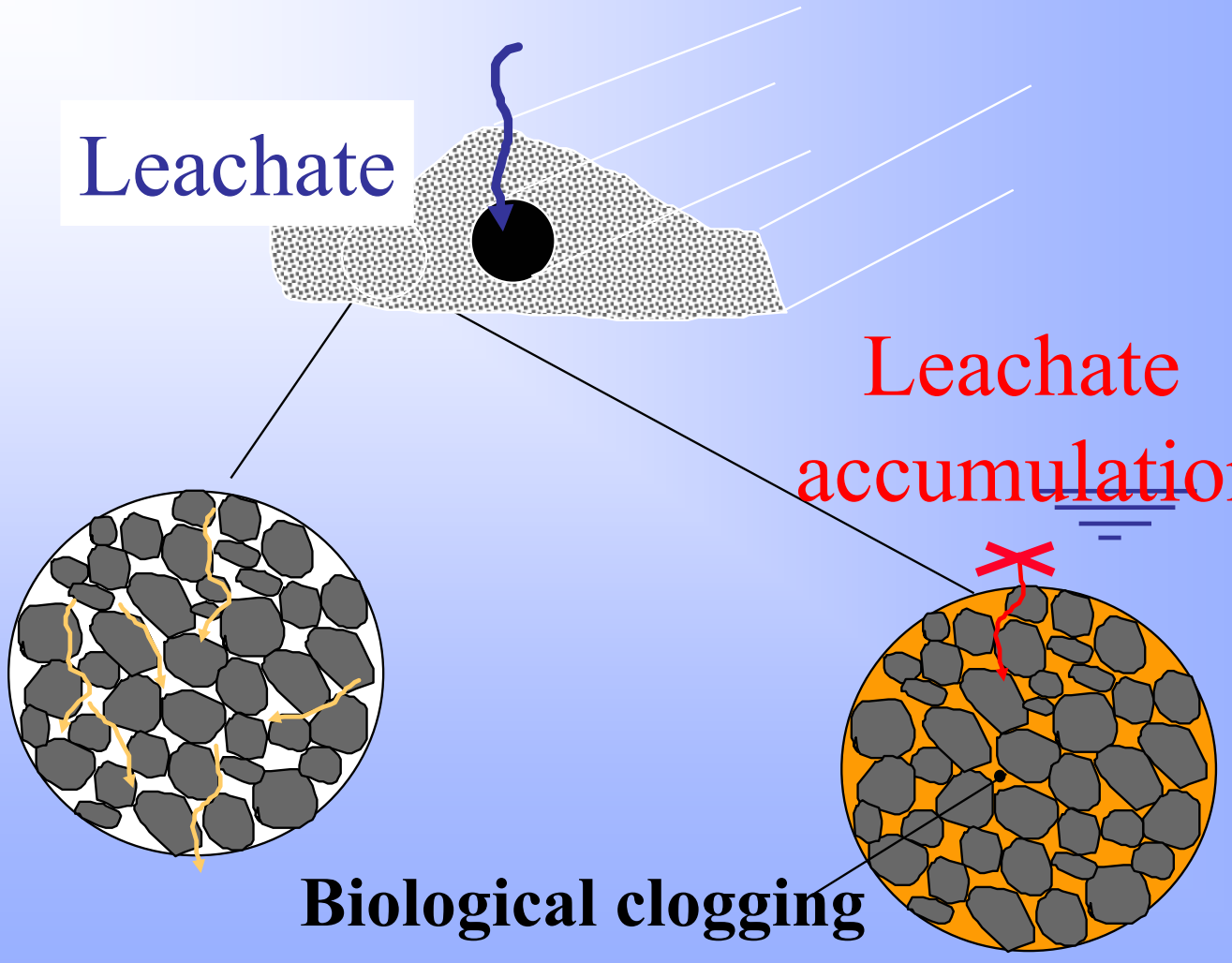


Draining pipe-shaft

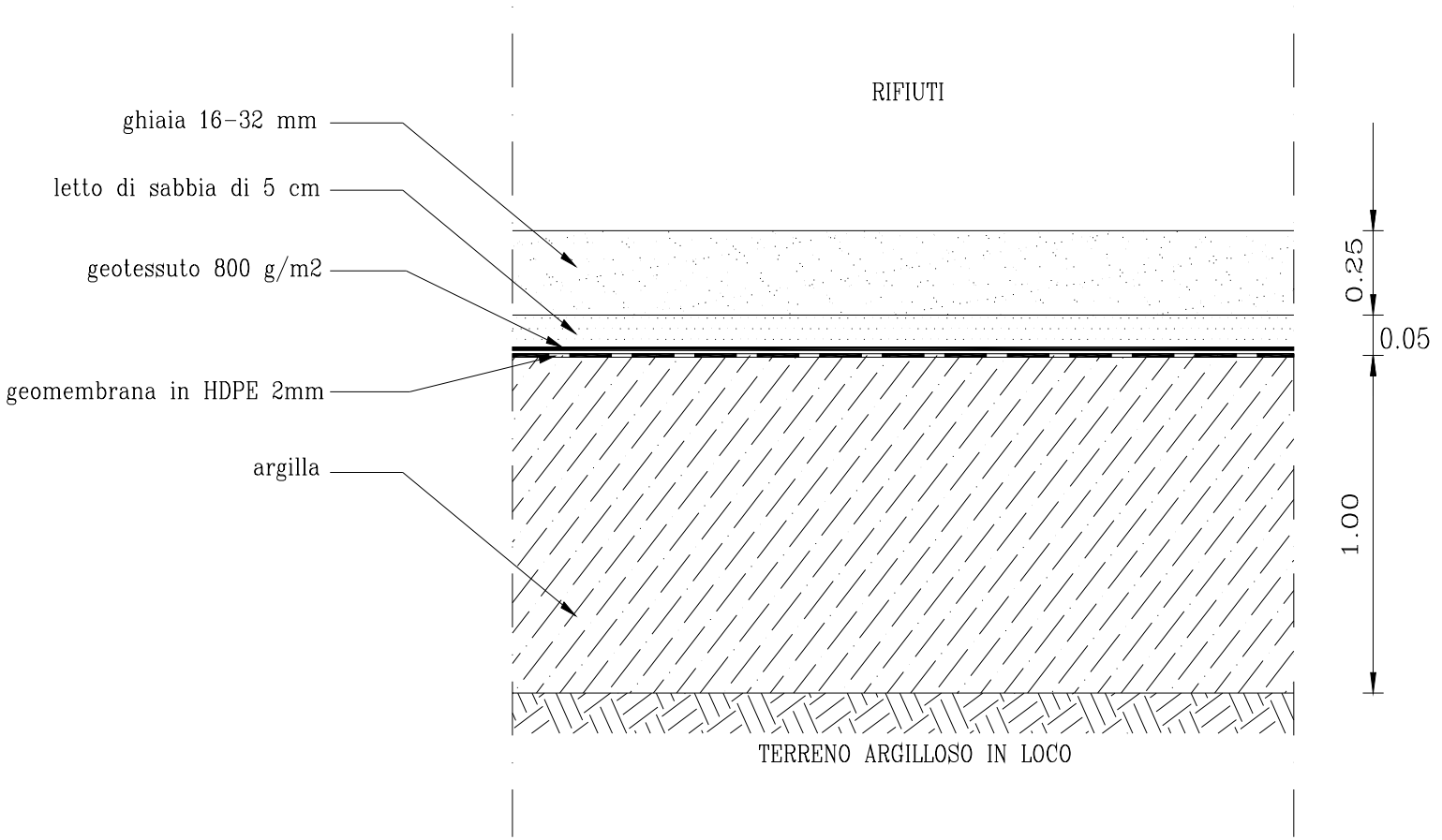


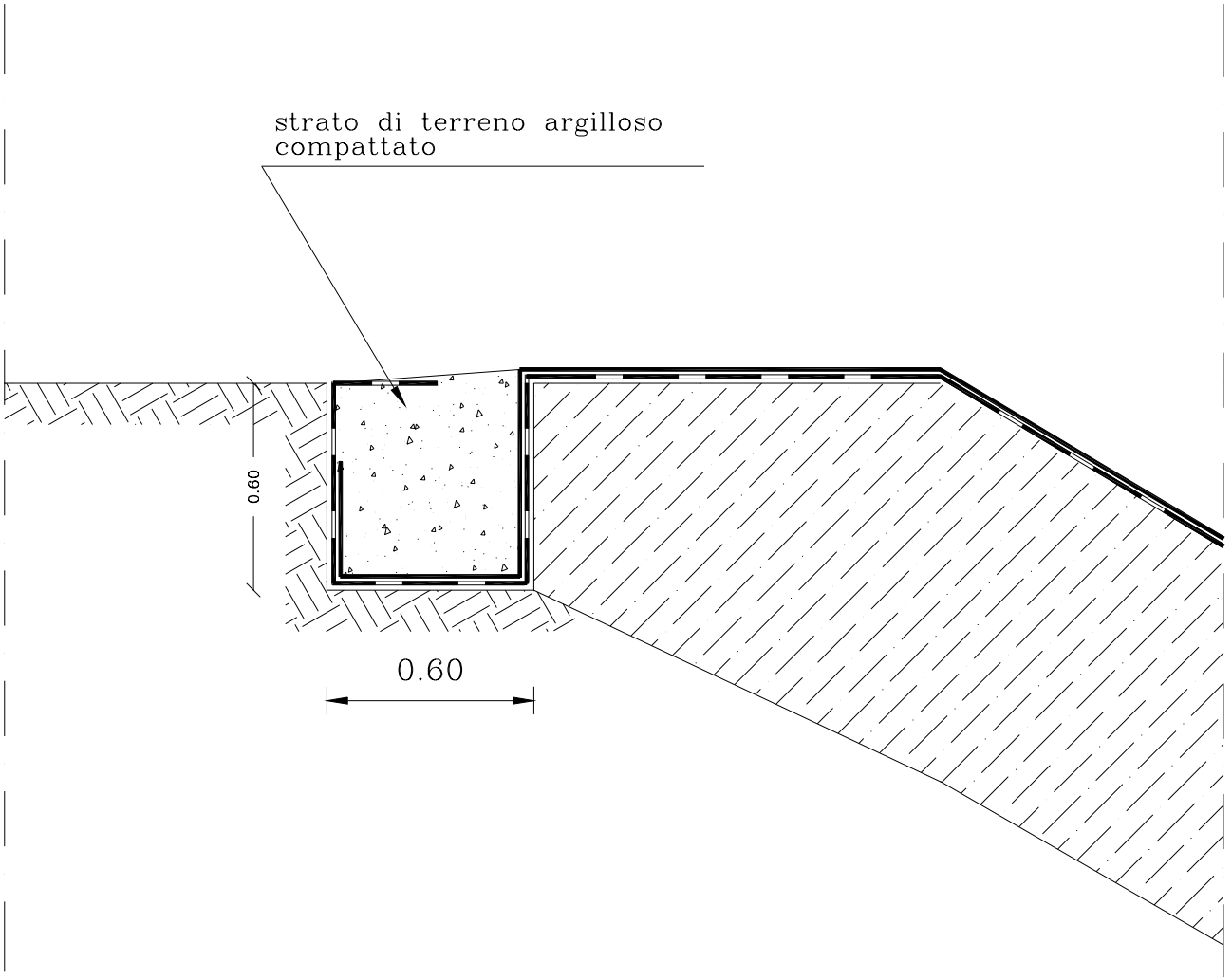

50-60 m
300 (max 600) m
> 2%
> 1%
trench of split gravel
drain pipe
collecting manhole (external)

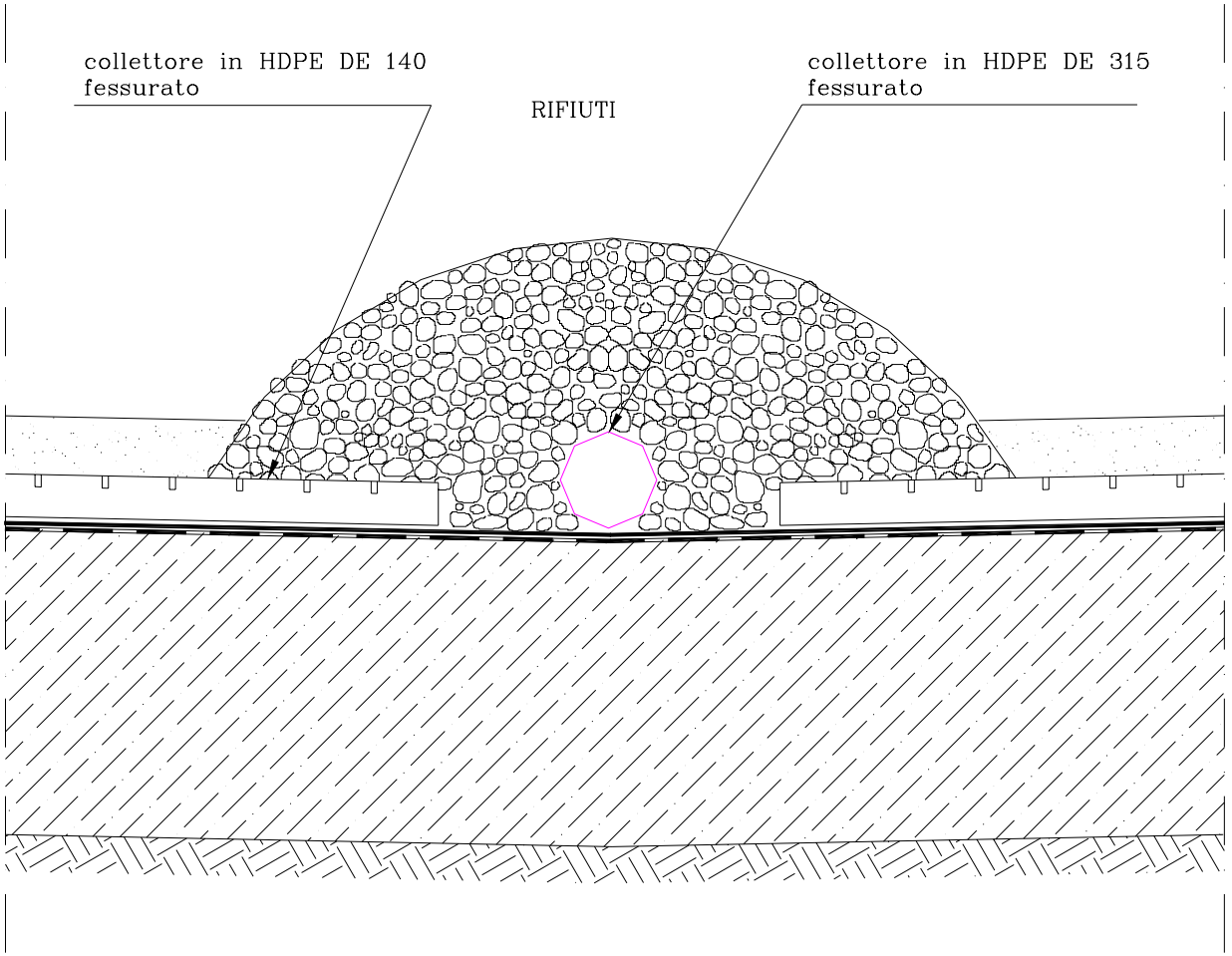
Drainage clogging



Fotografie

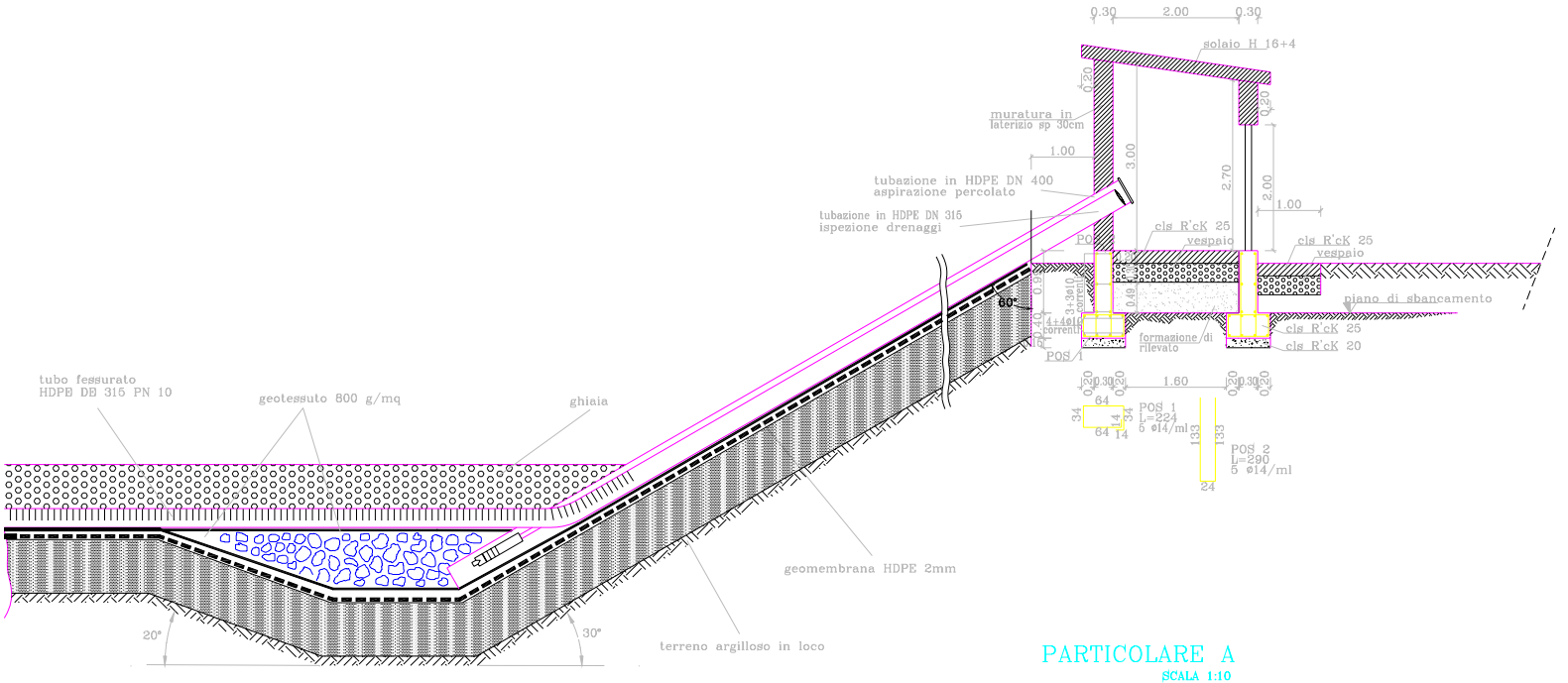

RIFIUTI
ghiaia 16-32 mm
letto di sabbia di 5 cm
geotessuto 800 g/m2
geomembrana in HDPE 2mm
argilla
0.25
0.05
1.00
TERRENO ARGILLOSO IN LOCO


strato di terreno argilloso
compattato
0.60
0.60


collettore in HDPE DE 140
fessurato
RIFIUTI
collettore in HDPE DE 315
fessurato

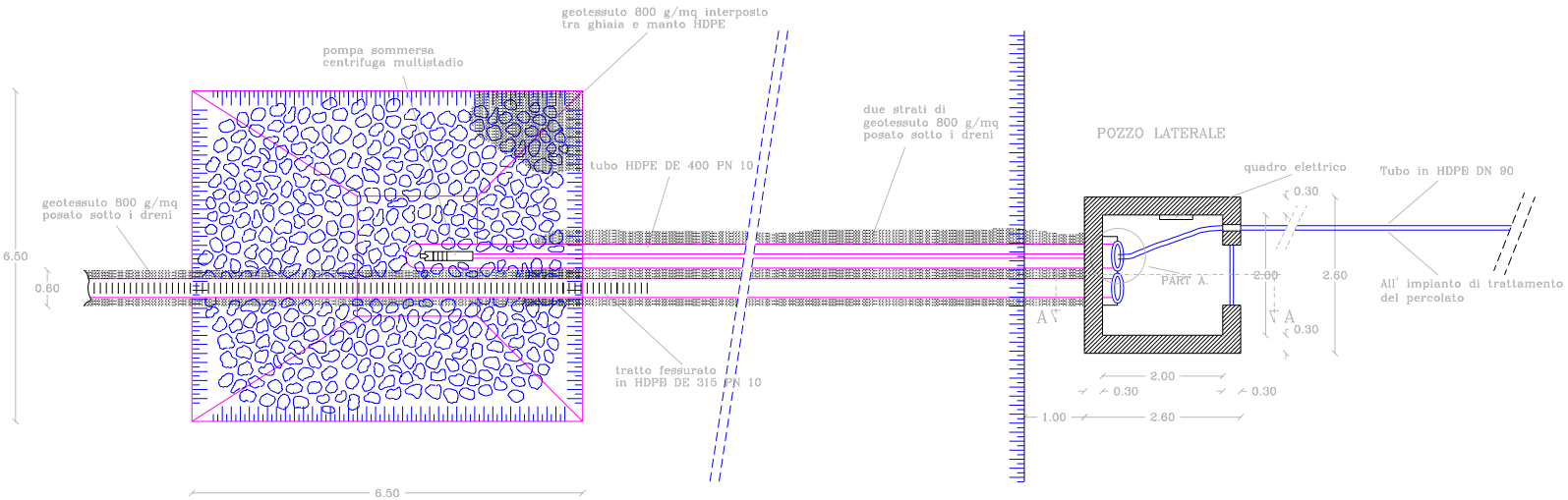
SEZIONE A–A

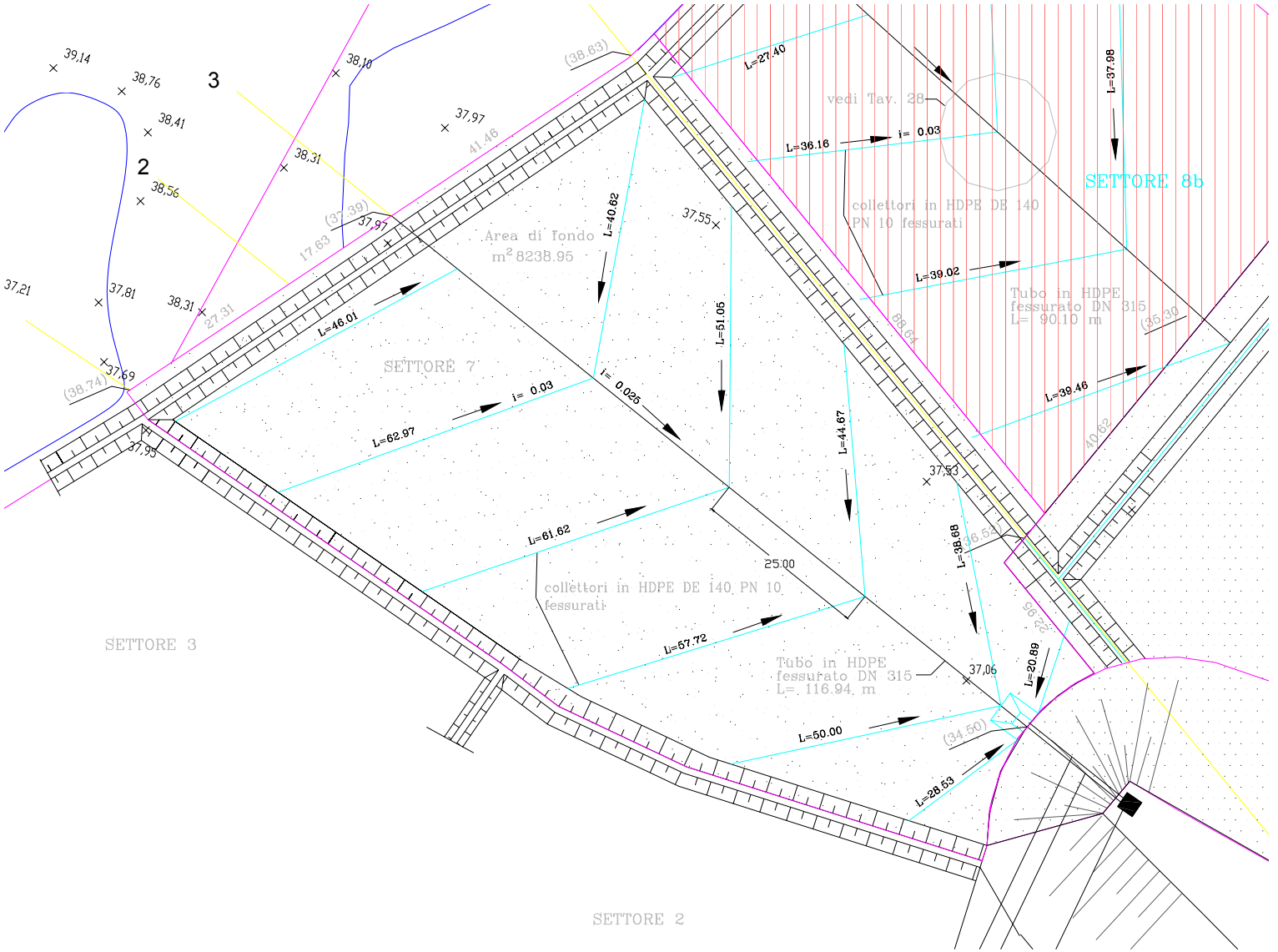
SCALA 1:50



PARTICOLARE A

SCALA 1:10


geotessuto 800 g/mq interposto
tra ghiaia e manto HDPE
pompa sommersa
centrifuga multistadio
due strati di
geotessuto 800 g/mq
posato sotto i dreni
POZZO LATERALE
quadro elettrico
Tubo in HDPE DN 90
tubo HDPE DE 400 PN 10
geotessuto 800 g/mq
posato sotto i dreni
6.50
0.60
0.30
2.00
2.60
PART A
A
A
0.30
All' impianto di trattamento
del percolato
tratto fessurato
in HDPE DE 315 PN 10
2.00
0.30
0.30
1.00
2.60
6.50


39,14
38,76
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38,56
38,10
38,31
37,97
41,46
(38,63)
37,21
37,81
38,31
27,31
37,69
(38,74)
37,95
17,63
(37,39)
37,97
L=46.01
Area di fondo
m² 8238.95
L=40.62
37,55
L=51.05
SETTORE 7
i= 0.03
i= 0.025
L=62.97
L=61.62
25.00
L=44.67
37,53
L=38.68
36,52
collettori in HDPE DE 140 PN 10
fessurati
L=67.72
Tubo in HDPE
fessurato DN 315
L=. 116.94. m
37,06
L=20.89
L=50.00
(34,50)
L=28.53
SETTORE 3
SETTORE 2
vedi Tav. 28
L=27.40
L=36.16
i= 0.03
L=37.98
SETTORE 8b
collettori in HDPE DE 140
PN 10 fessurati
L=39.02
Tubo in HDPE
fessurato DN 315
L= 90.10 m
(35,30
88.64
L=39.46
40.62
36,52
36,52
2
3