SALT SOURCES IN IRRIGATION WATER

Nearly all waters contain trace levels of salts, which dissolve into water as a result of mineral weathering in the earth's surface. In addition, water runoff from urban and agricultural lands during storm and irrigation events can also impact water quality. Salinity, or the presence of salts, within irrigation water can impact plant growth and soil structure. The salinity of water sources vary (Table 1) as do the influence of various trace elements that combine with salts to make up the total salinity or salt presence within your water source.

» **Storm surge related flooding could directly induce salinity problems** in land previously free of such issues via storm water runoff.

The total salinity of a water source is contributed by cations and anions. Common elements that contribute to salinity include calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), chloride (Cl^{-}), bicarbonate (HCO_3^{-}), carbonate (CO_3^{2-}), sulfate (SO_4^{2-}), and others.

NATURAL WEATHER PATTERNS

Salts are commonly found in coastal area soils and water bodies. Fluctuating tides influence fresh surface water sources and soils with shallow groundwater levels. Natural saline aquifers can also be close enough to the surface that it is very tricky to determine proper well depth. Further inland are deeper saline aquifers (commonly found out west) that are used alone, and or blended with fresher water for irrigation purposes.

Rainfall contains few salts, and is nature's way to remediate soil salt accumulation. Humid regions that are inland from the coast, receive plenty of rainfall and thus the soils do not experience any long-term salt accumulation. Arid climates, where evapotranspiration (ET) demand far exceeds rainfall, are another hot spot for salt issues. As water is lost from the soil via ET, the salts accumulate in the soil profile and near the soil surface.

Grasses that naturally grow in arid conditions or in coastal environments are adapted to living under moderate to high salt conditions. For example, bermudagrass, zoysiagrass, and buffalograss all have leaf glands that excrete excess salts.

▼ **Table 1.** Salinity values of various water sources reported for total dissolved salts in parts per thousand (ppt) and parts per million (ppm), and as electrical conductivity (EC) in uS/cm, and mS/cm.

	ppt	ppm (mg/L)	µS/cm (µmhos/cm)	mS/cm (mmhos/cm, dS/m)
Most freshwater streams	< 1	< 1000	100-2000	0.1 – 2.0
Distilled water			0.5 -3.0	0.0005 – 0.003
Water supply limit	0.5	500	782	0.782
US salt concentration limits in drinking water	1	1000	1560	1.56
Melted snow			2- 42	0.002 – 0.042
Typical limit for irrigation	2	2000	3130	3.13
Brackish: mild	1 - 5	1000 - 5000	1560 - 7810	1.56 – 7.81
Brackish: moderate	5 - 10	5000 - 10,000	7810 -15,600	7.81 – 15.6
Brackish: heavily	10 - 35	10,000 - 35,000	15,600 – 54,700	15.6 – 54.7
Sea water	> 35	> 35,000	55,000	55
Brine	> 50	> 50,000	78,100	78.1

Certain regions also experience the opposite of a salinity issue, in that some water sources do not have *enough* salts. Many inland regions of the U.S. have ground and surface water that is so low in salts that remedial actions are needed to alleviate the "salt-less" condition.

Hurricanes and extreme storm events also introduce salts into soil and aquifers. Storm surge related flooding could directly induce salinity problems in land previously free of such issues via storm water runoff. Saltwater intrusion into subsoil and groundwater aquifers can increase when storms produce differential hydrologic heads. Salt removal can occur naturally, aided by rainfall and leaching, but extended dry periods following such storm events often intensify negative salt effects on plants.

Seasonal weather patterns (dry summers) may also induce temporary salt issues. During this period, salts may accumulate in the soil profile if not properly irrigated to leach the salts. Fortunately, this is an issue only in extreme cases, due to the returning rains in fall.

ANTHROPOGENIC SOURCES OF SALTS IN IRRIGATION WATER

Groundwater drawdown by urban and agricultural water use has contributed to saltwater intrusion into the underlying aquifer. Fresh water bodies that are influenced by tides are susceptible to saltwater intrusion occurring further upstream than normal as freshwater uses increase in urban areas. When this water is used for irrigation, it contributes to the salt levels in landscaped areas.

Parameter (units)	# of samples analyzed	Range	Average
	ESSENTIAL NUTRIENTS		
Nitrate-N (ppm)	14	6.8 - 18	13.0
Ortho-P (ppm)	14	1.2 - 3.7	2.5
Potassium (ppm)	12	10.3 - 25.0	12.7
Calcium (ppm)	14	42.3 – 70.7	54.6
Magnesium (ppm)	12	3.5 – 4.0	3.8
Sulfate (ppm)	12	26 - 40	30.5
Sodium (ppm)	14	56 – 79	63.4
Chloride (ppm)	14	55.5 – 80.9	66.6
	INDICATORS AND OTHER CONSTITUENTS		
pH	12	6.9 – 7.7	7.2
TDS (ppm)	12	384 - 467	418.8
EC (mmhos cm-1)	14	0.58 -0.73	0.65
SAR	12	1.9 – 3.1	2.3
Bicarbonates (meq L-1)	14	0.01 – 1.80	1.05
Carbonates (meq L-1)	14	0 – 0.33	0.05
RSC (calculated)	12	0.00007 - .008	0.005

▲ **Table 2.** Mineral values in reclaimed water (treated effluent) used for irrigation from the Myrtle Beach Wastewater Treatment Plant.

In the future, reclaimed water (treated effluent) from municipal wastewater treatment plants may become the prevalent irrigation source for turfgrasses and landscapes. Many golf courses already use treated effluent as a primary irrigation source. Large planned communities also use treated effluent to irrigate municipal parks and sports fields, commercial areas, and residential lawns. Examples include Tradition Hilton Head in South Carolina, which uses storm water as well as treated effluent for irrigating turfgrass areas. Treated effluent from the Michelson Water Reclamation Plant in Irvine, California is used to irrigate school playfields, athletic fields, parks and other turfgrass areas. Many ball fields, school yards, and parks in St. Petersburg, FL are irrigated with reclaimed water. Many other examples exist, yet treated effluent is not the most common water source for sports fields. This is primarily due to the lack of infrastructure to pipe treated wastewater to the end user. However, as freshwater demands increase, it is likely that treated effluent will become the MVP in the irrigation game.

One of the main issues with using treated effluent for irrigation is that disinfection residuals, typically chlorinators (e.g. chlorine gas and bleach (sodium hypochlorite)) may remain in treated solution. Low concentrations of chlorine and sodium can be problematic when used to irrigate plants. Emerging water treatment techniques use less of these disinfectants; however, the newer technologies require retrofitting or installation of new infrastructure, and thus are costly and will be implemented slowly. Although treated effluent may have a higher salt content, they typically also have a higher nutrient content, which can (and should) be considered into a facility's fertility program (Table 2). For example, treated effluent from the Myrtle Beach Waste Water Plant (Table 2) will most likely supply adequate levels of phosphorus, potassium, and calcium for maintaining highly managed turfgrass.

Although limited to those areas of the country that receive snow, it is noteworthy to comment on the salts contained in storm water runoff from roads deiced during winter storm events. The most commonly used deicers applied to roads are salt. Salts lower the melting point of water, causing the snow to melt in temperatures under which it would not typically melt. If the storm water runoff from our highway systems drains into a pond used for irrigation, the salts may concentrate over the winter making the water quite salty.

What does this all mean? Knowing your water source(s) is the first step to managing salts. In the next installment of this series, we will investigate what makes salts (or the lack of) such a problem for growing plants. ■

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