Metropolitan Water Reclamation District of Greater Chicago

# Welcome to the January Edition of the 2023 M&R Seminar Series

# NOTES FOR SEMINAR ATTENDEES

- Remote attendees' audio lines have been muted to minimize background noise. For attendees in the auditorium, please silence your phones.
- A question and answer session will follow the presentation.
- For remote attendees, Please use the "**Chat**" feature to ask a question via text to "Host". For attendees in the auditorium, please raise your hand and wait for the microphone to ask a verbal question.
- The presentation slides will be posted on the MWRD website after the seminar.
- This seminar has been approved by the ISPE for one PDH and has been approved by the IEPA for one TCH. Certificates will only be issued to participants who attend the entire presentation.

# Ahmad Laban, P.E., MBA
## Engineering/Operations Manager
## Metropolitan Water Reclamation District of Greater Chicago

Ahmad Laban is a Managing Engineer with over 30 years of experience in water reclamation management and environmental regulatory compliance. He has been with the District since 2001.

He received a Bachelor of Science in Civil Engineering with a minor in Mathematics from Southern Illinois University, Carbondale, Illinois. He completed graduate courses in Environmental Engineering at Southern Illinois University, and received his MBA in Management from Governors State University, University Park, IL

Prior to joining the District, Ahmad spent 14 years working at the Illinois Environmental Protection Agency. Outside of work, Ahmad enjoys travel and outdoor activities.

# Dr. Theresa Johnston
## Senior Environmental Soil Scientist
## Metropolitan Water Reclamation District of Greater Chicago

Dr. Theresa Johnston is a Senior Environmental Soil Scientist at the MWRD. She received her Ph.D. in Environmental Toxicology from the University of Illinois at Urbana-Champaign. Dr. Johnston earned a Bachelor of Science and a Master of Science in Natural Resources and Environmental Sciences with focuses on resource ecology, soil science and urban ecology at the University of Illinois. She spent time at McGill University and the U.S. EPA Atlantic Ecology Division for post-doctoral research before teaching at Loyola University Chicago for three years. Dr. Johnston now works in biosolids research and outreach. Her research focus at the District is application of biosolids and restoration of native soils using biosolids. Theresa continues to think about soil outside of work because she loves to garden, get messy with her kids, and spend as much time on trails as possible.


# Biosolids Program at the Metropolitan Water Reclamation District of Greater Chicago

BIOSOLIDS

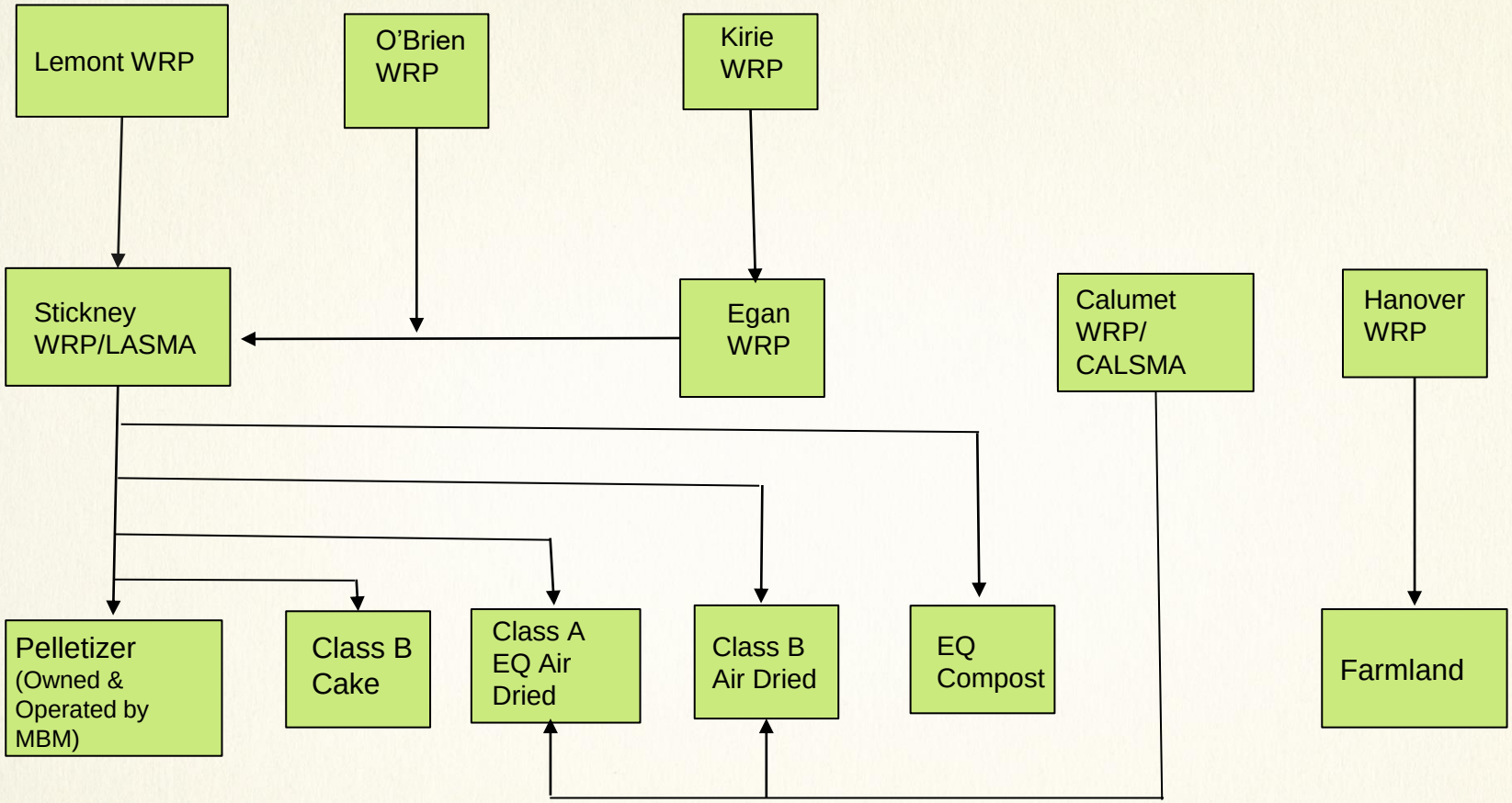
# Outline

- Biosolids Production at MWRD
- Biosolids Process Flow
- Biosolids Products
- Biosolids Utilization
- Biosolids Handling and Management
- Biosolids Beneficial Use


# Biosolids Production at the District

- The District generates approximately 150,000 dry tons of biosolids annually
- Three of the District's seven WRPs (Stickney, Calumet, and Hanover Park) produce a final biosolids product; sludge from the remaining three WRPs is sent to the other WRPs for final processing
- District owns and operates eight solids management areas (six currently in use) for dewatering, aging, and stabilization

# Biosolids Process Flow

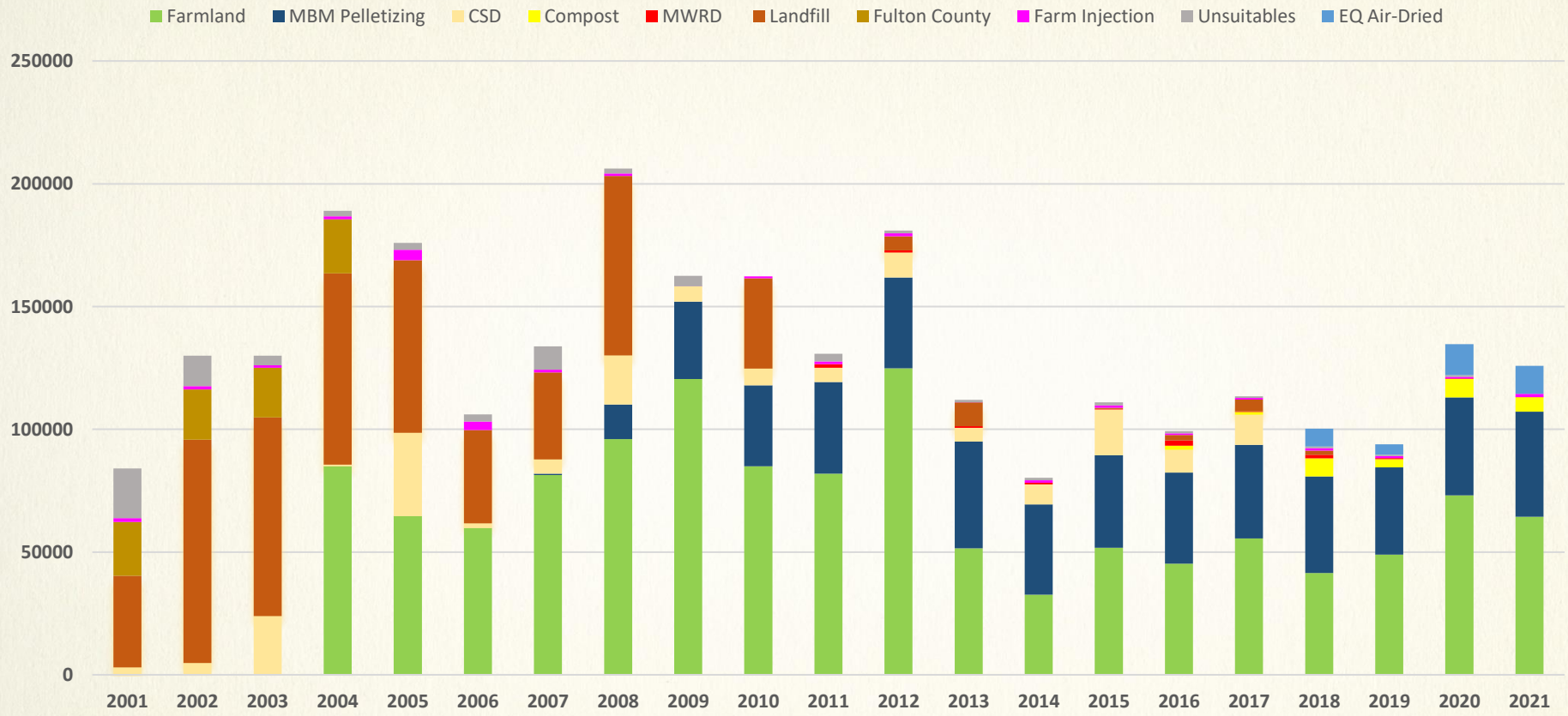



# PRODUCTS

| WRP | Dewatering Technology | | Final Products Produced | | | |
|---|---|---|---|---|---|---|
| | Lagoons | Centrifuges | Class B (Farmland) | Class A EQ Air Dried | Class A EQ Compost | Class A EQ Pellets |
| Stickney | X | X | X | X | X | X |
| Calumet | X | | X | X | | |
| Hanover Park | X | | X | | | |

BIOSOLIDS

# Utilization of District Biosolids (DT) 2001-2021



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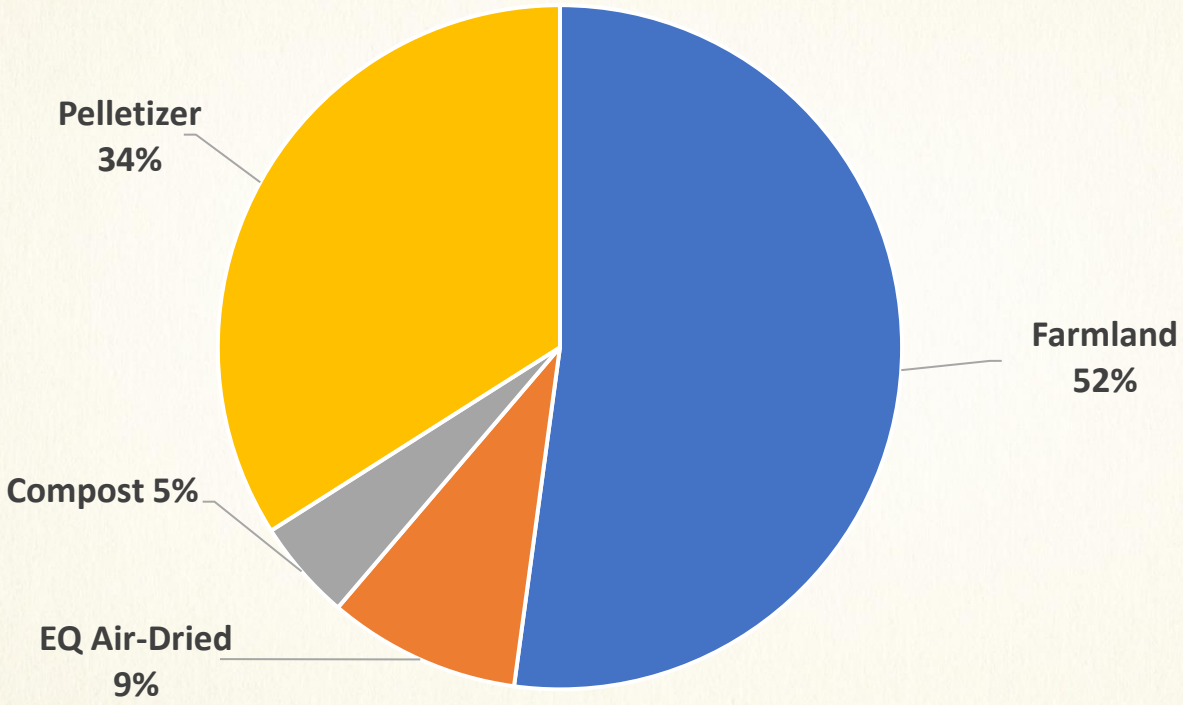
# 2021 Biosolids Utilization DT



BIOSOLIDS

# Centrifuge Dewatering

BIOSOLIDS

# Rail Car Loading

# Heat Drying (Pelletization) at the Stickney WRP

- Facility operated by Veolia North America
- Produces approximately 40,000 dry tons of pellets annually

BIOSOLIDS

# Lagoon Dewatering

BIOSOLIDS

# Rail Car Unloading

BIOSOLIDS

# Lagoon Outloading

BIOSOLIDS

# Drying Cells

BIOSOLIDS

## Unloading and Mechanical Agitation

BIOSOLIDS


**Tractor-Rotavator (Tiller)**

BIOSOLIDS


**Paddle Aerator (Auger)**

BIOSOLIDS

# Loading Farm Trucks

BIOSOLIDS

# Air-Dried EQ Biosolids

# Resource Recovery Ordinance – Material Requirements

## Woodchips

- Defined as any wood derived solid material made by cutting or chipping larger pieces of wood
- Shall be “processed to a size measuring less than 1.0 inch in two dimensions”
- Must be brought in bulk (unbagged) form and be free of debris (i.e. glass, gravel, plastic bags, etc.)

## Vegetative Material

- Defined as brush, grass clippings, and leaves
- Must be brought in bulk (unbagged) form and be free of debris

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# Woodchips

BIOSOLIDS

# Composting Process

- Dewatered biosolids and woodchips/vegetative material combined in a 1:3 ratio by volume
- Monitoring: Temperature probes with data collection
- Active Composting – 23 days at 55 degrees C (5 turns)
- Curing – 16 weeks
  - Lowers phytotoxicity (volatile organic acids), improves pH, lowers C/N ratio
  - Ensures finished compost stability

BIOSOLIDS

# Composting with Turner


BIOSOLIDS

# Compost Screening

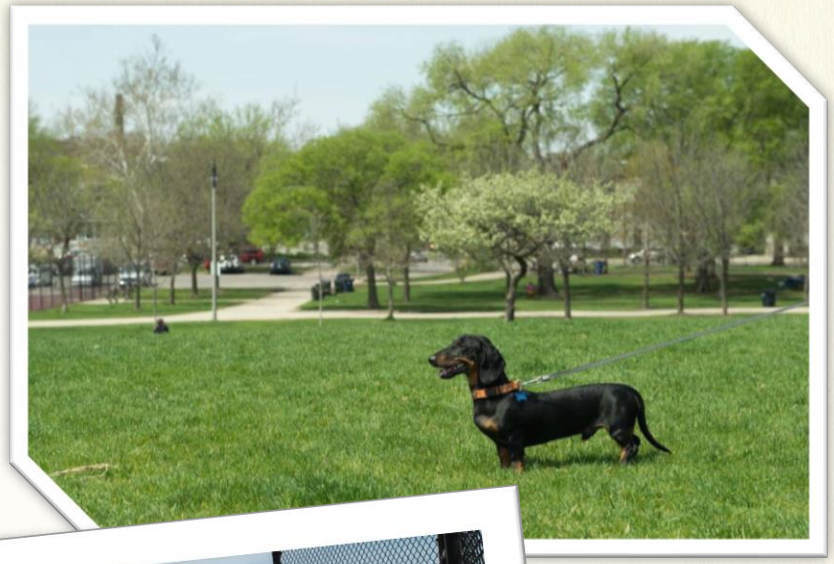
BIOSOLIDS

# EQ Compost

# EQ Biosolids Spreader

BIOSOLIDS

# EQ Biosolids Beneficial Use - Parks



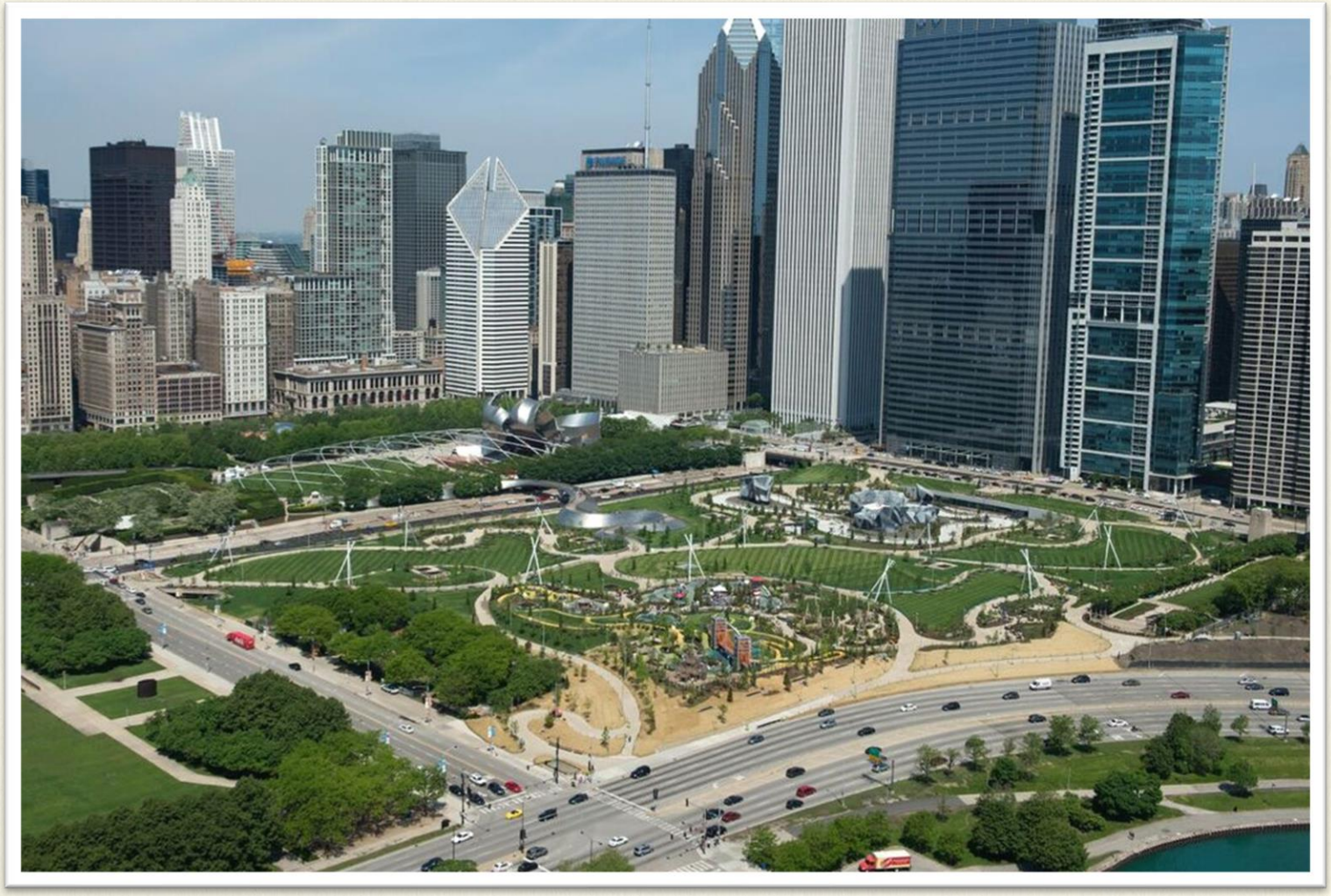
BIOSOLIDS

# Ford Heights Baseball Field

# Illinois Tollway – I-355 Tree Planting Initiative

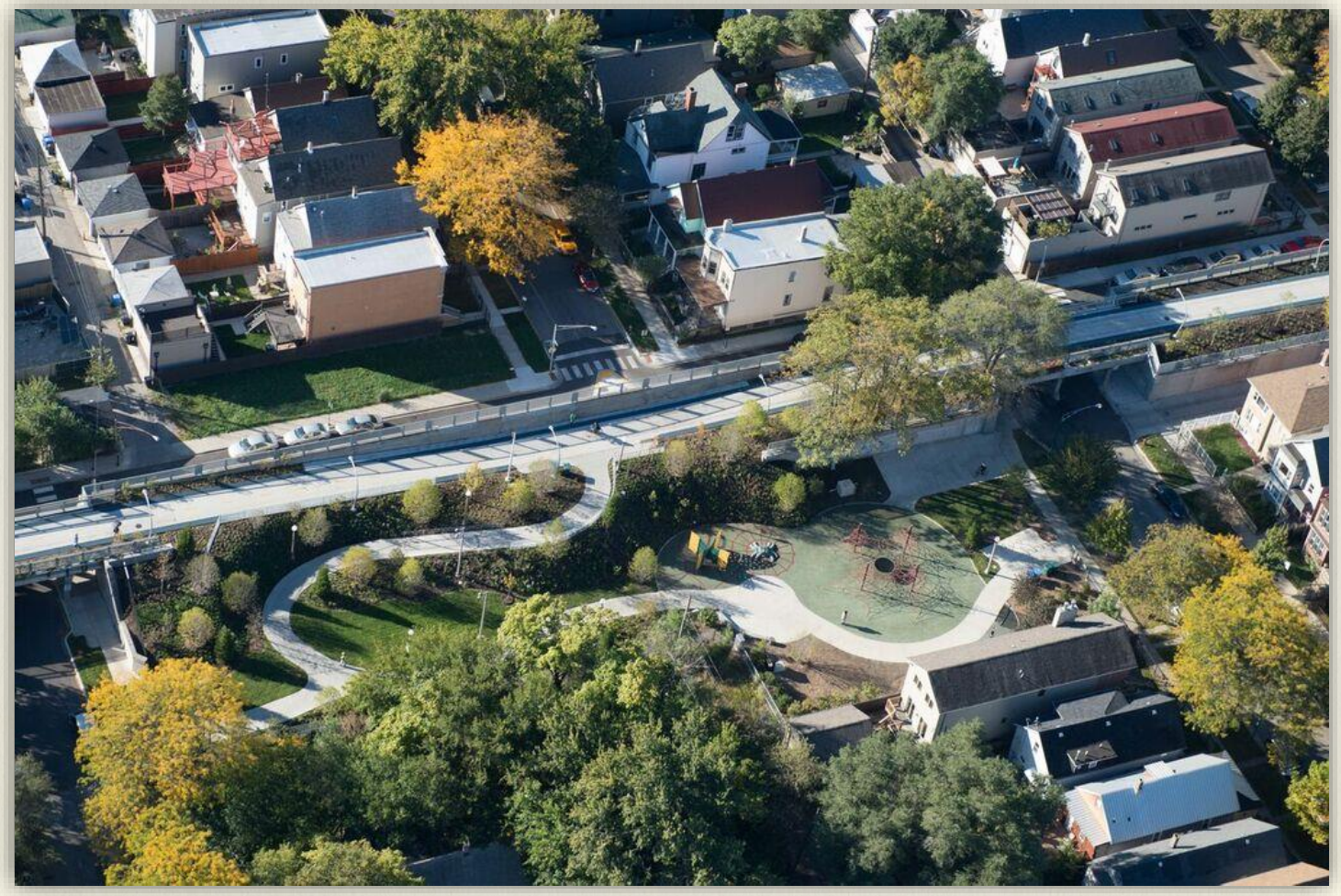
BIOSOLIDS

# Maggie Daley Park



BIOSOLIDS

# EQ Biosolids Beneficial Use – 606 Trail



# Historical Biosolids Use at MWRD – Fulton County

- Site consisted of ~13,000 acres of barren land strip-mined for coal
- Several acres of gob piles (mining refuse) that produced acidic drainage polluting local waterways
- The District applied over 1 million dry tons of biosolids between 1972 to 2004
- Operation included an environmental protection system including rigorous monitoring of soil, water, and crops.
- The site is a unique resource for studying long-term benefits and the impact of land application of biosolids.

# Historical Biosolids Use at MWRD – Fulton County

BIOSOLIDS

# Strip Mining in Fulton County

BIOSOLIDS

# Fulton County


Thanks
Ahmad Laban
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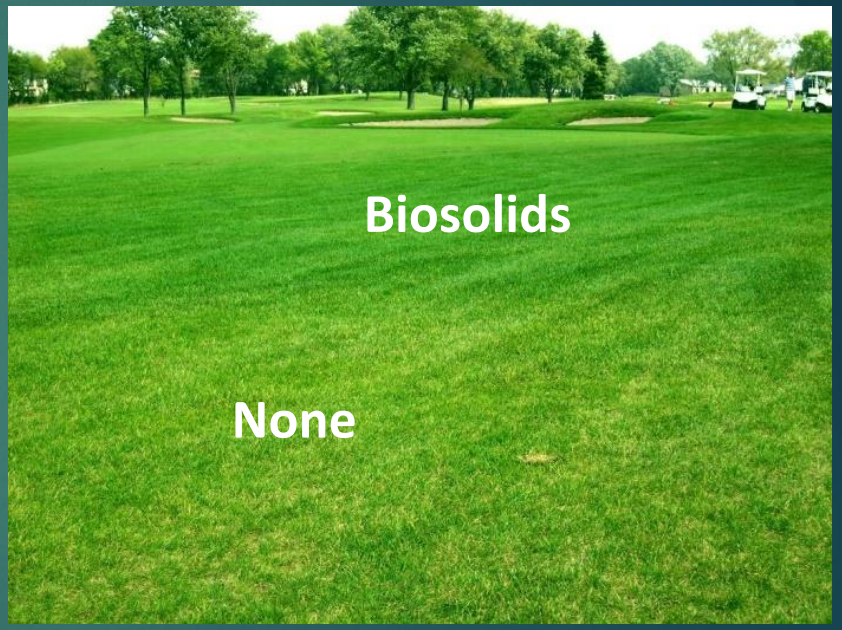
# Overview of biosolids benefits and research

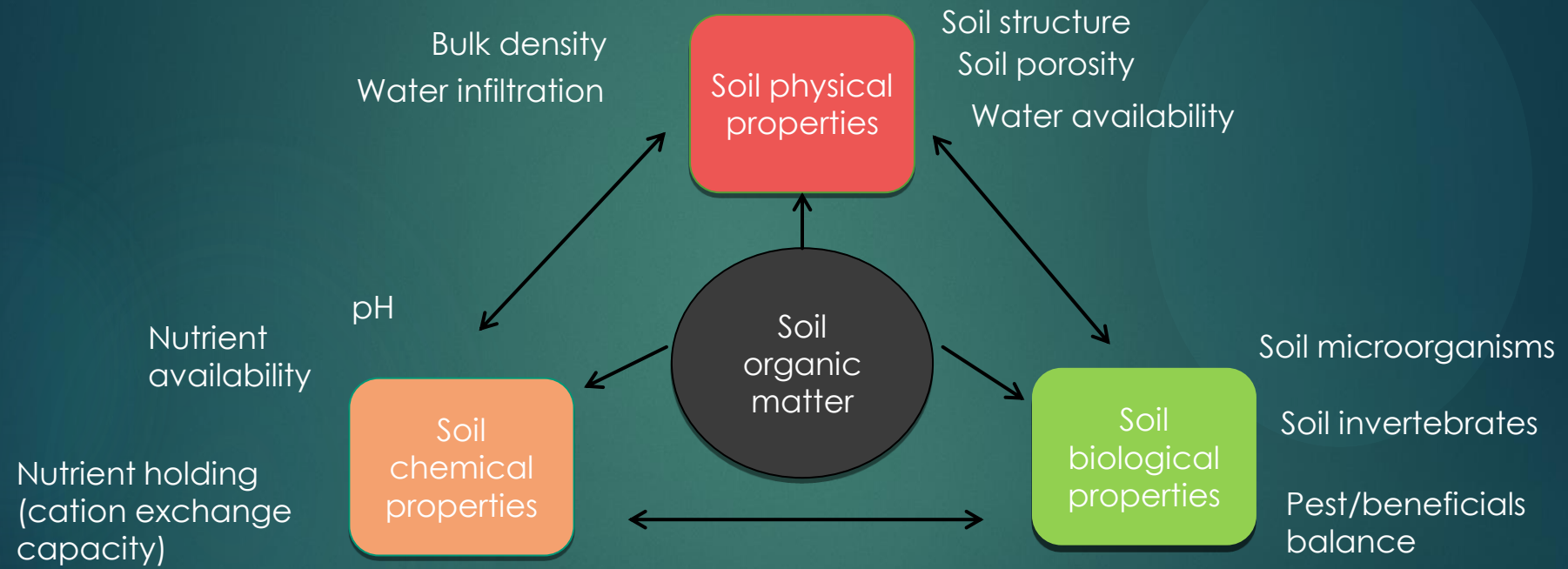
Metropolitan Water Reclamation District of Greater Chicago

- Benefits of biosolids for soil and plants
- Recent research: micronutrients in turfgrass
- Recent research in agricultural carbon sequestration
- Urban ecosystem revitalization
- Outreach and Future work

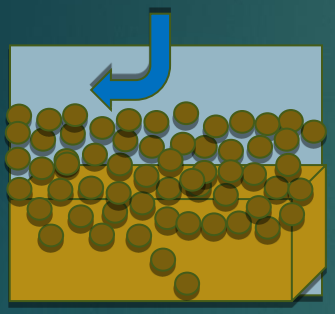



Biosolids on Turfgrass
Rough at Coyote Run Golf Course

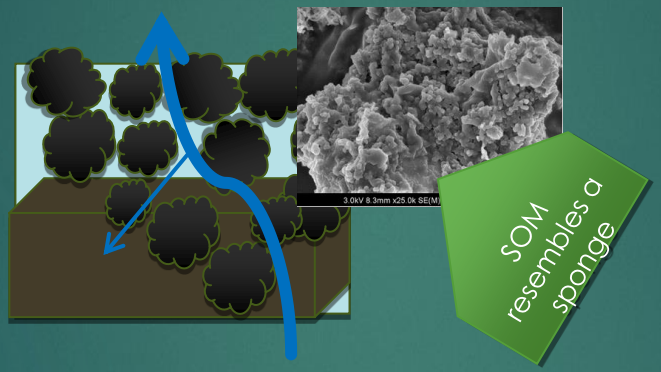
# The importance of soil organic matter (SOM) to soil quality



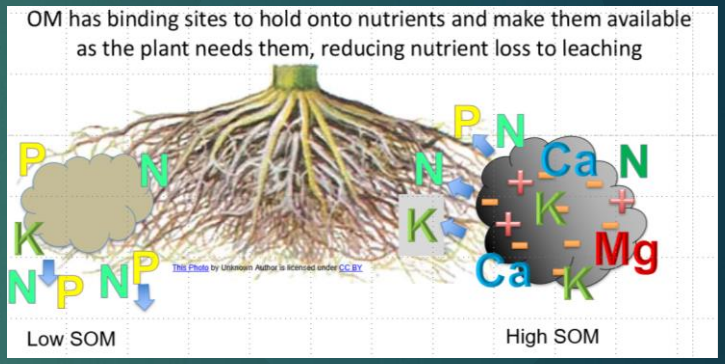
# Biosolids increasing SOM, creating high soil quality



Compacted soil with low SOM




Well structured soil with high SOM




- Soil high in organic matter has "highways" for water and nutrient movement, root growth
- SOM provides a higher capacity for nutrient retention and exchange

# Environmental benefits of biosolids for degraded urban ecosystem

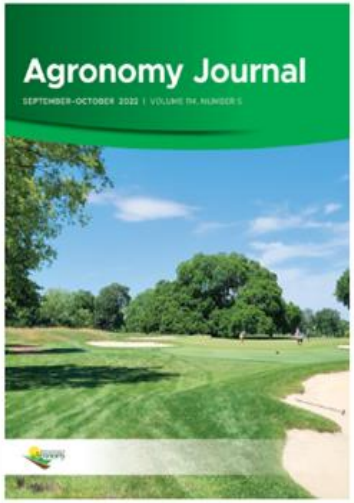
**Biosolids applications:**


Basta et al. (2015) Restoring ecosystem function in degraded urban soil using biosolids, biosolids blend, and compost. J. Environ. Qual. 45:74.

Cover Image, Volume 114, Issue 5

First Published: 30 September 2022

**On the cover**: North Shore Country Club in Glenview, IL routinely uses biosolids to improve turfgrass and soil health. In the article, "Assessment of availability of trace elements in turf soil after biosolids application" by Johnston et al., the lawn outside the clubhouse was used as a site in their micronutrient study, but biosolids are used throughout the golf course as well. Photo credit: Theresa Johnston.




Received: 5 January 2022 | Accepted: 14 June 2022

DOI: 10.1002/agj2.21155

Agronomy Journal

ARTICLE

Soil Fertility and Crop Nutrition

# Assessment of availability of trace elements in turf soil after biosolids application

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Assigned to Associate Editor Henry Qu.

**Abstract**

Soil amendments rich in organic matter and micronutrients can benefit plants by increasing the availability of micronutrients. To evaluate changes in the availability of trace elements in biosolids-amended soil, soil and plant samples were collected from six managed turfgrass locations across the Chicago metropolitan area that received air-dried biosolids topdressing at two rates: 2.2 Mg ha$^{-1}$ per application (low biosolids rate), 11 Mg ha$^{-1}$ per application (high biosolids rate), and urea 48.8 kg ha$^{-1}$ total N per application (control). The low and high rates refer to biosolids total N and plant-available N, respectively, considered for meeting the turfgrass N recommendation. Biosolids and urea application was conducted for each year of 2006–2008 with multiple applications per year. For micronutrients tested, biosolids application increased concentrations of soil-available (Mehlich-3 extraction) Zn (29.5 ± 2.9 mg kg$^{-1}$, mean ± SE) and Cu (9.0 ± 0.6 mg kg$^{-1}$) for the high rate vs. the control (10.4 ± 2.9 mg kg$^{-1}$ for Zn and 6.1 ± 0.7 mg kg$^{-1}$ for Cu). Soil-available Mn, Fe, and Mo in the biosolids treatments did not differ from the control. Application of biosolids increased turf plant Cu, Zn, Mn, and Mo concentrations for both 2007 and 2008 and Fe for 2007 vs. the control with statistical significance at the high rate of biosolids. Topdressing with a plant-available N-based application rate for biosolids increased turfgrass nutrition of micronutrients without a concern of heavy metals.

## 1 | INTRODUCTION

Biosolids, the nutrient-rich organic solids produced in the wastewater treatment process, have been used as soil amendments for a variety of crops for nearly a century (Lue-Hing et al., 1974). The use of biosolids in the turfgrass industry is strongly supported because they provide benefits including fast establishment and growth (Linde & Hepner, 2005; Voigt et al., 2014), increased soil cation exchange capacity and nutrient availability, and soil pH buffering (Stofella et al., 2014). Biosolids also improve soil water balance, as biosolids can increase both soil drainage and water holding capacity (Stofella et al., 2014). Biosolids increase microbial populations in the root zone, leading to more mineralizable N supply (Tian et al., 2008). Many turfgrass species, including Kentucky bluegrass (*Poa pratensis* L.), tall fescue (*Festuca arundinacea* Schreb.), creeping bentgrass (*Agrostis stolonifera* L.), perennial ryegrass (*Lolium perenne* L.), redtop (*A. gigantea* Roth), and creeping red fescue (*Festuca rubra* L.), have shown denser cover, darker color, stronger

**Abbreviations:** CRG, Coyote Run Golf Course; DCP, Danny Cunniff Park; KWG, Knollwood Club; LFA, Lake Forest Academy; MWG, Midwest Golf House; MWRD, Metropolitan Water Reclamation District of Greater Chicago; NSCC, North Shore Country Club.

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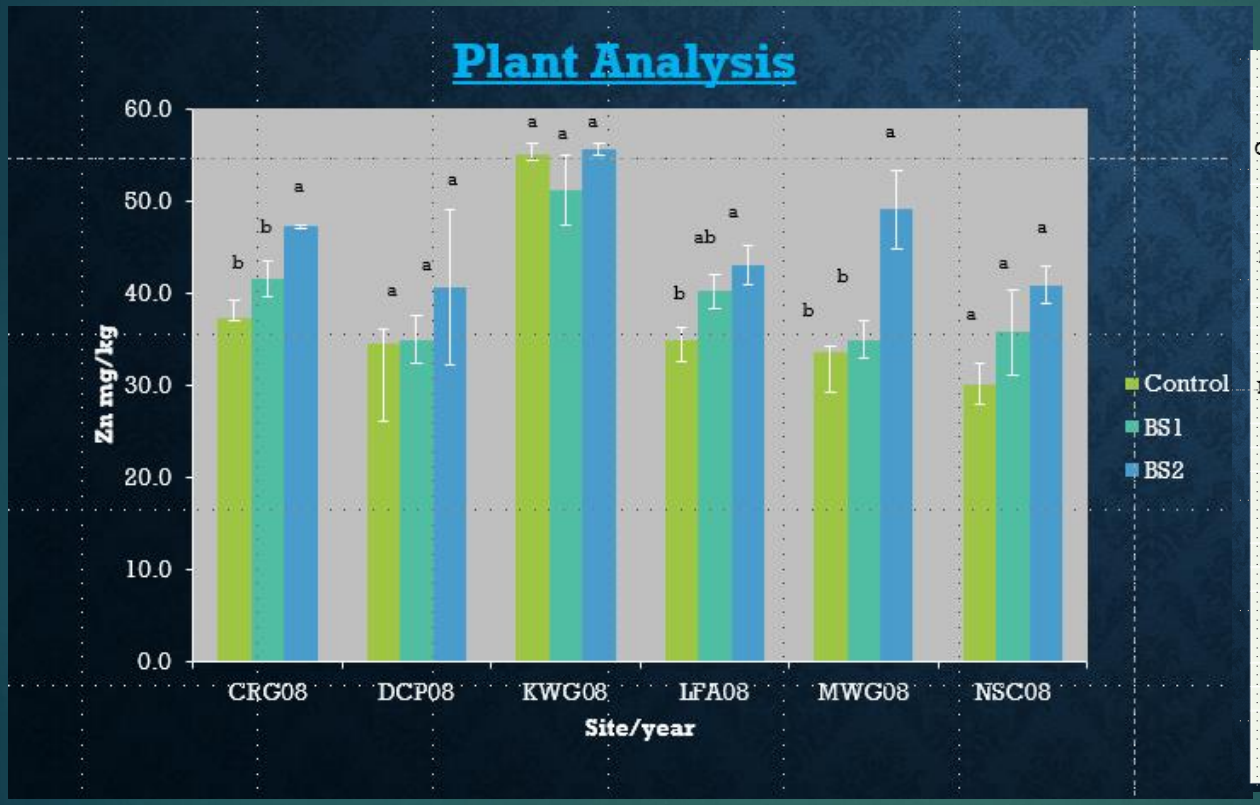
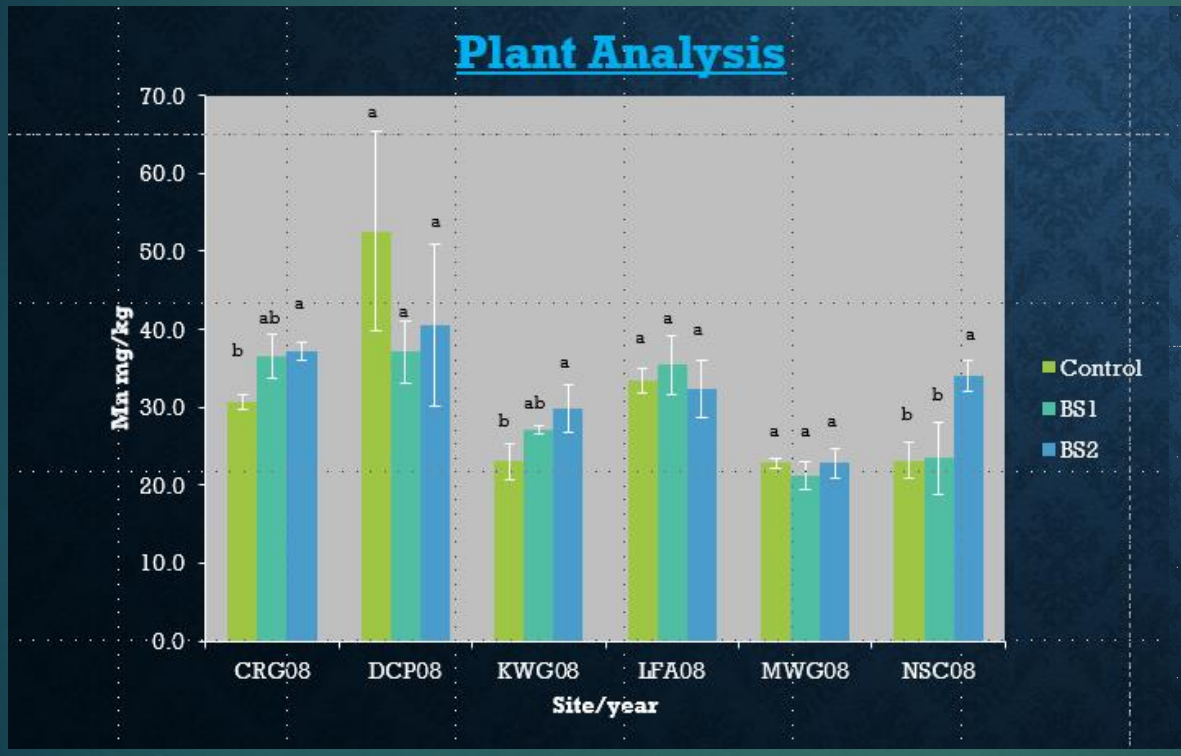
# Zinc plant tissue and soil response




Soil analysis

| Site | Meh-3 extractable concentration (mg $kg^{-1}$) | Total concentration (mg $kg^{-1}$) |
|---|---|---|
| Coyote Run GC | + | + |
| Highland Park PD | + | + |
| Knollwood GC | | |
| Lake Forest Academy | | |
| Midwest Golf House | + | + |
| Northshore Country Club | + | + |

# Manganese plant tissue and soil response



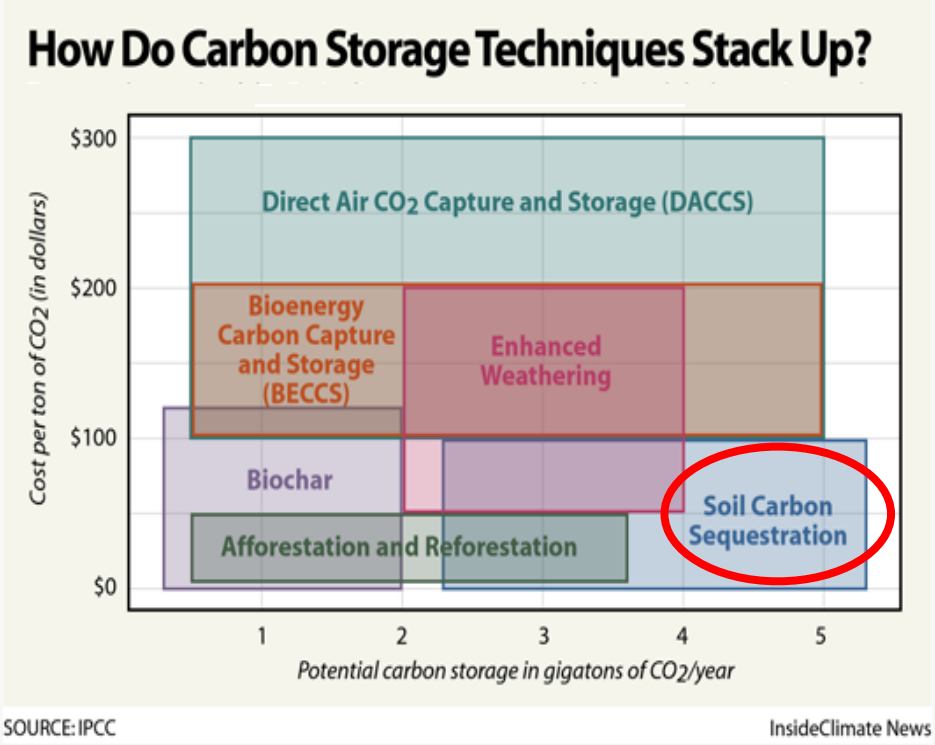

Soil analysis

| Site | Meh-3 extractable concentration (mg $kg^{-1}$) | Total concentration (mg $kg^{-1}$) |
|---|---|---|
| Coyote Run GC | | |
| Highland Park PD | | |
| Knollwood GC | | |
| Lake Forest Academy | | |
| Midwest Golf House | | |
| Northshore Country Club | | |

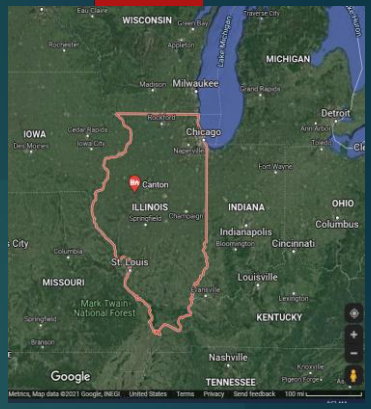
# What is the role of biosolids in resolving global problem?

# Soil is our greatest carbon storage tank

- MWRD Biosolids: 40,000 tons carbon per year, which can help this directly and indirectly.



# JumpStart of soil organic matter by biosolids towards climate-smart agriculture

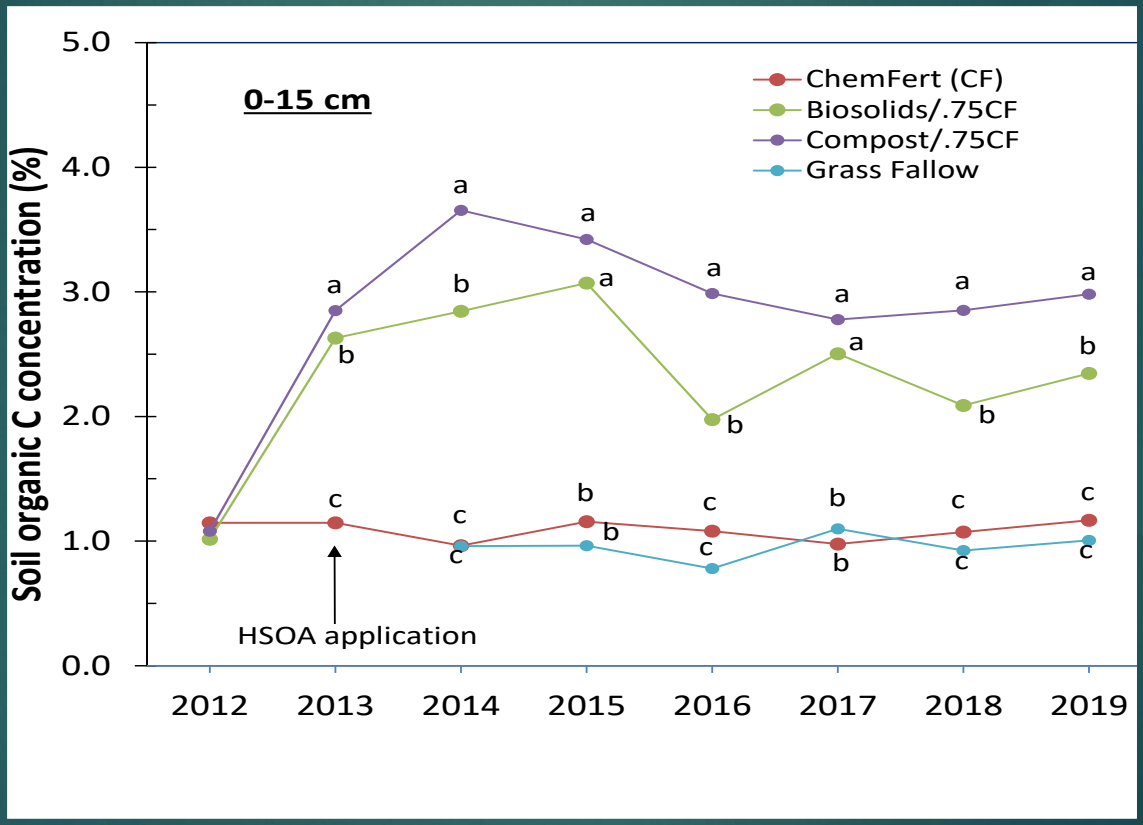



**Objective:**

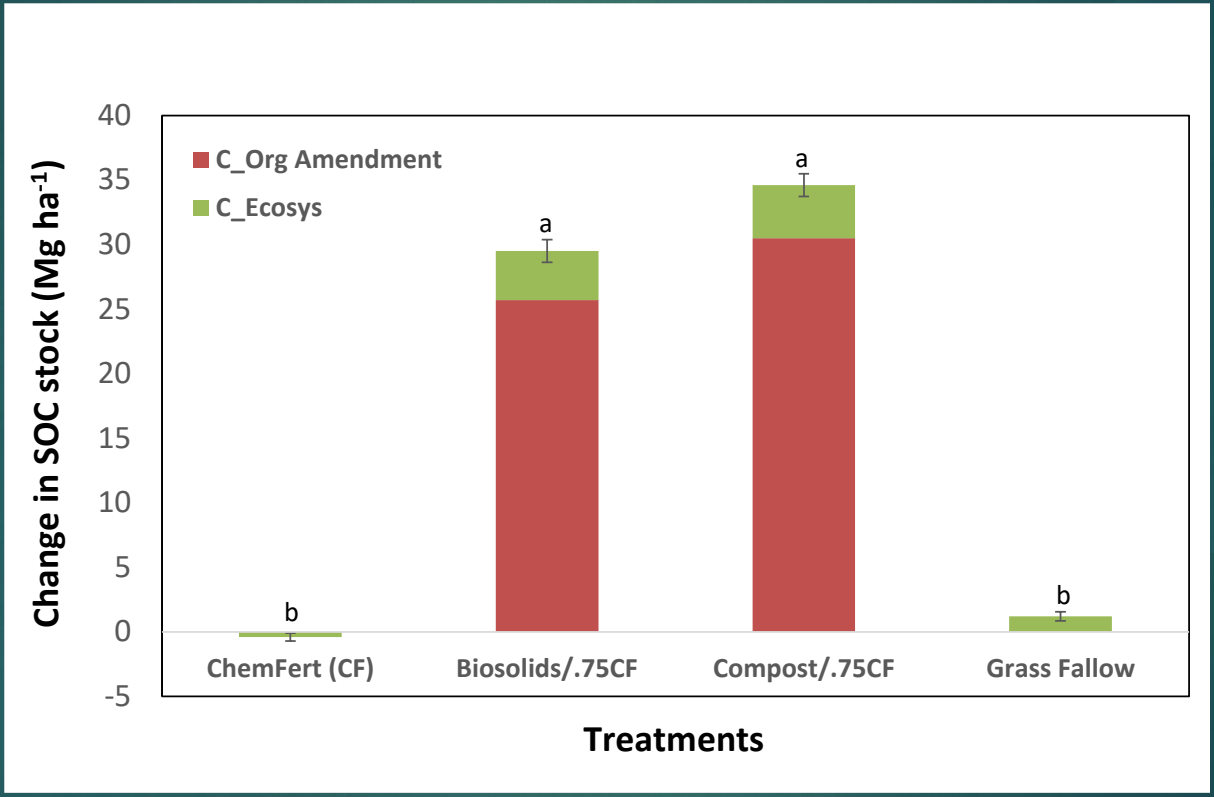
To upgrade soil organic matter of low quality soil to the level of high quality soil to improve soil health for achieving soil carbon sequestration, contributing to net zero emission goal.

**Globally, 8.5 Gt C in non-harvested plant biomass produced per year**

# Soil organic carbon dynamics after one-time application of air-dried biosolids

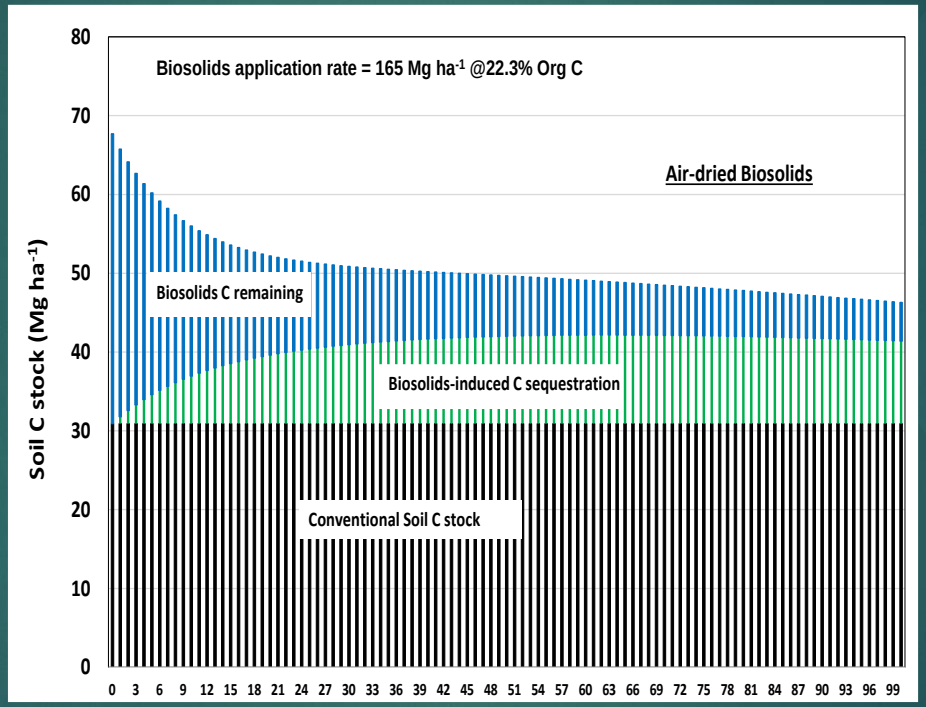


# Net soil carbon sequestration over first 5 years



# 100 years Simulation of Soil C after one-time Biosolids Application

- SOC stock in biosolids-amended soil constantly high for several decades
  - Sequestration of crop residue C
  - Long-lasting of biosolids C



# Biodiversity and habitat

United Nations biodiversity goal: …protect and restore terrestrial ecosystems…

Single application of biosolids on degraded land increase
(Gagnon, Plough, Harris, Gardner, Pypker, Fraser, 2021)

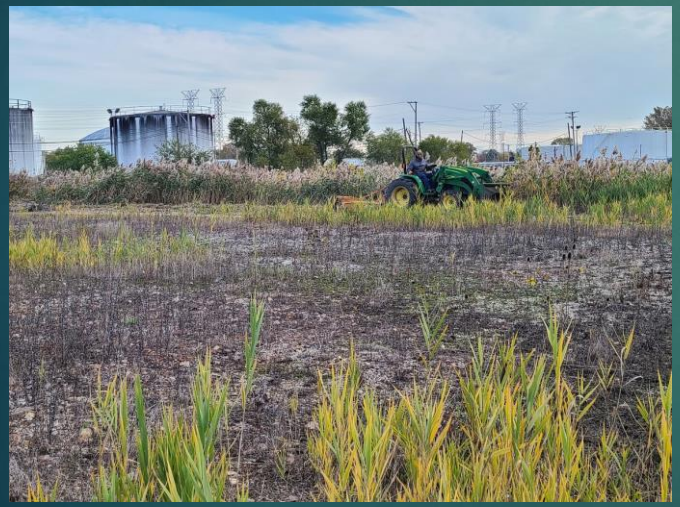
+ Species richness and evenness

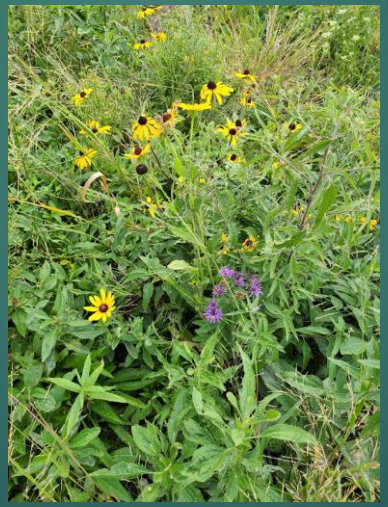
+ Plant cover

Promotes diversity and plant communities long-term

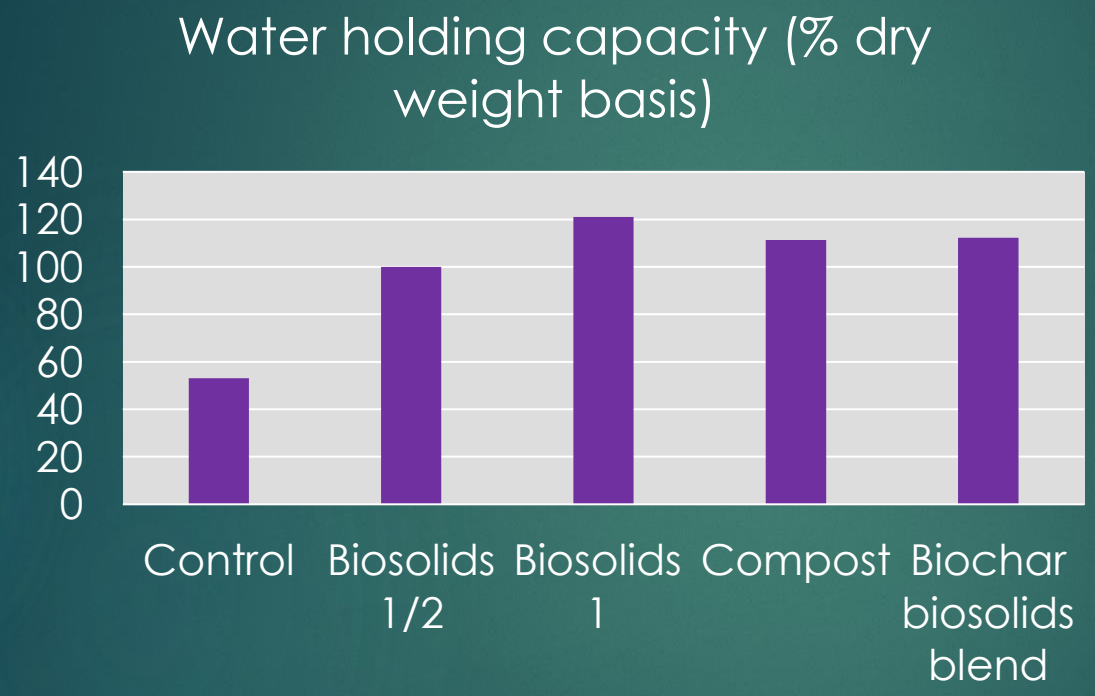
# Brownfield Research site established in 2021

- Assess impacts of biosolids on soil health (respiration, microbial biomass, and nitrogen mineralization potential).
- Assess ecosystem function (biomass, carbon sequestration, plant diversity, and microbial functional groups).
- Leverage the co-existence of biosolids amendment and native plant mix for soil remediation.

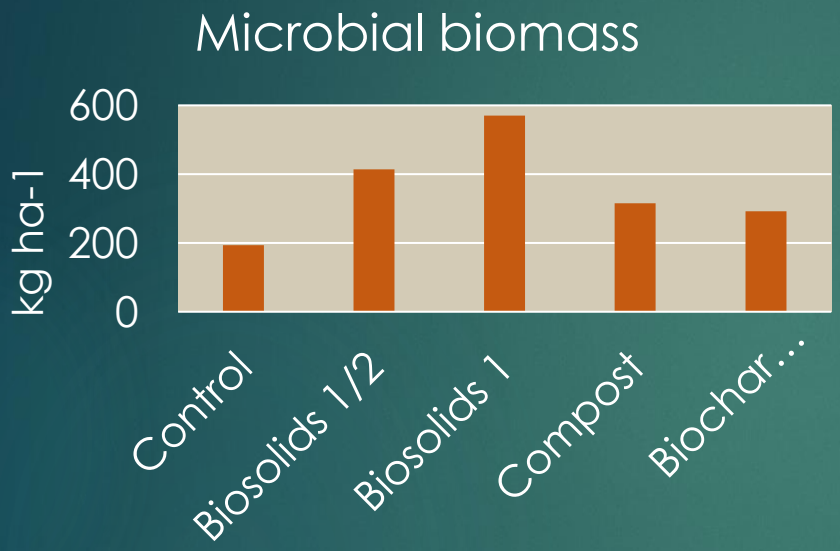


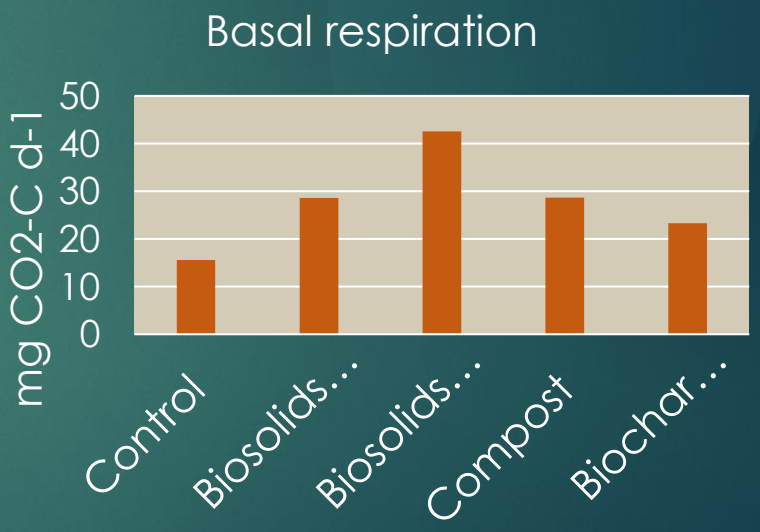


# Soil physical property




# Soil biological property



# Research informs outreach

Alsip Boat Ramp
Mary Schmidt Community Sanctuary

- Village of Alsip
- Morton Arboretum
- Chicago Region Tree Initiative
- Great Lakes Restoration Grant

# Partnerships with the MWRD

## Green Infrastructure Project Opportunity Program

- Municipal partners in Cook County

# Recently disturbed/new construction areas


# Working together with golf courses and parks

North Shore Country Club has used biosolids for decades and continues to collaborate on research

# Challenges

- The term biosolids is used… to emphasize the beneficial nature of this valuable, recyclable resource…. Also, it is important to point out that while many of the substances found in biosolids are called pollutants… many also are beneficial elements that are essential for the growth of plants and animals."
  EPA Part 503 Rule
- Challenge: biosolids are a reflection of the population
  - Trace concentrations of emerging contaminants
- optimize benefits with public support

# Summary

- Biosolids improve soil and plant through multiple effects (organic matter, macro-micronutrients).
- Biosolids improve capacity of soil to hold water for plant use.
- Biosolids help soil to achieve better ecosystem services such as carbon sequestration

"EDF and NRDF have been steadfast proponents of reusing biosolids of appropriate quality as the best biosolids management alternative. Biosolids can be a valuable natural resource…."

-FRED KRUP, *Executive Director,* Environmental Defense Fund

-JOHN ADAMS *Executive Director*, Natural Resources Defense Fund

# Future work

- Increase use of biosolids to restore ecosystems on degraded urban land.
- Establish partnerships with multi-stakeholders to produce wider impact of biosolids beneficial reuse in communities.
- Continue research on the benefits of biosolids and disseminate this information to the public through newsletter and other media.

Amending land that was previously under industrial use at the Illinois International Port District

# Current outreach/distribution strategy

- Rotational program
  - 10-20 park districts and golf courses
  - Rotating application in 3-year cycle at each site
- Large users
  - Construction projects
  - Ecosystem/brownfield restoration sites
- Stormwater management projects

Thank you!

Questions?

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