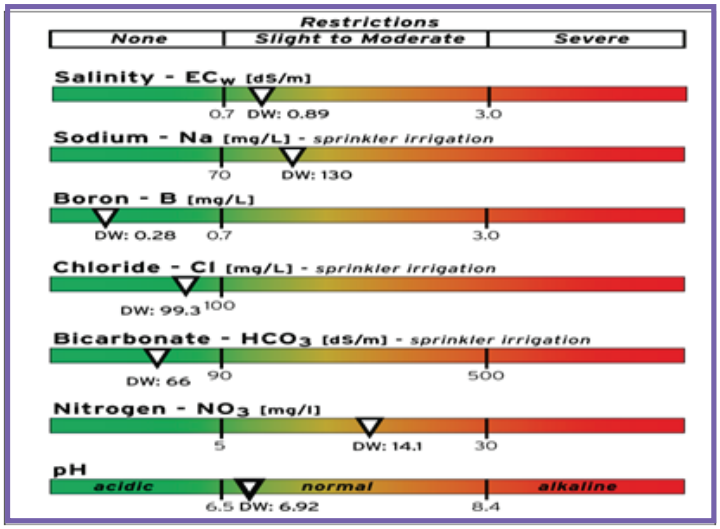
RECYCLED WATER FOR SOIL AND TREES

BACKGROUND

As part of an overall water supply strategy, Denver Water began operation of a recycled water treatment plant and distribution system in 2004. This system serves various users composed mostly of parks, golf courses and school grounds who rely on the aesthetics of their sites. Recycled water quality differs from potable water quality, so Denver Water contracted with experts to evaluate water quality, effects on soil, turf and trees and landscape management solutions.

WATER

A 2004 study evaluating Denver Water's recycled water quality showed that it is generally well suited for landscape irrigation, as indicated by the figure below. Two parameters, sodium and nitrogen, were present at levels high enough to potentially impact soil and vegetation. With that in mind, further study was performed to gauge those potential impacts and minimization strategies.



SOIL

Denver Water conducted a major soil study in which samples were collected in 2004 and 2009, before and after irrigation with recycled water, to determine the change in soil characteristics that occurred. Results are shown in the following table. The study indicated that sodium was the primary constituent that increased during the five years.

Soil Parameter	Baseline	5 years after the initiation of recycled water irrigation
Cation Exchange Capacity (meg/100g)	20.8	18.5
pH	7.26b	7.55a
SOM (%)	2.0	2.0
Electrical conductivity (EC) dS m^{-1})	0.88	0.84
Ca (mg kg^{-1})	3.0	3.1
Mg (mg kg^{-1})	1.3a	0.9b
Na (mg kg^{-1})	3.9b	6.5a
Mn (mg kg^{-1})	2.3a	1.4b
Cu (mg kg^{-1})	4.4	4.0
Zn (mg kg^{-1})	13.9	13.0
Extractable P (mg kg^{-1})	13.7	11.9
NO3-N	6.2	6.2
Boron (mg kg^{-1})	0.67	0.60
Cl (mg kg^{-1})	27.7	34.0
K (mg kg^{-1})	228b	251a
K paste	0.58b	0.86a
Exchangable sodium percentage (ESP)	2.7b	5.3a
Sodium absorption ratio	2.8b	5.3a

The mean followed by a letter "a" is significantly higher than the mean followed by a letter "b"

TREES

A study to examine the effects of recycled water on trees was conducted in 2009. Tree observations and samples were taken from a potable water irrigator and compared with those collected from recycled water irrigators. Trees at all sites exhibited symptoms such as crown dieback, foliar burn and desiccation, which are all common along the Front Range due to factors including humidity, drought conditions, temperature extremes, and elevation, making it difficult to determine the impact of recycled water. The condition of observed trees was classified as good, fair or poor. Approximately 71 percent of the trees observed at the potable water irrigator were classified as good, with overall structure, shape and color being acceptable. Recycled water sites had an average of 56 percent of trees classified as good, with a range of 20 to 86 percent. Tree tissues analysis indicated that sodium was the only constituent of concern. Data is presented in the table on the following page.

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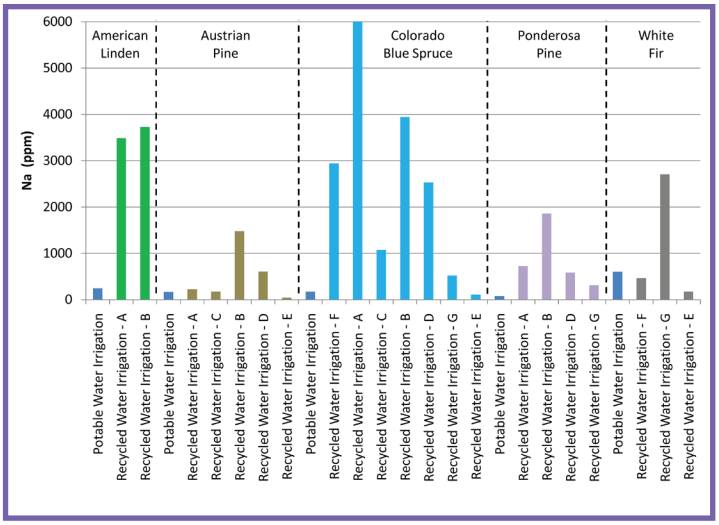
TREE TISSUE SODIUM DATA



SOLUTIONS

A study was conducted in 2010 to explore landscape management options and financial impacts of implementation for sites irrigating with recycled water. The following solutions were identified in order of increasing expense:

- Potable water flush & leach*
- Applying a sodium blocker product that ties up sodium before reaching the root zone of plants*
- Employing a "sulfur burner" as a sodium exchange system for soil rehabilitation*
- Reducing direct application of recycled water to tree tissues using low-angle irrigation nozzles or adjusting application patterns*
- Improving drainage using surface and subsurface drainage systems*

*Irrigator Operational Strategy

**Utility Operational Strategy

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SOLUTIONS, CONT'D

The following additional measures were identified in studies that did not consider financial ramifications:

- Deep core/fracturing aeration*
- Adding sand as a topsoil amendment, where possible*
- Gypsum application*
- Over-excavation/enlargement of planting hole width*
- Radial trenching*
- Using salt-tolerant species for replacement or new development*
- Reducing sodium levels in recycled water**

Potable water flushing is practiced in many places to flush sodium through root zones. A study was performed in which flushing took place on half of an irrigated facility's grounds, and then soil samples were taken from both flushed and non-flushed areas and results were compared. While flushing generally seems to reduce sodium levels, it also removes other beneficial nutrients such as potassium. Further study is being performed to assess the effectiveness of this measure.

CONCLUSION

Recycled water is used throughout Colorado and the world for a number of reasons – it lessens potable water demands, lessens impacts of water shortages, reduces waste water discharge volume, provides nutrients beneficial to irrigators and is an efficient, sustainable way to produce high-quality water.

Because of the treatment processes and source water associated with recycled water, water quality is different than potable water. While this does not present a problem for most plants and soils, additional management strategies may need to be implemented to maintain healthy landscapes. Once testing is performed to understand the site-specific water/soil/plant dynamics in play, users can implement any of a wide variety of measures to ensure that landscapes flourish while contributing to sustainable water resource management.