TREE FUND
WEBINAR SERIES

UtahStateUniversity
FORESTRY EXTENSION

The Salt Dilemma: Growing Better Urban Trees in Northern Climates

James Urban, FASLA, *Urban Trees + Soils*
Andrew Millward, PhD, *Ryerson University*
Adam Nicklin, *PUBLIC WORK*

Thank you to our Crown, Diamond and Platinum Partners who make our work possible:

ASPLUNDH · BARTLETT TREE EXPERTS · DAVEY Proven Solutions for a Changing World Education Crown Partner · Green Manufacturing, Inc. · ISA · Mowbray's Tree Service · WRIGHT · ACRT INC · Bandit Industries, Inc. · CORTEVA agriscience · FirstEnergy · Ohio Chapter ISA · PG&E · TCIA Voice of Tree Care · UAA · ARBORjet Revolutionary Plant Health Solutions · KASK · PECO An Exelon Company

See all TREE Fund Partners at treefund.org/partners

TREE FUND
Cultivating Innovation

Tree Research and Education Endowment Fund
Treefund.org

Over $3.9 Million in funding support for:

Scientific research on urban tree care issues
Education programs related to trees
Scholarships for students aspiring to be tree care professionals

New 2018 Endowment Campaign

Tree and Soil Research Fund for Landscape Architecture

LACES CEUs for Landscape Architects

Supported by deeproot

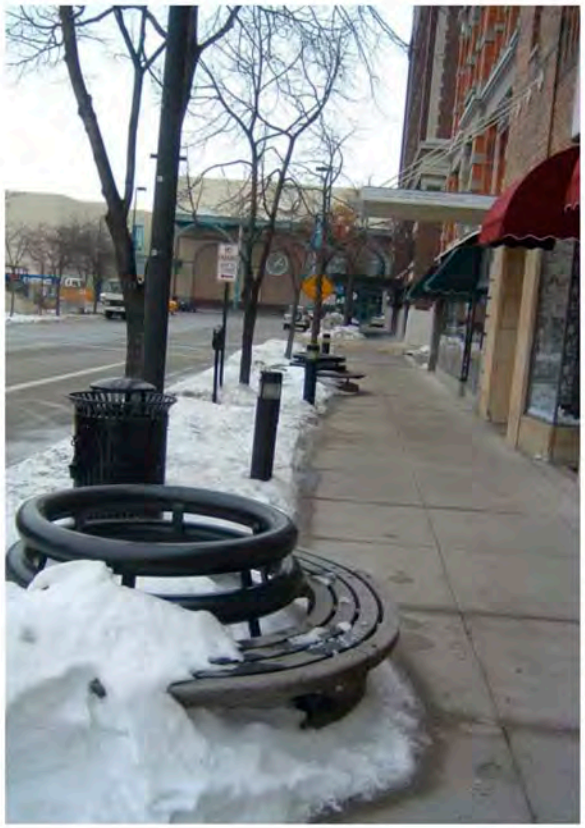
The Salt Dilemma: Growing Better Urban Trees in Northern Climates

Introduction Salt - Its complex!

Typically tree decline from salt is not a single issue in tree decline.
But it can be!

The science of trees is much easier to understand than the relationship of trees and people!

Two kinds of salt damage that must be considered



Salt in soil water

Air born salt

Salt

Multiple factors in salt damage
Where you are!

More salt problems
More density

Less salt problems
Less density

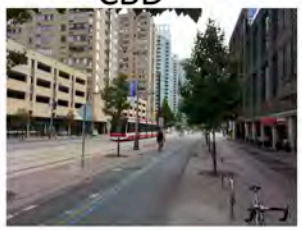
CBD

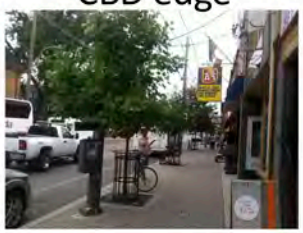
CBD edge

Older neighborhoods

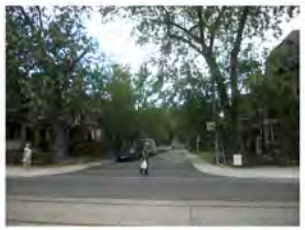
Suburban

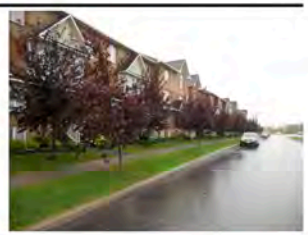
Commercial





Residential





Parks

Soils, Drainage, Topography, Land Use

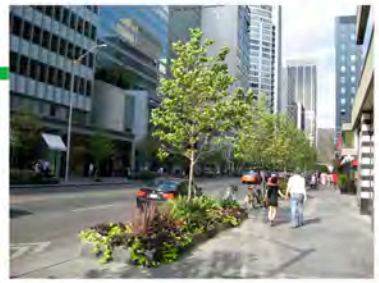
Multiple factors in salt damage:

Soil

Soil type, volume
Soil drainage

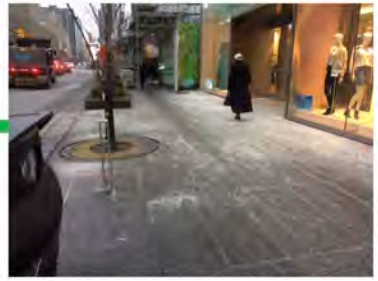
Design/Installation

Tree space design
Tree species
Nursery stock quality



Salt

Salt type
Application frequency,
and dosing



Environmental

Sun/shade
Wind and microclimates

18.06.2015

Multiple factors in salt damage

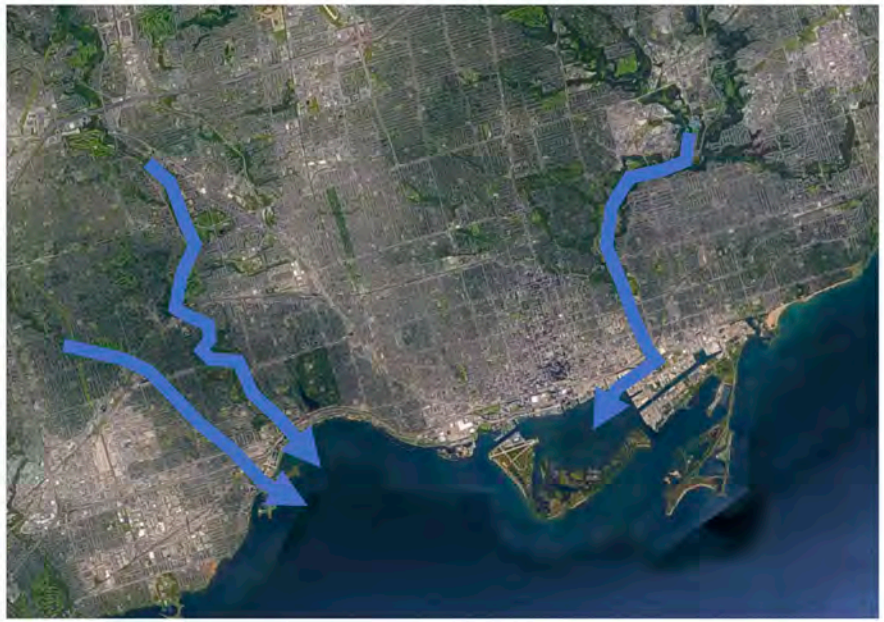
Salt influences beyond tree health

Ecological impacts

Human health impacts

Infrastructure impacts

Cost $$$



Finding a balance with public safety real and imagined.

Andrew Millward, PhD
Principal Investigator, UFRED Group
Ryerson University, Toronto, ON, Canada
millward@ryerson.ca | www.ufredgroup.ca
&
Justin Miron
Research Associate, UFRED Group

UFRED Group has more than a decade of experience investigating and improving tree cover in cities. We are a multi-disciplinary team whose skills and focus span the social-ecological dimensions of urban forest management to the application of geospatial technologies for mapping and monitoring tree cover.

Arboriculture & Urban Forestry 2018. 44(3):133–145

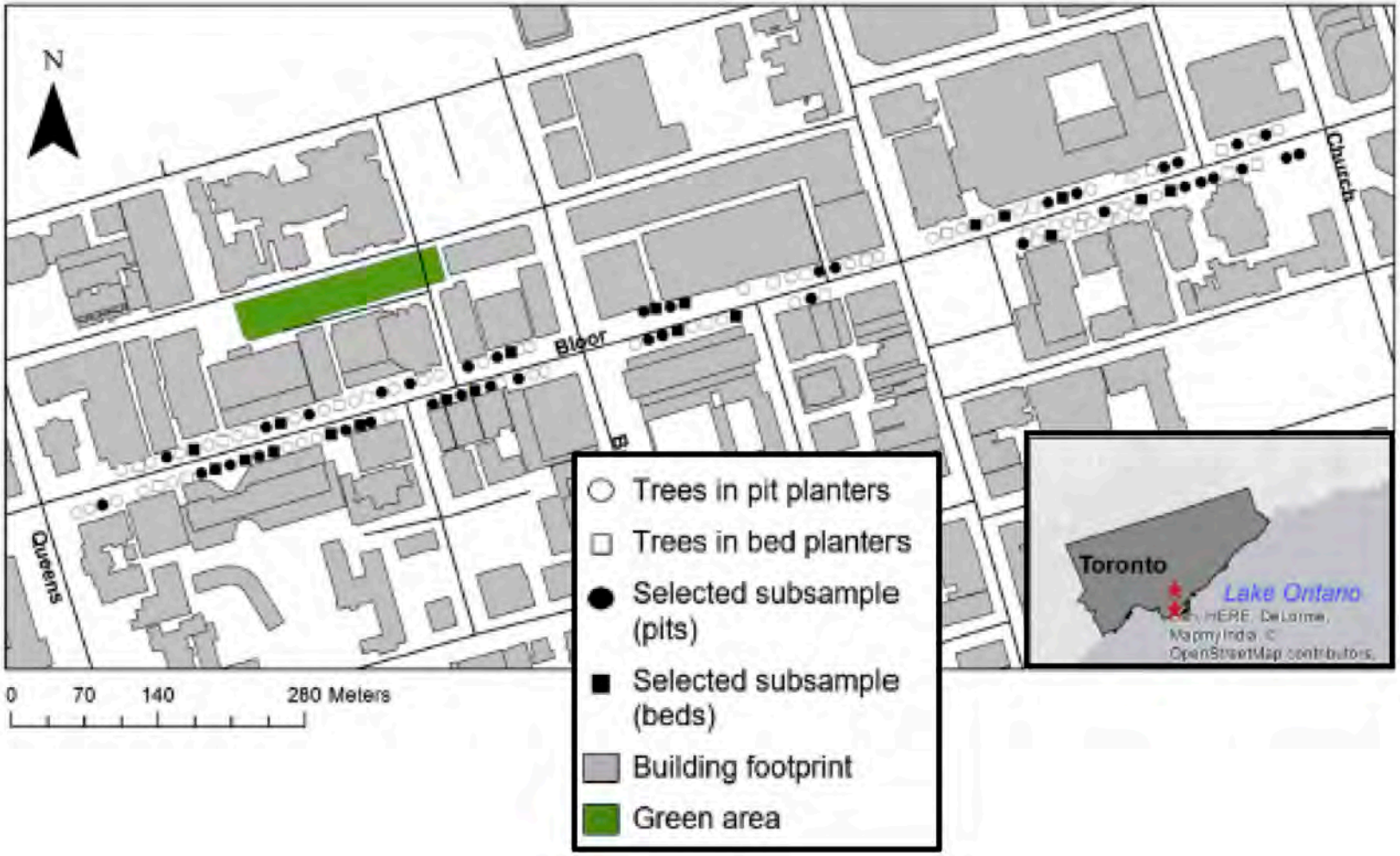
The Influence of Abiotic Factors on Street Tree Condition and Mortality in a Commercial-Retail Streetscape

Camilo Ordóñez, Vadim Sabetski, Andrew A. Millward, James W. N. Steenberg, Amber Grant, and James Urban

Tree decline and mortality along Toronto's Bloor Street

2010 - Streetscape revitalization – 100% London planetree (n=133)
2015 - Wholesale replanting – mixed species (e.g., elm cultivars)

Bloor Street Revitalization - **133 London planetree** (*Platanus* × *acerifolia*)



Soil sampling and excavation (Toronto's Bloor Street)

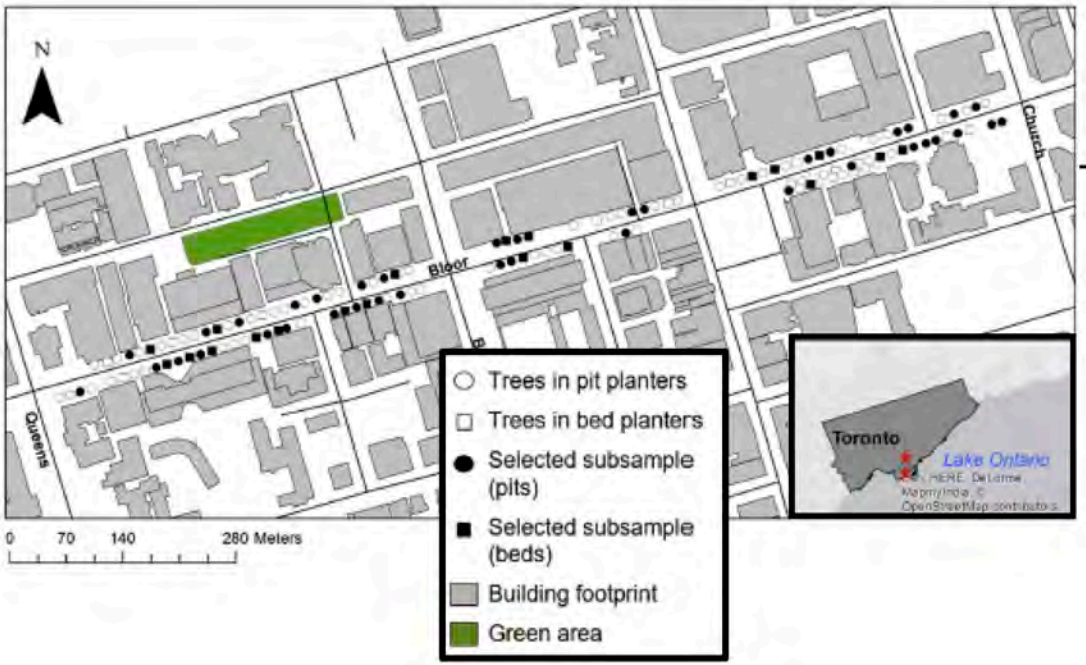
Sidewalk Cutouts

Tree excavation and root architecture (Toronto's Bloor Street)

Raised Planter /Curb Surround

DATA: Tree decline and mortality (Toronto's Bloor Street)

Type of Data	Collection Technique	Site	Number of samples	Depth	Measurements	Dates
Soils	Soil samples	Bloor Street	57	25 cm	Organic Matter (% of total), pH, electro-conductivity (EC (dS/m)), sodium, magnesium, calcium (ppm)	May 2015
Trees	Field Assessment	Bloor Street	133	n.a.	Mortality (alive/dead) before removal 2015 Tree foliar condition (0–3 scale)	May 2015 June 2014 and August 2016 (new trees)



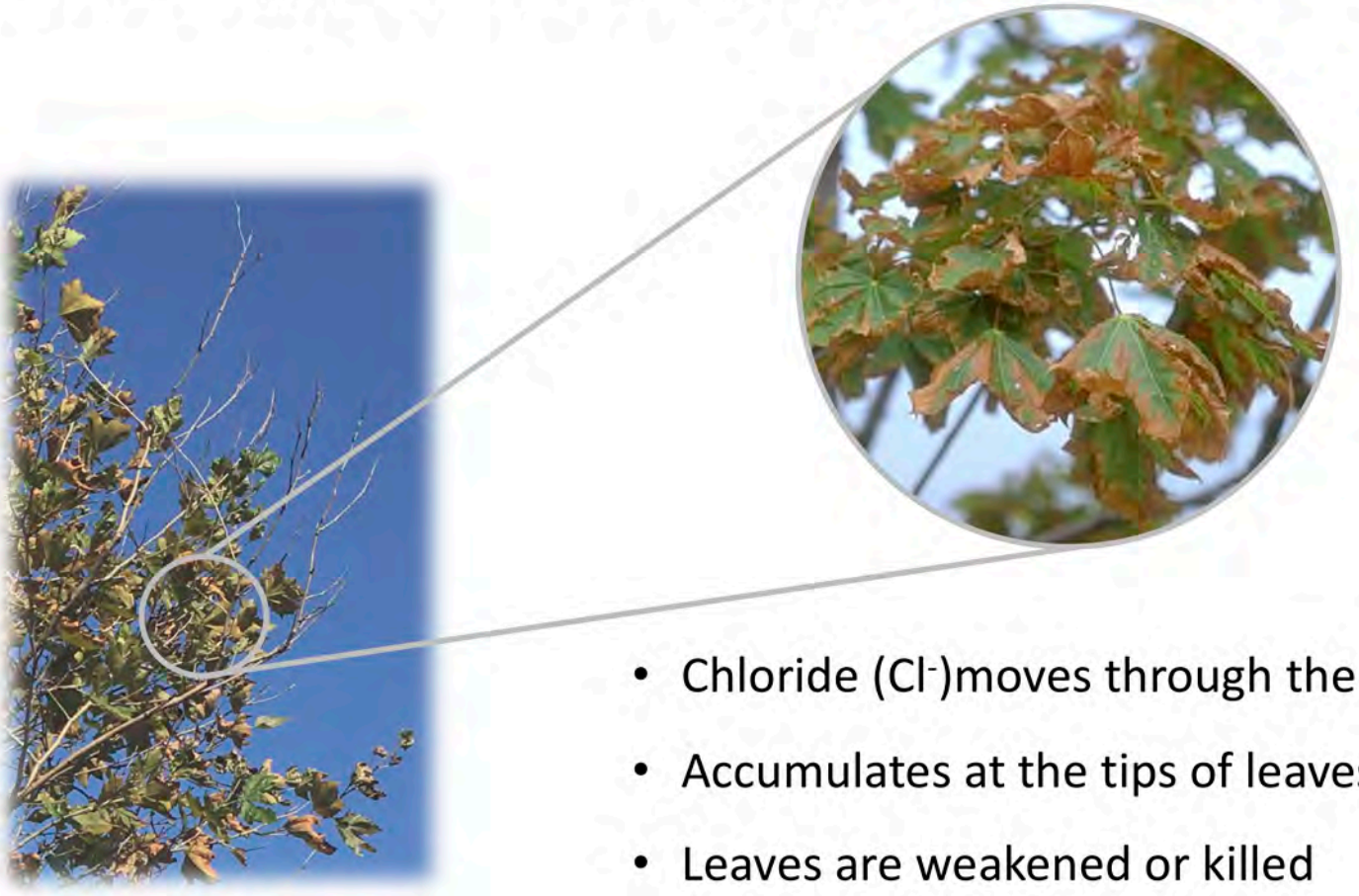
FINDINGS: Tree decline and mortality (Toronto's Bloor Street)

- Soil in all tree plantings showed elevated Sodium and Magnesium (road salt residual)
- Greater concentrations of Sodium and Magnesium as well as electroconductivity correlated with poorer canopy condition
- Trees in raised bed planters had better survival rates and their canopy was determined to be in better condition
- Light (solar radiation) was significant in predicting canopy condition
- Other variables studied were not determined to be significant predictors of canopy decline and mortality

Application of de-icing salts (NaCl)

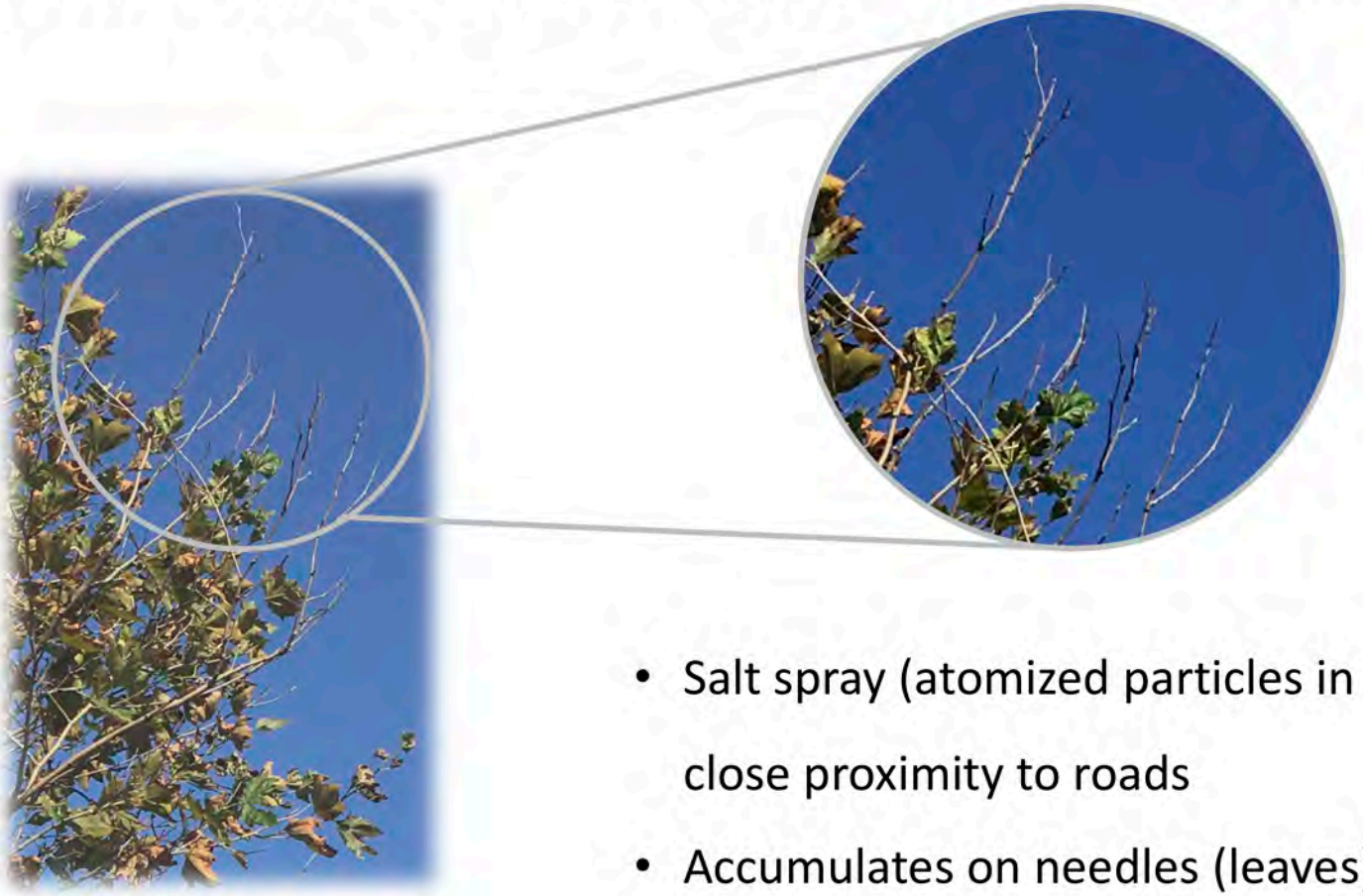
- **Safety motivated** (a little is good…more is better…)
- **Imprecise application** (logistics and knowledge)
- **Unregulated** (mostly)
- **Lack of alternatives** (inertia)
- **Cost** (cheap!)

Visible signs of salt damage (toxicity) in Tree Leaves



- Chloride (Cl^-)moves through the tree's xylem tissues
- Accumulates at the tips of leaves or needles
- Leaves are weakened or killed

Visible signs of salt damage (toxicity) in Branches/Buds



- Salt spray (atomized particles in air) coat trees in close proximity to roads
- Accumulates on needles (leaves) and branches
- Leaves, buds are weakened or killed and branches dieback creating narrow crowns

Environmental Pollution 234 (2018) 562–571

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

De-icing salt contamination reduces urban tree performance in structural soil cells☆

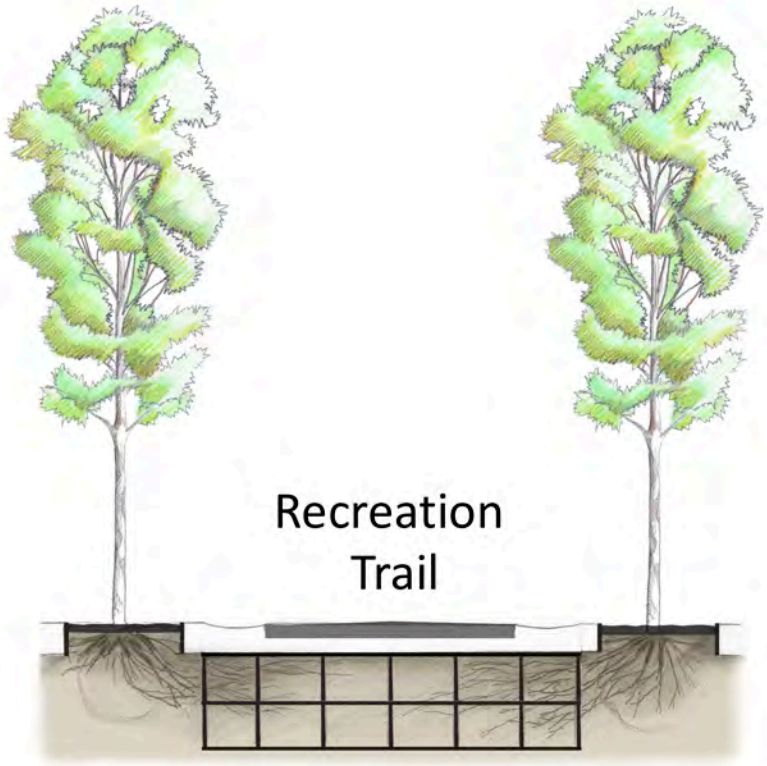
Camilo Ordóñez-Barona [a], Vadim Sabetski [a], Andrew A. Millward [a, *], James Steenberg [b]

[a] Department of Geography & Environmental Studies, Ryerson University, Canada
[b] School for Resource and Environmental Studies, Dalhousie University, Canada

Tree decline an mortality along Toronto's Queens Quay

- Streetscape revitalization
- 2015 Pan American and Parapan American
- 154 London planetrees
- All plantings in sidewalk cutouts / structural soil cells

Streetscape design (Toronto's Queens Quay)



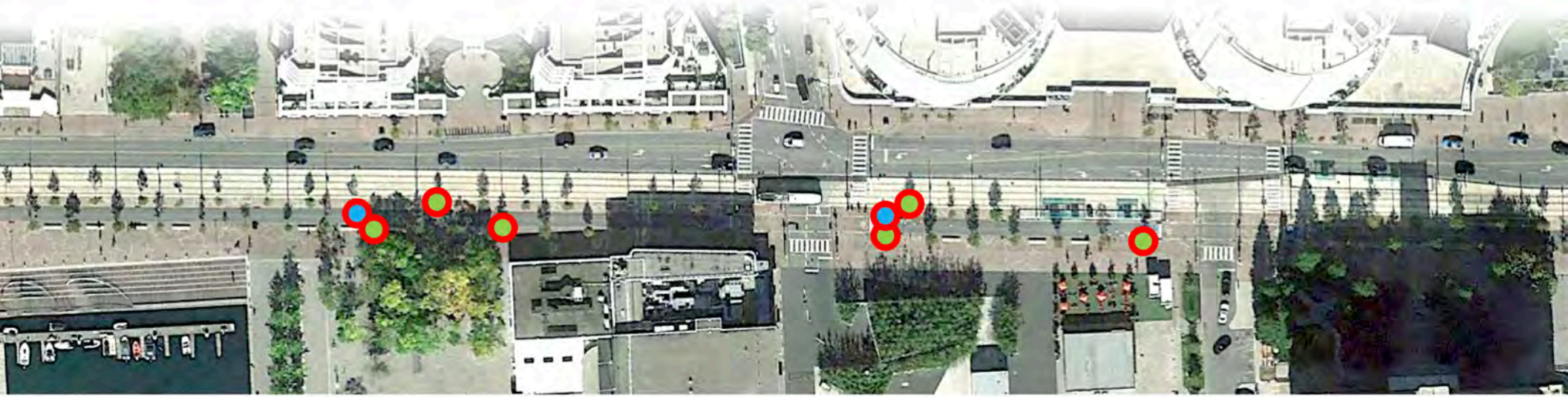
Structural soil cells

Passive irrigation

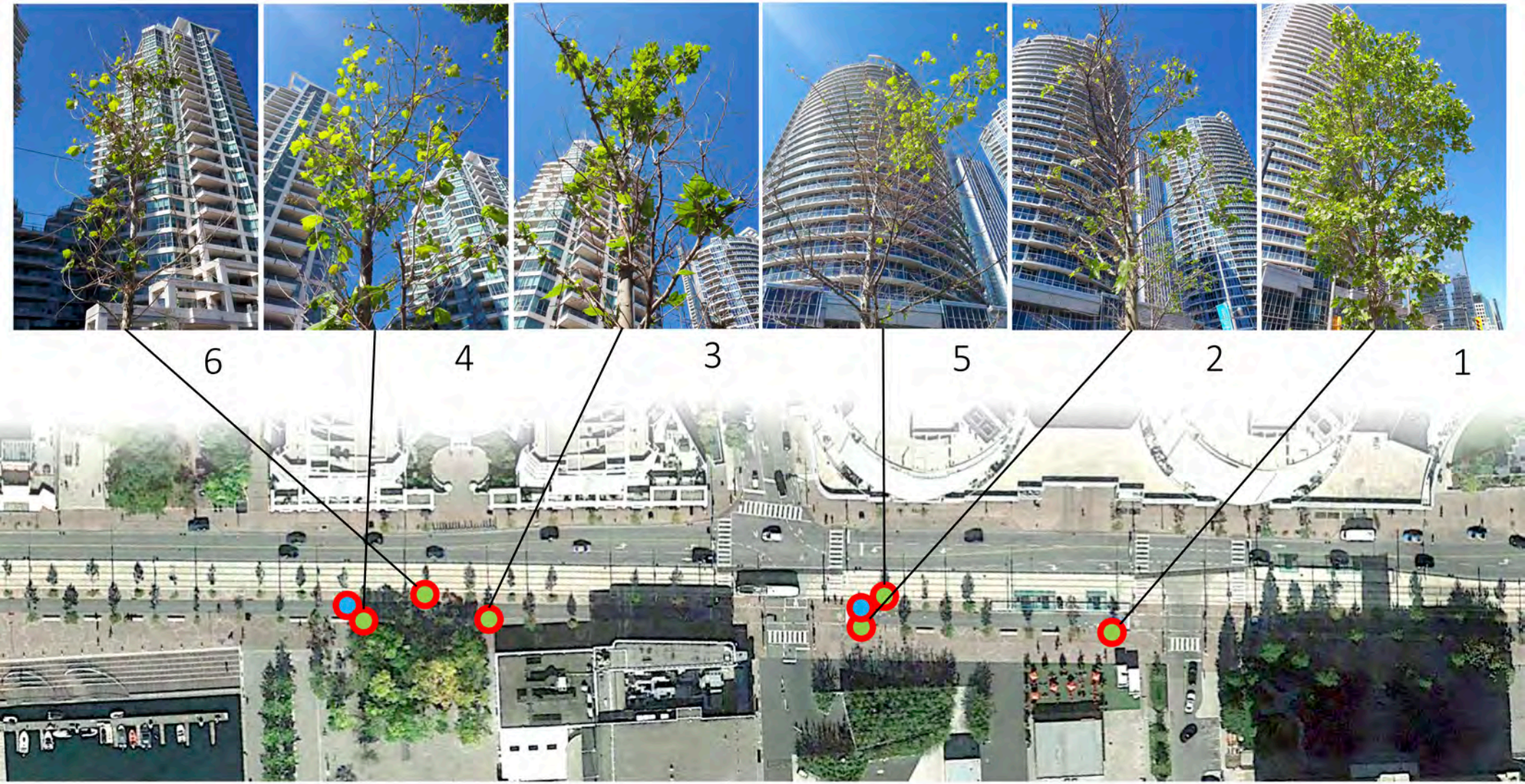
Bird's-eye view of streetscape and data collection (Toronto's Queens Quay)

- Six in-ground sensor locations in upper soil adjacent trees (EC, Temp, Moisture) - Sampling every 10 minutes, for ~3 months

- Two water sensors in catch basins (EC, Temp)
  Sampling every 10 minutes, for ~2.5 months



Tree canopy condition (June 2018)



Species: London planetree (*Platanus × acerifolia*)

Data collection

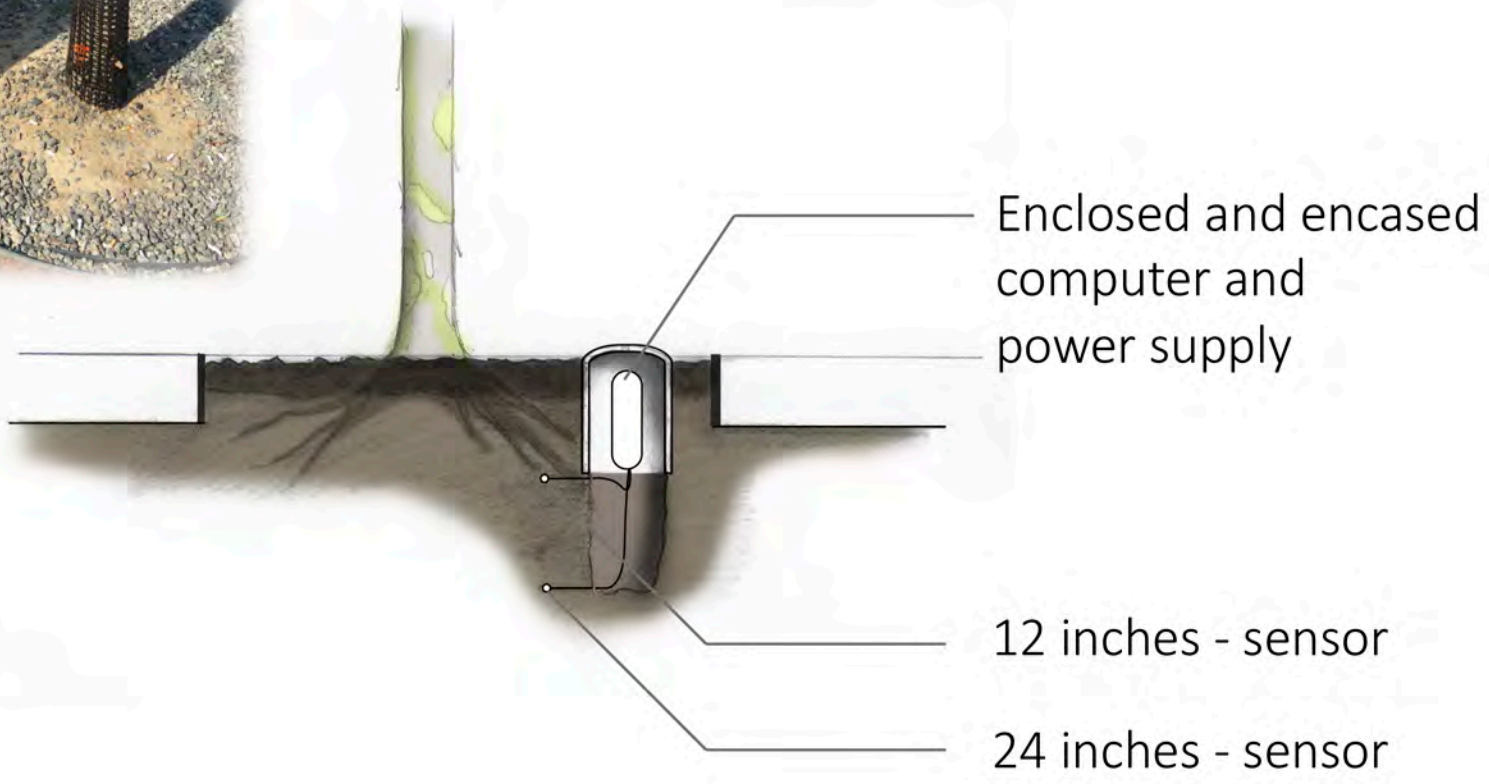
- In-ground sensors

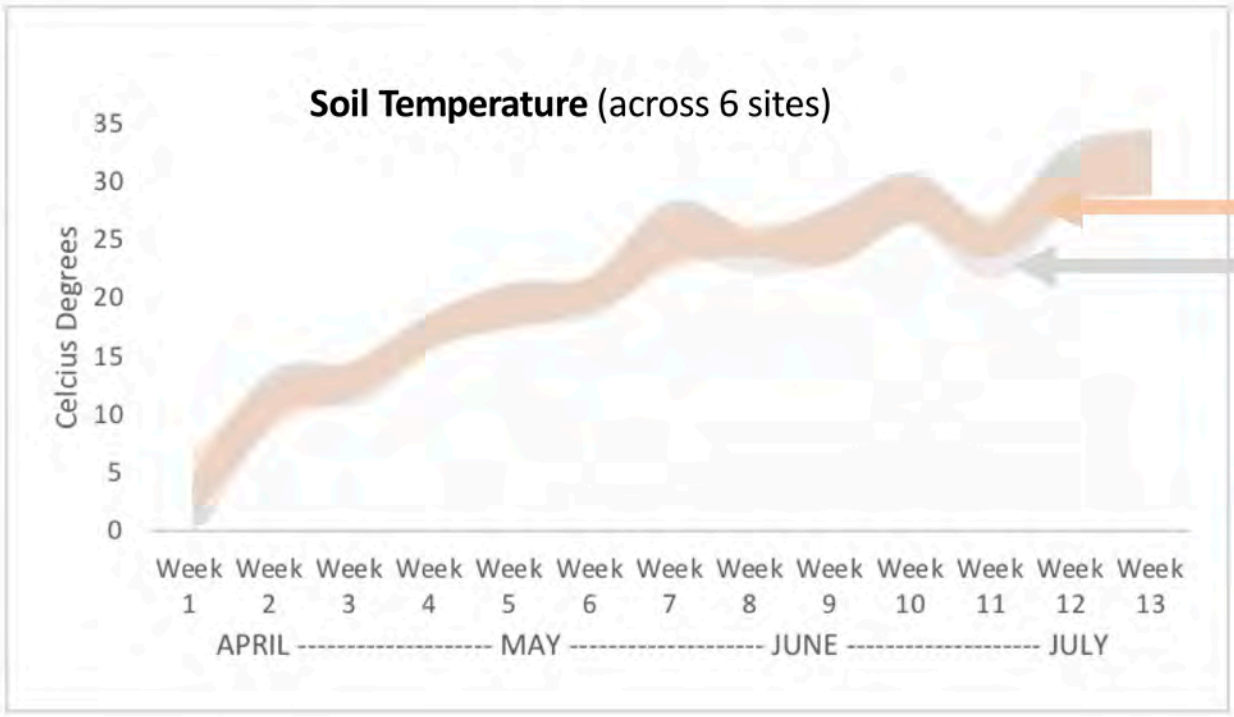
  Soil **Temperature**
  Soil **Moisture**
  Soil **Electroconductivity**

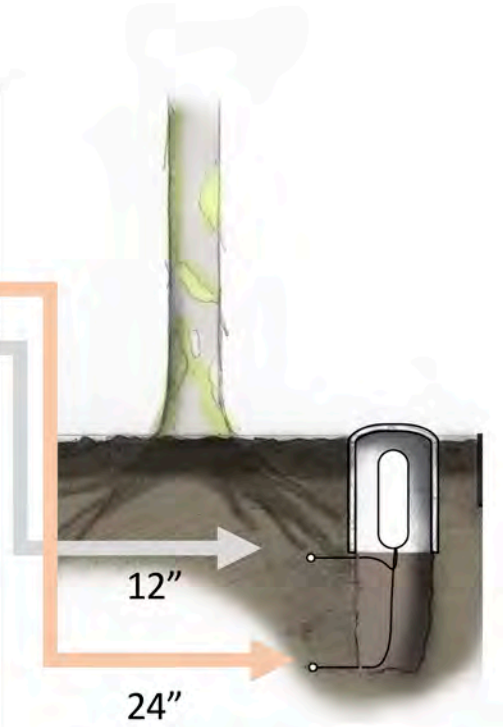
- Catch basin sensors

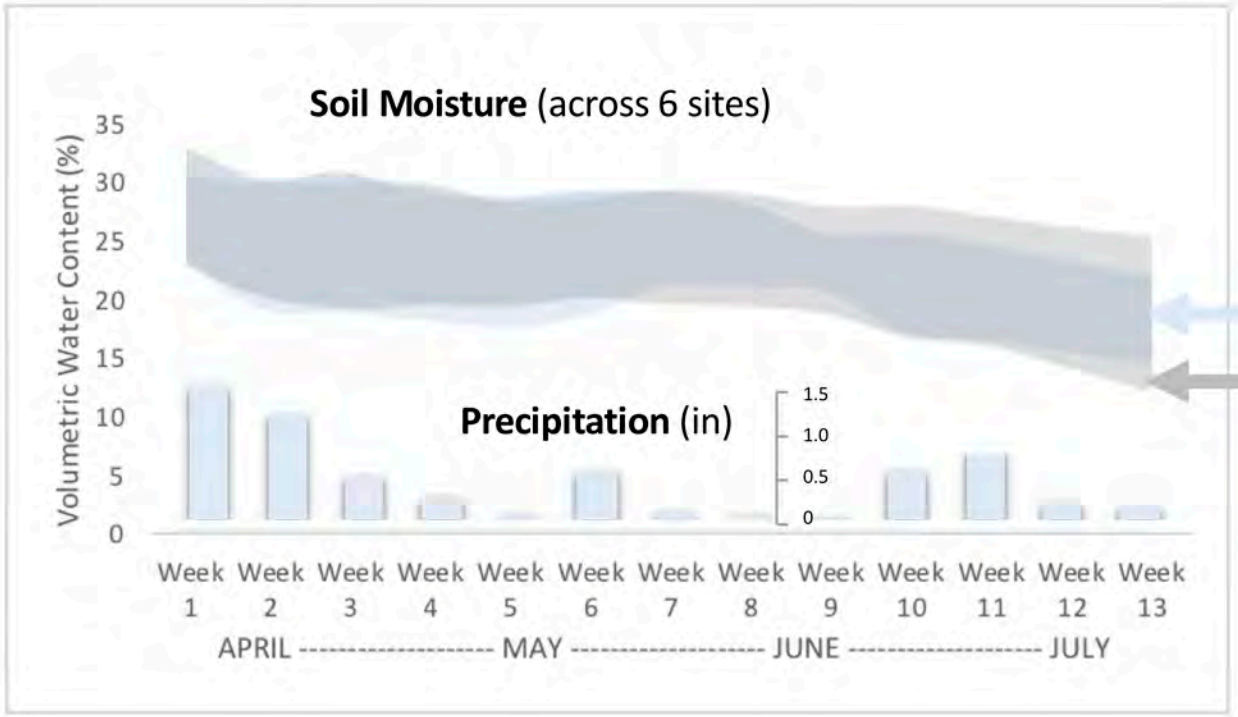
  Water **Electroconductivity**
  Water **Temperature**

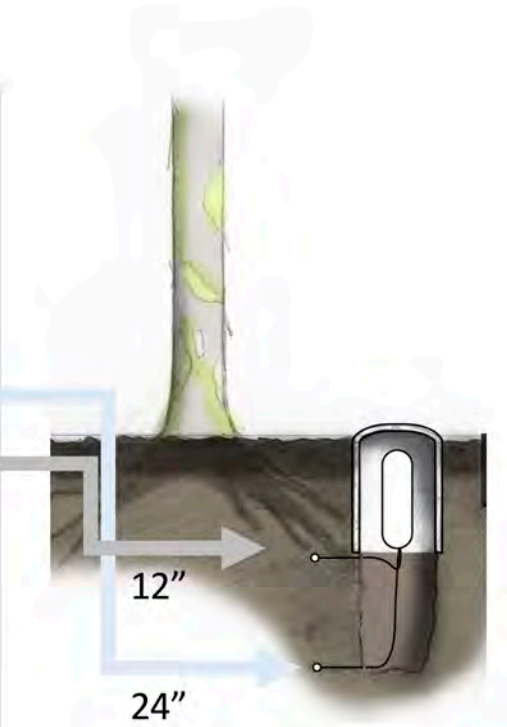
In-ground sensor deployment

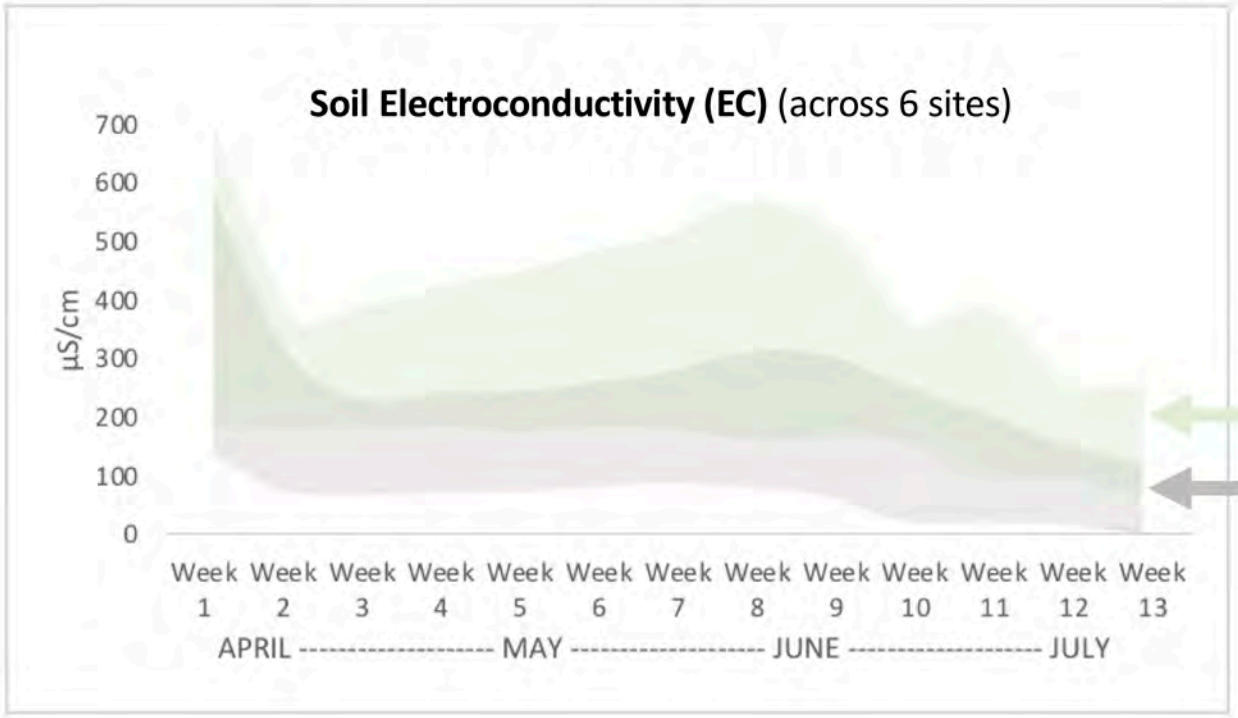


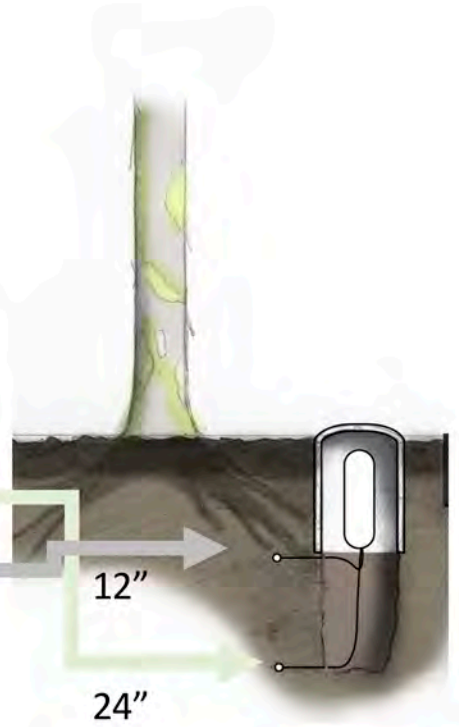

Soil Temperature (across 6 sites)
Celcius Degrees
35
30
25
20
15
10
5
0
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13
APRIL
MAY
JUNE
JULY


12”
24”


Soil Moisture (across 6 sites)
Volumetric Water Content (%)
35
30
25
20
15
10
5
0
Precipitation (in)
1.5
1.0
0.5
0
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13
APRIL
MAY
JUNE
JULY

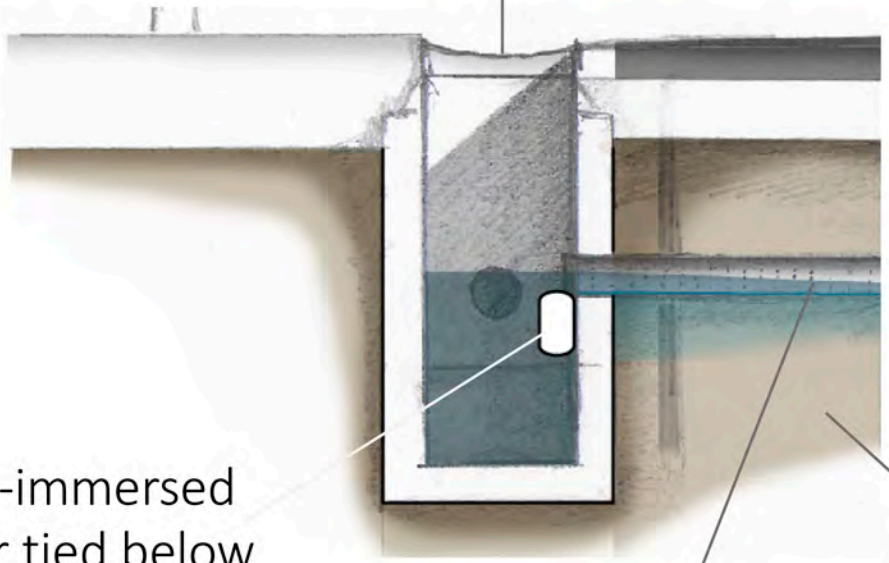

12”
24”


Soil Electroconductivity (EC) (across 6 sites)
µS/cm
700
600
500
400
300
200
100
0
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13
APRIL
MAY
JUNE
JULY


12”
24”

Catch basin sensor deployment

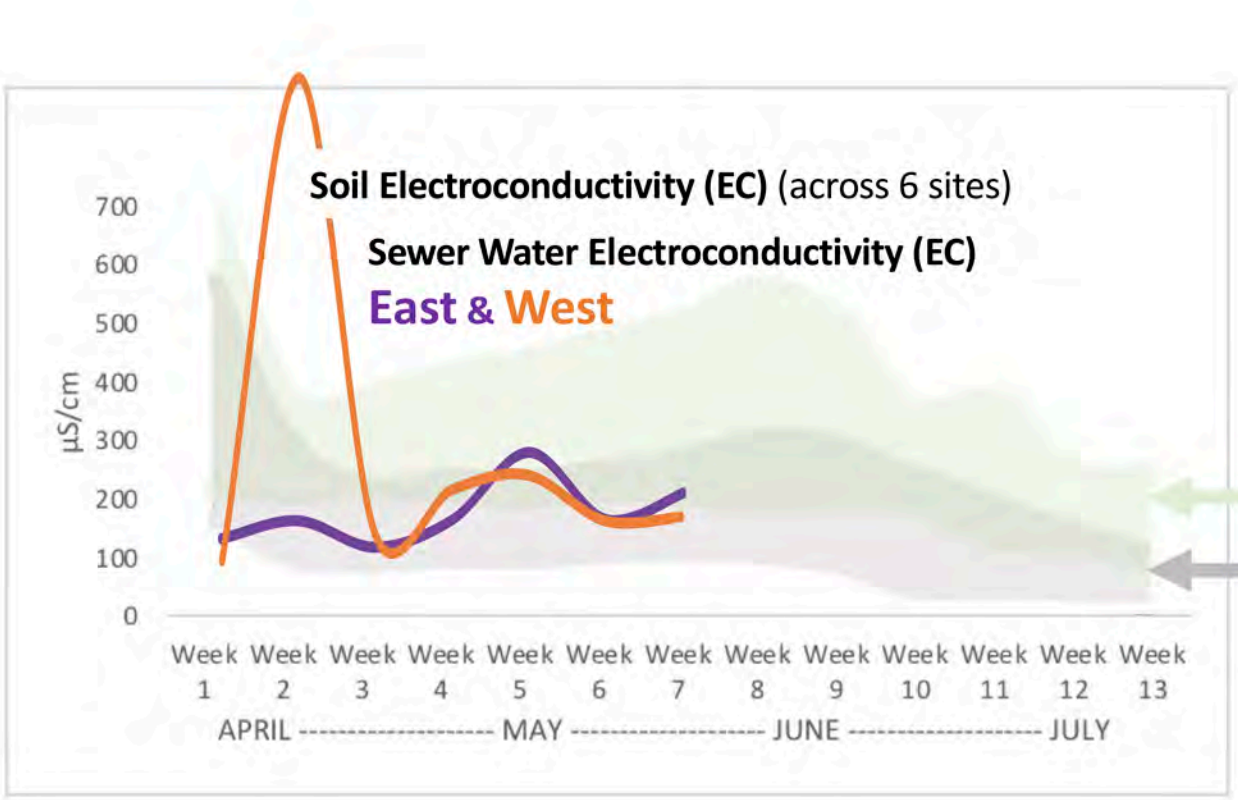
Catchment cover (grate)

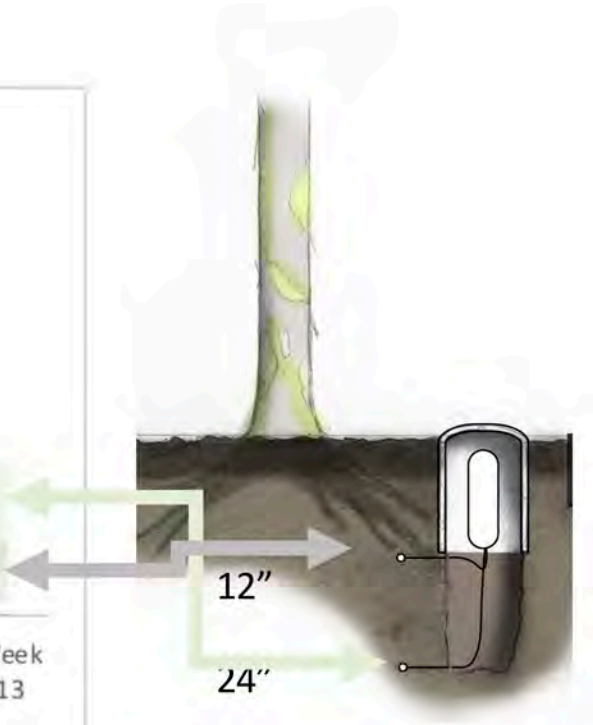


Water-immersed sensor tied below pipe opening

Irrigation pipe

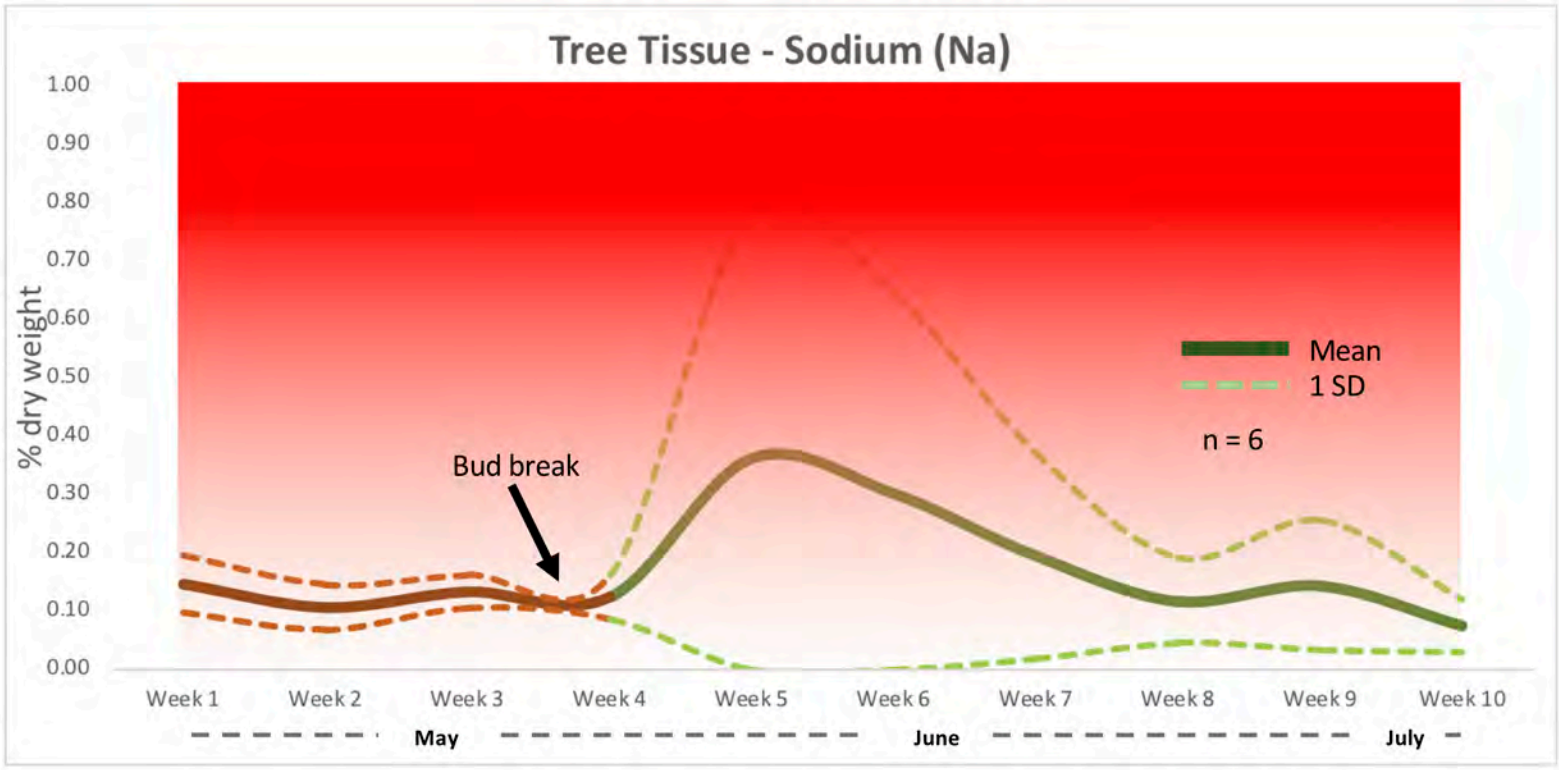
Soil cell


Soil Electroconductivity (EC) (across 6 sites)
Sewer Water Electroconductivity (EC)
East & West
µS/cm
700
600
500
400
300
200
100
0
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Week 11
Week 12
Week 13
APRIL
MAY
JUNE
JULY


12”
24”

Stem and leave sampling for Sodium (Na) and Chloride (Cl)

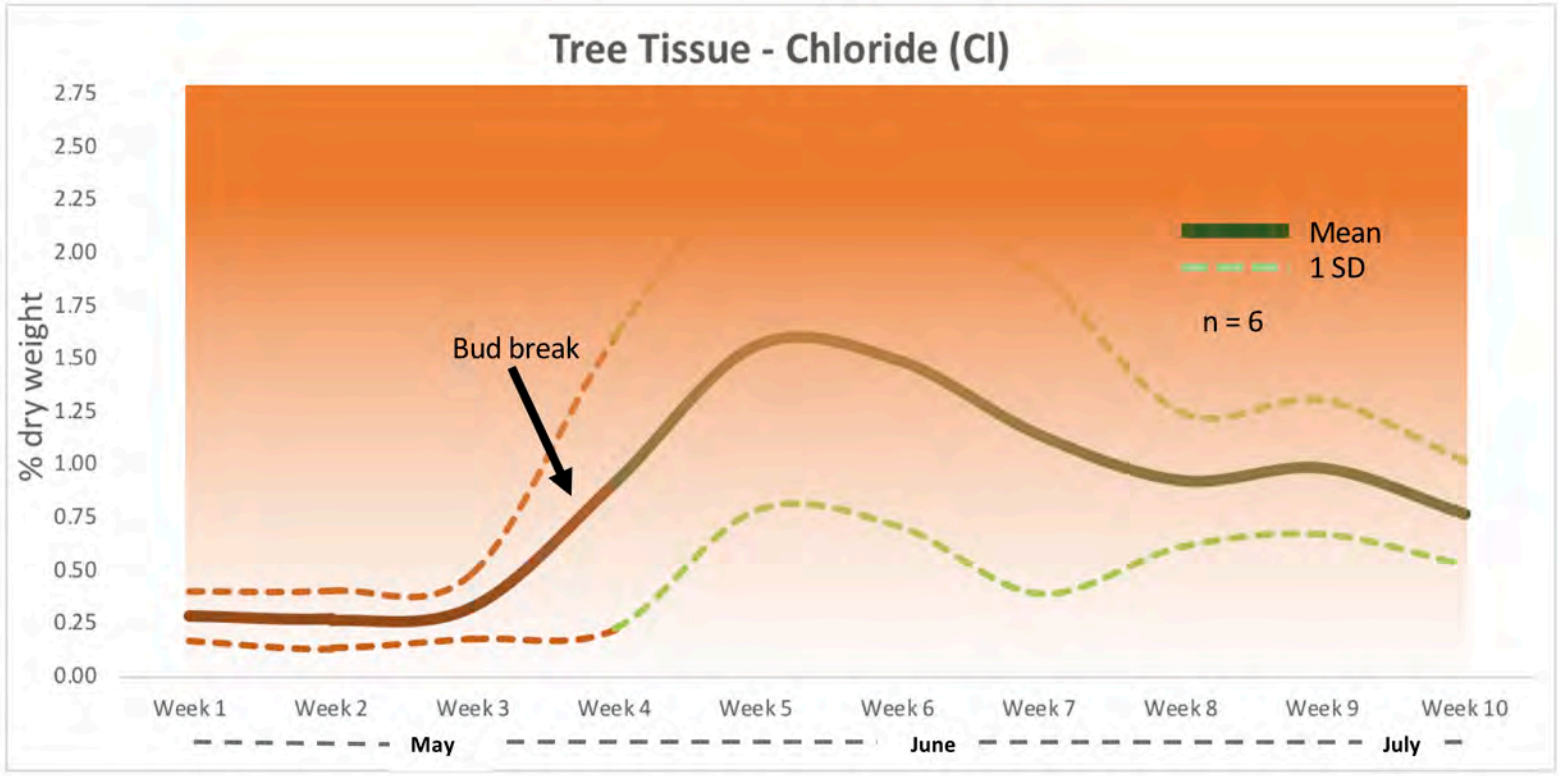
- 6 trees
- 10 weeks (3 stem / 7 leaf)



Sodium Toxicity (% dry weight)

Low **Extreme**

0.25 0.5



Chloride Toxicity (% dry weight)

Low **Extreme**

0.3 1.0

Typically salt is not the single driver of tree decline and mortality in northern climates

But it can be!

Better tree survival where road salt is used

- Context (use/density)
- Planter design
- Tree species (tolerance & diversity)
- Education (salt application, flushing, alternatives to salt)

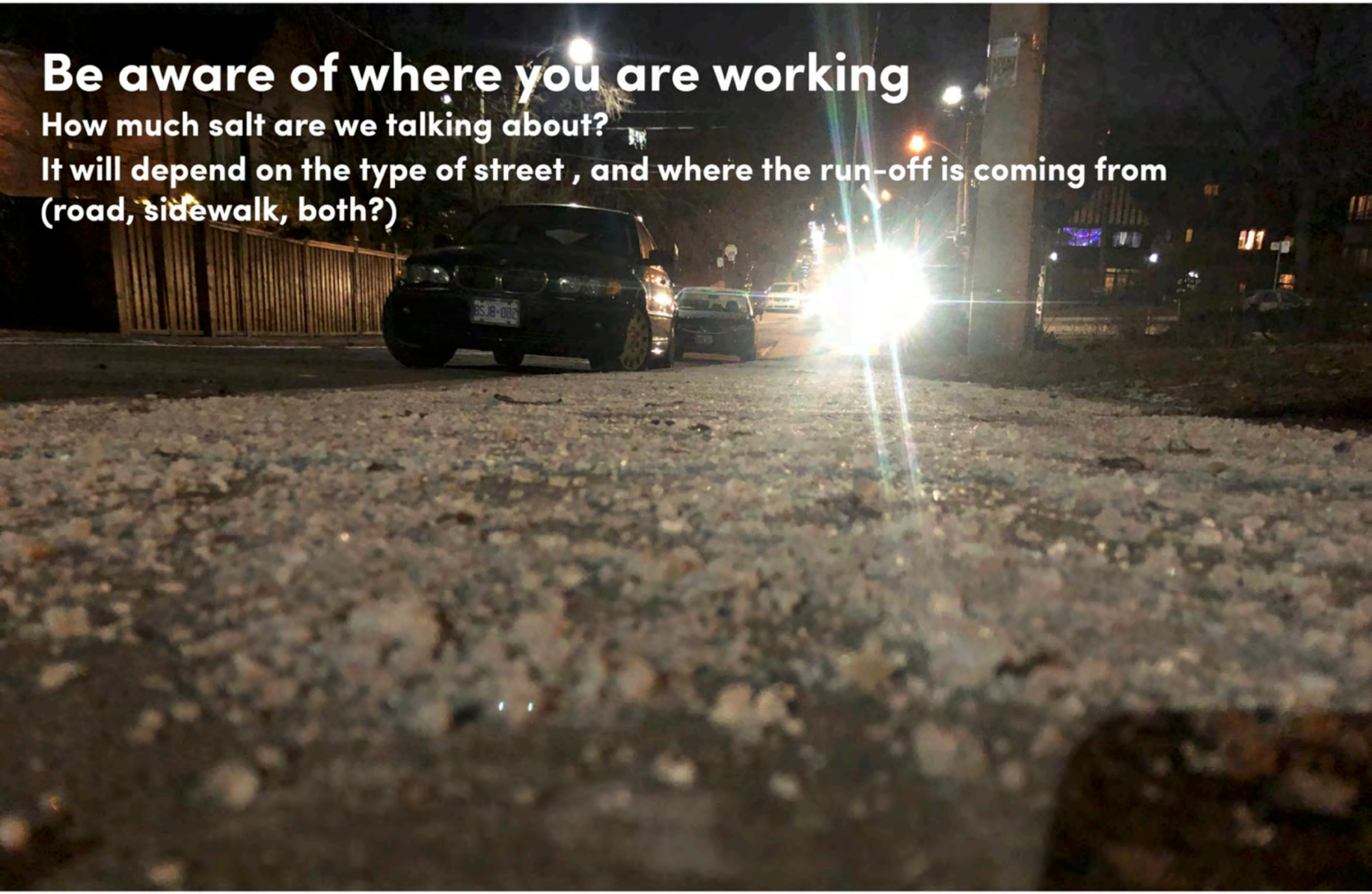
1. Be aware of where you are working
2. Multiple versus monocultures
3. Successional planting versus ‘object ‘ trees
4. Raised versus flush conditions
5. Bioswales and salt
6. Drainage
7. Mechanical and seasonal strategies

Planning Level Consideration

Detail Level Consideration

1. Be aware of where you are working
2. Multiple versus monocultures
3. Successional planting versus ‘object ‘ trees
4. Raised versus flush conditions
5. Bioswales and salt
6. Drainage
7. Mechanical and seasonal strategies

In the broadest terms, the strategies for dealing with salt are consistent with best practices for growing healthy urban trees in any climate. If anything, in northern climates it is even more imperative that we get the fundamentals right.


Be aware of where you are working
How much salt are we talking about?
It will depend on the type of street , and where the run-off is coming from (road, sidewalk, both?)

Be aware of where you are working

The easiest and cheapest places to plant a tree often coincide with the lowest risk areas for salt exposure and damage.

This principle should inform the very first design sketches and will influence the aesthetic form of the project. More than any other principle, this one is dependent on understanding the information found throughout this book. Planting the easy places first almost always reduces the cost of construction and maintenance. It is less expensive and more sustainable to plant trees in large areas of good soil than in small spaces confined by paving and compacted soil, walls, and curbs. Designers should take into account the information gathered in the soil assessment, and avoid designs that force trees into restrictive soil conditions when better locations are available (see Part 1, Chapter Seven). All too often, we see landscapes built with trees in small holes adjacent to better, but unused, spots.

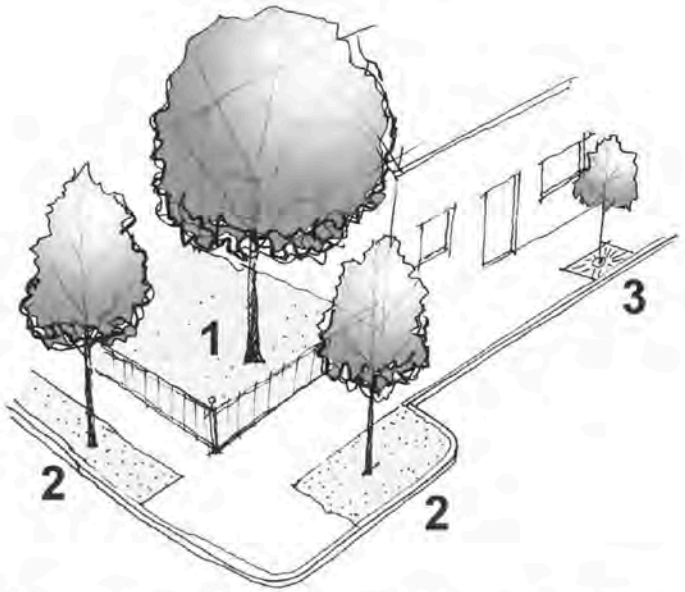
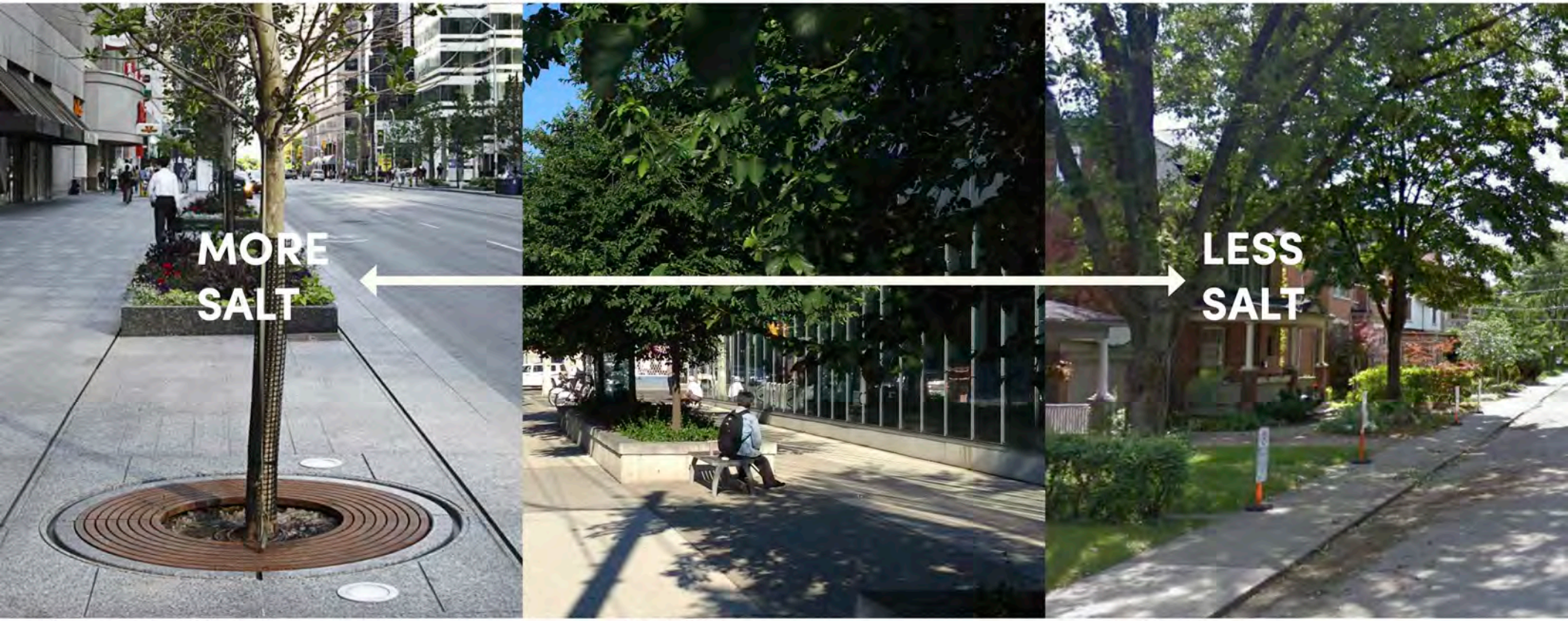


Figure 2.1.1. Plant the easy places first: Tree 1 is in an easy location, while location 2 is easier than location 3.

Be aware of where you are working

Depending on where you are and the expectations you're working with, interventions should keep in mind the budget available and the intensity of salt expected



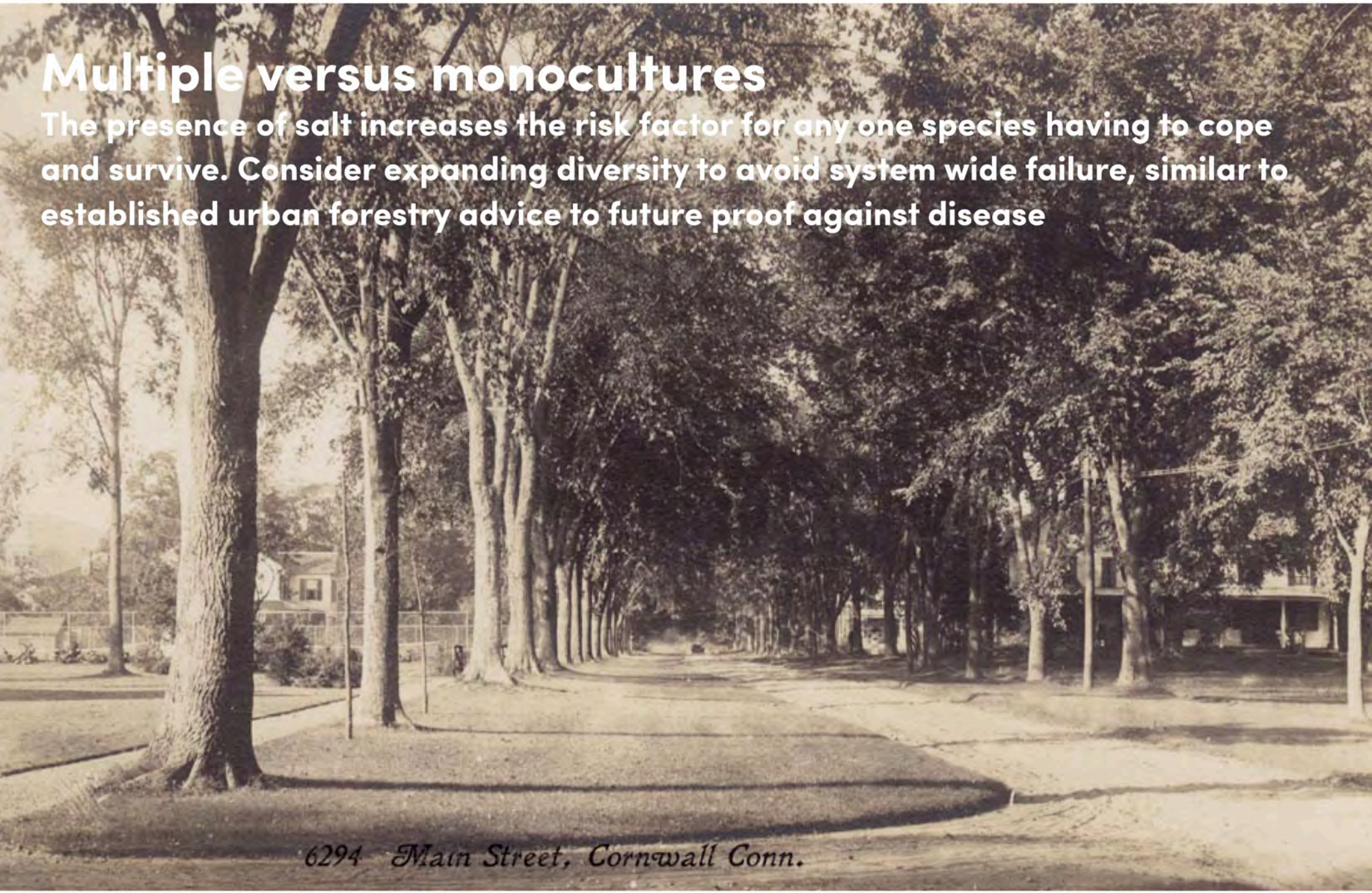
<u>High End Retail Street</u>
Highest expectations for snow clearing
Higher budget $$$
Mechanical solutions: e.g. valves, heated pavement

<u>Local Retail Street</u>
Normal expectations for snow clearing
Mid range budget $$
Practical solutions: e.g. trees in raised planters

<u>Residential Street</u>
Lower expectations for snow clearing
Lowest budget $
Frugal solutions: e.g. get the tree away from the salt

Multiple versus monocultures

The presence of salt increases the risk factor for any one species having to cope and survive. Consider expanding diversity to avoid system wide failure, similar to established urban forestry advice to future proof against disease

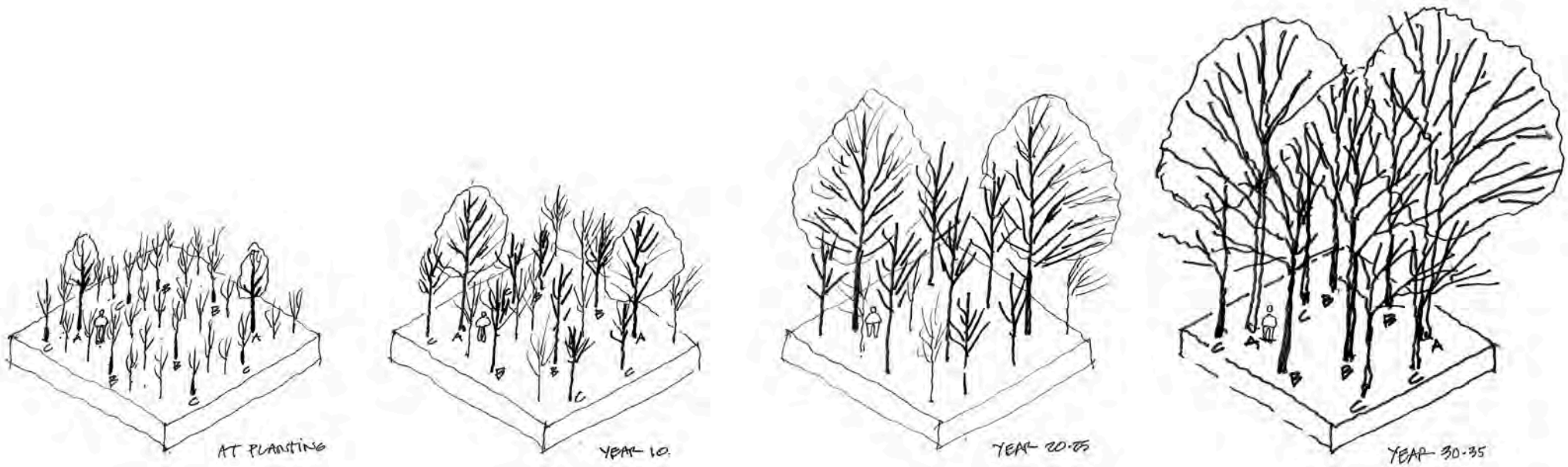


Successional planting versus 'object ' trees

Don't get hooked on the impossible paradigm

Successional planting versus 'object ' trees

Contemporary robust ecologies don't pick a winner and can be more flexible for succeeding in salt risk environments



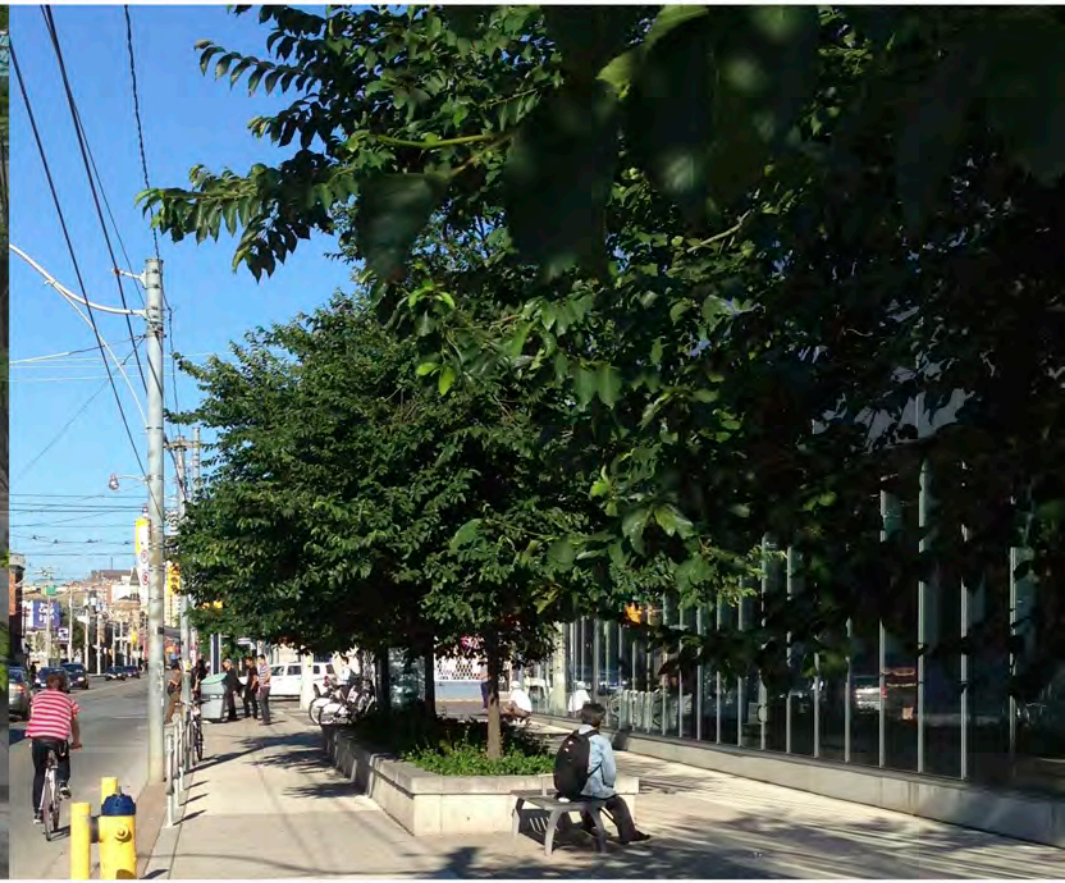
A = climax tree such as oak or maple
B = smaller shade tolerant tree
C = shade tolerant understorey tree

Successional planting versus ‘object ‘ trees

In heavy salt environments, contemporary robust ecologies might be a better bet for urban trees than more vulnerable historic models of formal street tree planting

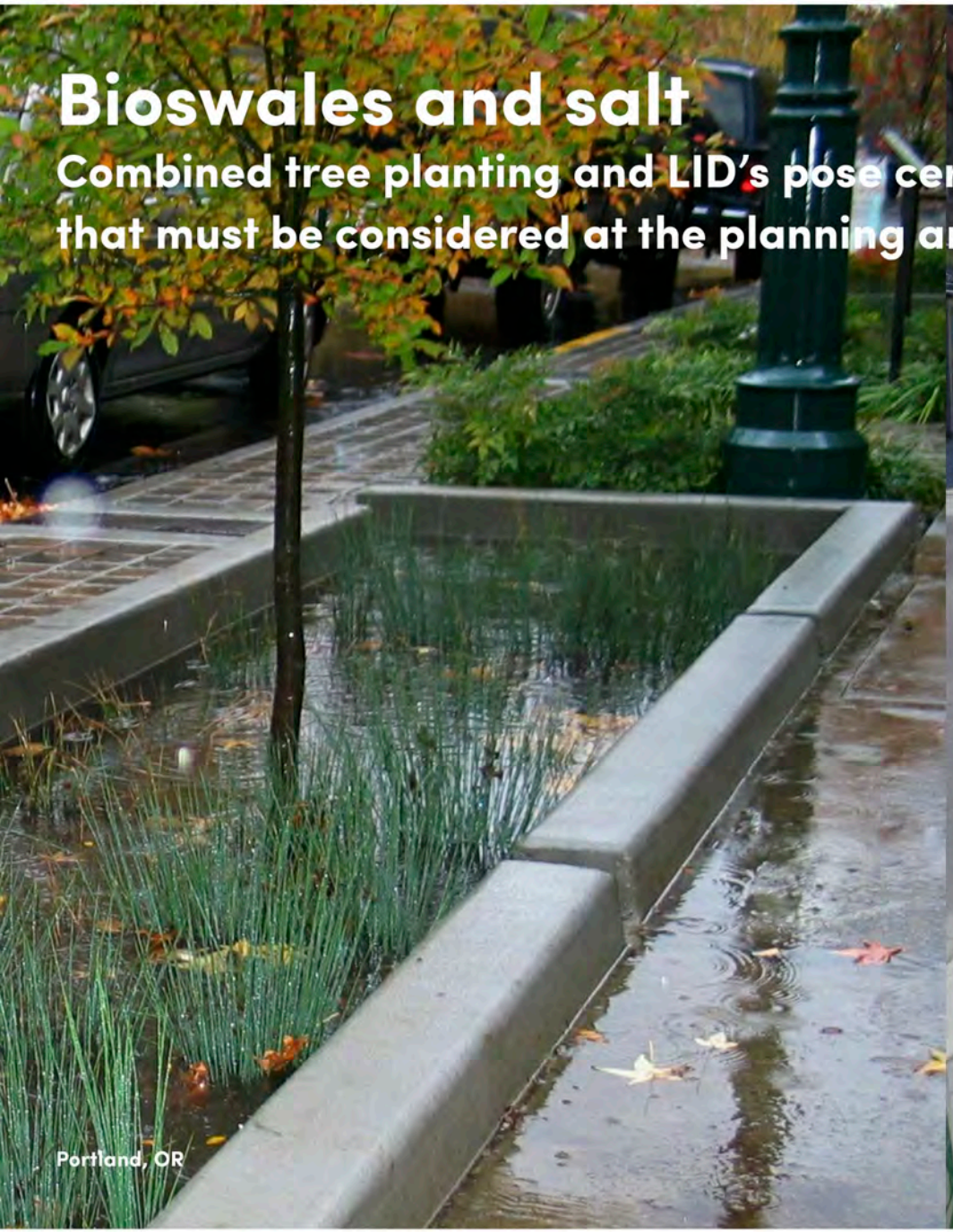
Raised versus flush conditions

Based on observations and results from Bloor Street and Dundas Street East, a raised planting condition is more likely to succeed in a salt laden environment. It's low hanging fruit if you have the space, or can make a virtue out of it...



Bioswales and salt

Combined tree planting and LID's pose certain risks - and rewards - that must be considered at the planning and design stage



Portland, OR

Kitchener, ON

Bioswales and salt

Keep the tree high and dry; use planter width and soil volume to avoid the worst concentrations of salt. Consider combining with a diverse, successional tree planting design strategy to absorb some level of inevitable risk

Bioswales and salt

Separated tree planting and LID's can be considered, but potentially sacrifice valuable soil resources that can be of benefit to the tree. Consider where you are working and plan appropriately.

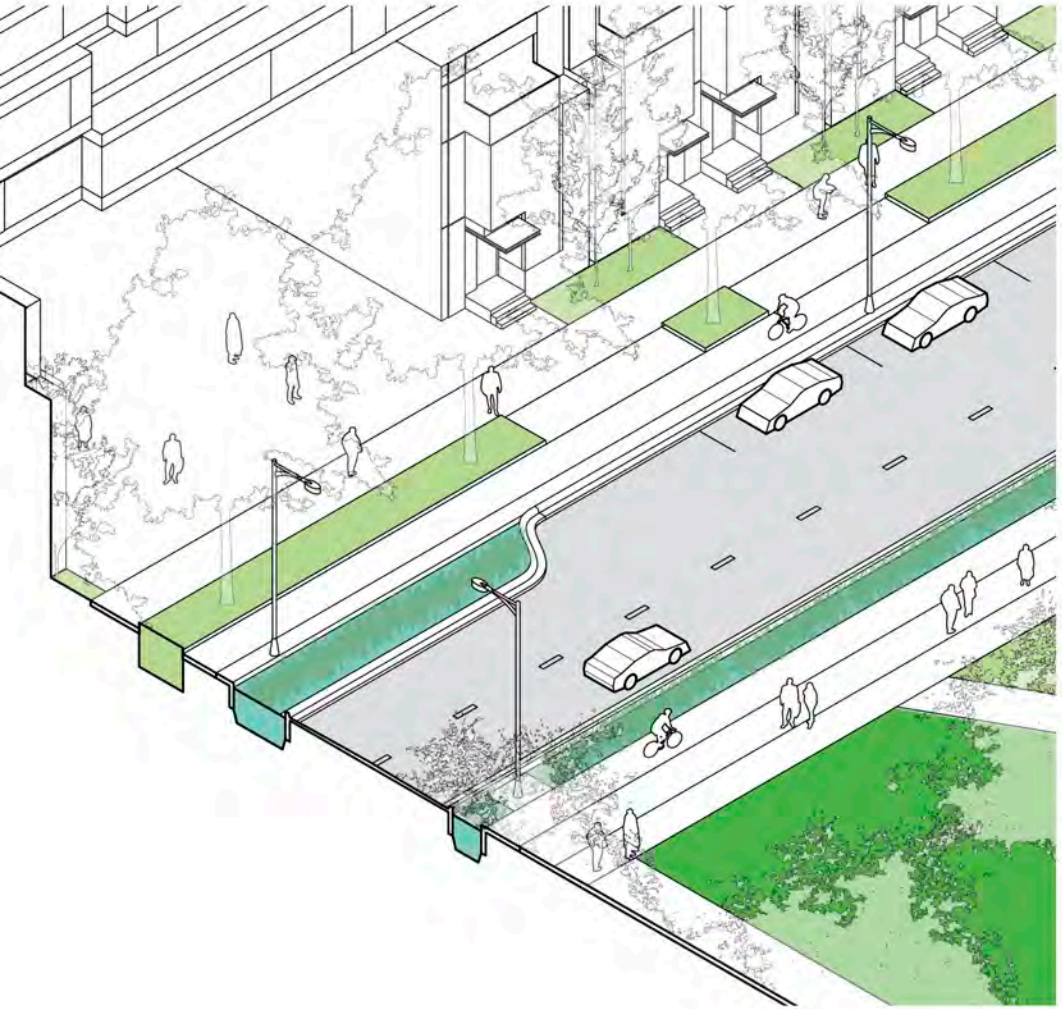


Image from Philadelphia Green Street Manual

Drainage

In passive irrigation situations, getting water in is as important as getting water out, particularly for flushing salt water

Mechanical and seasonal strategies

Seasonal passive water valves can be deployed to keep salt melt out of the system over the winter season.

Mechanical and seasonal strategies

Seasonal passive water valves can be deployed to keep salt melt out of the system over the winter season.

RootRain Linear Drain

Mechanical and seasonal strategies

Diversion and treatment of salt water to salt specific beds or willow mulches avoids simply pushing the problem downstream to our lakes.