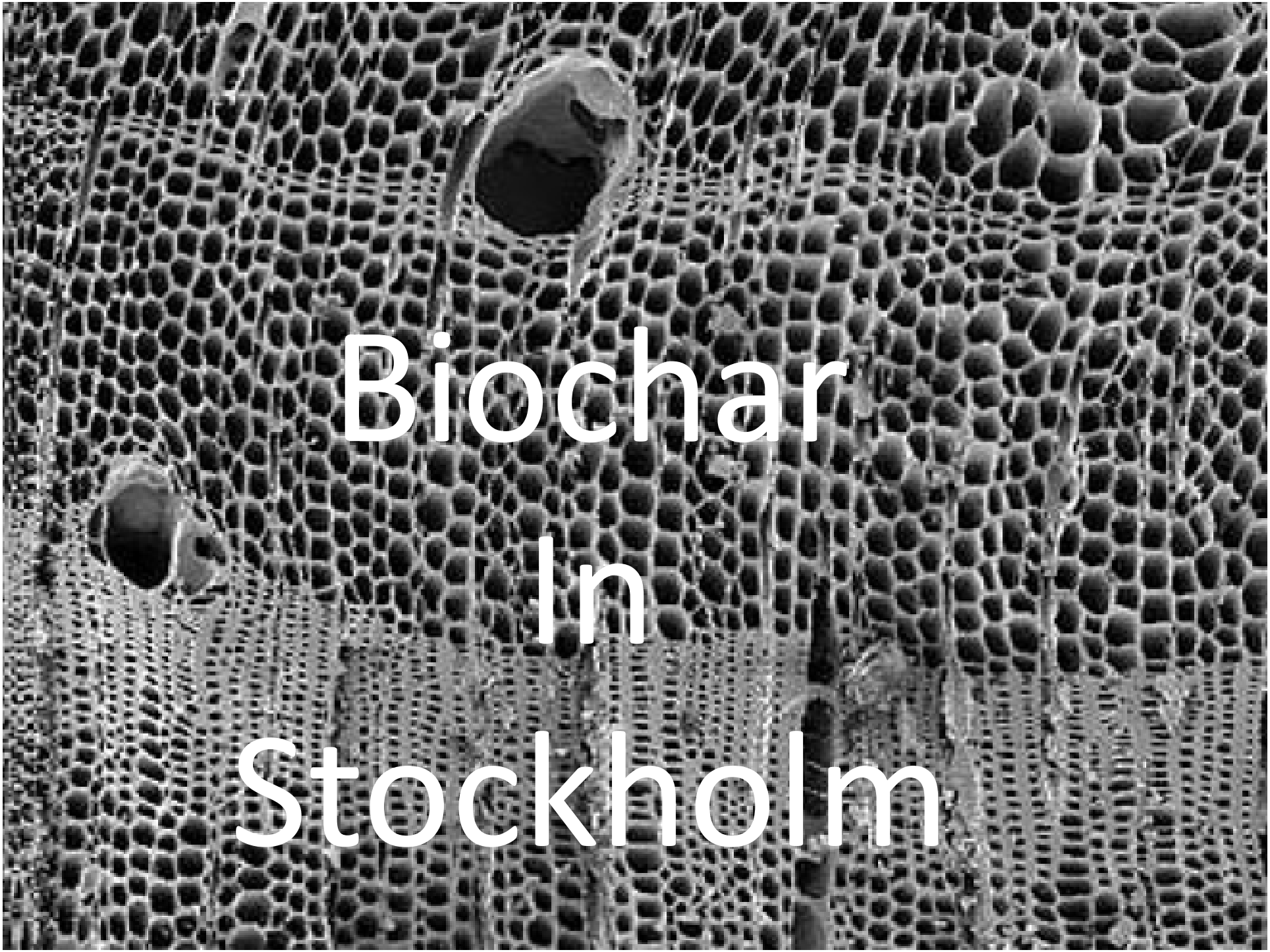

Biochar
In
Stockholm


100 years


15 years


50 years


1980-2012


6 years
Toffelbacken


100 years


15 years


75 years

conventional construction for sidewalks in Stockholm
a completely sealed surface where no water can be infiltrated or gas exchange can take place

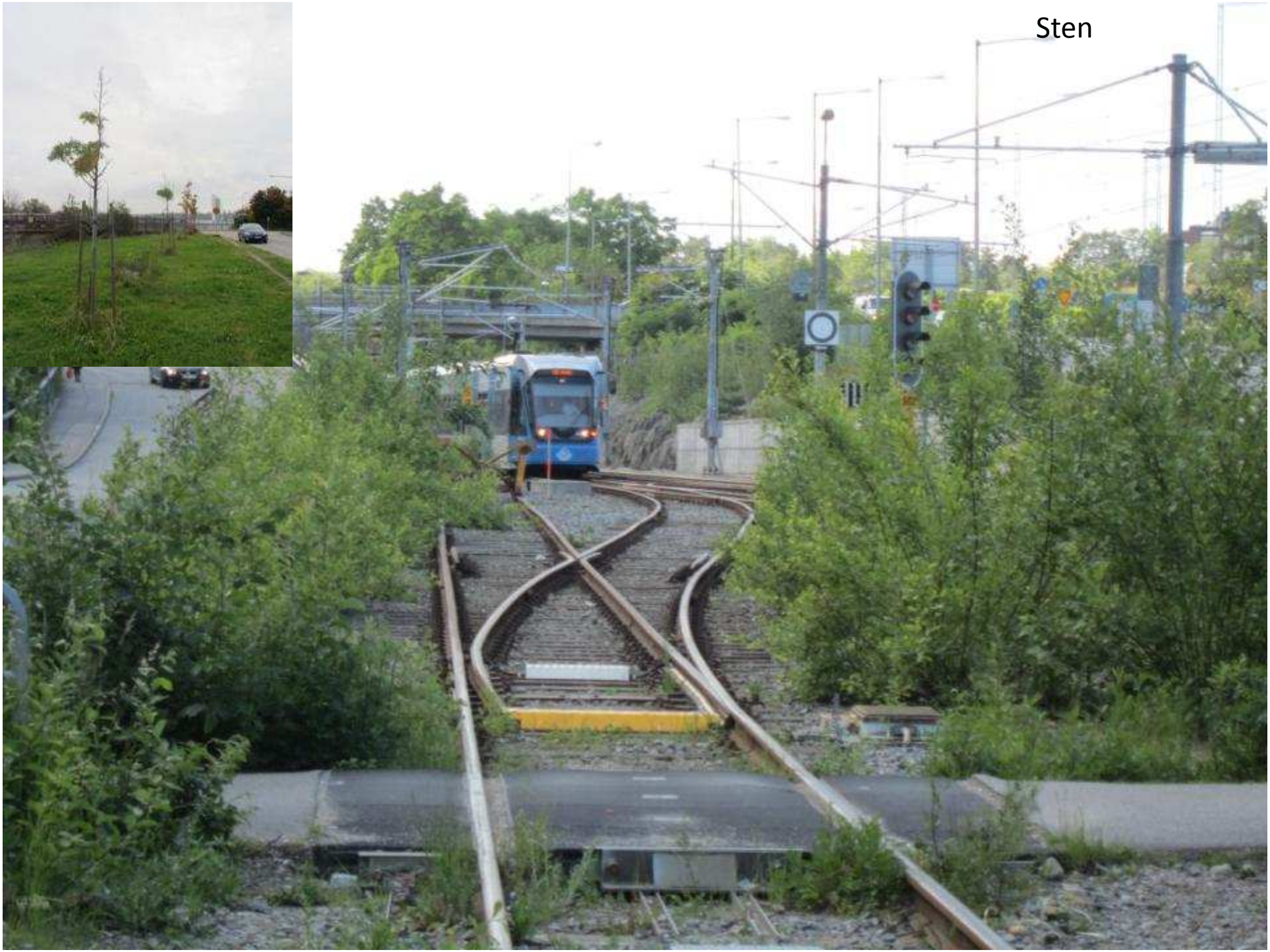

More than 40
years on the
site

Compaction of soil and dense surface layers the main reason that trees do not grow in urban environments

- **subgrade**
- sorted stone material 0-8, 0-16, 0-32, 0-63mm
- grain sizes between zero and upper grain fraction are included

Toffelbacken

Sten



Using a rock based growing substrate as a benefit for both for trees and stormwater management

How to create good growing conditions and taking care of the rain water

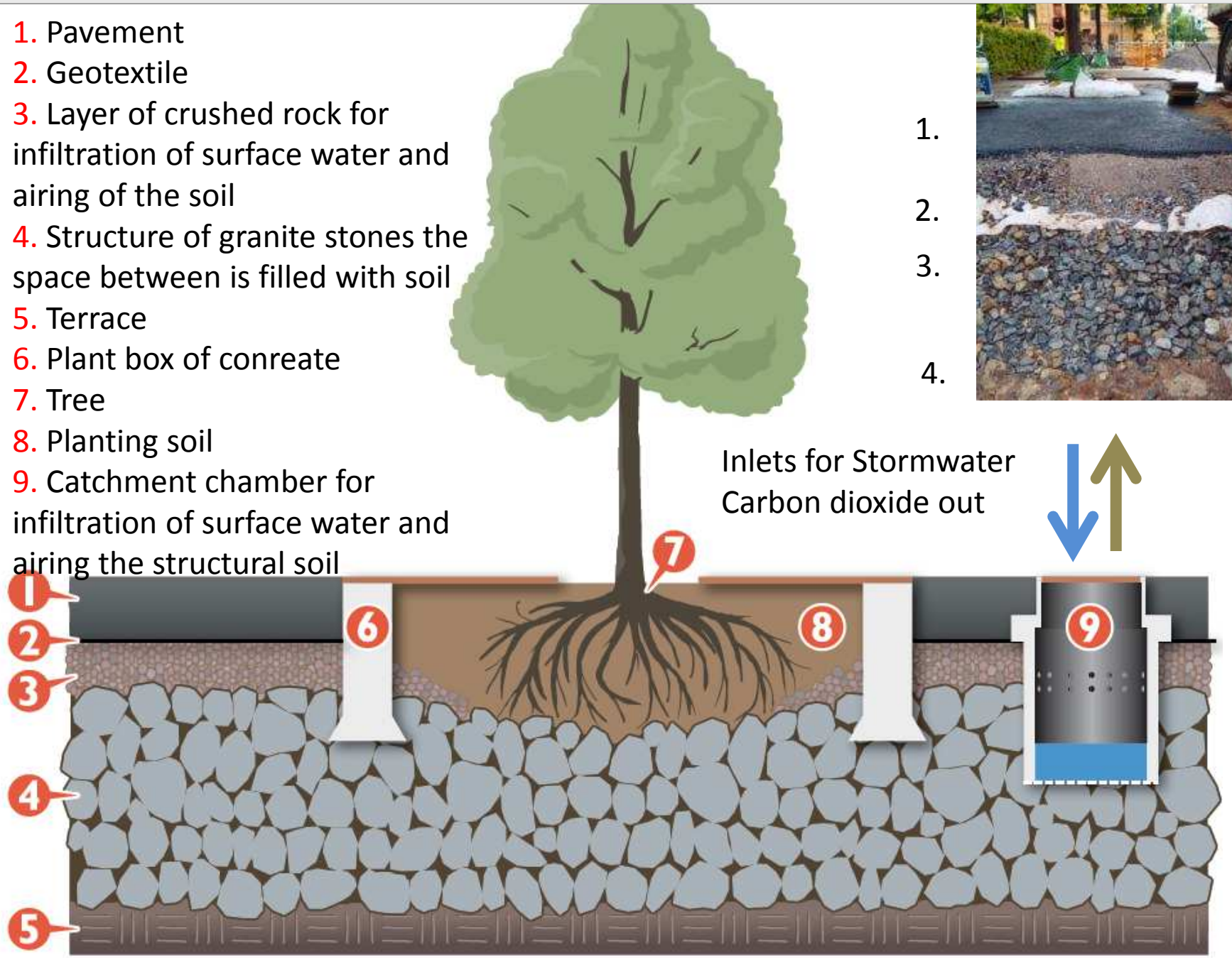
1. Pavement
2. Geotextile
3. Layer of crushed rock for infiltration of surface water and airing of the soil
4. Structure of granite stones the space between is filled with soil
5. Terrace
6. Plant box of conreate
7. Tree
8. Planting soil
9. Catchment chamber for infiltration of surface water and airing the structural soil

1.

2.

3.

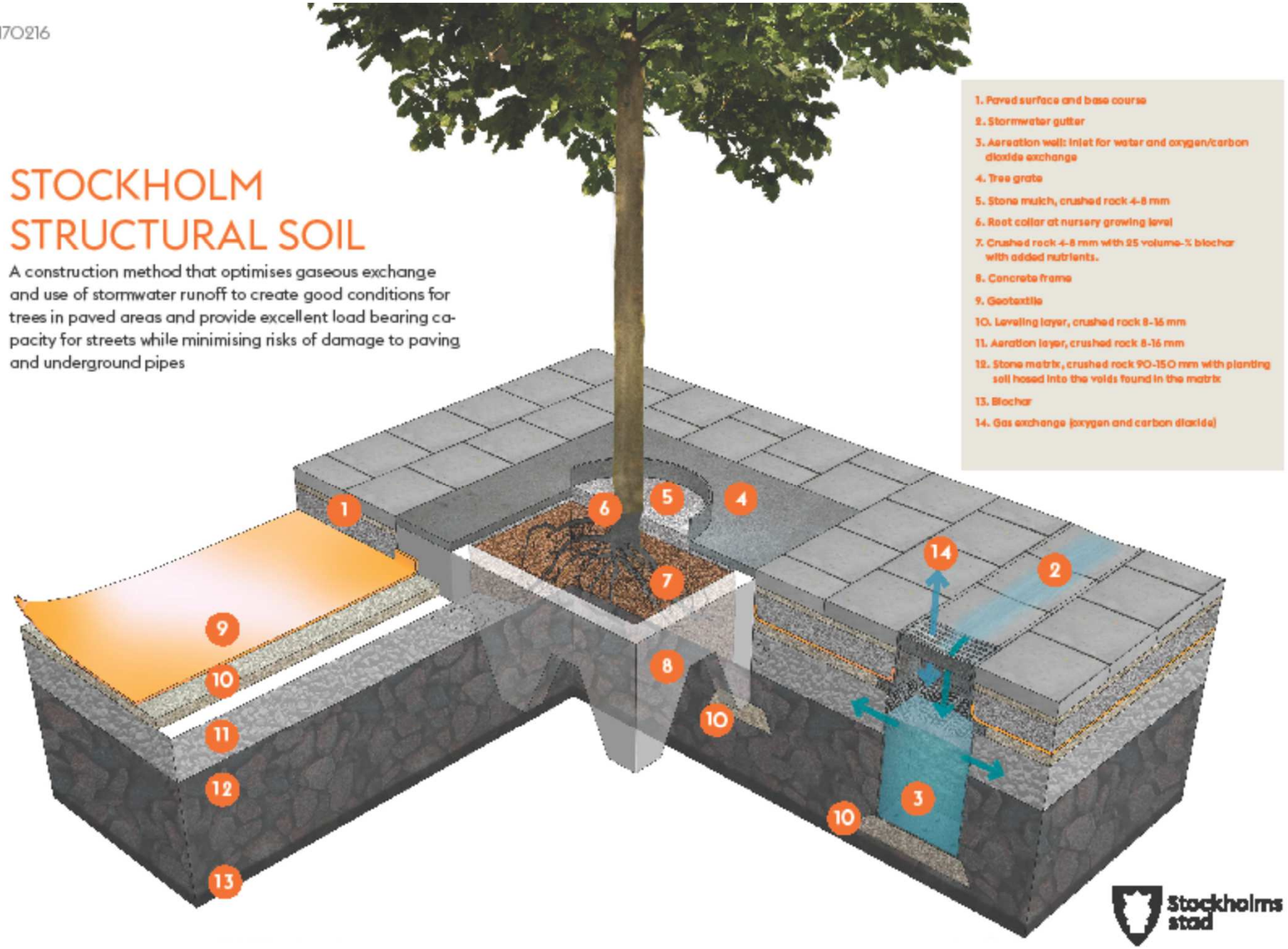
4.



170216

STOCKHOLM STRUCTURAL SOIL

A construction method that optimises gaseous exchange and use of stormwater runoff to create good conditions for trees in paved areas and provide excellent load bearing capacity for streets while minimising risks of damage to paving and underground pipes



1. Paved surface and base course
2. Stormwater gutter
3. Aeration well: inlet for water and oxygen/carbon dioxide exchange
4. Tree grate
5. Stone mulch, crushed rock 4-8 mm
6. Root collar at nursery growing level
7. Crushed rock 4-8 mm with 25 volume-% biochar with added nutrients.
8. Concrete frame
9. Geotextile
10. Levelling layer, crushed rock 8-16 mm
11. Aeration layer, crushed rock 8-16 mm
12. Stone matrix, crushed rock 90-150 mm with planting soil hosed into the voids found in the matrix
13. Biochar
14. Gas exchange (oxygen and carbon dioxide)

Stockholms stad

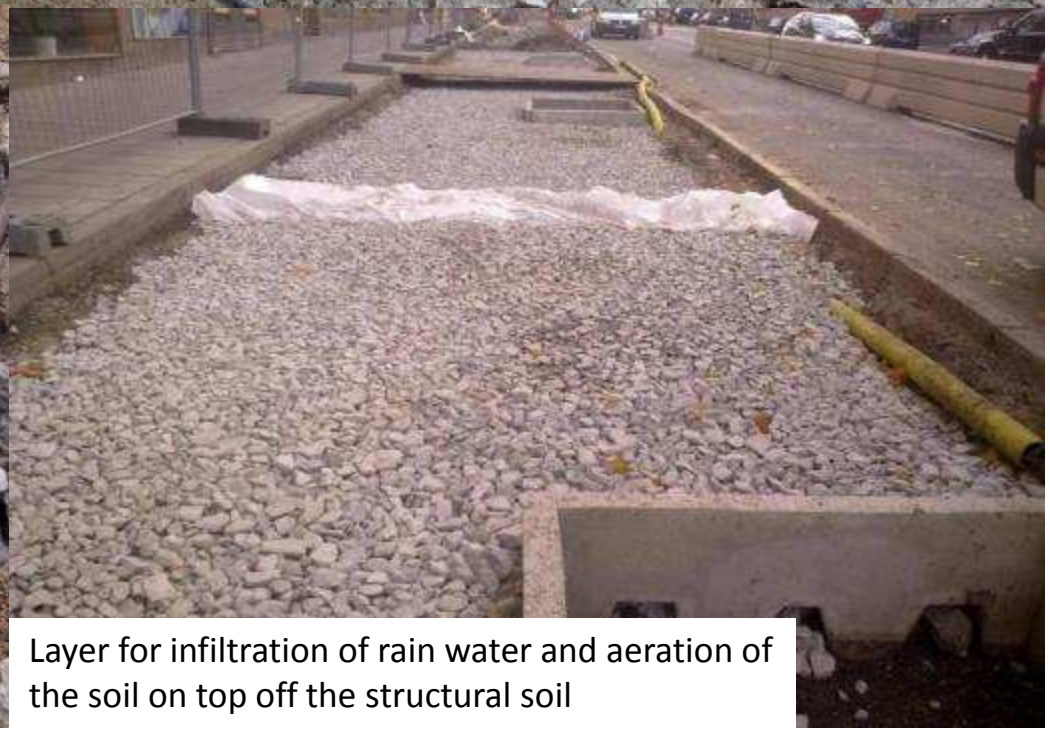
Granit 90-150mm
Each layer 300 mm compacted for stability

Recycled concrete used as a part of the structural soil instead of granite

Flushing the soil into the structure

Ventilation chamber and inlet of surface water

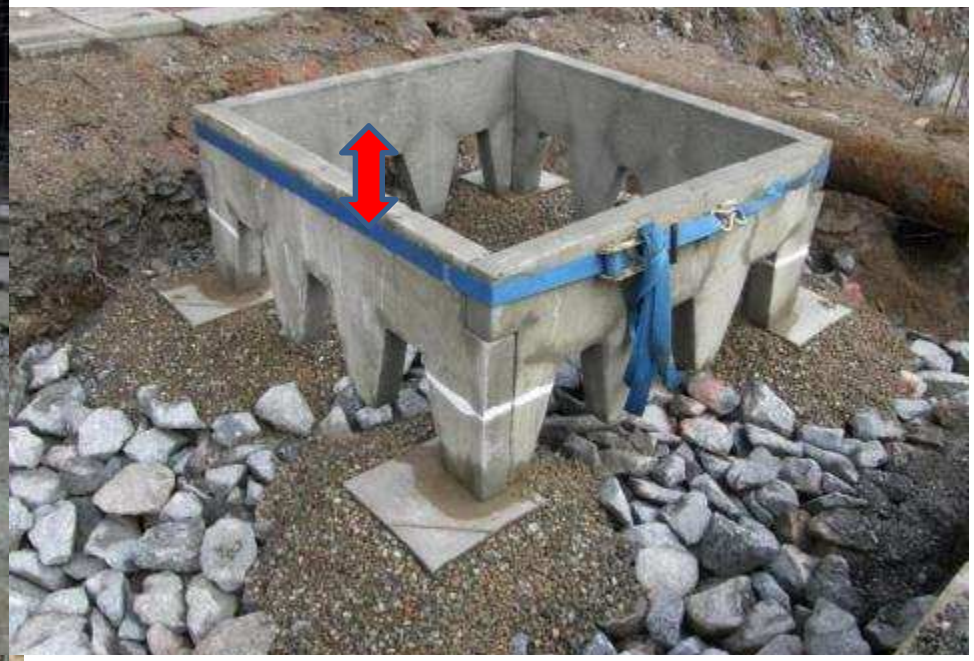
Slow release fertilizer



Layer for infiltration of rain water and aeration of the soil on top off the structural soil

Granit size 90-150mm

Concrete box to hold the paved surface in place



Compacting befor soil is washed in to the voids

The stone shall fall into the box to get a stabel construction

Layer for infiltration of rain water and ventilation of the ground

Important with geotextile connection against curbs inlets concrete boxes etc.so that no fine material could run into the airy base course

- We take water from roofs and pavements through inlets to the ventilated bearing layer and the structural soil.

If the percolation layer is full, the storm water flows into the old street inlet.

- Roof and pavement surface 4600kvm Rainfall 600mm year (2 fot)
  Approximately 2.3 million liters of water year Saved cost for the treatment of stormwater = 2300 euro /year
  Reduced load on the Baltic Sea / and lakes at torrential rains

we find mykorrhitza in our structural soils which only thrives in good conditions (planting pits acting as a biological filter)


Norrsida planterad
December 2010
-9 Celsius


GREEN ROOM

left 2002 right 2013 Kungsbroplan tree before and after structural soil

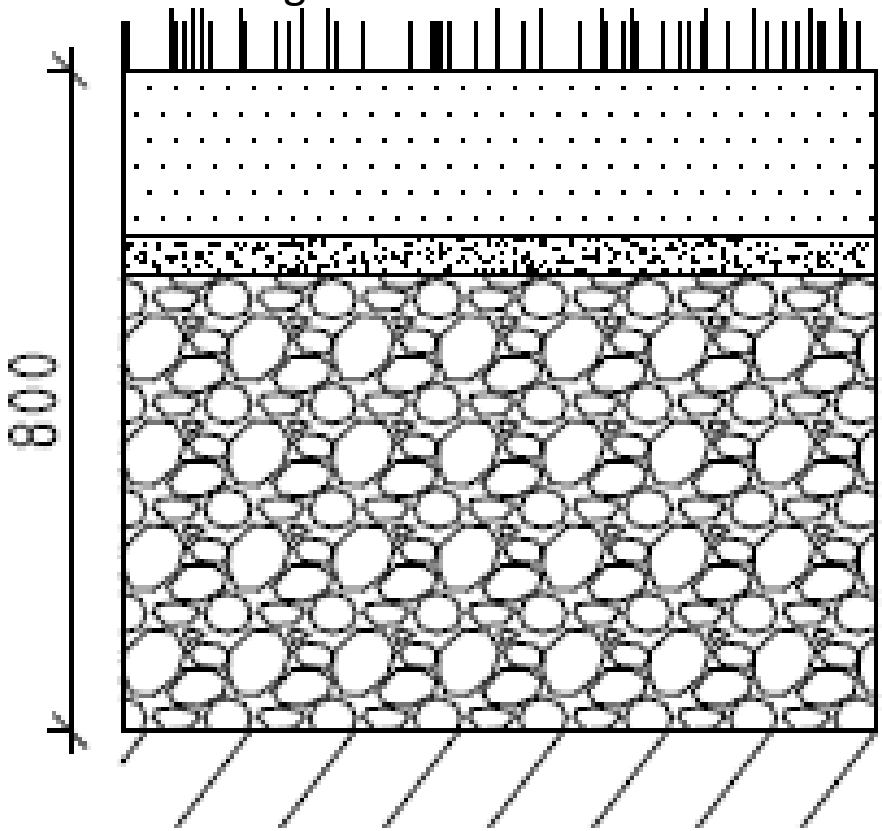

Stockholm Biochar Project
Stockholms stad
Stockholm Vatten
Fortum
Bloomberg Philanthropies

Herrhagsvägen 2009
förstagången vi
använder träkol i en
jordblandning

100mm 50% växtjord typ-a 50% träkol

Kokosmatta nu använder vi 50mm
avjämningslager kross 8-16 (4-16)

850mm Bärlager Makadam 32-63



Herrhagsvägen
Träd planterade i en blandning
av jord/träkol 50/50
Andra växtsäsongen

peat

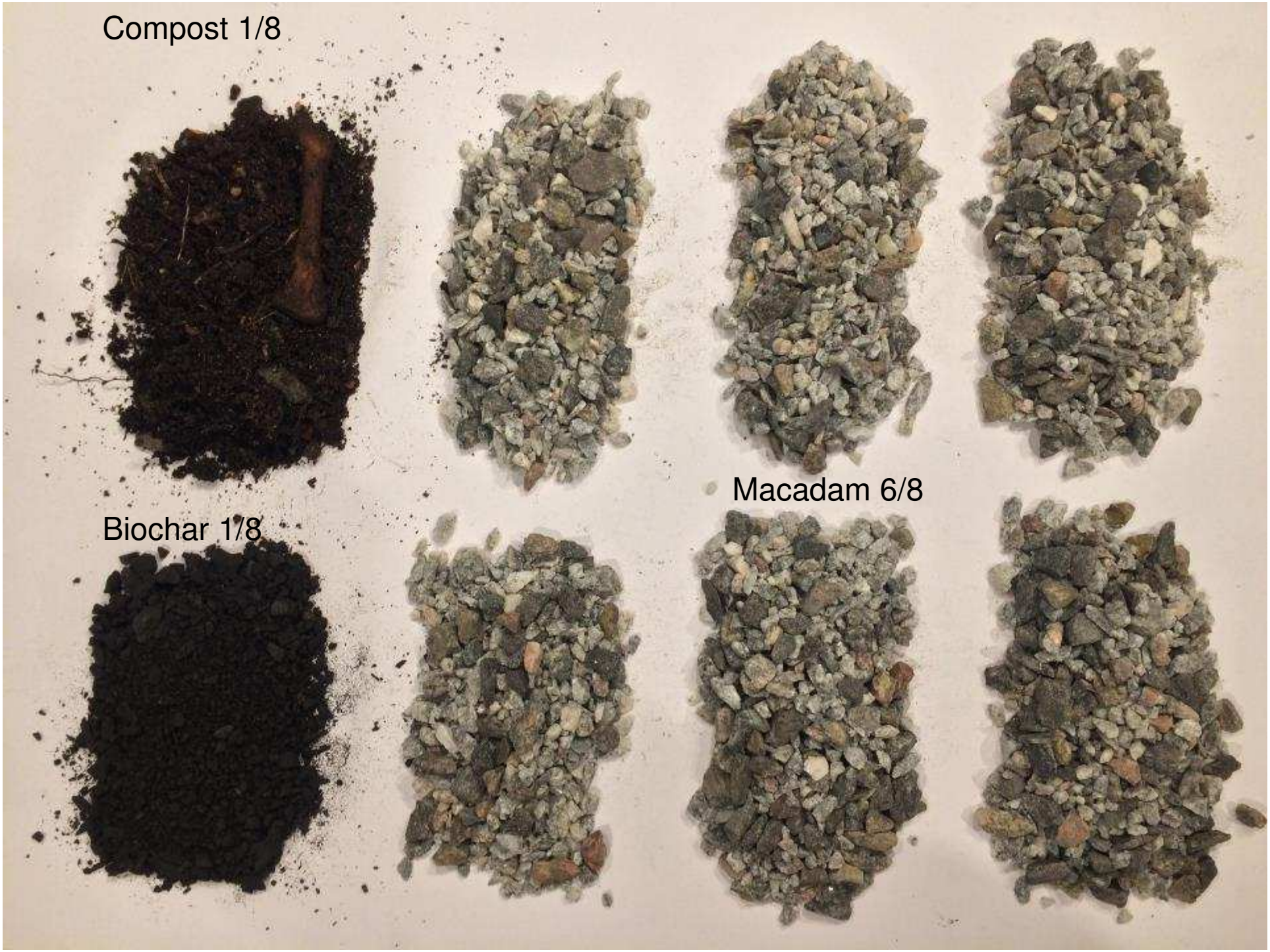
About 500 000 tonnes of soil are sold every year in Stockholm made of Sand Clay and Peat that are finite resources

clay

sand
gravel

from
esker

Biochar and stone chips = crushed granite 3/4 (2-6mm) and nutrient-enriched charcoal 1/4. volume


Compost 1/8
Biochar 1/8
Macadam 6/8

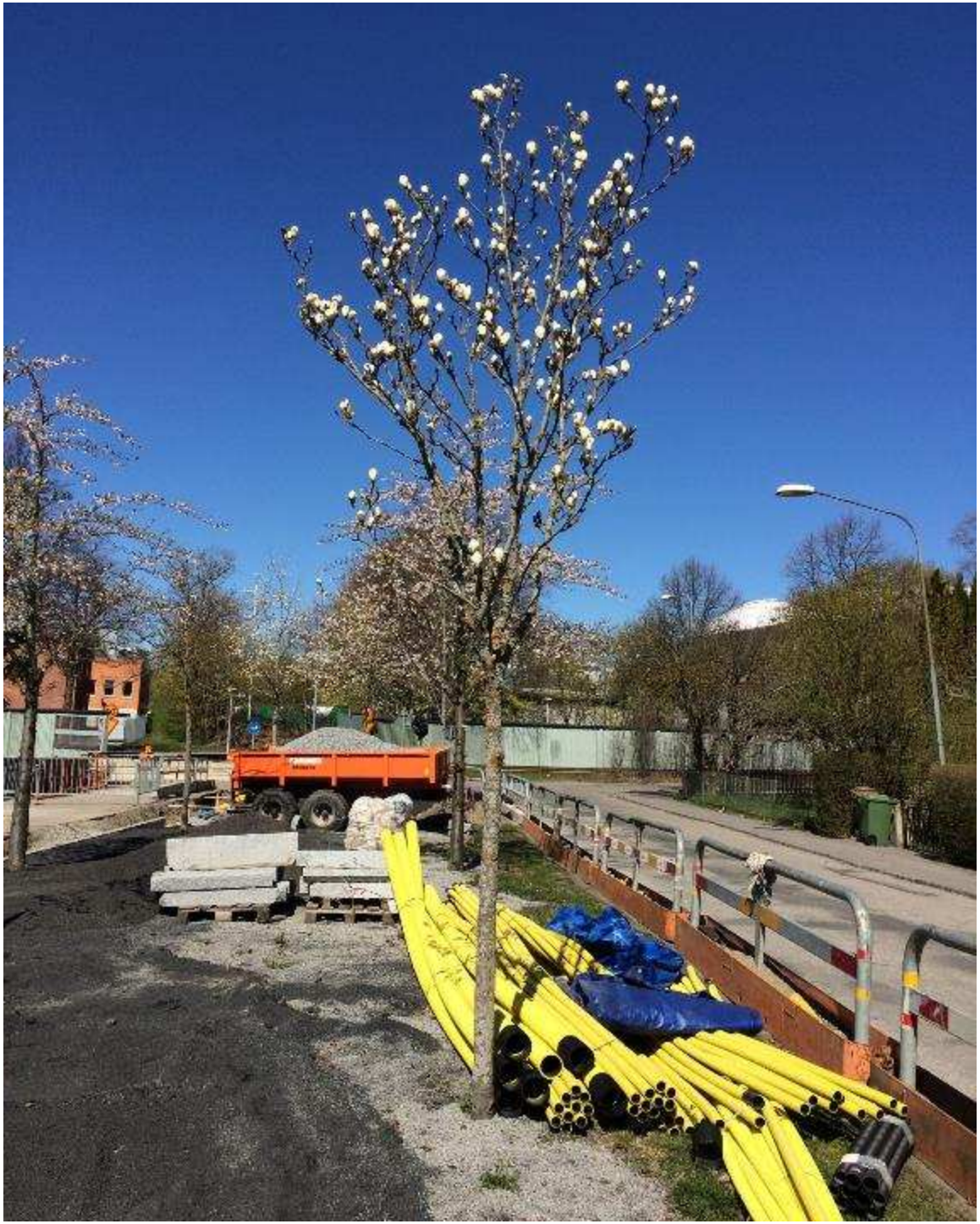
Biochar and stone chips = crushed granite **6/8 volume parts** (2-6mm) and nutrient-enriched biochar **1/8 volume parts**
+ compost **1/8 volume parts**

Biochar and stone chips = crushed granite (32-63 mm) and nutrient-enriched charcoal 15%. volume

Kolonivägen 2016

Magnolias, Cersis, Prunus.

1 en del biokol 0-10mm och 3 delar makadam 4-8 mm 600mm.



Haukadalsgatan kolgrus

Magnus Ladulåsgatan Stockholm
Biochar with infiltration of stormwater

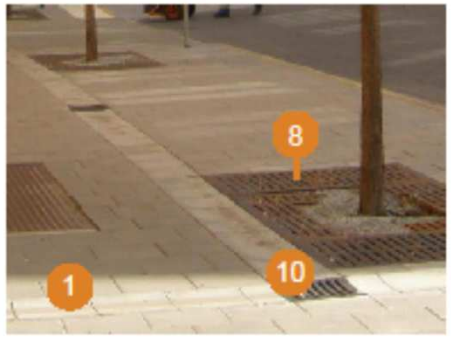
- Image # 1. Plant bed renovation a block of Magnus Ladulåsgatan where we follow our drawing ‘structural soil with biochar’.
- The stone and biochar, Concrete box where the tree is planted,

FHK 150311

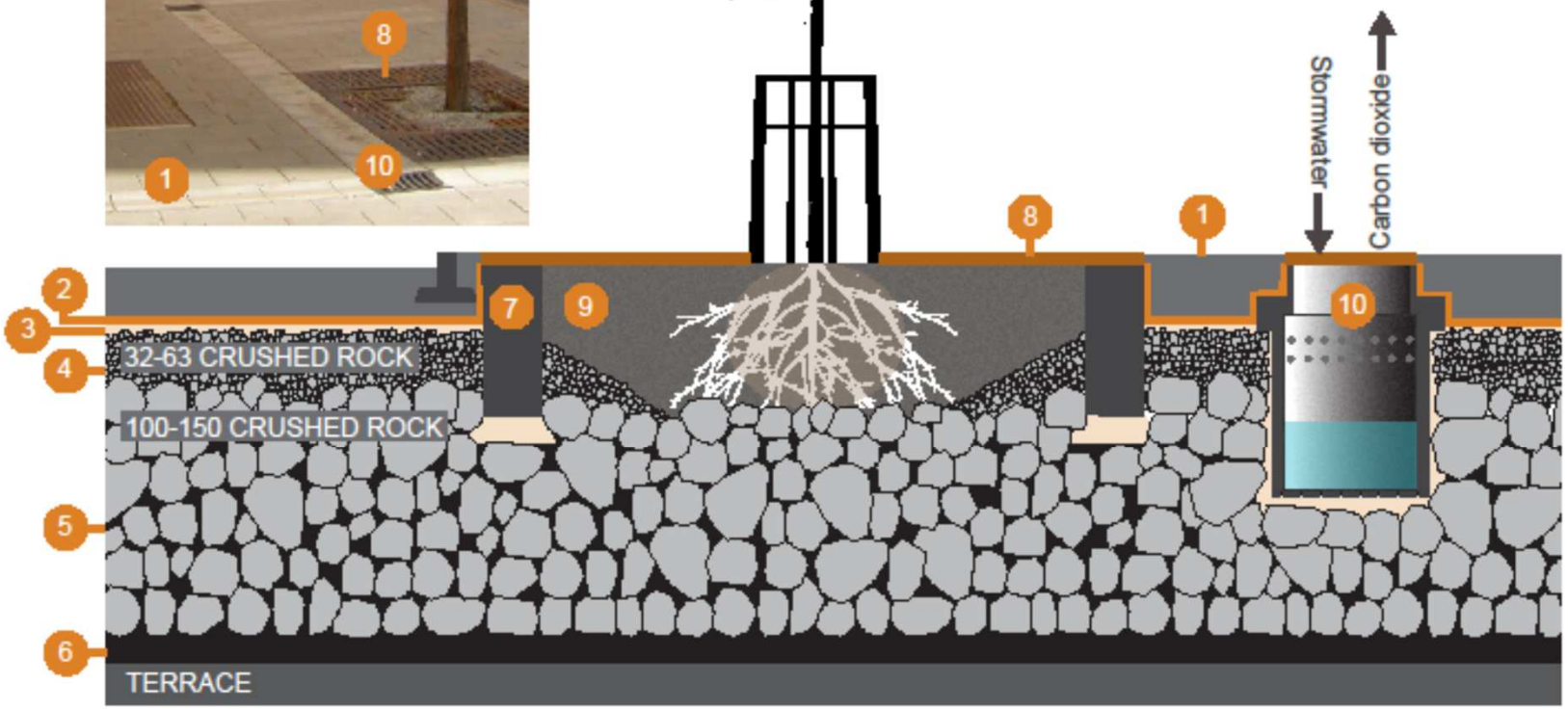
Stockholms stad

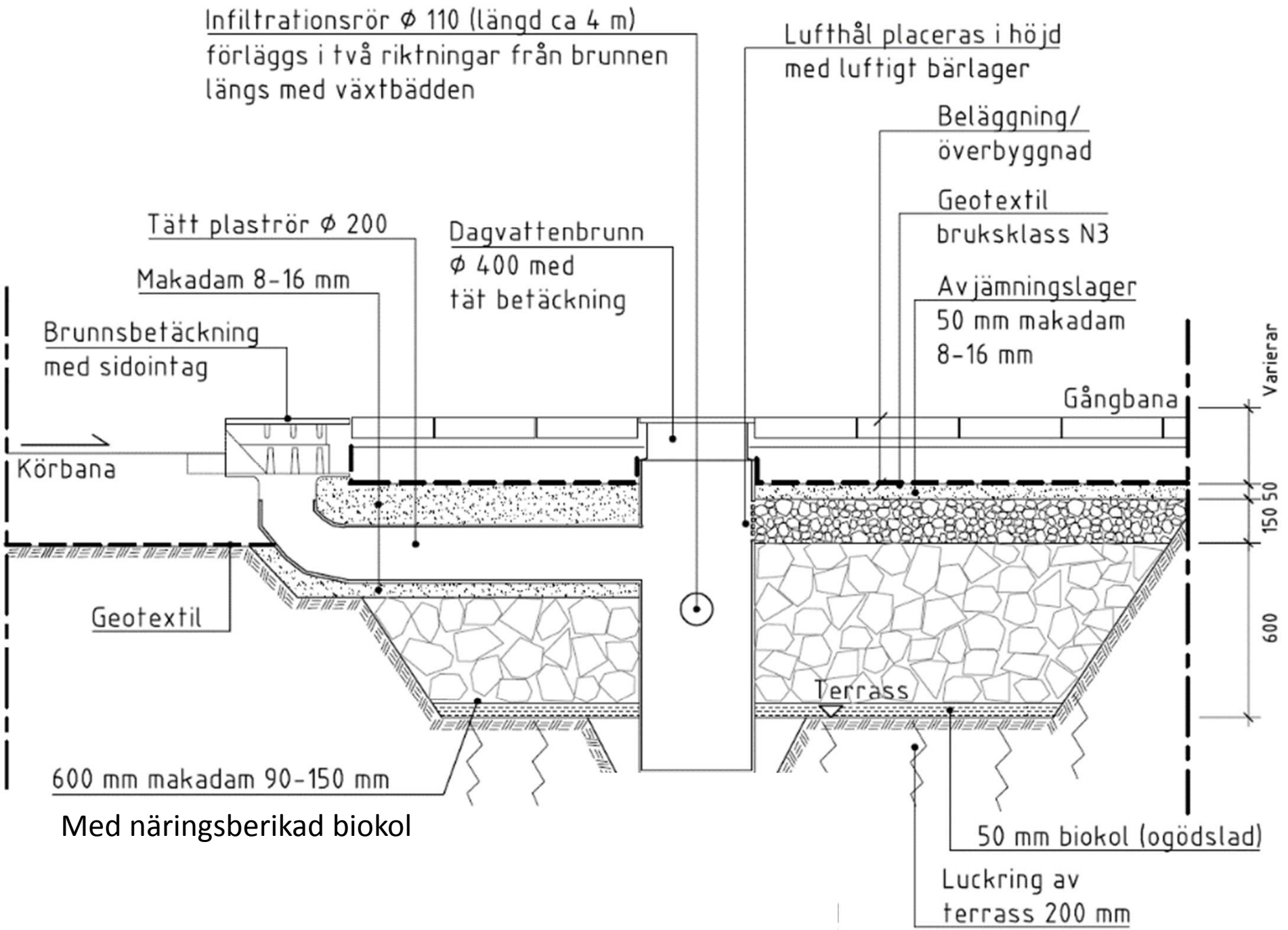
Structural soil with biochar

A method for building with stability and to create good growing conditions for trees in paved areas with the use of stormwater and the added value of decreasing the risk of roots damaging paving or underground pipes



1. Paved surface with dished stormwater gutters
2. Geotextile
3. Leveling layer (crushed rock 8-16 mm) – also used for concrete bunker and water/air inlet.
4. Aerated bearing layer (crushed rock 32-63 mm)
5. Structural soil (crushed rock 100-150 mm) with fertilized biochar hosed into the structural volume
6. Pure biochar on terrace
7. Concrete bunker
8. Surface grid
9. Crushed rock with fertilized biochar
10. Inlet for air and water supply





Med näringsberikad biokol

Nybrogatan Stockholm
Biochar with infiltration of stormwater

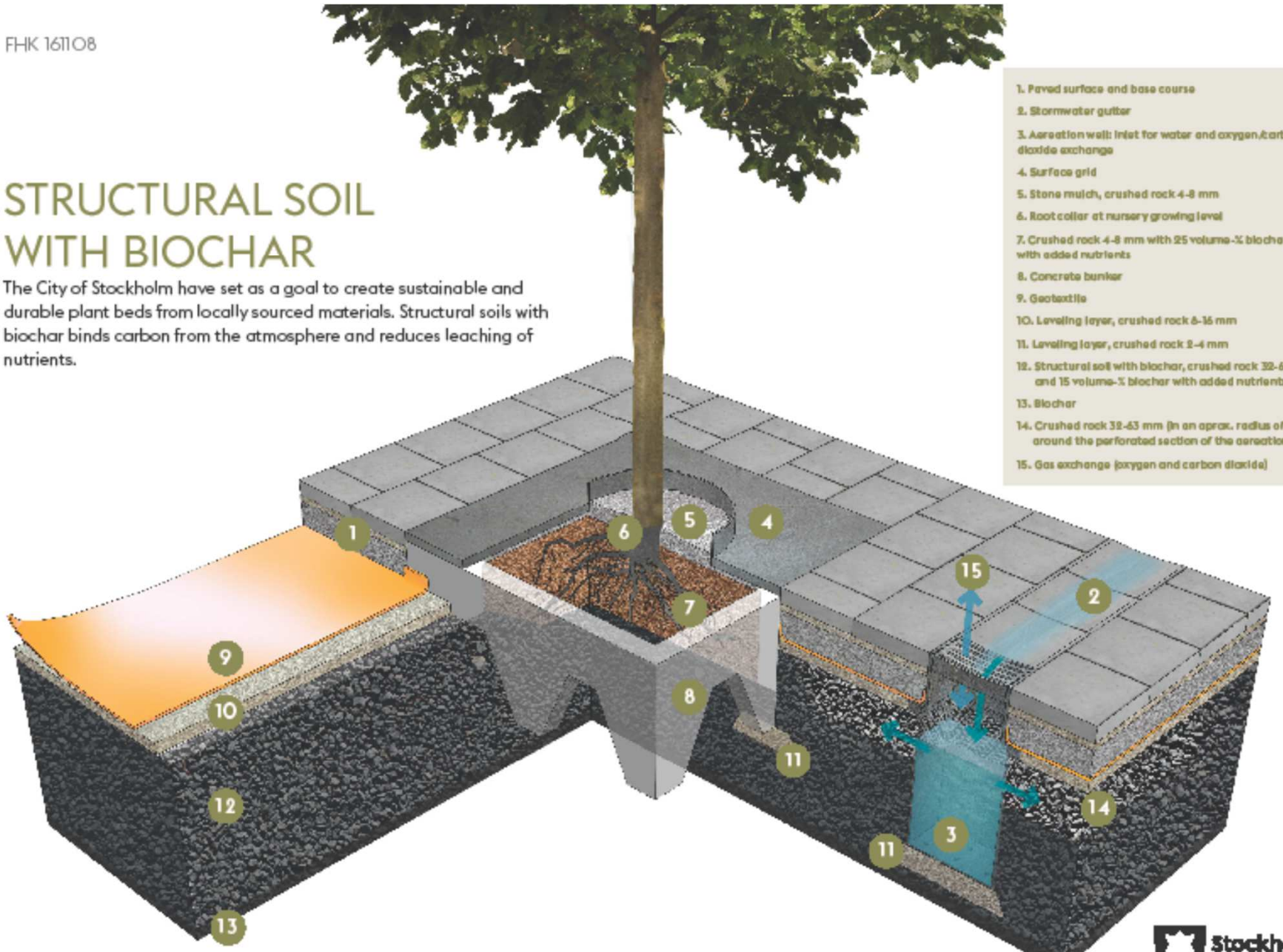
- Plant bed renovation a block of Nybrogatan where we follow our drawing ‘structural soil with biochar’. Some of the old trees were saved.
- The stone and biochar are mixed before the material is laid down, 15% by volume biochar.
- Closest to the roots of saved trees added a mixture of crushed granite and 25% manured biochar.
- Concrete box where the tree is planted,

in it you can see macadam mixed with 15% biochar

FHK 161108

STRUCTURAL SOIL WITH BIOCHAR

The City of Stockholm have set as a goal to create sustainable and durable plant beds from locally sourced materials. Structural soils with biochar binds carbon from the atmosphere and reduces leaching of nutrients.



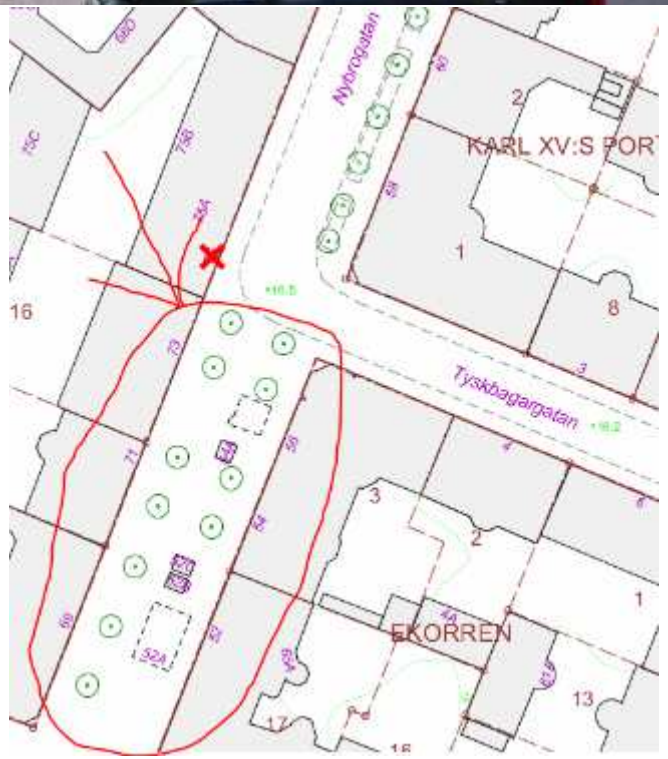
1. Paved surface and base course
2. Stormwater gutter
3. Aeration well: inlet for water and oxygen/carbon dioxide exchange
4. Surface grid
5. Stone mulch, crushed rock 4-8 mm
6. Root collar at nursery growing level
7. Crushed rock 4-8 mm with 25 volume-% biochar with added nutrients
8. Concrete bunker
9. Geotextile
10. Leveling layer, crushed rock 8-16 mm
11. Leveling layer, crushed rock 2-4 mm
12. Structural soil with biochar, crushed rock 32-63 mm and 15 volume-% biochar with added nutrients
13. Biochar
14. Crushed rock 32-63 mm (in an aprox. radius of $0,5$ m around the perforated section of the aeration well)
15. Gas exchange (oxygen and carbon dioxide)

Stockholms stad

Nybrogatan 2015
Kolmakadam

Plant bed for street trees charcoal and macadam = crushed granite 32-63 mm mixed with 15% nutrient-enriched charcoal, granite can be replaced with recycled concrete with reinforcement (iron)

Nybrogatan 2015
Kolmakadam

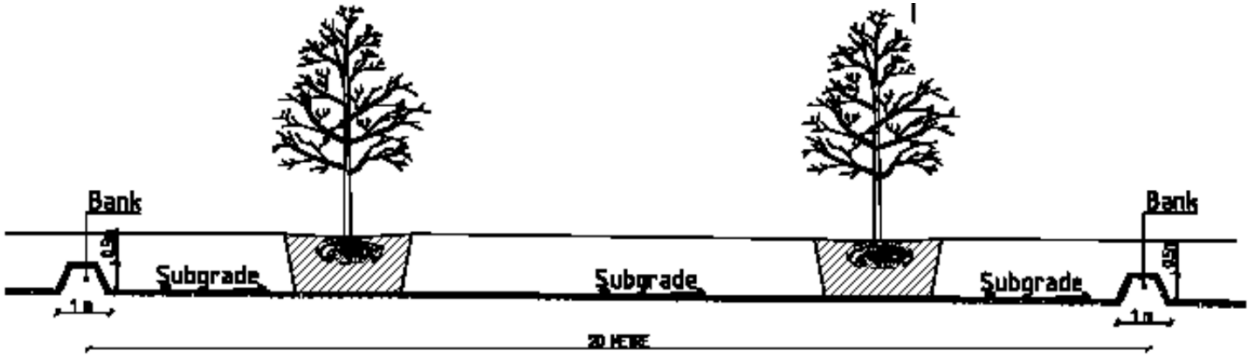


Nybrogatan 2016
Magnolia

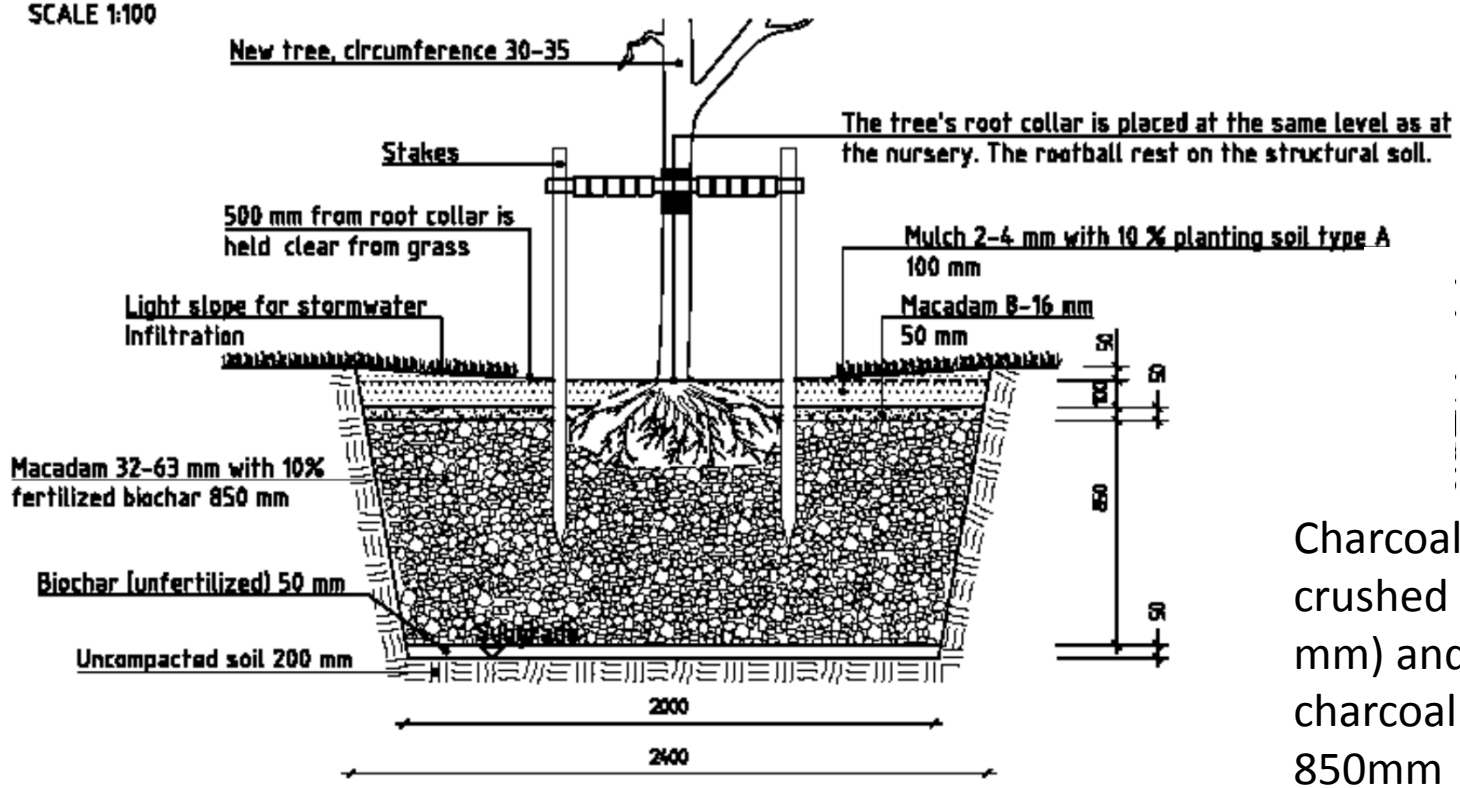
Lingvägen

biochar with infiltration of stormwater

- Image # 1. Plant bed renovation a 600 meter by 2m wide and 1 m deep.
- Image # 2. where we follow our drawing ‘tree pit with slanting subgrade’
- Image # 3. The ditch filled with biochar and gravel 8-16mm and a few months after planting



PLANTING PIT WITH SLANTING SUBGRADE
ELEVATION
SCALE 1:100



TREE PIT WITH BIOCHAR IN GREEN SPACE, TYPE 2
TYPE SECTION
SCALE 1:20

Drawing showing how we build plant bed for trees in the green area along streets and roads to maximize infiltration of storm water through a charcoal filter in the bottom of the plant bed where we catch up nutrients and pollutants.

Charcoal stone chips = crushed granite (32-63 mm) and nutrient-enriched charcoal 10/1. volume. 850mm

Plant bed for street trees charcoal macadam = crushed granite 8-16 mm mixed with nutrient-enriched charcoal


Maj 2015

Vallhallavägen

one hundred years old avenue of trees get

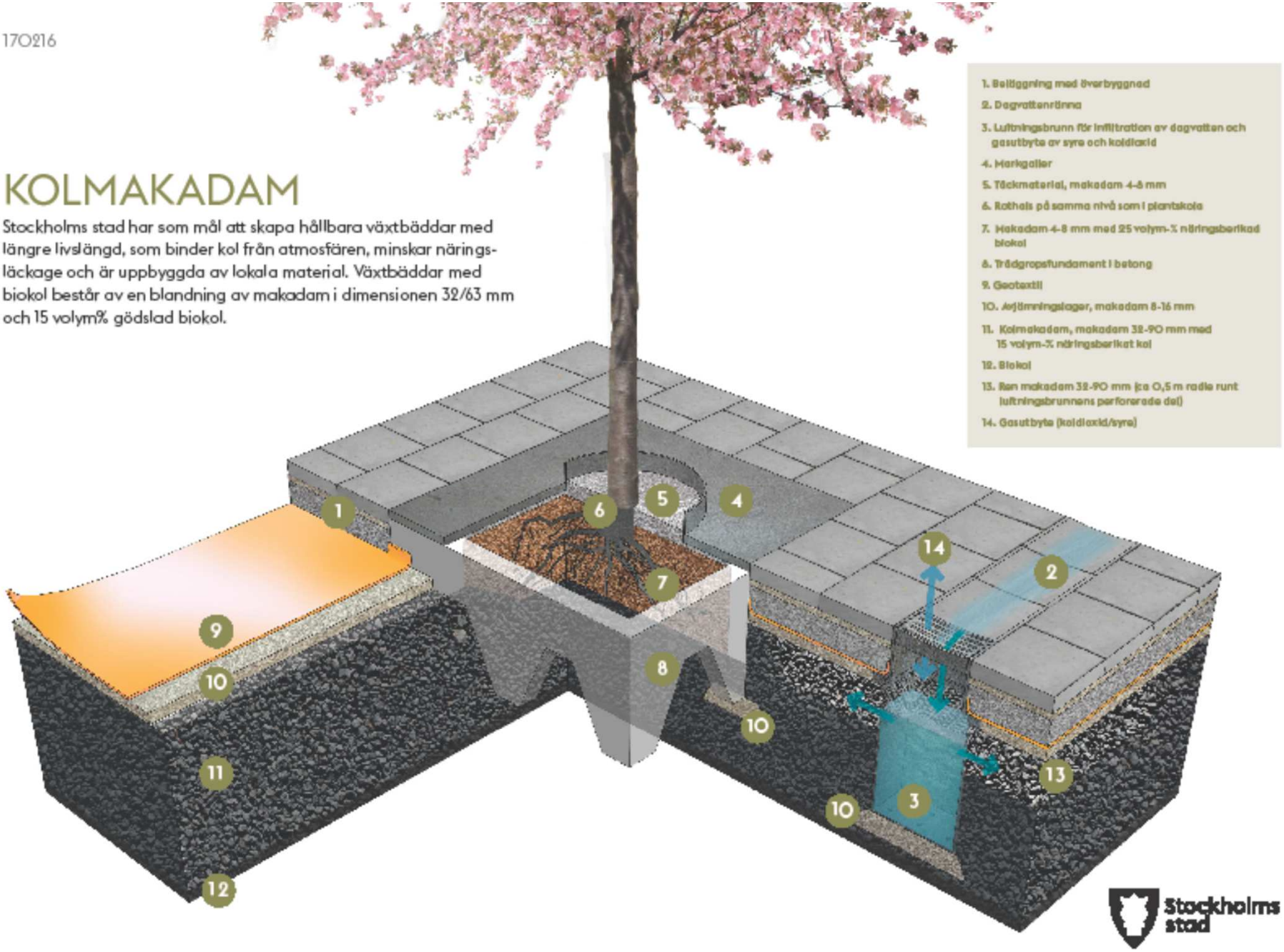
Biochar and macadam

- Compacted soil which is changed to ditch filled with biochar and macadam 32-63mm to save the trees with infiltration of stormwater
- the first time we sow grass on 2-6mm 3 parts 1 part biochar 100mm

170216

KOLMAKADAM

Stockholms stad har som mål att skapa hållbara växtbäddar med längre livslängd, som binder kol från atmosfären, minskar näringsläckage och är uppbyggda av lokala material. Växtbäddar med biokol består av en blandning av makadam i dimensionen 32/63 mm och 15 volym% gödslad biokol.



1. Beläggning med överbyggnad
2. Dagvattenrännа
3. Luftningsbrunn för infiltration av dagvatten och gasutbyte av syre och koldioxid
4. Markgaller
5. Täckmaterial, makadam 4-8 mm
6. Rotfals på samma nivå som i plantskola
7. Makadam 4-8 mm med 25 volym-% näringsberikad biokol
8. Trädgropsfundament i betong
9. Geotextil
10. Avjämningslager, makadam 8-16 mm
11. Kolmakadam, makadam 32-90 mm med 15 volym-% näringsberikat kol
12. Biokol
13. Ren makadam 32-90 mm (ca 0,5 m radie runt luftningsbrunnens perforerade del)
14. Gasutbyte (koldioxid/syre)

Stockholms stad

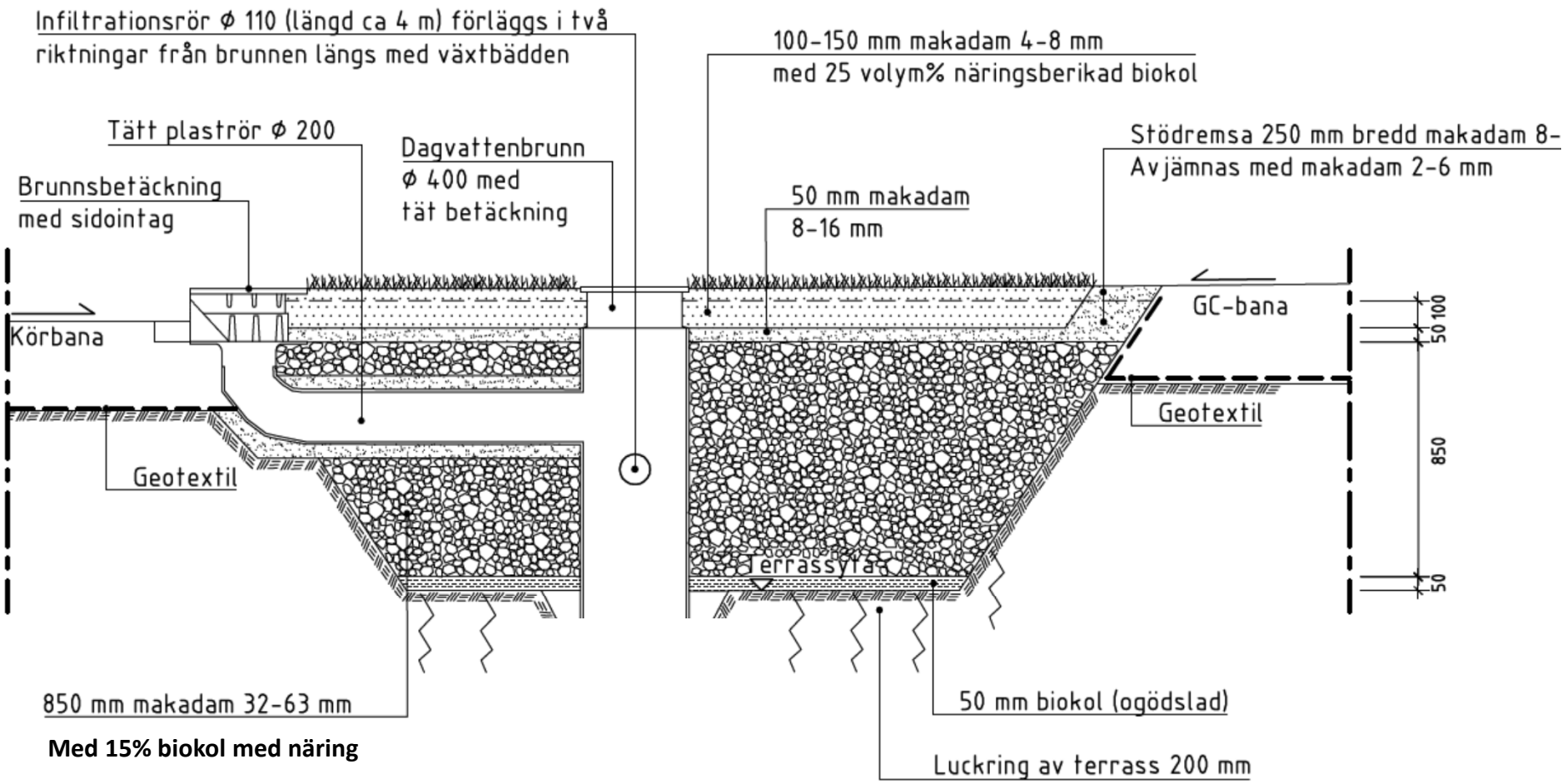
Valhallavägen

Vallhallavägen 2015


100mm mix of macadam 2-6mm 3 parts, 1 part biochar, and grass seed
8-16mm
30mm
32-63mm and 15% biochar
800mm
Valhallavägen
2016


Green
Bobcat
OSN 639
HL


2-6mm 3 parts 1 part biochar
100mm and grass seeds on the
surface



Med 15% biokol med näring

DAGVATTENFÖRDRÖJNING – GRÄSYTA MED KOLMAKADAM

Bo Bergman Gata 2016

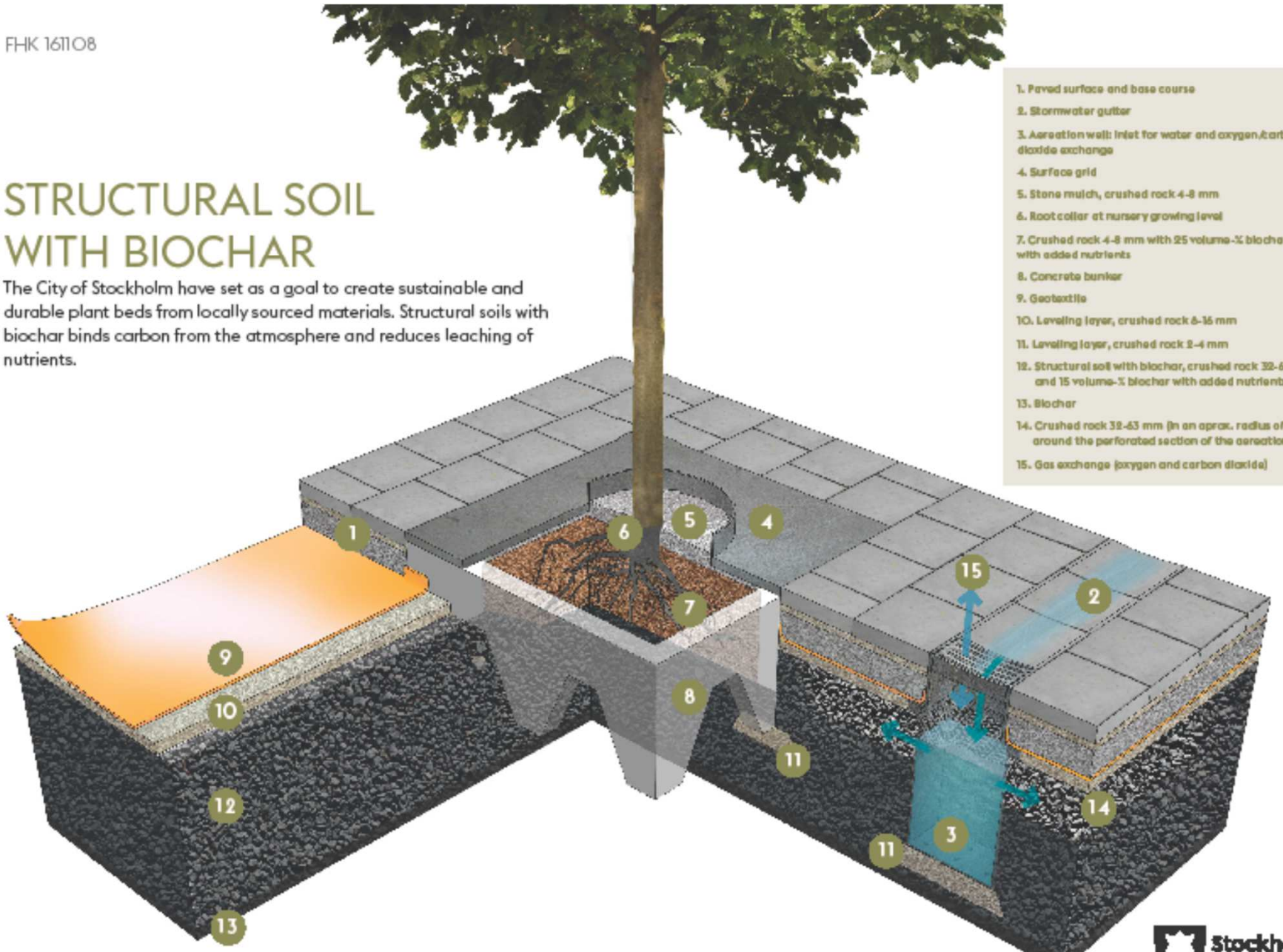
Biochar with infiltration of stormwater

- Plant bed renovation a block of Tilias
- The stone and biochar are mixed before the material is laid down, 15% by volume biochar.
- Closest to the roots of saved trees added a mixture of crushed granite and 25% manured biochar.

FHK 161108

STRUCTURAL SOIL WITH BIOCHAR

The City of Stockholm have set as a goal to create sustainable and durable plant beds from locally sourced materials. Structural soils with biochar binds carbon from the atmosphere and reduces leaching of nutrients.



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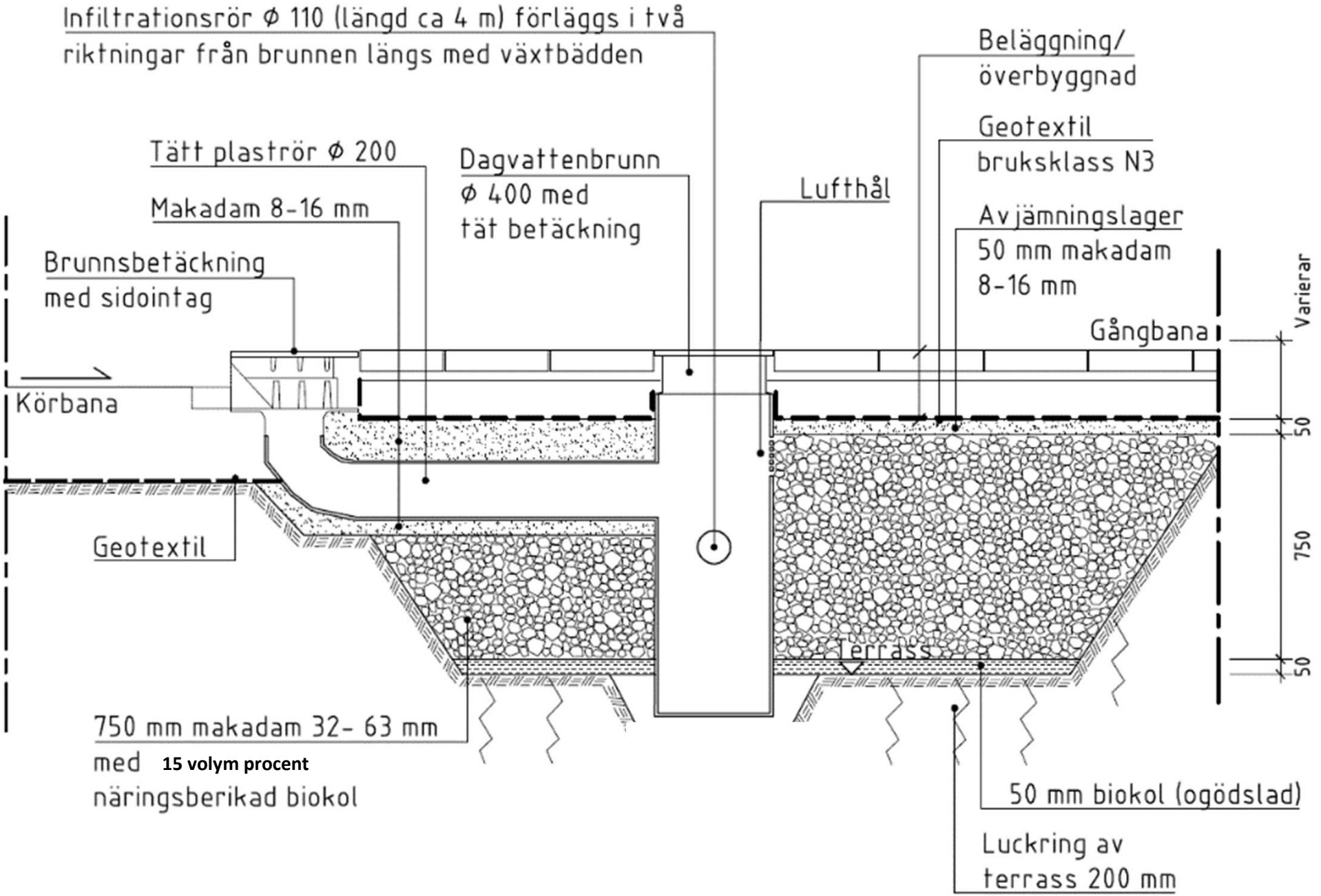
13. Biochar
14. Crushed rock 32-63 mm (in an aprox. radius of $0,5$ m around the perforated section of the aeration well)
15. Gas exchange (oxygen and carbon dioxide)

Stockholms stad


Infiltrationsrör ø 110 (längd ca 4 m) förläggs i två riktningar från brunnen längs med växtbädden
Beläggning/ överbyggnad
Geotextil bruksklass N3
Tätt plaströr ø 200
Dagvattenbrunn ø 400 med tät betäckning
Lufthål
Avjämningslager 50 mm makadam 8-16 mm
Makadam 8-16 mm
Brunnsbetäckning med sidointag
Gångbana
Varierar
Körbana
50
750
50
Geotextil
Terrass
750 mm makadam 32- 63 mm med 15 volym procent näringsberikad biokol
50 mm biokol (ogödslad)
Luckring av terrass 200 mm

Pilgatan 2014

Biochar with infiltration of stormwater
Magnolias and perennials
1 part biochar 0-10mm and 3 parts crushed granite size 4-8 mm
800mm deep.


2014/12/04

Biochar and stone chips = crushed granite 3/4 (2-6mm) and nutrient-enriched charcoal 1/4. volume

Biochar and stone chips = crushed granite 3/4 (2-6mm) and nutrient-enriched charcoal 1/4. volume

the material acts as an open magasin able to receive storm water to at least 30% of its volume


2017 augusti


2017 augusti

Råckstarondellen
Biochar and macadam

•Roundabout with new design, 2000 square meters with 15 multi stem pines and 20 000 Hakone grass two different layers of biochar and crushed granite in the bottom size 32-63 mm and the top layer 2-6mm 300mm crushed stone mixed with biochar.

Råckstarondellen
2015

Råckstarondellen
2015

Råckstarondellen
2016

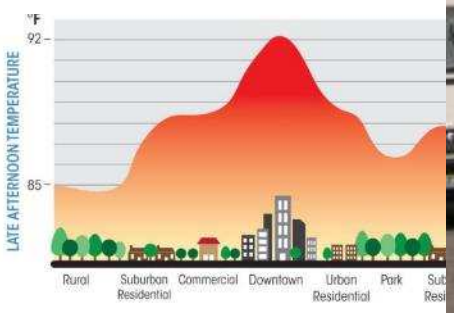
Råckstarondellen
2016

Helsingborg
Drottninggatan

Uppsala 2017

Reduce the risk of floods

counteract the heat island effect



Reduce the presence of particles and carbon dioxide in the air

Reduce the load on the storm water systems, thereby reducing pollution in Lake Mälaren and the Baltic Sea

300mm deep, = crushed granite **6/8 volume parts** (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) **2/8 volume parts**

Stone trough with alpines

300mm deep, = crushed granite **6/8 volume parts** (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) **2/8 volume parts**

Magnolia tripetala

300mm deep, = crushed granite **6/8 volume parts** (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) **2/8 volume parts**
Lettuce artichoke potatoes

2017
First potatoes grown in macadam biochar and compost