

Stockholm Biochar Project



100 years old



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



Concrete tile

Sand

Asphalt

Roadbed crushed granite fraction 0-63 compacted

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



More than 40
years on the
site

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

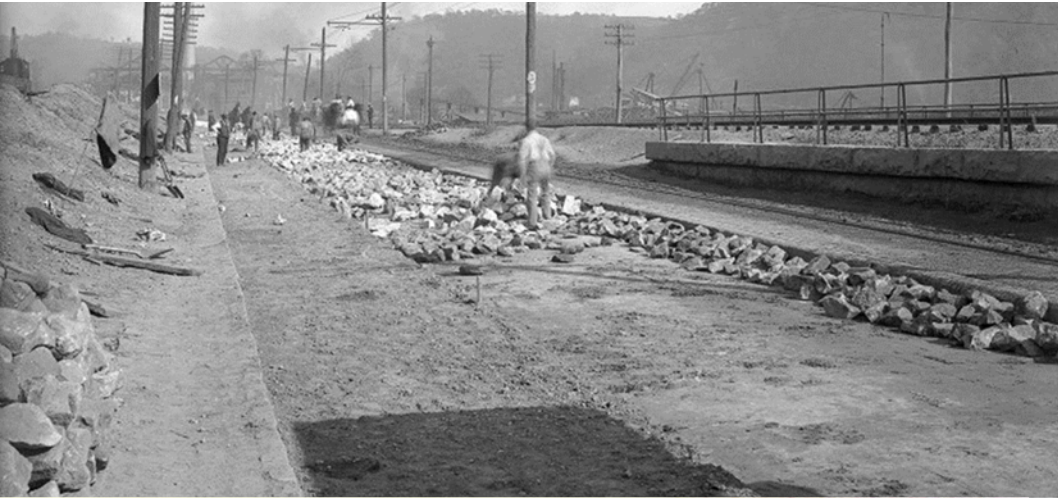


Entrepreneurs do not have a clue on how to handle soil

2003 we started to use a rock based 'macadam' growing substrate to benefit for both for trees and storm water management



Macadam is a type of road construction, pioneered by Scottish engineer John Loudon McAdam around 1820, in which single-sized crushed stone layers of small angular stones are placed in shallow lifts and compacted thoroughly (WIKI)

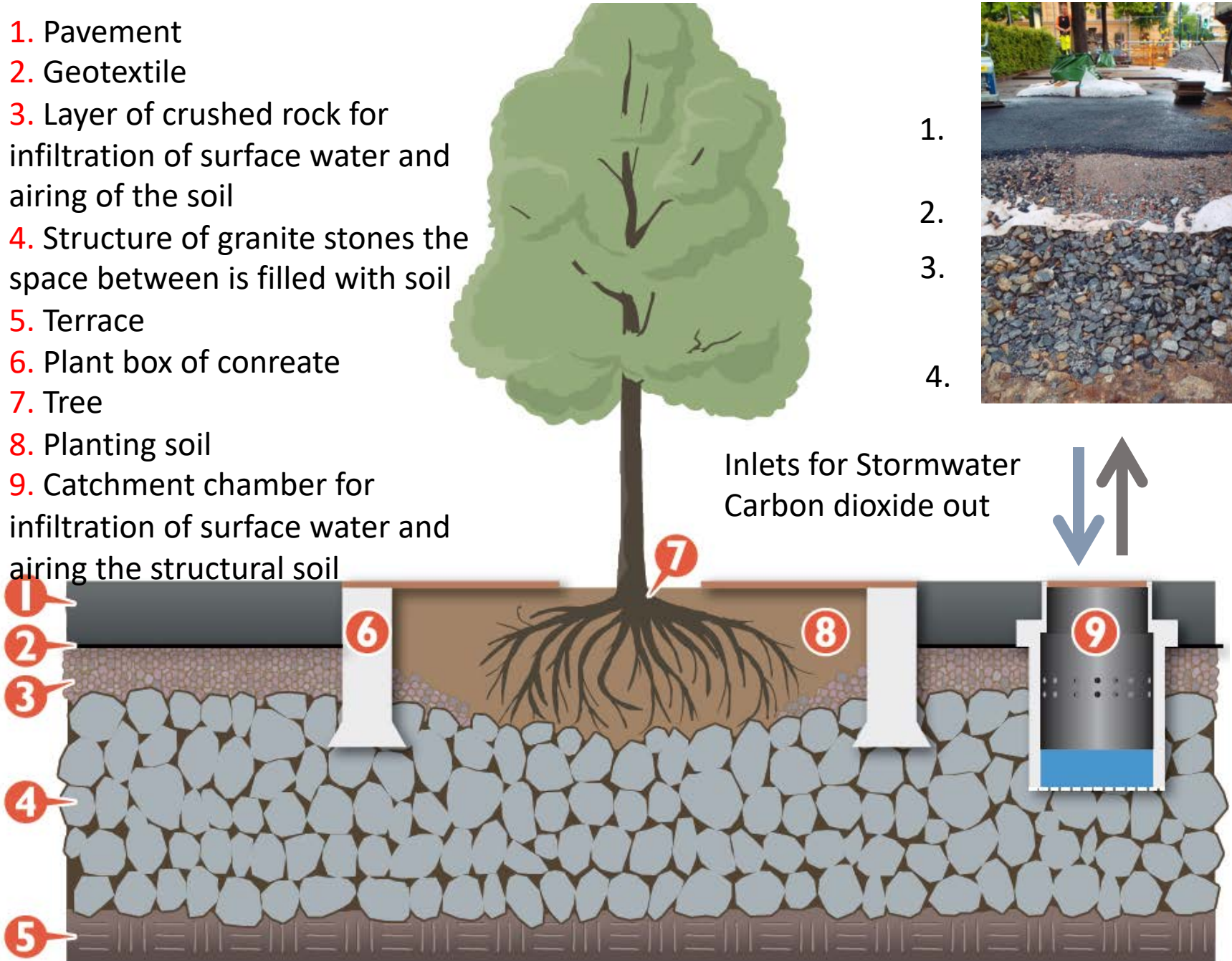


Gives 35-40% porosity

First macadam road in the USA 1823 (WIKI)

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 concrete
7. Tree
8. Planting soil
9. Catchment chamber for infiltration of surface water and airing the structural soil



left 2002 right 2013 Kungsbroplan tree before and after structural soil



Macadam

16-32mm

32-63mm

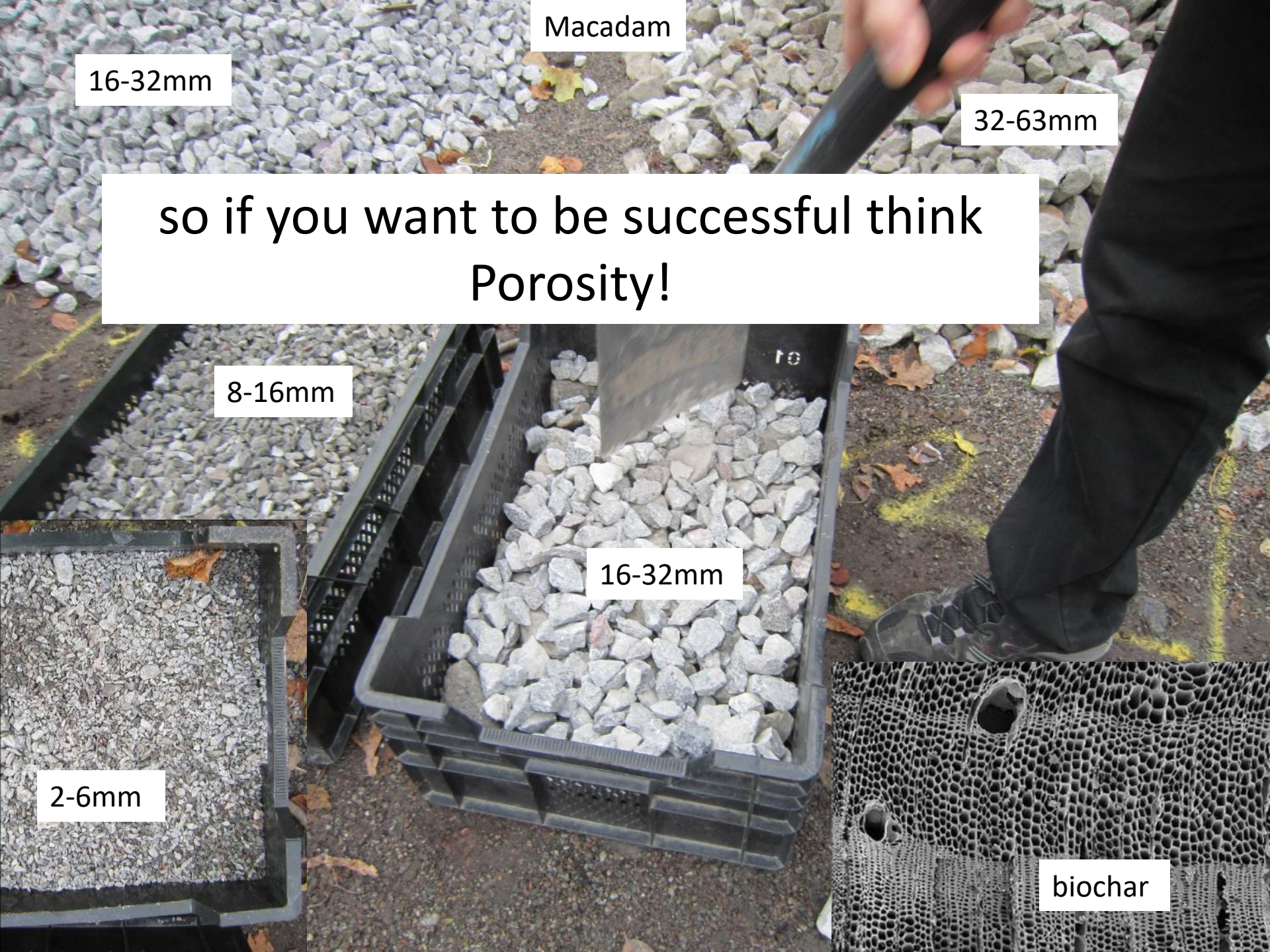
so if you want to be successful think
Porosity!

8-16mm

16-32mm

2-6mm

biochar



Compost 1/8



Biochar (0-10mm) 1/8



Macadam(2-6mm) 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**





Bare rooted plants of shrubs and perennials get the best and fastest establishment

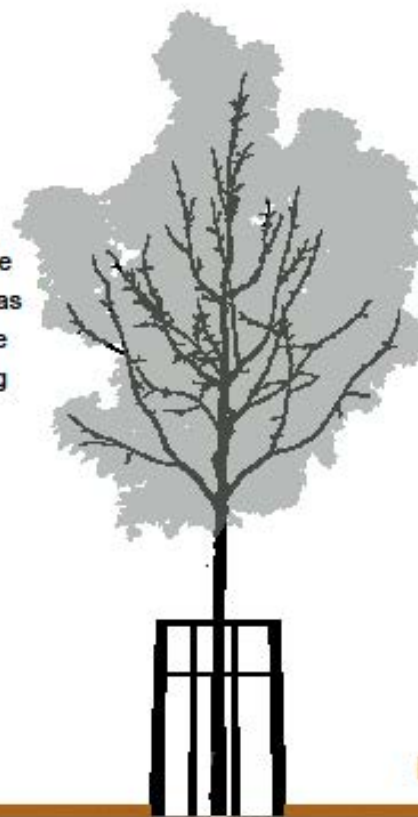
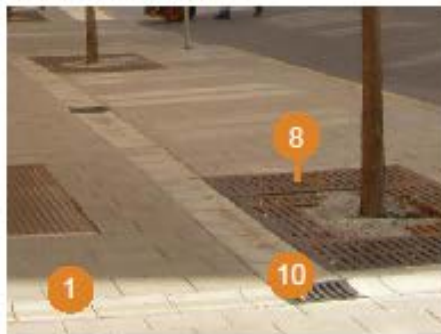


Magnus Ladulåsgatan Stockholm

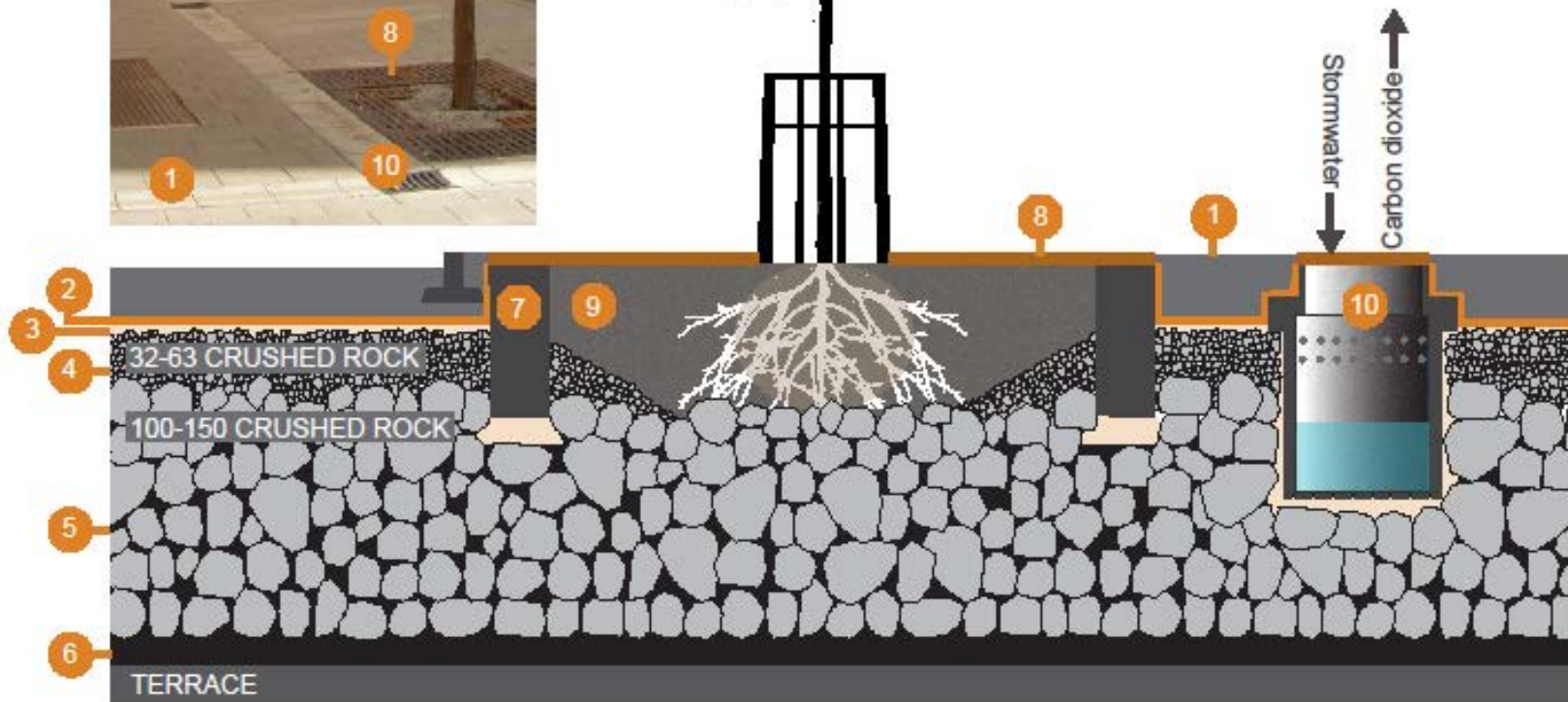
Biochar compost and macadam with infiltration of stormwater

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

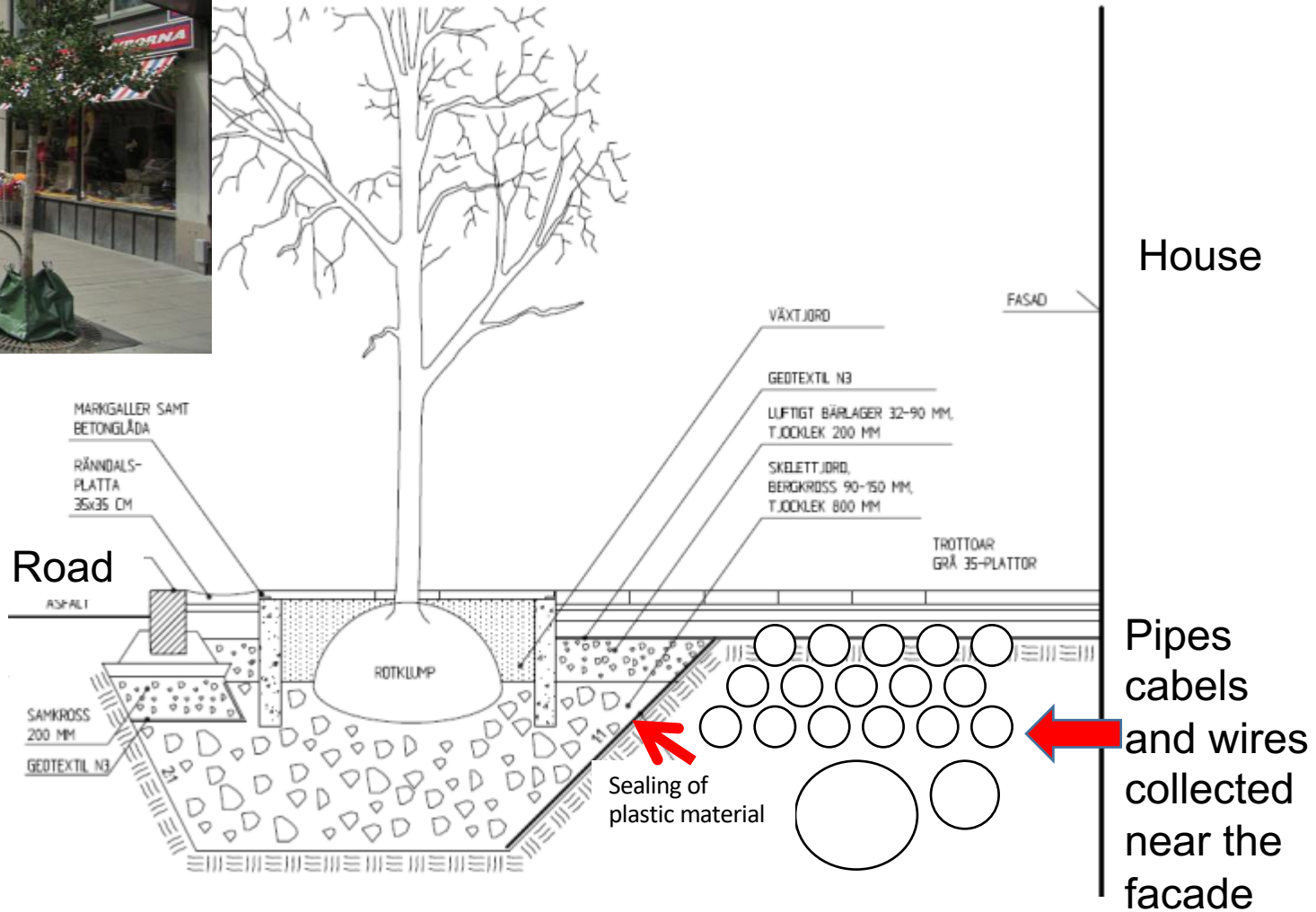


1. Paved surface with dished stormwater gutters
2. Geotextile
3. Leveling layer (crushed rock 8-16 mm) – also used for concrete bunker and water/air inlet.
4. Aerated bearing layer (crushed rock 32-63 mm)
5. Structural soil (crushed rock 100-150 mm) with fertilized biochar hosed into the structural volume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





Sidewalk Cross section of planting bed

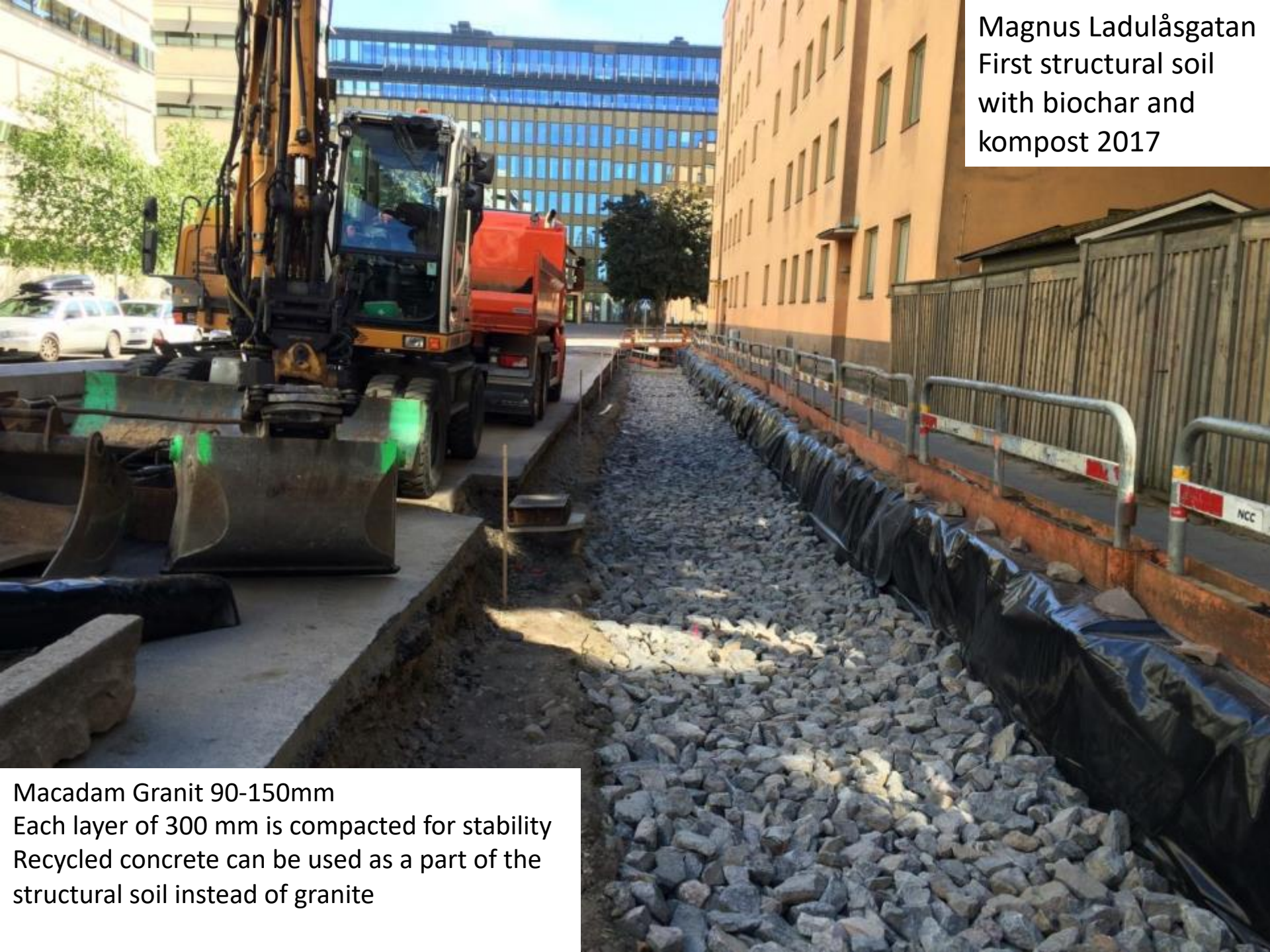


connected plant beds along the block for the best conditions for the trees



Magnus Ladulåsgatan
First structural soil
with biochar and
kompost 2017

Macadam Granit 90-150mm
Each layer of 300 mm is compacted for stability
Recycled concrete can be used as a part of the
structural soil instead of granite



Granit size 90-150mm



Concrete box to hold the paved surface around the tree in place



Compacting befor soil is washed in to the voids



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





90-150mm macadam
And biochar compost 50/50
flushed down between the stones
provides the strongest structure
for heavy loads



Flushing the soil into the structure



Ventilation chamber and inlet of surface water



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

Layer for infiltration of rain water and ventilation of the soil





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



If the old trees is healthy, we will remove the material around the roots and re-fill with structural soil

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



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



Estimated Numbers from Hornsgatan 40trees x 25sqm
Roof and pavement surface 5000 sqm Rainfall 600mm year
Approximately 3million liters of water year

Saved cost for the treatment of stormwater = 3000 euro /year
Reduced load on sewage system and the Baltic Sea / and lakes



Koelreuteria
paniculata second
growing season



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

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 wall: 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 wall)
15. Gas exchange (oxygen and carbon dioxide)

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



Nybrogatan 2015
Kolmakadam





Nybrogatan 2015
Macadam and
biochar

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 2016
Magnolia

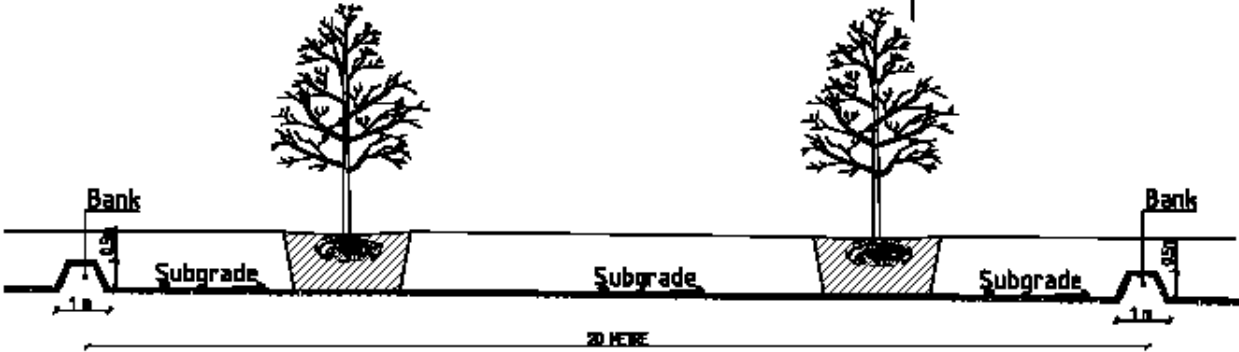
Lingvägen

biochar with infiltration of stormwater

- Plant bed renovation a 600 meter by 2m wide and 1 m deep.
- where we follow our drawing 'tree pit with slanting subgrade'
- The ditch filled with biochar and gravel 8-16mm

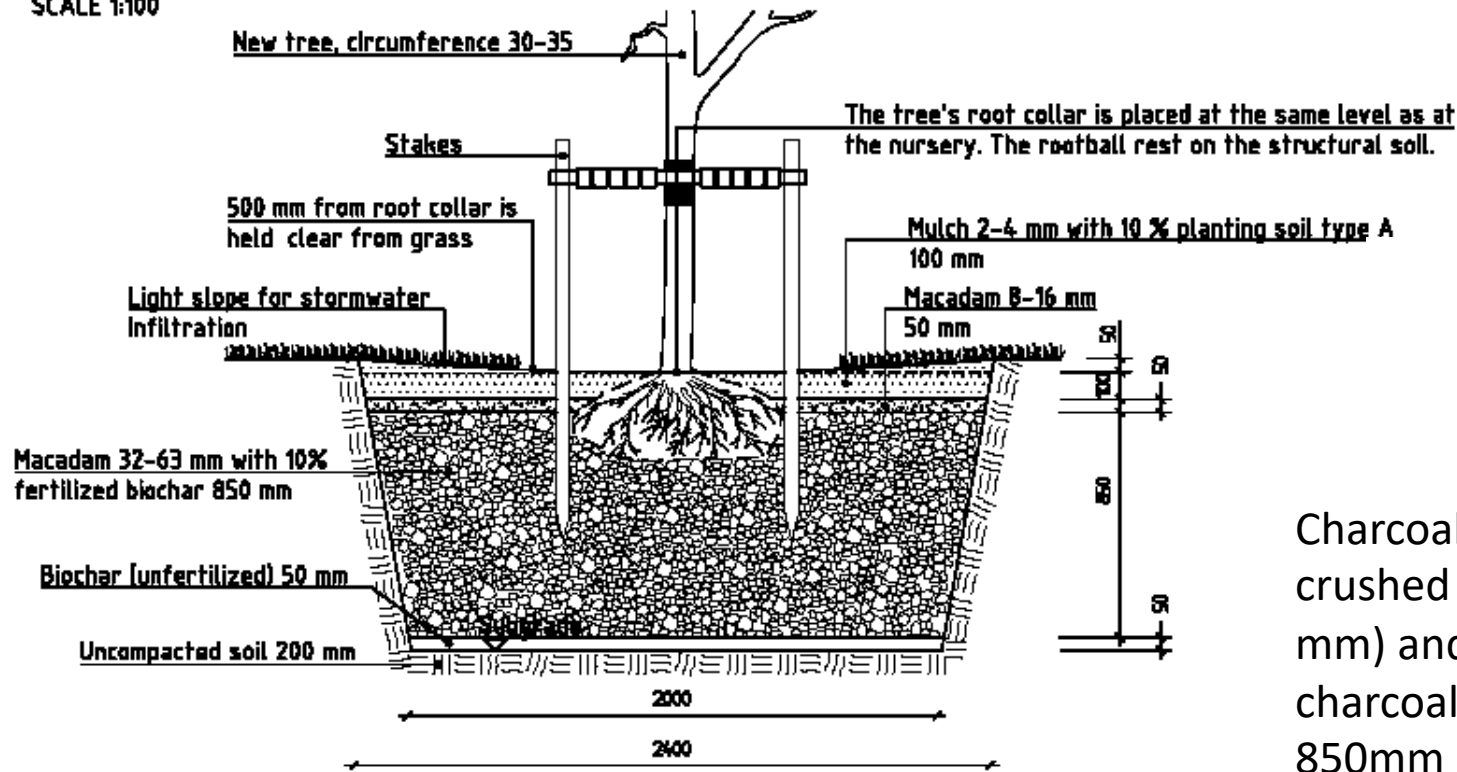
Lingvägen biochar macadam and infiltration of stormwater





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





2018



2017 Haukadalsgatan biochar 1 part, compost 1 part, macadam 4-8mm 6 parts



2018 aug.



Vallhallavägen

hundred year old avenue of trees get

Biochar compost 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

Valhallavägen



vacuum cleaned root system





Green

OSN 639

Bobcat

HIL

UCADAR

ATA IITL

Paracross
Avgift
8-17
8-18
8-19
8-20
8-21
8-22
8-23
8-24
8-25
8-26
8-27
8-28
8-29
8-30
8-31
8-31

Valhallavägen
2016-2018

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

8-16mm
30mm


32-63mm and 15% biochar
600mm



8-16mm 30mm

32-63mm and 15% biochar
800mm





100mm mix of macadam 2-6mm 3 parts, 1 part biochar/compost, and grass seed

8-16mm 30mm



- the first time we make grass on macadam 2-6mm 3 parts and 1 part biochar/compost

Pilgatan 2014

Biochar and macadam with infiltration of stormwater

1 part biochar 0-10mm and 3 parts crushed granite size 4-8 mm 800mm deep.

Magnolia and perennials



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



2017 augusti





New tree in grass
planting volume 2x2x0,8m
Macadam 4-8mm 3parts
Biochar and compost 1part



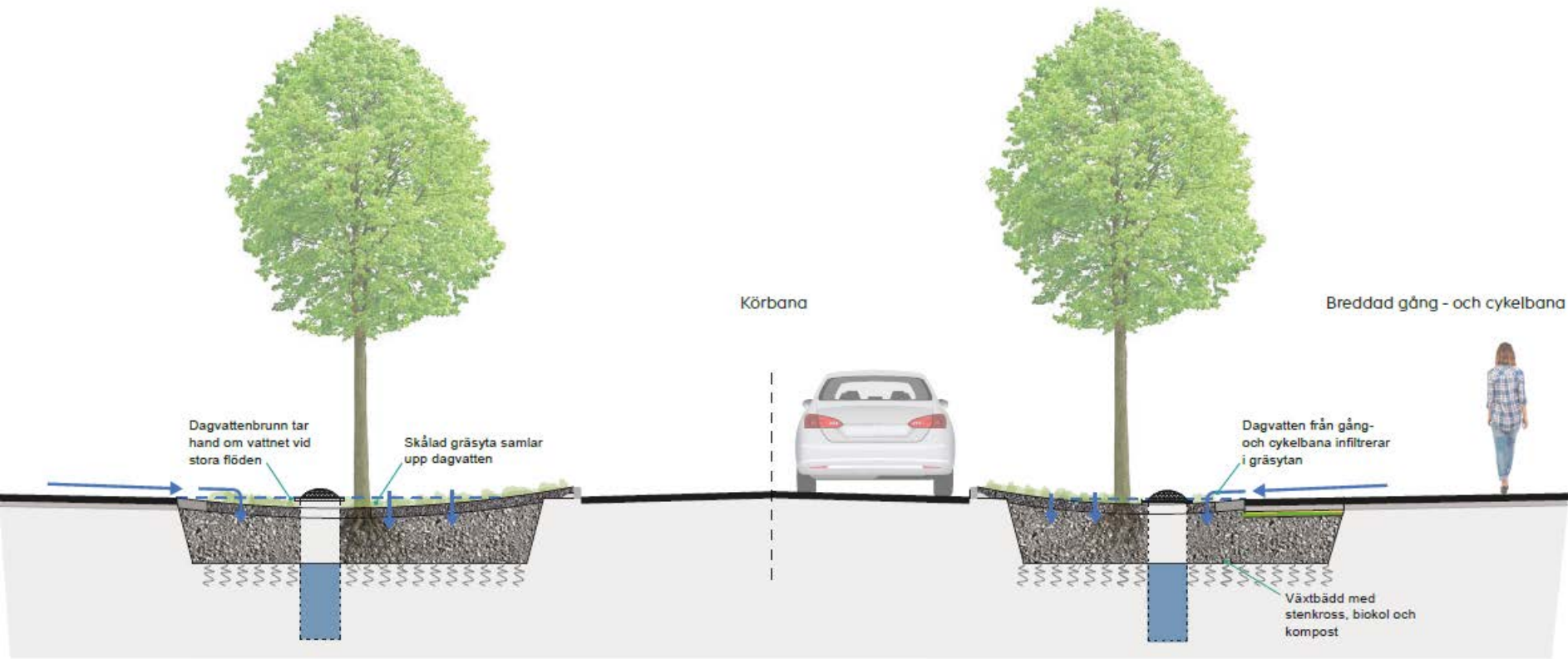
Kolonivägen 2016-2017

Magnolias, Cersis, Prunus.

1 part biochar 0-10mm och 3 parts macadam 4-8 mm 600mm.











Gives healthy trees with all the positive effects it provides



Reduce the risk of flooding



Reduce the heat island effect



locks down carbon dioxide into the ground with the use of biochar in the planting beds

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





Uppsala 2017





300mm deep, = crushed granite **3 parts** (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) **1 part**
Magnolia tripetala



Stone trough with alpinas

crushed granite $\frac{3}{4}$ volume parts (2-6mm) and nutrient-enriched biochar (50%) + compost (50%) $\frac{1}{4}$ volume part







2017

First potatoes grown in
macadam biochar and
compost



2018
First carrots grown in
macadam biochar and
compost



Växtbäddar i Stockholms stad

– en handbok 2017