

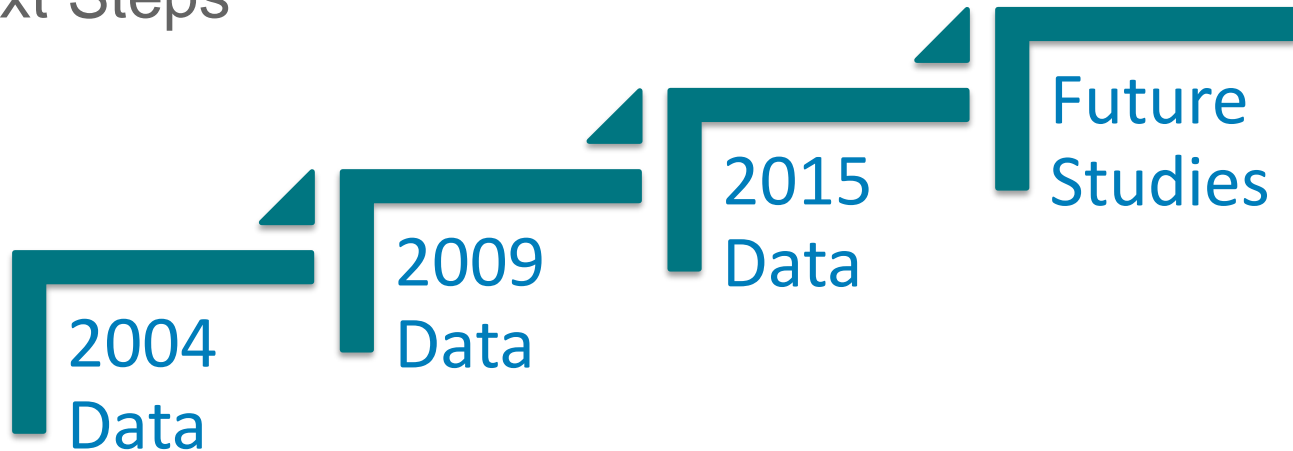
2015 CSU SOIL REPORT



March 24, 2016

Agenda

- Water Quality Discussion
- Previous CSU Studies
- 2015 Report Findings
- Next Steps



Water Quality Parameters

- Sodium (Na)
- Sodium Adsorption Ratio (SAR)
- Salinity (as measured by electrical conductivity- EC)
- Sodicity (as measured by exchangeable sodium percentage - ESP)
- pH
- Chloride (Cl)
- Boron (B)
- Nutrients (N, P, and K)

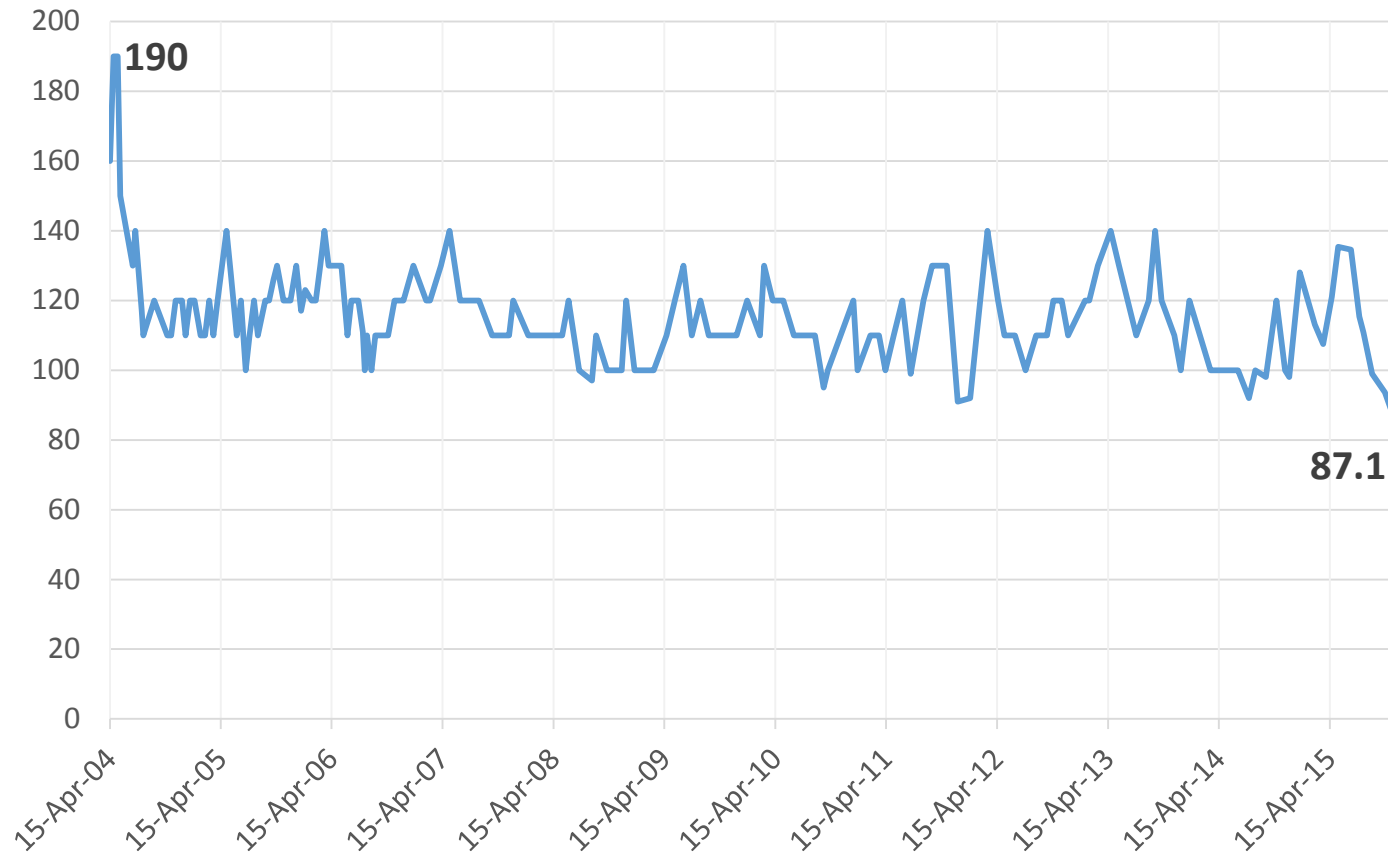
Definitions

- **Sodic Soil:** This term is used to describe excessive levels of sodium. Soil sodicity can cause degradation of the soil structure.
- **Saline Soil:** This term is used to describe excessive levels of soluble salts in the soil water. Impacts from saline soils include the decreased ability for plants to uptake water (reduced osmotic potential).

Water Quality Improvements

- Sodium has reduced from Q1 2004 (194 mg/l) to Q4 2015 (94 mg/l) in finished water.
 - Average sodium for 2015 is somewhat higher (112 mg/l), and higher yet for the irrigation season (121 mg/l) in the distribution system.
- S.W.I.M: Selective Water Ion Management
 - Currently studying the ion content and distribution patterns throughout the daily and weekly wastewater flows.

Sodium Reductions



Other Sources of Salinity

- There are many other sources of salinity both natural and anthropogenic:
 - Agricultural practices
 - Commercial and industrial activity
 - Road/ sidewalk de-icing activities
 - Water softeners
 - Household cleaning products
 - Pharmaceuticals
 - Inflow & Infiltration
 - Ground water
 - Treatment chemicals
 - Fertilizers

CSU STUDIES

2004 CSU Study

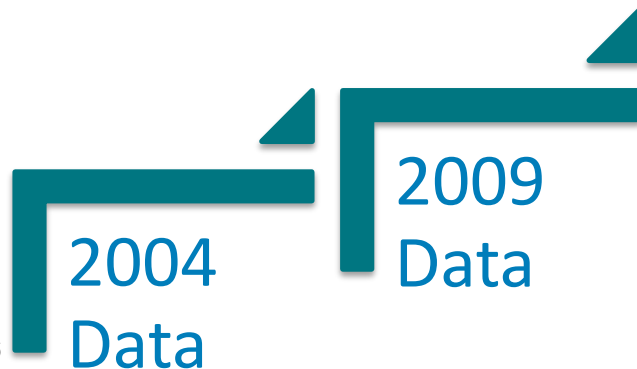
Goal: To establish soil baseline information. The information collected can be used to study changes that may occur in the soils after recycled water is used for long periods of time.

- Findings:
 - The issues surrounding recycled water are complex and further research is needed to provide more information.
 - Special attention should be made to maintenance practices at locations that utilize recycled water for irrigation.

2009 CSU Study

Goal: To evaluate changes after 5 years of irrigation with recycled water.

- Findings:
 - Soil salinity did not increase at most locations
 - Slight increase in soil pH from 2004 to 2009.
 - The average ESP and SAR, otherwise referred to as sodicity, approximately doubled over the five-year period.
 - Further studies are needed to determine if these parameters would continue to increase or stabilize.



2015 CSU Study

Goal: To evaluate changes to soil concentrations after 11 years of irrigation with recycled water.

- Findings:
 - Notably, soil sodicity (as measured by ESP and SAR) decreased at 7/10 sampling locations.
 - These decreases are most likely the result of increased rain, mitigation strategies, and improved water quality.
 - On average, soil salinity (as measured by electrical conductivity) has increased



4/20/2016

2015 CSU Study

- Findings (cont.):
 - The addition of soil amendments that contain calcium can help to reduce the amount of sodium in the soil.
 - The nutrients in recycled water can reduce or eliminate the need for fertilizer application.
 - The build-up of heavy metals at sites that utilize recycled water is not a concern.



4/20/2016

Salinity and Sodicity Levels

Parameter	Acceptable Level*	Average DW 2015 Levels
Salinity	Less than 4 dS/m	0.98 dS/m
Sodicity	Less than 12-15 %	4.43%

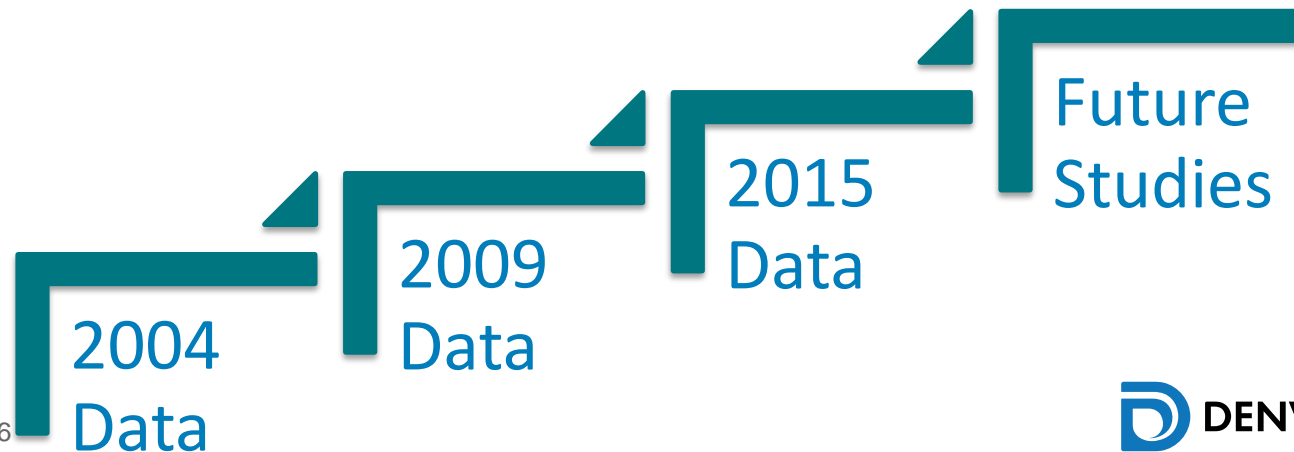
* These levels will vary based on soil type and species tolerance levels. Management is still recommended for concentrations within the acceptable level.

Recycled Water Management

- Improve Soil Conditions
- Improve Irrigation Practices
- Flushing
- Tree replacement
- Data Collection

Next Steps

- Tree Study with CSU
- Formation of an advisory workgroup
- More research



All Denver Water Research

Research Project	Consultant	Date Complete	Dollars Spent
Recycled Water for Denver Landscapes	Aqua Engineering	8/31/2004	\$14,888.75
Reclaimed Water at Select Locations in Denver, CO	Day and Associates	7/31/2010	\$17,513.75
Recycled Water Landscape Management Guidance	PRZ Sports Turf Consulting	12/3/2010	\$13,270.00
Soil Testing After 10 Years with Recycled Water	Colorado State University	1/30/2016	\$42,613.00
Soil Testing Five Years after Irrigation with Recycled Water	Colorado State University	8/1/2010	\$38,949.00
Real Time Monitoring And Management of Soil Salinity in Recycled Water Irrigated Golf Courses	Colorado State University	4/26/2010	\$22,864.00
Total			\$150,098.50

Questions