Improving and Sustaining the Performance of Living Green Infrastructure (LGI)

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StormWaterForestry and the City of Toronto

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Toronto | April 4 & 5, 2019

Presentation Overview

1. Brief history of Green Infrastructure and development in Ontario
2. Overview of higher development standards (Soil Management)
3. Long term maintenance of Living Green Infrastructure (LGI)
4. Transformed and New High Performance Landscapes
5. Check list for sustainable maintenance of LGI

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Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments.

US EPA Definition

- Vegetation (Urban Tree Canopy)
- Soils
- Natural Processes

The opportunity to create a new legacy of development

Examples of Green Infrastructure

- Downspout Disconnection
- Rainwater Harvesting
- Rain Gardens
- Planter Boxes
- Bioswales
- Permeable Pavements
- Green Alleys and Streets
- Green Parking
- Green Roofs
- Urban Tree Canopy
- Gardens and Landscapes
- Turf
- Land Conservation
- Soil/Subsoil

History of Development in Ontario
(Yes this is Ontario)

Orr Lake circa 1910

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Ontario 300 years ago

Undisturbed Ecological Services:

- Balance
- Redundancy
- Stability

Ontario 100 years ago

Loss of Ecological Services

- Droughts
- Floods
- Erosion & sedimentation
- Fires
- Abandonment of farms, businesses and whole communities

Deforestation and past farming practices

Ontario recent past (late 20th Century)

Return of many Ecological Services

- Reduced droughts
- Reduced flooding
- Stable economy

A landscape still in recovery

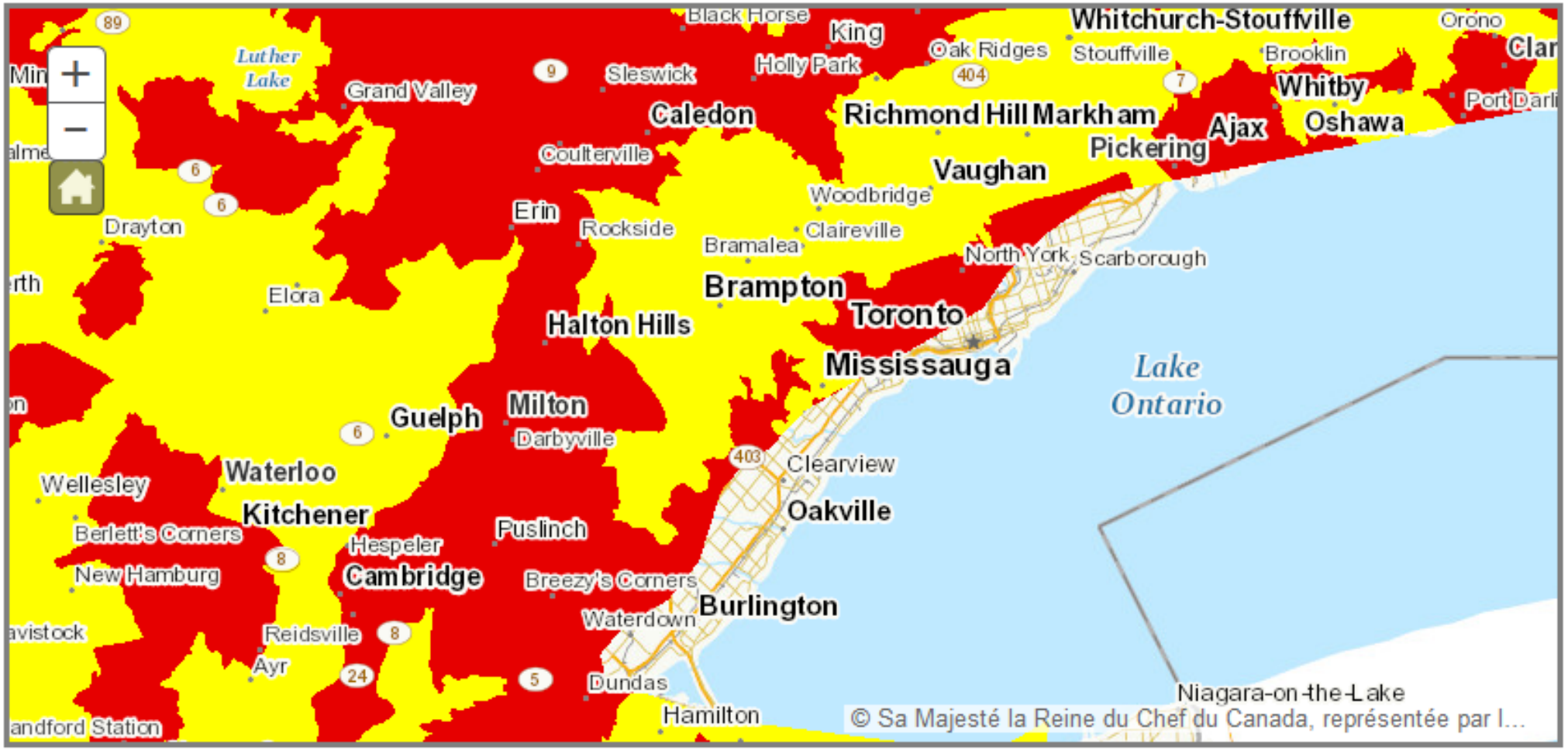
Reforestation and improved farming practices

Ontario Today – Erosion of Ecological Services again

- Droughts
- Flooding
- Erosion & sedimentation
- Erratic local weather
- Reduced water quality
- Hard infrastructure failures and repairs

Harriston/Drayton, Wellington County
June 2017

Figure 6: Soil organic carbon change in Eastern Canada, 1981 to 2011



Legend:

Brief History of Development
What is the difference between then and now?

- Mass grading and master planned communities

Modern development processes Post WWII

- Vastly alter large blocks of land
- Compact subsoil to levels not possible prior to 1950

- Degrade topsoil resources through handling and storage practices
- This is actually no longer topsoil

What is expected of this site?

This site will be graded, topsoil added and the finished landscape expected to perform as a natural and pervious site

This planting site contains……

- Compacted fill
- “A” gravel
- Screenings
- Concrete washout
- Anaerobic topsoil
- 1% – 2% organic matter
- Compaction levels approaching 2 g/cm³
- This is the present topsoil specification in reality

Planting: What is the…

- Correct tree for this site?
- Correct planting procedure?
- The truth?

  Often no tree is suitable for many sites

- What will be the contribution of these trees in 40 years?

Are we counting on these trees for future benefits such as SWM?

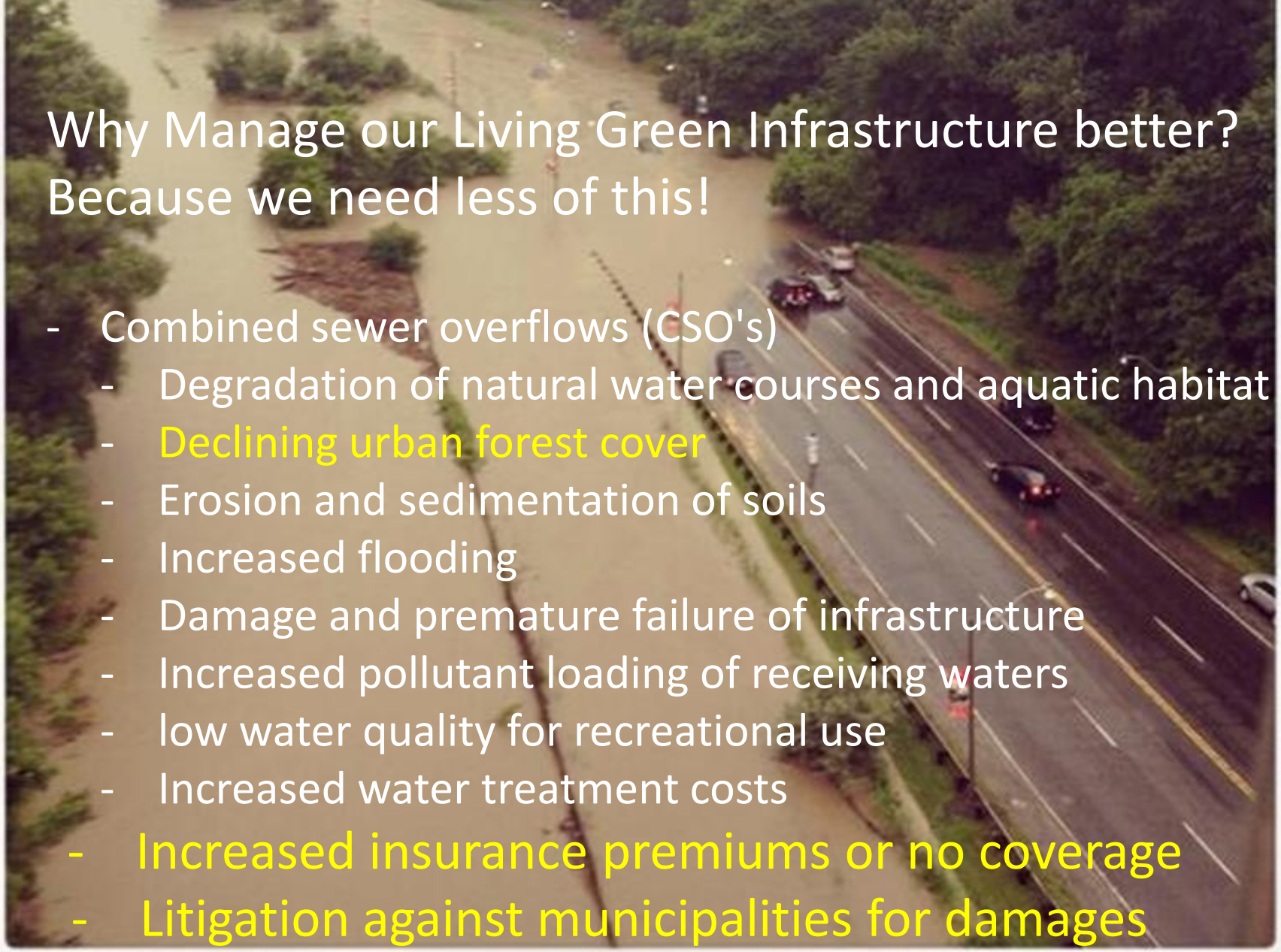
- These trees are 40 years old
- Have caused extensive infrastructure damage
- Received significant injury
- Will decline and be removed

Sidewalk replacement due to damage from tree roots
Scarborough 2011


143 DAYS
WITHOUT
ADDRESSING
THE REAL
PROBLEM
ANDERSON

Conclusions? It is easier to implement higher standards for all future development, than try to fix the past

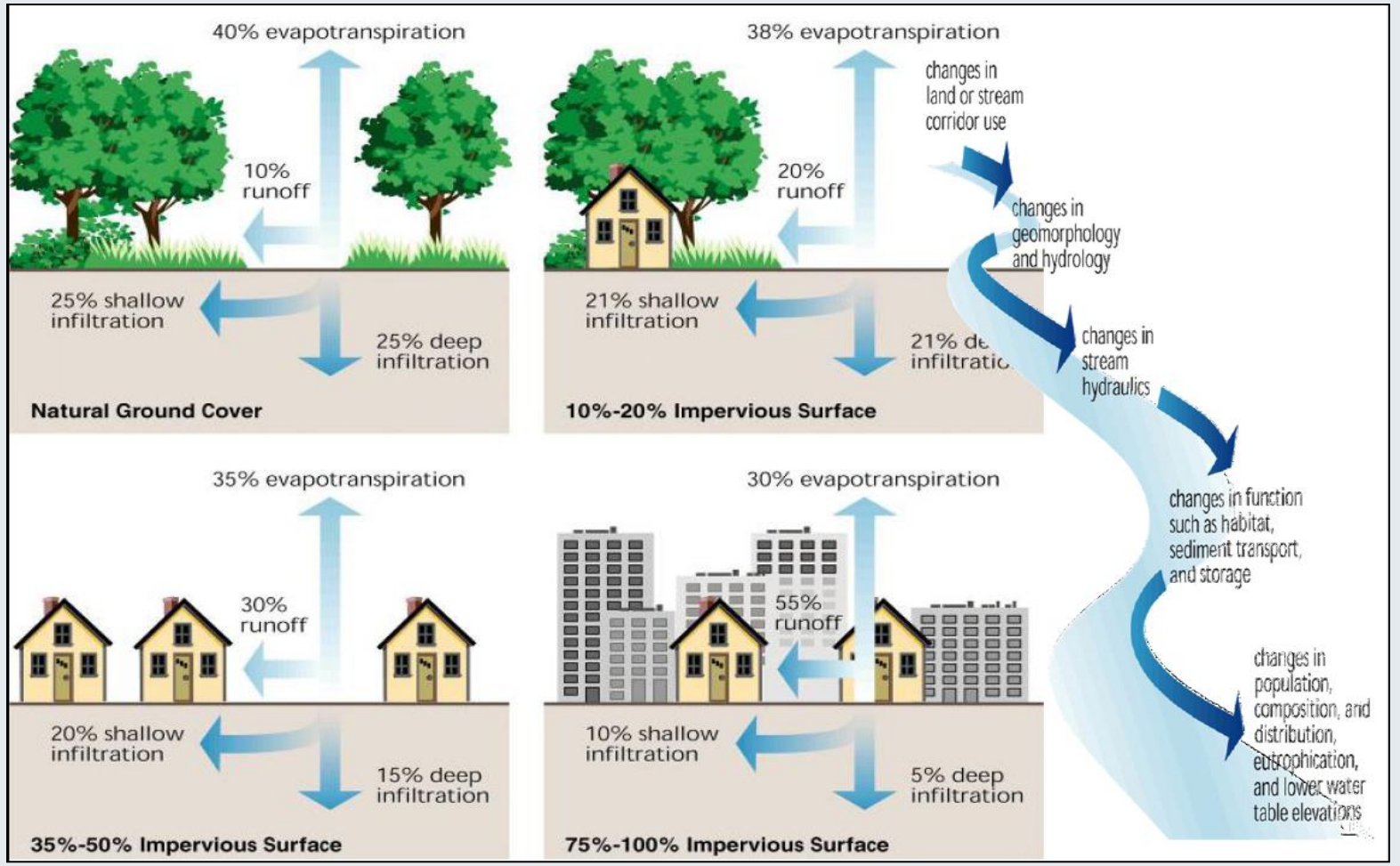
Substantial changes to Urban Forest and Soil management best practices are required to ensure the natural functions of soils and vegetation in future developments & improve existing sites



Why Manage our Living Green Infrastructure better?
Because we need less of this!

- Combined sewer overflows (CSO's)
  - Degradation of natural water courses and aquatic habitat
  - Declining urban forest cover
  - Erosion and sedimentation of soils
  - Increased flooding
  - Damage and premature failure of infrastructure
  - Increased pollutant loading of receiving waters
  - low water quality for recreational use
  - Increased water treatment costs
- Increased insurance premiums or no coverage
- Litigation against municipalities for damages

Hydromodification



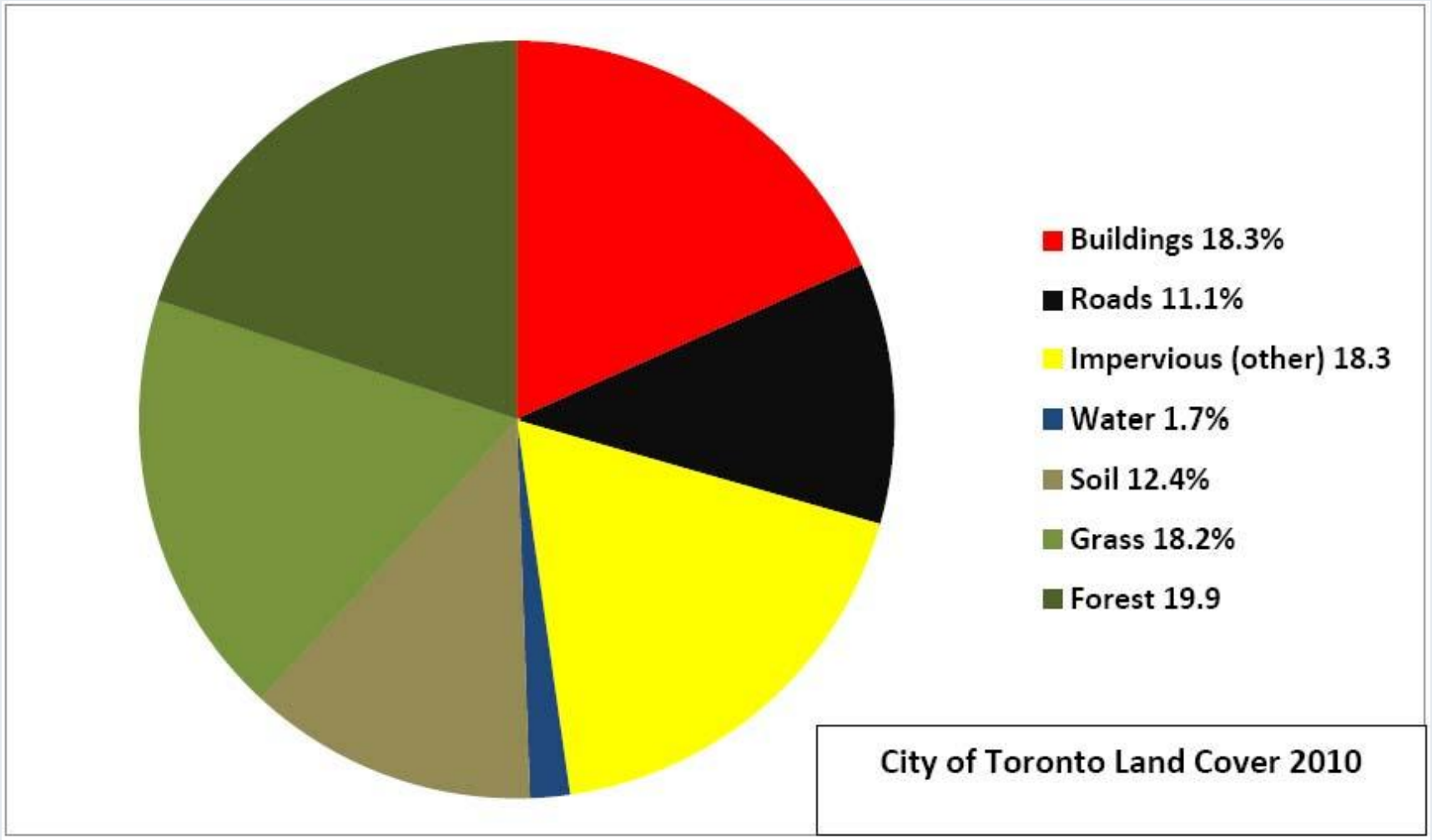
Water Balance

Precipitation (P) = Runoff (R) + Infiltration (I) + Evapotranspiration (ET)

Or

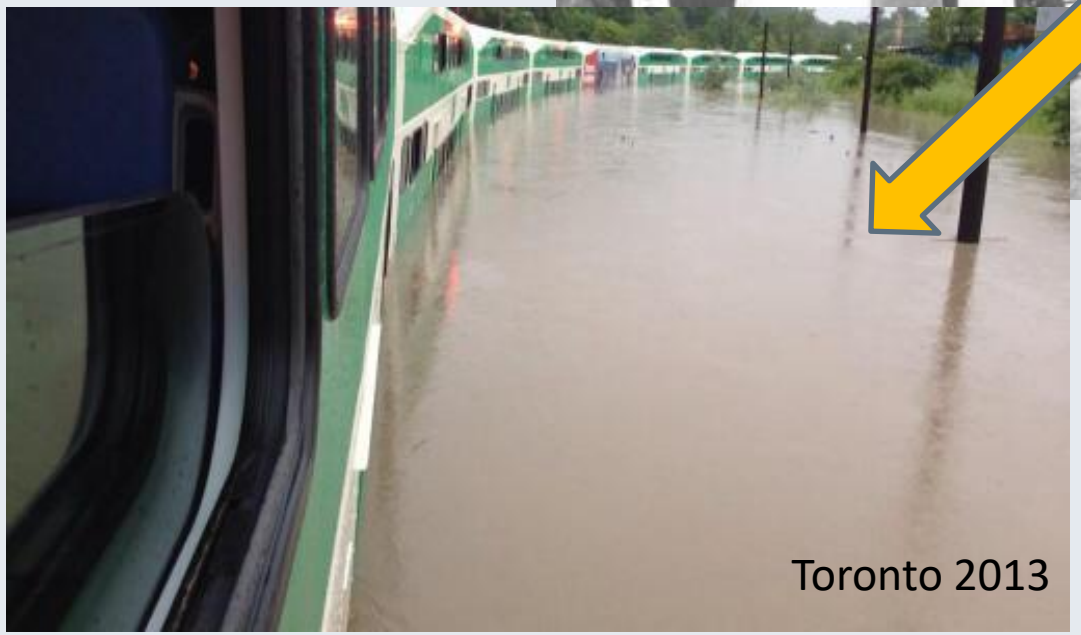
P = R + I + ET

Why is this happening?



How did we recover in the past, and can we apply this to the present?

London ON 1937



Toronto 2013

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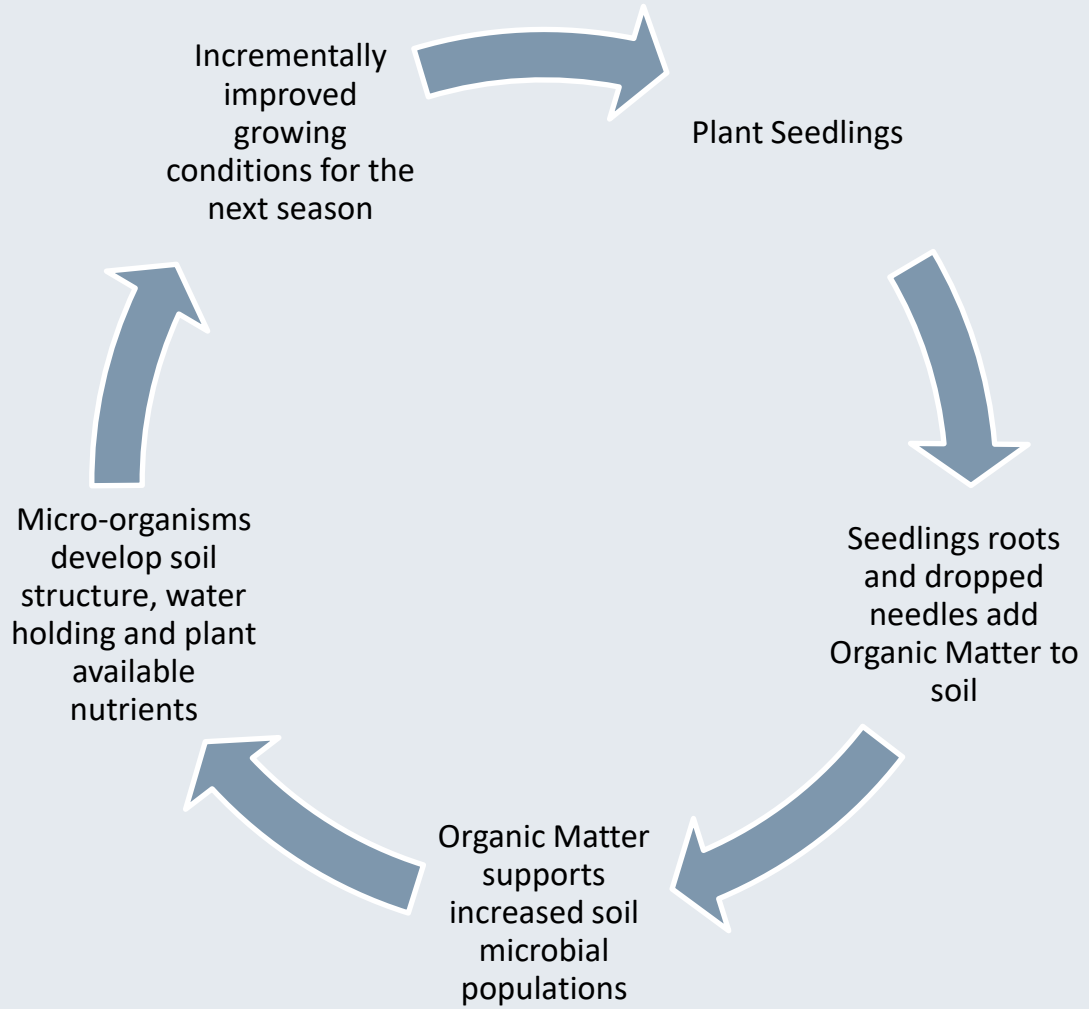
Science of Green Infrastructure 1905



Reforestation by E. Zavitz and Associates

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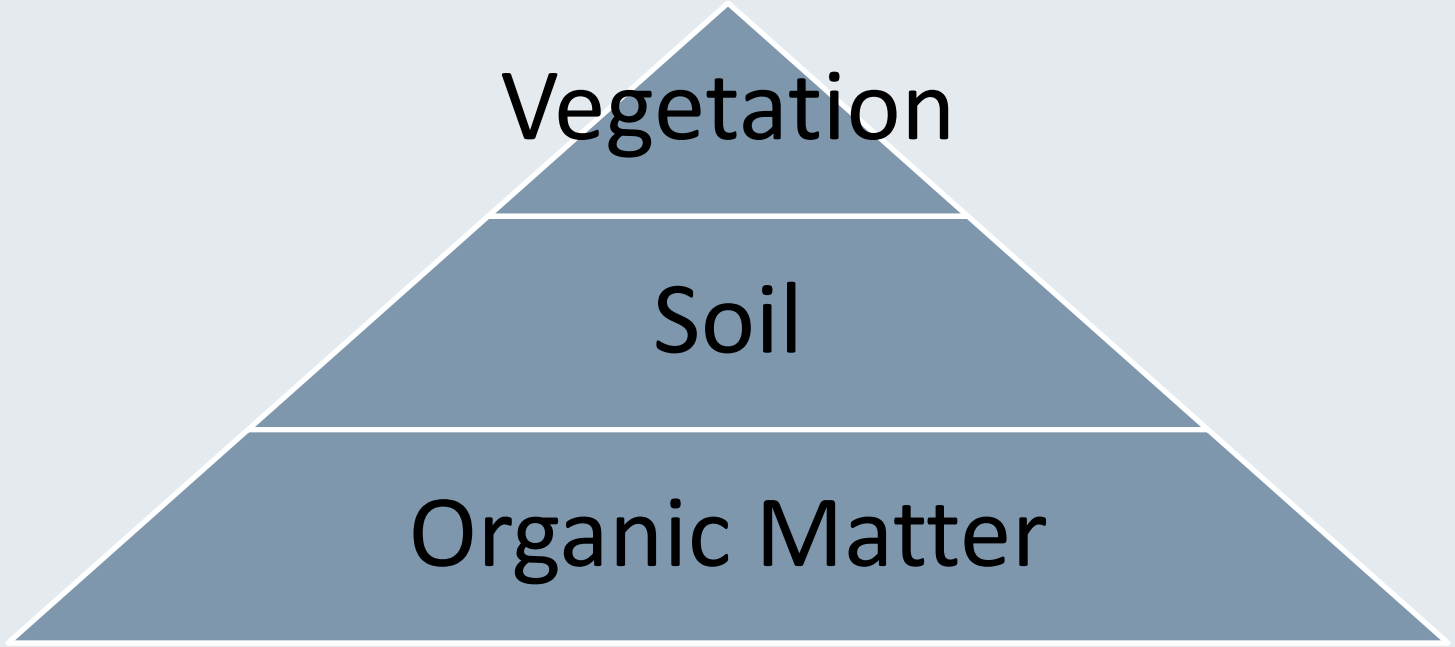
The Simple Truth about G. I.



Vegetation is dependent on soil quality.
Soil quality is dependent on Organic Matter
Therefore Green Infrastructure quality is dependent on Organic Matter

GREEN INFRASTRUCTURE = Organic Matter

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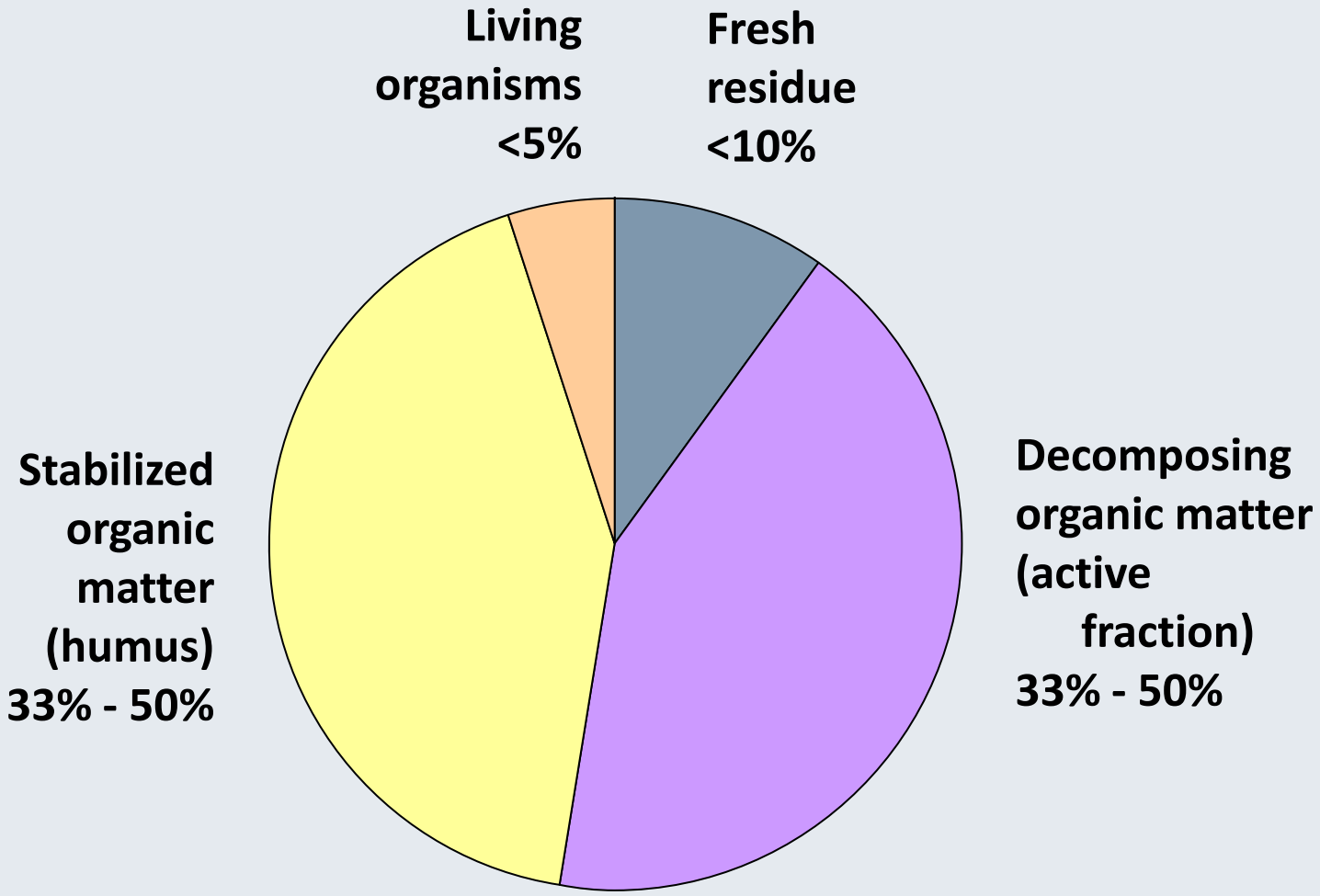
Components of soil organic matter (SOM)



Nutrient Holding Capacity (NHC)

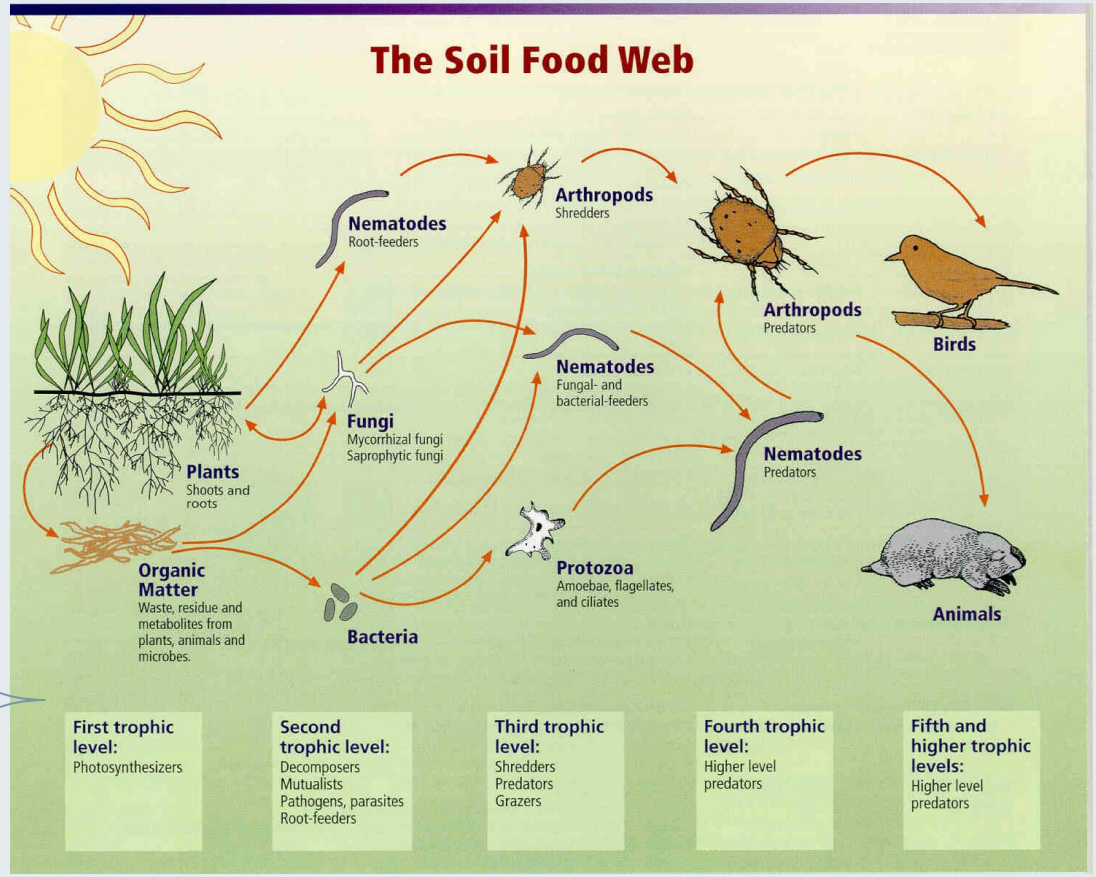
	CEC mEQ/100g soil
Humus	100 - 300
Soil Texture	
Clay Loam	30
Silt Loam	27
Loam	24
Sandy Loam	17
Loamy Sand	9

The Soil Food Web

Physical and chemical soil properties depend on micro-organisms

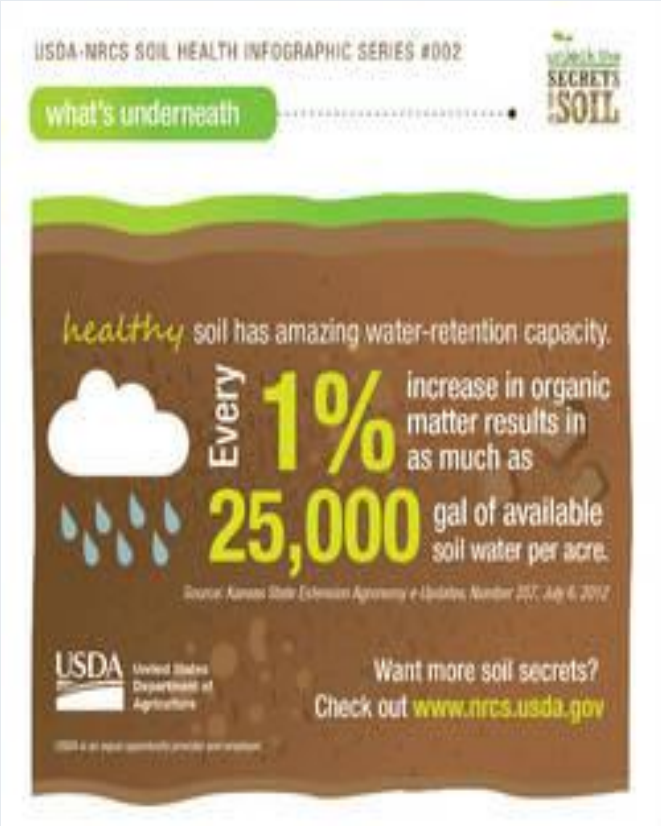
And other soil dwellers found abundantly in healthy soils

- Structure
- Water holding capacity
- Infiltration
- Cation (anion) exchange capacity



Stormwater Management/Water Quality

Humus	Water Holding Capacity / acre
1%	10,000 gallons
6%	60,000 gallons



Top 15cm, 1.33g/cm³ bulk density

Increased organic matter results in:

- Increased water storage
- Increased carbon storage

USDA Natural Resource Conservation Service

Table 1
30 cm soil depth. Bulk density 1.2 g/cm^3

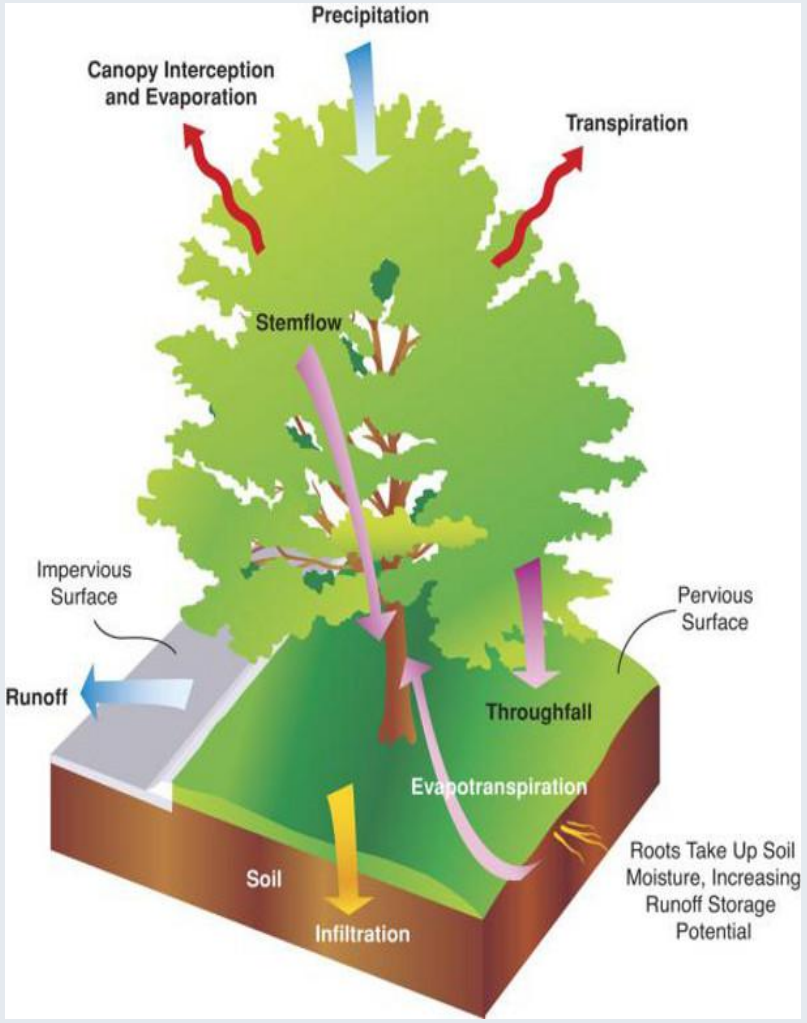
Increased Organic Matter levels effect on water holding and carbon storage

Change in OC level	Change in OC (kg/m^3) [lb./ft.^{3}]	Extra water (litres/m^3) [U.S. gal/yd^3]	Extra water (litres/ha) [U.S. gal/acre]	CO_2 sequestered (tonnes/ha) [tons/acre]
1%	3.6 kg [0.22]	14.4 [2.9]	144,000 [15,400]	132 [59]
2%	7.2 kg [0.45]	28.8 [5.8]	288,000 [30,800]	264 [118]
3%	10.8 kg [0.67]	43.2 [8.7]	432,000 [46,200]	396 [177]
4%	14.4 kg [0.90]	57.6 [11.6]	576,000 [61,600]	528 [236]

Christine Jones, Ph.D. Carbon For Life Inc. Visit www.amazingcarbon.com

Green Infrastructure
An Urban Forest Perspective

- Trees are a major component of the hydrologic cycle
- Trees reduce runoff through processes of
  - Interception
  - Evaporation
  - Infiltration
  - Transpiration
  - **Mature trees maximize these benefits**



Evapotranspiration: estimated at 57% of avg. annual rainfall in United States

For trees to provide these benefits, they require

- Sufficient soil volume and soil quality to allow them to reach maturity

- The same benefits and requirements apply to turf and all other plants also

- **Organic matter** is the key to a fully functional soil

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Preserving and Restoring Healthy Soil: Best Practices for Urban Construction

Prepared by Toronto and Region Conservation Authority
June 2012
Version 1.0

Sustainable Technologies EVALUATION PROGRAM

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Winter

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Welcome reviewer! We have been looking forward to your arrival.

In anticipation we have prepared a short printable form to help direct your critique of the wiki.

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If you have a shorter comment or observation please use the anonymous feedback box at the bottom of every page.

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Credit Valley Conservation inspired by nature
Lake Simcoe Region conservation authority
Toronto and Region Conservation Authority

This page was last edited on 15 March 2019, at 18:50.

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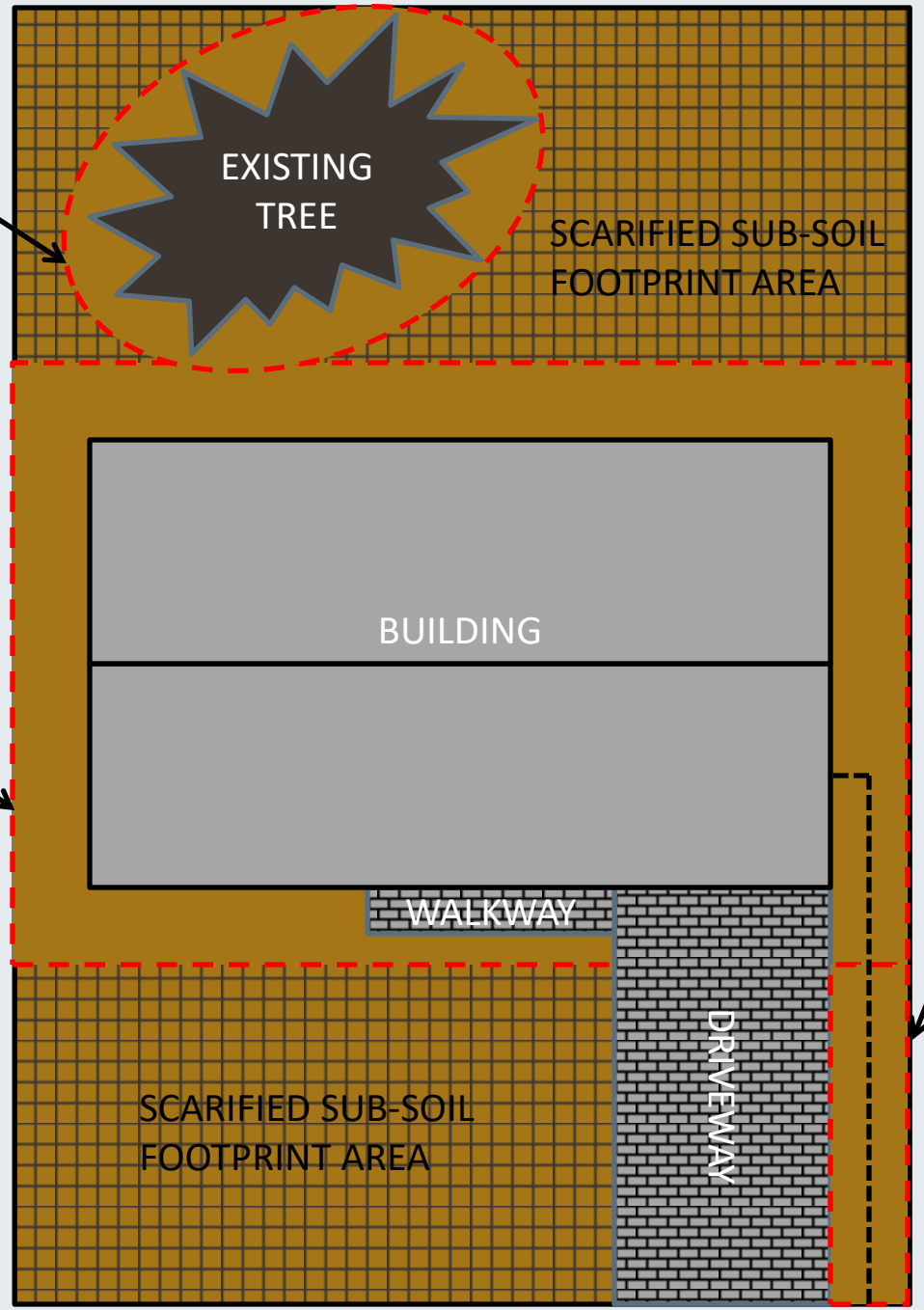

Example of a simple SMP:

10cm depth scarified sub-soil
30cm depth compost amended topsoil
40cm total uncompacted depth

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Compaction Thresholds for root growth

Compaction	Cone Penetrometer (PSI)	Proctor Density Method (%)	Bulk Density (g/cm³)
Acceptable	≤ 260	75 - 85	1.10 – 1.60
Root Limiting	260 - 400	85 - 90	1.10/1.60 – 1.47/1.80
Root Restricting	≥ 400	≥ 90	≥ 1.47 – 1.80

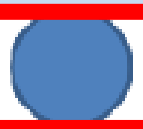
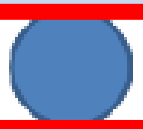
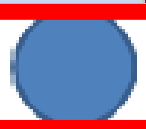
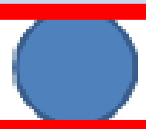
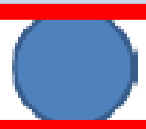
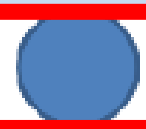
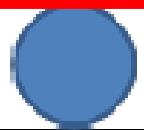
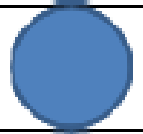
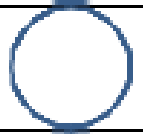
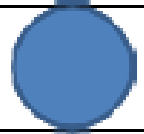
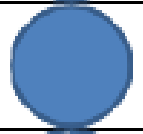
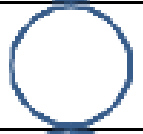
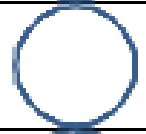
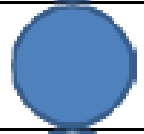
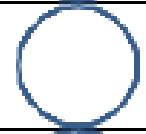
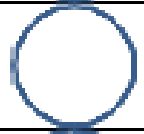
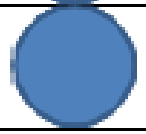
Current Development Practices

2018

Ontario excess soils estimated at 25 million m^3/yr.

Proposed Runoff Volume Control Targets (RVCT)

Table 2.1 – Stormwater Criteria, Benefits and Efficacy

Criteria Type	Benefits/ Efficacy								
	Peak Flow Reduction	Runoff Volume Reduction	Water Quality (Load reduction)	Water Balance	Erosion Control	Flood Control	Thermal Impact Mitigation	Preservation of Aquatic Habitat & Species	Preservation of Terrestrial Habitat & Species
Volume Retention/ Reduction									
Volume Capture and Treatment									
Flow Rate Limitations									
Volume Detention									
Load Reduction Criteria									
Relative Effectivness									
Low	Low to Moderate	Moderate	Moderate to High	High					

Aquafor Beech Ltd 2016

Living Green Infrastructure!

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Design, Build and Maintenance considerations of Living Green Infrastructure

- Implement a Soil Management Plan (SMP) setting minimum soil volumes, quality and maximum allowable compaction levels along with acceptable soil handling practices
- Ensure protection of all LGI to be retained during development
- Have a verification process in place to ensure the SMP is implemented properly during construction
- **Provide a post-construction maintenance manual and training for staff and contractors….often the missing link**

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So let’s put our boots on and get down and dirty

Urban Forests and Turf Management

Improving the health of the tree while parked on its root system!

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2 inch mowing height

3.5 mowing height

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Rule of Thumb

- Soil metabolic rate (respiration) doubles every 10°C temperature increase

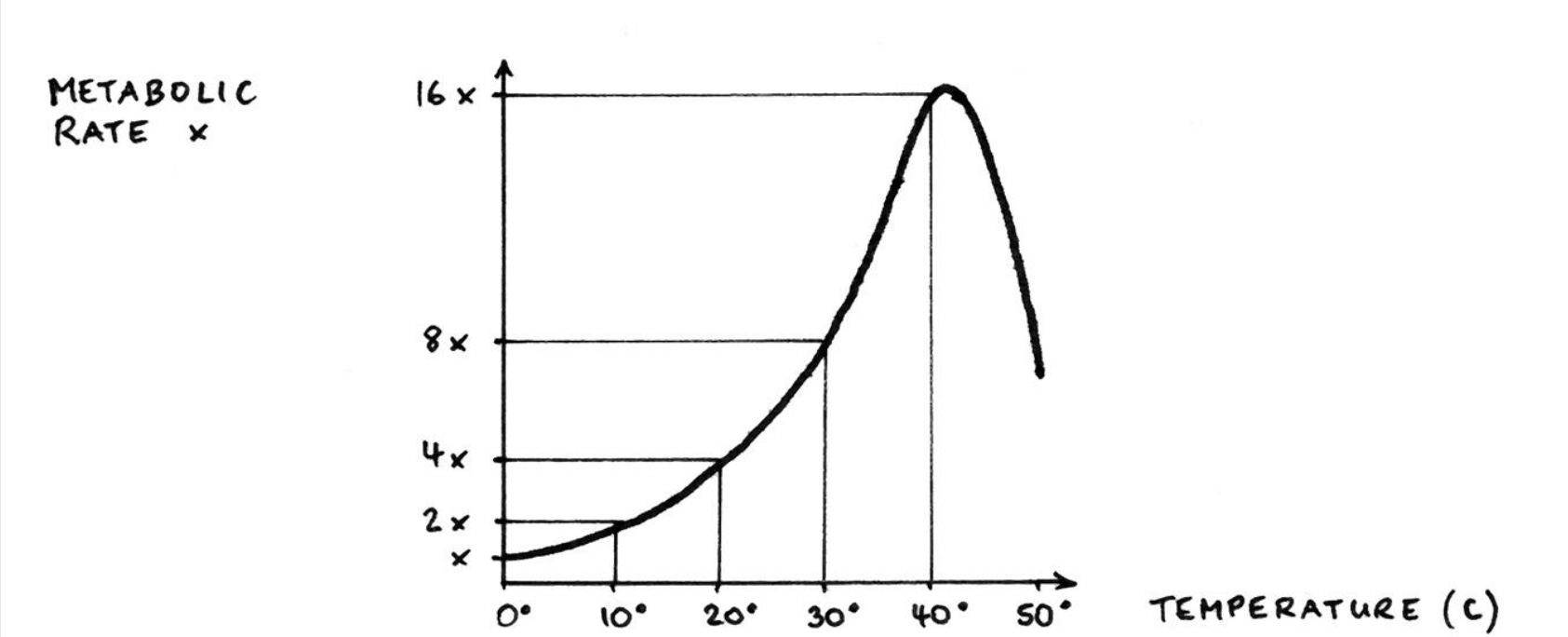


Illustration: Christina Nikolic

- Soil respiration drops rapidly over 40°C leading to turf dormancy or death and reduced tree health, increased soil compaction and reduce water infiltration

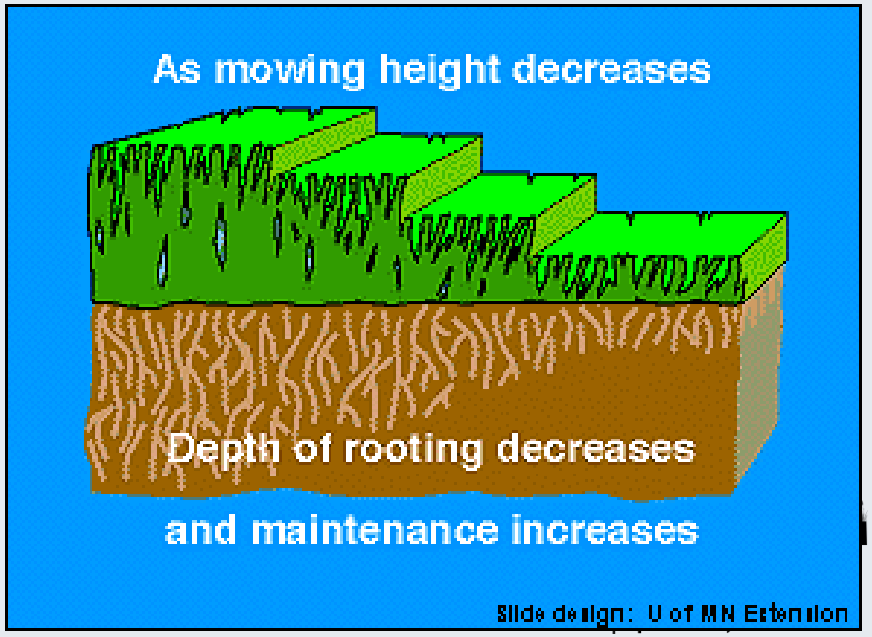
Temperature Dependence

- Microbes and insects cannot regulate own temperature (metabolism is temperature dependent)
- Beneficial Fungi = best at 10 - 30 C
- Beneficial Bacteria = best at 20 - 35C
- Landscape maintenance practices which support these temperature ranges are required

Mowing Height affects:

Photosynthetic capacity
H_20/nutrient uptake
Rooting depth
H_20 infiltration and holding
Soil nutrient holding capacity
Soil temperature
Soil compaction
Soil respiration
Drought tolerance
TREES

Mowing height / Root Development
Photo: RND Reid & PD Ball



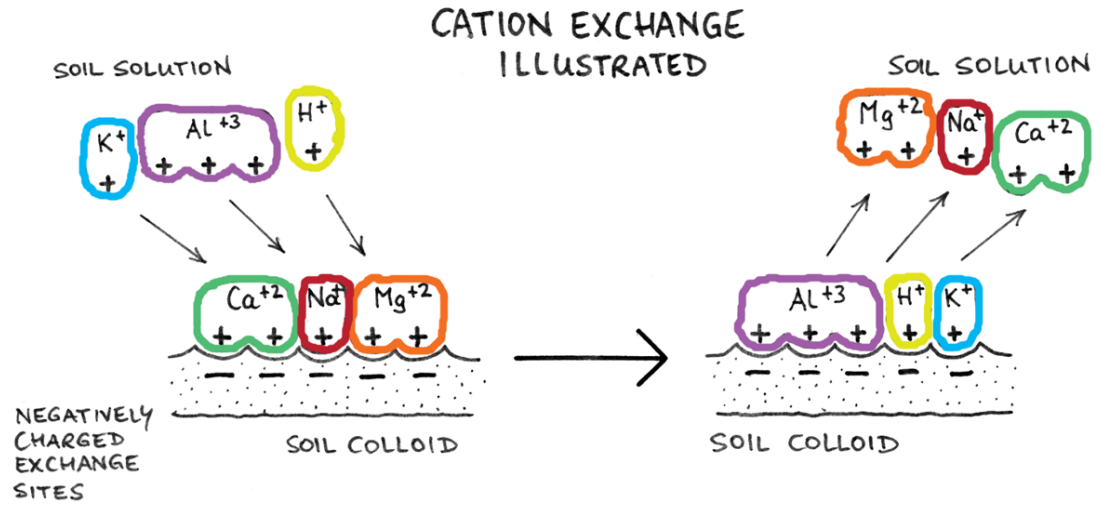
Synthetic Fertilizers

Not intended for a sustainable landscape

Acidifying

Oxidize O.M.

Reduce soil fertility



Reduce or eliminate if the intention is soil health and water quality

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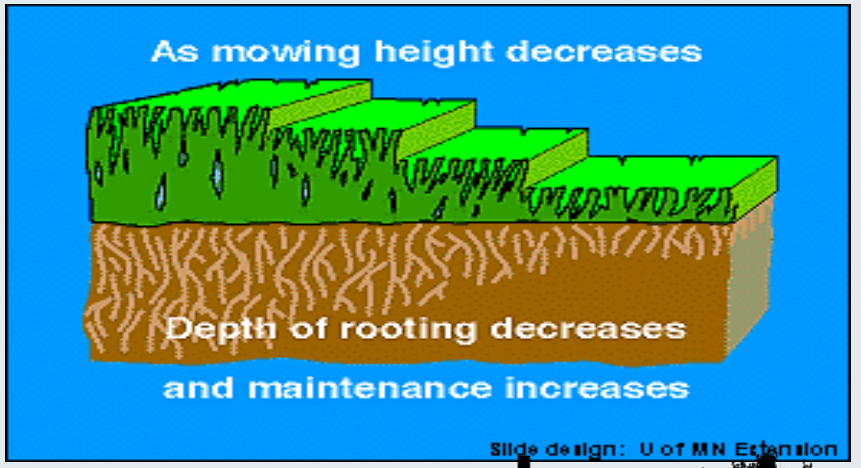
Common Practices – helpful?

- Bagging Mowers and Leaf Blowers – constant decrease in O.M. unless re-applied
- De-Thatching – highly injurious to plant and fungi. Healthy soil has lignin feeding fungi
- Aeration – doesn't improve soil structure. Only improved soil biodiversity does
- Irrigation – higher O.M. means less irrigation or none

Mowing height / Root Development
Photo: RND Reid & PD Ball



Maintenance of G.I. Post Construction Summary (Urban Forests and Turf)

- Reduce or eliminate synthetic fertilizers
- Avoid traditional maintenance practices which degrade the functions of G. I.
- Implement maintenance practices which support soil health, add organic matter, increase biodiversity above and below ground
- ***Provide a maintenance plan (manual) and training for staff and contractors to ensure the long term performance of L.G.I.***

fusion landscape PROFESSIONAL

Study Manual

Region of Peel Working for you

HORTICULTURAL TRADES ASSOCIATION landscape ontario.com Green for Life!

York Region

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Softscape

Plantings

In a Fusion landscape, plantings will not only provide aesthetics, but will also create important ecological benefits. While all plants provide some ecological benefits, using the right plant in the right place can optimize their impact.

Drought-tolerant Plantings (Xeriscaping)

Biodiveristy Garden

Alternative Lawns and Drought Tolererant Plantings

Alternative Lawns

Biodiversity Garden

Vegetated Retaining Walls

Tree and Shrub Clusters

Design

Design Considerations

- Potential uses: emphasize focal points; enhance entrances and walkways; provide shade; stabilize soils; add colour, texture line and form; provide a food source and habitat for birds, insects and small mammals.
- Benefits include: water efficiency stormwater management, biodiversity enhancement, climate change resilience, reducing urban heat island effect, water quality improvements, urban tree canopy enhancement, and air quality improvements.
- When used in conjunction with other Fusion elements, plantings can augment stormwater management and water efficiency in a landscape.
- Planting the right plant in the right place will reduce maintenance and impact overall plant performance.
- Using a variety of plants, both native and non-native, will maximize performance, improve the overall success of the planting, and achieve additional benefits such as supporting pollinators, or creating a healthy, diverse ecosystem.

Choosing the Right Plant for the Right Place

When selecting plantings consider the following:

- **Client Desires**
  Clients may want specific plant species, or a specific colour scheme in their landscape. When selecting plantings, you will need to balance the clients desired aesthetic with landscape conditions and ecological benefits.
- **Soils**
  Soil type will influence plant selection. For instance, in sandy soils that do not retain much moisture, plants with deep root systems will thrive best.
- **Water Use**
  Plants have different water requirements. Knowing your client's irrigation requirements, as well as moisture conditions in the yard will help you choose appropriate plants
- **Winter Conditions**
  Consider potential salt spray and snow load locations when choosing plantings. If planting cannot be avoided in these areas, choose plants that are more tolerant to snow load and harsh conditions.

Organic Land Care Principles

•Is the design, construction and maintenance of landscapes to promote and preserve environmental health both above and below ground.

•These practices arise from the understanding that all organisms in nature are interdependent, and to have healthy landscapes requires assuring the health of the entire ecosystem.

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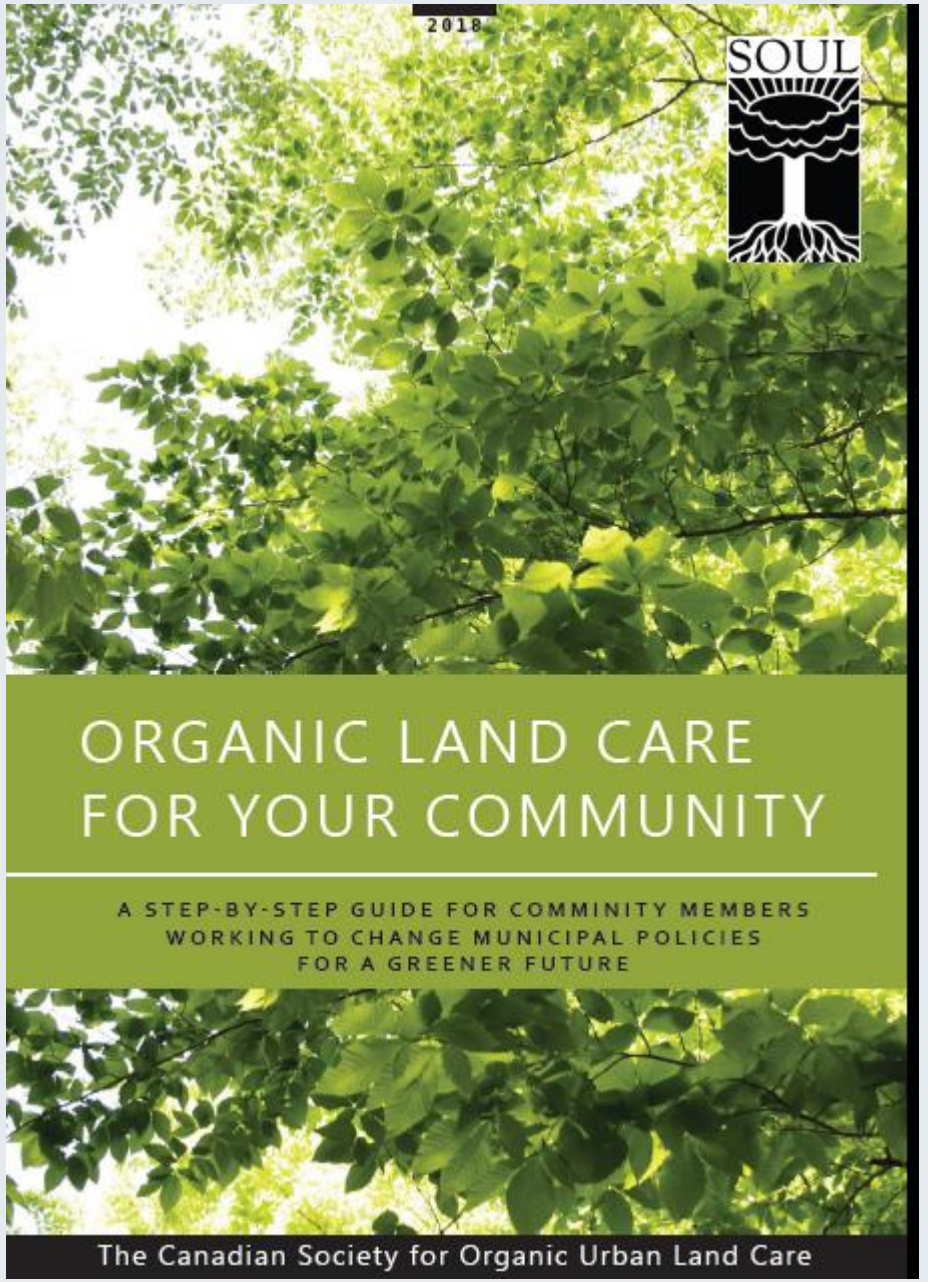
SOUL
SOCIETY FOR
ORGANIC
URBAN
LAND CARE
ORGANIC LAND CARE
STANDARD FOR CANADA
SEVENTH EDITION (DRAFT)


2018
SOUL
ORGANIC LAND CARE
FOR YOUR COMMUNITY
A STEP-BY-STEP GUIDE FOR COMMINITY MEMBERS
WORKING TO CHANGE MUNICIPAL POLICIES
FOR A GREENER FUTURE
The Canadian Society for Organic Urban Land Care

Presentation Overview

1. Brief history of Green Infrastructure and development in Ontario
2. Overview of higher development standards (Soil Management)
3. Long term maintenance of Living Green Infrastructure (LGI)
4. **Transformed and New High Performance Landscapes**
5. Check list for sustainable maintenance of LGI

Sunnybrook Health Sciences Centre

Rohan Harrison, Grounds Manager

Landscape maintenance practices transition from conventional to organic 2007 - 2018

Sunnybrook Health Sciences Centre

Organic Land Care Program Development – Transition phase

•2005 Elimination of all landscape pesticides (5 years prior to provincial ban)

•2006 Last year for conventional maintenance practices (3500kg of Synthetic Fertilizer applied)

•2007-2011 Fully Organic Maintenance initiated. Basic program included:
- •Compost for gardens and turf topdressing (imported in bulk or palletized form)
- •Overseeding turf areas with traditional seed mix and aeration
- •Addition of organic fertilizers to turfed areas (Alfalfa 5-1-5 with kelp)
- •Mulching of most planting beds (goal of no bare soil)

Program annually modified to suit the response of the landscape

•2012
- •Introduction of on site composted materials.
- •Addition of mycorrhizae and RTF (rhizomatous tall fescue) grass for topdressing
- •Mowing height set at 3 inches (75mm)

•2014 Staff trained in Organic Land Care

•2018 Effective microorganisms (EM) and Compost Tea added (under trials)

Sunnybrook Health Sciences Centre

Benefits and Improvements in this time frame 2006-2018

- Sustainable elimination of all pesticides and synthetic (chemical) fertilizers
  - These materials are now not entering ground water or waterways
- 97% of natural waste is recycled into compost/mulch and re-applied to the very same landscape
- Off site waste disposal volume reduced by 95%
- Reduced staff maintenance hours to maintain turf
  - Reduction of 1400 plus staff hours from 2008 to 2018
- Reduced stormwater runoff and ponding due to higher infiltration rate of the landscape
- Reduced weed populations and pest/disease problems
- Increased pollinator populations
- Visually healthier landscape

Conventional Maintenance Practices with synthetic fertilizer applications
2007

Organic Land Care Practices one year after the first compost top dress with mycorrhizae
2013


NO PARKING
Sunnybrook
ENVIRONMENTAL SERVICES
THE COMFORT MAPLE

Organic Horticulture at Corktown Common

Yafit Rokach
Toronto Parks, Forestry and Recreation

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Corktown Common

- Situated in West Don Lands
- 7.3 hectares (18 acres)
- Lower River St. & Bayview Ave
- Former industrial site

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Corktown Common

- Marsh
- Sprawling lawns
- Urban prairie
- Playground and splashpad
- Fireplace, BBQ, picnic tables

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Corktown Common

- Designed and built for organic horticulture
- First of its kind in T.O.

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Corktown Common Beginnings

- Assigned in 2012
- Organic horticulture
- Don River Park
- Under construction

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Children's Eco Programs

- 15 years with Children's Eco Programs
- Expansion of organic gardening / nature exploration programs

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Corktown Common Key Players

WATERFRONToronto + MICHAEL VAN VALKENBURGH ASSOCIATES INC + TORONTO

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Corktown Common Beginnings

- Little in-house expertise
- I needed more knowledge
- Staff would need support
- Still under construction
- Operating funds available
- Needed to be sustainable
- MVVA invested in long-term

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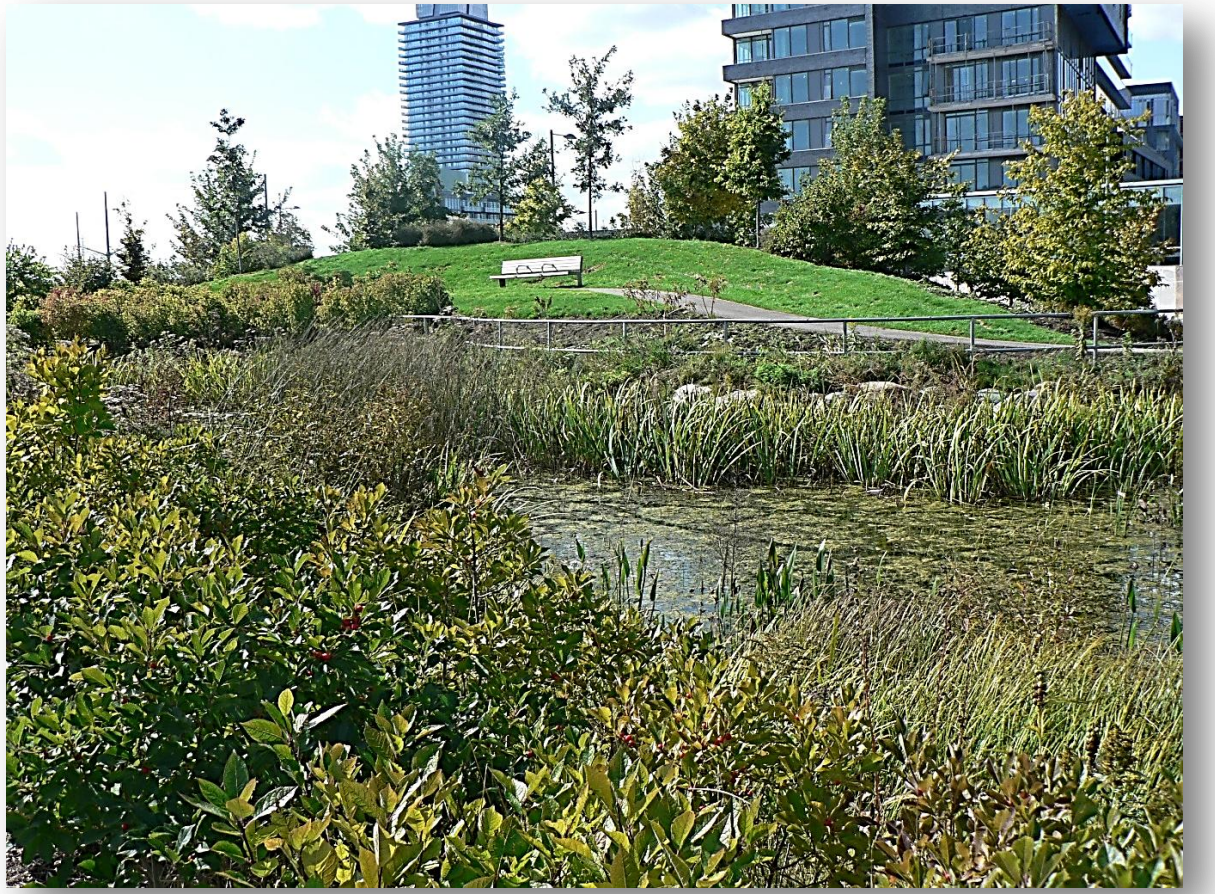
Specialized Knowledge

- Organic Horticulture Specialist course
- Online at Humber College
- Foundational knowledge

Corktown Common



- Consulted with Parks staff
- Initial plan to train staff
- MVVA explored manual idea

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Children's Eco Programs Expansion

- Experience in expansion
- Took Eco Programs City-wide
- Started in 1999

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Children's Eco Programs Expansion

- Eco Programs Manual and Toolkit
- Trained staff from 4 centres annually
- Site support for first year

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Children's Eco Program Model

- Long-term success inconsistent
- Lots of staff movement
- Adjusted the model:
  - Job postings for hiring
  - Redesigned manual
  - Provision of ongoing support

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Corktown Common – The Staff

- Needed the right staff
- Worked with HR and Union
- Agreed to gardeners with expertise
- Organic Horticulture Assessment
- Organic Horticulture Specialist for F/T
- Pool of 45 organic hort gardeners

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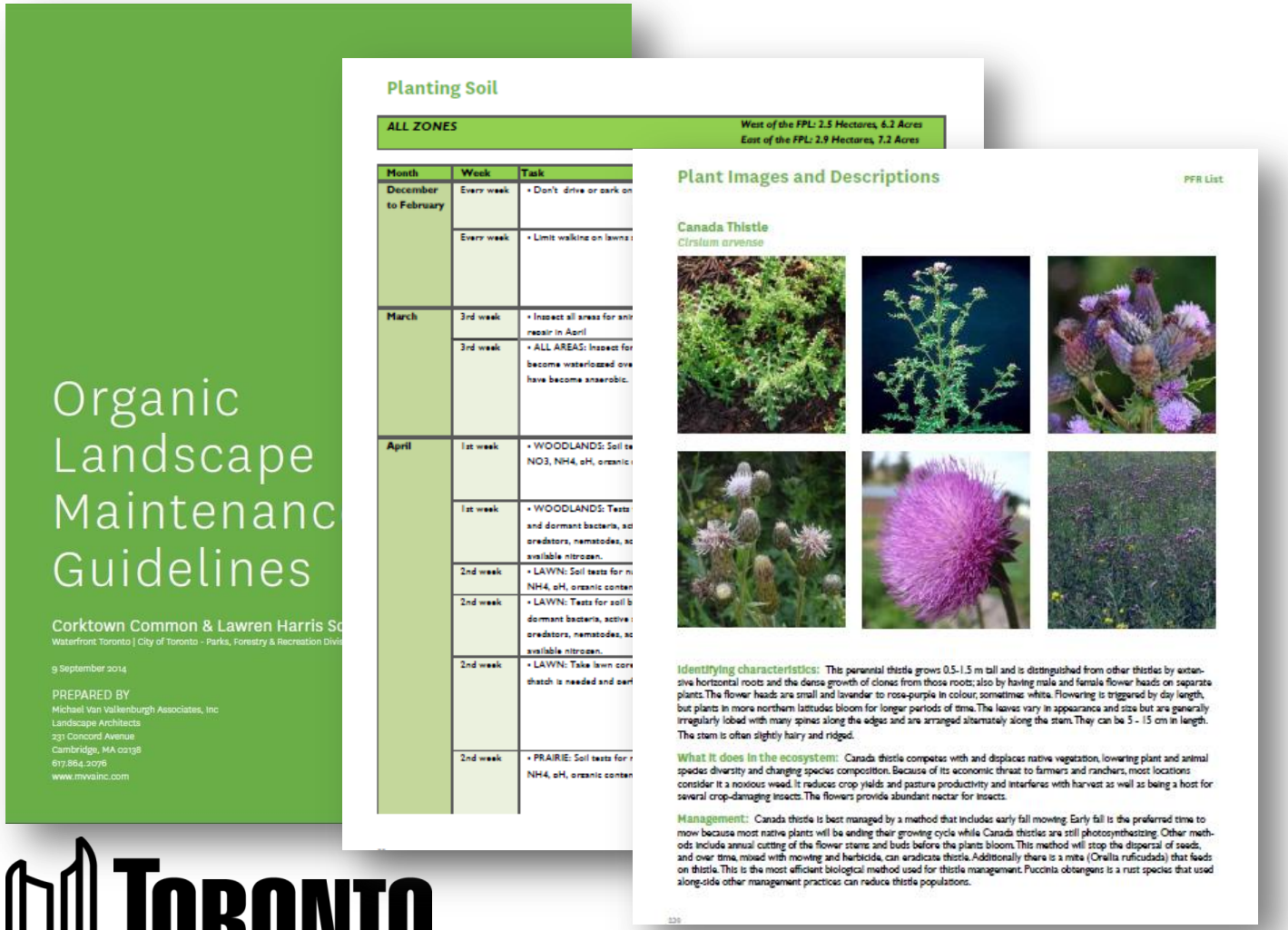
Corktown Common – The Manual



- User friendly
- Organic horticulture 101
- Calendar of staff duties
- Plant palette summary
- Invasive plants/pests and treatments
- Living document

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Corktown Common – The Manual

- Well used
- Permanent instructional resource
- Long-term sustainability

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Corktown Common – Building Support

- Addressed staff concerns about office/storage space, resources, staffing
- Set expectations for work arounds
- Supported leadership roles
- Open door policy
- Shared the vision

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Corktown Common Materials & Supplies

List of Materials and Supplies for Corktown Common

1. Compost liquid extractor and supplies
2. Yard waste chipper/shredder
3. Composter
4. Leaf Bin
5. AEM
6. Micorrhyzal inoculants (grandular for planting beds; clay coated for turf areas)
7. Nitrogen fixing plants: wild lupines (*Lupinus perennis*), (*Fragaria virginiana*), fragrant sumac – low-grow variety (*Rhus aromatica*), and Sweet grass (*Hierochloe odorata*)
8. Ramial Chipped wood
9. Leaf mould mulch
10. Cardboard
11. Burlap
12. Compost
13. Catalyst and liquid kelp
14. Endophyte-enhanced grass seed
15. 50% range fed cattle/sheep or horse manure mixed with bedding – aged minimum 2 years, 10% vermicompost 40% yard waste compost - for turf areas
16. Hand held nets and skimmers to remove wetland algae
17. Set-up 3 wire compost bins 5' round by 5' high (available as 5 ft. x 50 ft. 14-Gauge Vinyl Galvanized Welded Wire or click here)
18. - truck mounted sprayer with hose: beds and gardens at larger scale, sports field turf, trees
19. - tow behind boom sprayer: sports field turf
20. - backpack sprayer: beds and gardens at smaller scale, localized sports field turf areas, smaller trees
21. - portable tank system with hose: beds and gardens at smaller scale, smaller trees
22. - watering can: hanging baskets, planters, small trees
23. Where designed, liquid compost application can also be integrated with automatic irrigation systems. The liquid compost is metered out at a set rate into the water and the solution applied when required through the irrigation system.

- New kinds of materials/supplies
- Developed resource document
- Gathered quotes
- Helped develop contracts

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Corktown Common Soils

- Complex and large park
- Low soil biological activity
- Soil is foundational in organic hort
- Need for greater expertise

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Organic Horticulture Consultant

- Hired organic horticulture consultant
- Site inspections and walk-throughs
- Written recommendations
- Review and document best practices
- Conduct soil tests

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Corktown Common – Year 1 Review

- Review of challenges and lessons learned
- Strategy for year 2 improvements

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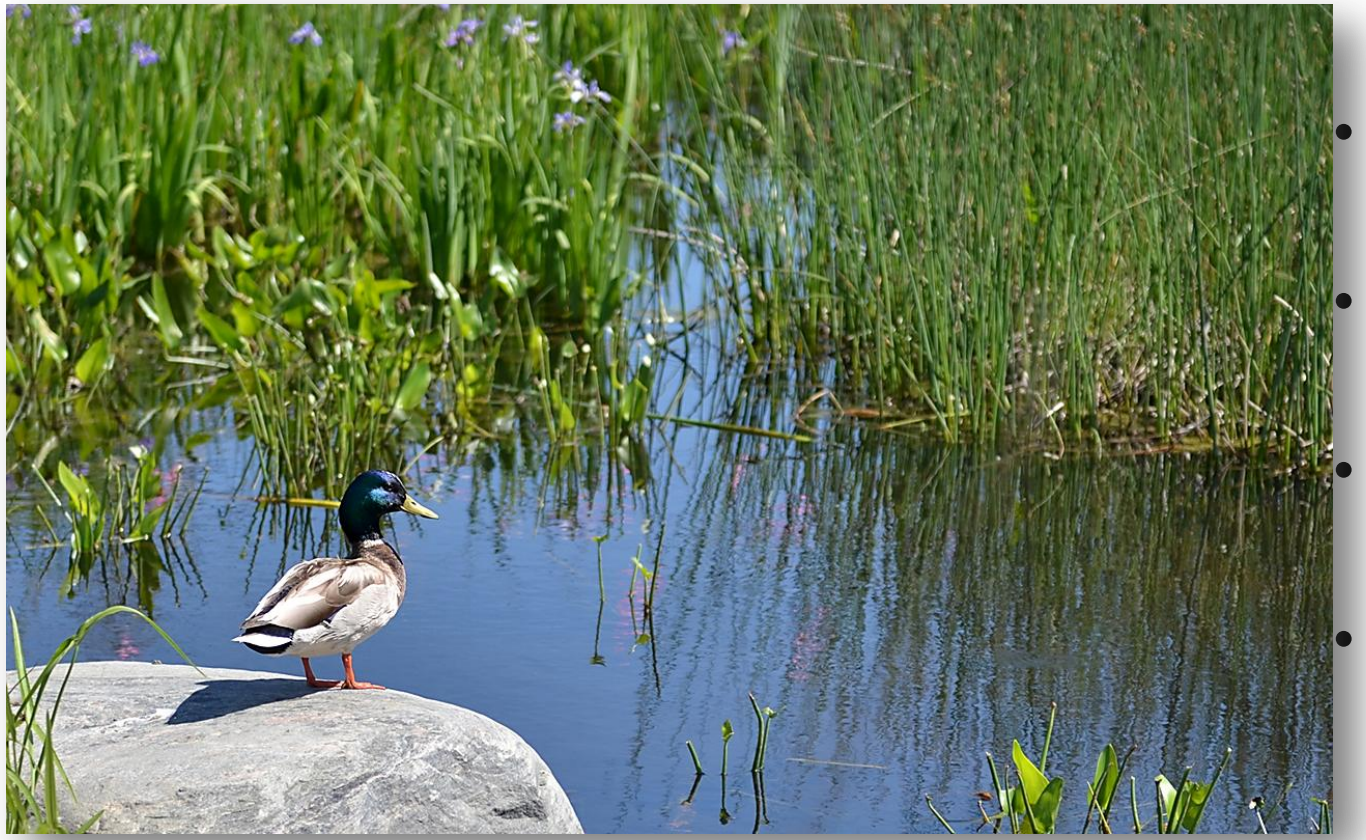
Corktown Common – Year 2

- Extensive review of Organic Landscape Maintenance Manual
- Determined what worked and what didn't
- Documented best practices on site
- Establishment of Organic Horticulture Guidelines

Corktown Common Today



- Lush and thriving landscape
- Used by wildlife and residents
- Test results show healthy soil
- Opportunity for expansion

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Final Recommendations

- Start with a pilot
- Approach implementation with long-term lens
- Get the right staff in place
- Develop resource documents
- Cultivate staff buy-in
- Source the right materials
- Provide on-site support for first few years
- Document challenges and best practices and adjust


Questions?
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